Resilient Coastal Development in Belize

Resilient Reefs Urban Design Studio and Accelerator Workshop Report
RESILIENT COASTAL DEVELOPMENT IN BELIZE

RESILIENT REEFS URBAN DESIGN STUDIO AND ACCELERATOR WORKSHOP REPORT

VIRTUAL WORKSHOP | JAN 24 - 29, 2022
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With COP 26 failing to set international policy to significantly curb greenhouse gas emissions, and global landscapes in varying states of collapse, it is clear that urban design strategies need to scale to defend the living planet’s massive critical ecosystems. The Mesoamerican Reef is the largest barrier reef in the Western hemisphere. A mosaic of mangroves, beaches, lagoons, coastal wetlands, limestone valleys and hills, and seagrass beds anchor an intensively productive ecosystem that has sustained human settlements over deep time. These “blue carbon” marine ecosystems store up to four times as much carbon as forests.

Lidar maps have revealed entire societies that thrived between forests and the Reef. In northern Yucatán, “in a region known as the Puuc (pronounced “Pook”), the Maya built remarkable structures, including artificial reservoirs, more than 1,200 ovens, a handful of terraces for farming and nearly 8,000 platforms where houses were built” (see article). Sprawling ancient hybrid wetland-fields among many other future oriented typologies of renewable energy, habitation, transportation, edge design and food production are examples of systems that could be part of a future strategy to interweave human habitation and the survival of the Reef in the climate emergency.

Today, the Mesoamerican Reef provides essential coastal and marine ecosystem services, sustains key economic sectors (especially fisheries and tourism), supports the livelihoods of millions of people, and contributes to protecting coastal communities against adverse effects of climate change.

At the same time, the Caribbean coastlines of Mesoamerica [e.g., Mexico, Belize, Guatemala, and Honduras] are among the most vulnerable regions worldwide to climate impacts [Regnolds, 2019]. As Columbia’s Cynthia Rosenzweig of CCSR explains, “Coral reefs are already experiencing damage [from climate change], and they’re projected to experience significantly more damage, even at temperature rises of 1.5 and 2 degrees Celsius” above pre-industrial levels. The Belize Barrier Reef system is a UNESCO world heritage site, and it is deeply tied to onshore urbanization, culture, and livelihoods. Further, rapid development in the Mexican context is being spurred by the Tren Maya project, which is designed to stretch along the Yucatan peninsula crossing Cancun’s tourist mecca and archeological and touristic sites. While the project aspires to enact economic development, reduce poverty, mitigate carbon emissions and shift from private cars to public transportation, it has also spurred land speculation surrounding the stops on its path. The rapid urbanization pressures that the train will bring also pose a threat to the natural capital of the peninsula of Yucatán due to accelerated and unplanned urban growth along with touristic development in the coastal region.

A “business as usual” approach will accelerate reef loss, endanger the entire reef ecosystem, and increase the risk for shoreline communities.

The time to act is now - in anticipation of demographic pressures, urban expansion and climate change effects along the coast of Belize and Yucatan peninsula.
Rapid development along Belize's coast and climate change is reshaping the coastline, land- and seas- scapes, and communities. It presents both challenge and opportunity for local communities and livelihoods, the region, and for the Belize Barrier Reef System. To clarify these challenges with stakeholders, align on possible strategies for improving outcomes at multiple scales, and visualize possible future scenarios the Resilient Reefs Initiative, the Coastal Zone Management Authority & Institute, Belize Fisheries Department, and Ministry for Blue Economy & Civil Aviation are partnering with the Center for Resilient Cities and Landscapes (CRCL) and Graduate School of Architecture, Planning, and Preservation (GSAPP) at Columbia University in the City of New York (together, referred to as "the Team") to deliver a Water Urbanisms Urban Design Studio and Accelerator Workshop.

The effort was anchored by a week-long virtual workshop which convened local partners, stakeholders, and interdisciplinary academics in order to ground the partnership in mutual learning and understanding of local policy and action. The workshop and subsequent Studio will explore and co-design a set of design principles, place-specific research, and conceptual design sketches that test those principles with students and faculty from the University of Belize, local stakeholders, subject-matter experts, and public agencies. Research and visualized design development scenarios prepared in the Studio will inspire the ongoing planning and engagement work of the Resilience Strategy, Coastal Zone Management Plan Update, and Ministry for the Blue Economy Strategy.
RESILIENCE ACCELERATOR WORKSHOP

The Resilience Accelerator (the Accelerator) is a program of the Center for Resilient Cities and Landscapes (CRCL) at Columbia University that supports partners responsible for the implementation of priority resilience projects. The Accelerator works with an expanded network of partners to strengthen the biophysical, drive social and climate justice, build institutional capacity, and expand equitable economic outcomes of projects. The program aims to generate investment opportunities, deepen relationships between project teams, and advance implementation concepts. The research, planning, and design expertise at Columbia when matched with local knowledge and relationships of partners, advances pre-design work of high priority projects using three key methods:

- Delivering synthetic research, analyses, visualization of issues, and design in support of project and concept development
- Facilitating immersive workshops that bring together multi-disciplinary teams to advance strategy, project design, and implementation
- Convening the perspective of international and place-based thought leaders, designers, and technical experts chosen for their ability to facilitate and advise on topical subject matter

Since the launch of the program in Spring 2018, the Resilience Accelerator has identified 13 projects across eight cities worldwide, two of which are in partnership with the Great Barrier Reef Foundation’s Resilient Reefs Initiative advancing action in UNESCO World Heritage Marine Sites.

The Accelerator Workshop was the anchor methodology to kick off the Urban Design Studio and convene local stakeholders with critical perspectives around Coastal Development in Belize and the Yucatan.

The goal of this urban design studio is to understand how marine & fisheries restoration, climate mitigation, and local jobs & prosperity can combine across the system in different sites and scales. In the Belize context, innovative coastal zoning, land-use standards, housing typologies, new management and resilience concepts have created ground for alternative forms of water driven development patterns.

By workshoping and testing the implementation of water sensitive coastal zoning proposed by the Belize Coastal Zone Management Plan in a range of sites and systems through iterative spatial design, coastal transects will explore upland tropical forest protection measures to new urban design imperatives, sustainable fisheries management to innovative green infrastructure finance models and reef restoration. Students and faculty will work together to devise alternative futures for eleven transects from forest to roof to reef that address pressures of housing, livelihoods, transportation, and social justice issues.

The GSAPP Urban Design Studio investigates the process of urbanization in a global context, examining sites facing substantive structural and social change. The studio is organized with the intensive participation of local partners, from city governments and planning departments, to humanitarian groups, local universities and community groups. The Studio produces exhibitions and public events with project partners and, as the final studio in the Urban Design sequence, students organize a publication documenting process, partnership findings and design proposals.

This Resilient Coastal Development in Belize studio will explore positive, regenerative “ridge to roof to reef” visions for key towns, cities and farms along the coast by focusing on green-blue infrastructure, eco-tourism, ocean-based renewable energy including wind and tidal, new housing and urban typologies, coastal design & zoning and regenerative agriculture.

The Studio will help advance shared work driven by the Resilient Reefs Initiative and Belize Resilience Strategy through co-creation of design principles across academia, government, philanthropic, NGO, and local stakeholders. By spatializing and visualizing alternative urban design futures that are grounded in local perspective, climate adaptation strategies prepared in the Studio can be a platform for deeper and more integrated engagement, action planning, and buy-in from multi-sectoral stakeholders.
To kick-off a semester-long Urban Design Studio, the Team delivered a 5-day virtual workshop with local stakeholders and partners, faculty and students from the University of Belize, and students and faculty from Columbia University. Each day was organized by thematic topic and included lectures by experts, scholars, and public servants; a set of stakeholder breakout sessions to surface key issues, opportunities, and local insights; and intensive student exchanges to advance research and design topics.

This learning culminated in final presentations developed collaboratively by GSAPP and UB students and delivered to stakeholders, invited guests, and faculty. Students presented multi-scaler and multi-disciplinary perspectives as related to a set of 11 sites, “what if” statements that capture opportunities for adaptation futures, and design principles that advance the core objectives of the Resilience Strategy and ongoing planning efforts in Belize. This workshop and resulting presentations are intended to be a starting point for the remainder of the Studio. The findings synthesized in this report are intended to both document these discussions for use by local partners as well as the Studio.

**WORKSHOP OBJECTIVES**

- Develop problem statements that capture the relationships, pressures, and opportunities related to coastal development, the Belize Barrier Reef System, and community livelihoods at the scale of the coastal system and (11) identified transect areas
- Articulate a set of design and planning principles to guide future design and planning in the context of the CZMAI update, Resilience Strategy, and MBE strategy to ground student design concepts for each transect
- Convene local stakeholders, students, faculty, and scholars to uncover opportunities and ground problem statements and relationships across academic disciplines and institutions, public agencies, and local stakeholders

**WORKSHOP AGENDA**

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WORKSHOP SITE SELECTION

**CHETUMAL**
Chetumal-Corazol
- Natural border of Rio Hondo
- Influence of Tren Maya development and transboundary impacts
- Problematic waste disposal
- Interconnected relationships of watershed, lagoon, and bay

**AMBERGRIS CAYE**
Ambergris Caye North
- Recent and recurring intensive resort development
- Patterns of dredging, cut and pile, land reclamation for development
- Discussion around transnational linkages to Tren Maya in Mexico and new San Pedro road
- Adjacent natural ponds and lagoons that have passed a tipping point for filtering and naturally treating water

**SAN PEDRO**
Town Core
Mahogany Bay
- Adjacent natural ponds and lagoons that have passed a tipping point for filtering and naturally treating water
- Recent and recurring intensive resort developments
- Patterns of dredging, cut and pile, land reclamation for development
- Presence of solid waste dumping in San Pedro
- Discussion around transnational linkages to Tren Maya in Mexico and new San Pedro road

**CAYE CAULKER**
Mangrove Reserve
Urban Center
Marine Protected Area
- Intensive solid waste dumping
- Existing IDB coastline stabilization study
- Recurring patterns of de-reserving protected mangroves for development
- Pursuit of wastewater storage funding by residents
- Dense, at capacity, development in Town Center, while less developed near the Marine Protected Area

**BELIZE CITY**
Ladyville
Belize City
- Rapid unplanned developed between Ladyville and Belize
- Presence of international airport
- Presence of shrimp farms in north
- Planned bridge at the mouth of the Belize River
- Planned solid waste disposal site

**PLACENCIA**
Mango Creek
Seine Bight
- New plan for tourism port
- Prevalence of aquaculture
- 3-4 distinct communities on the peninsula
- Planned wastewater treatment plant
- Varied development between Placencia (dense development) and Seine Bight (less developed)
At the start of each workshop day, presentations on key topics were given by local stakeholders, subject matter experts, and public agencies, with each day categorized into a thematic area.

These lectures provided students with the context and perspectives required to inform design and planning work as well as offered convening opportunities for local stakeholders.
PLANNING, NATURAL AND CULTURAL LANDSCAPE

RESILIENT REEFS INITIATIVE
Amy Armstrong, Program Director, Great Barrier Reef Foundation

Amy Armstrong presented an overview of the Resilient Reefs Initiative including its history, goals, partners and delivery approach. With the goal of dismantling barriers to managing for reef resilience, the initiative focuses on: 1) building capacity of reef managers, 2) empowering and equipping local communities to take action, 3) implementing solutions that have measurable impact on reefs and reef communities, and 4) fostering a global network of reef resilience leaders.

“Protecting and building more resilient coral reefs is of course an environmental issue. It’s also very much a humanitarian and development issue.”

RESOURCES
- Resilient Reefs Fact Sheet
- Reef Resilience Framework
- Protecting green turtles in New Caledonia
- Deloitte: Economic contribution of Ningaloo

BUILDING RESILIENCE IN BELIZE
Kalene Eck, Belize Chief Resilience Officer, CZMAI

Kalene Eck presented on the Resilient Reef’s Resilience Strategy development process, advancing a bold vision for implementing local short- and long-term solutions that directly address the Belize Barrier Reef and reef community’s vulnerabilities. A core part of this process is a Resilience Assessment, which includes direct engagement with eight Belizean NGOs and 11 local communities with a total of 150 participants.

Key findings of the Resilience Assessment were categorized into three framework dimensions: Ecosystem, Community and Governance. Three future opportunities: 1) Waste management; 2) Harnessing community support of management; 3) Balancing MPAs and commercial use.

“Reef Resilience: Where are we, where we want to be, and how are we going to get there?”

RESOURCES
- A full list of all nine coastal zone management plans
- The plan development process: Integrated Management in Coastal Belize
- InVEST Scenarios Case Study: Coastal Belize

SOCIAL, CULTURAL AND HERITAGE LANDSCAPES
Nigel Encalada, Sustainable Heritage Consulting

Nigel Encalada provided an overview of the policy and legal framework for the administration of Belize’s culture sector and explains its link to Belize’s potential for development. It also introduces a few macro-observations on issues concerning Belize’s cultural communities and will explain why these should be considered when pursuing any development agenda.

“Culture is the sum total of ways in which a society preserves, identifies, organizes, sustains, and expresses itself.”

RESOURCES
- Natural Heritage, Natural Wealth
- InVEST Scenarios Case Study: Coastal Belize

COASTAL ZONE MANAGEMENT PLAN UPDATE
Samir Rosado, Coastal Planner, CZMAI

Samir Rosado joined on Monday to discuss the development of Belize’s Integrated Coastal Zone Management Plan: a framework to facilitate improved management of coastal and marine ecosystems while ensuring the delivery of ecosystem service benefits. Coastal advisory committees and the general public were included in an iterative design process of nine planning regions and of three potential scenarios for coastal zone management: conservation based management, development based management and informed management which acts as a middle ground between the first two scenarios. Using the InVEST tool to inform the mapping of different use zones, the CZMAI then took results back to community stakeholders to determine whether these zones met the needs of those groups. Once an agreement was reached, the CZMAI finalized the coastal zone management plans for each distinct region as well as included frameworks for implementation.

“Not a blueprint for conservation but for sustainability”

RESOURCES
- Valuing Natural Capital of a Future Climate: Landscape, The Reef, Economy, Society
- Nadia Bood, Senior Program Officer, Marine Science & Climate Change at World Wildlife Fund Mesoamerica

Nadia Bood discussed the Smart Coasts Project, a climate adaptation project aimed to answer the following three questions: 1) What benefits were people receiving from nature throughout the region? 2) How might climate change affect these ecosystem services? 3) Where should there be investment in adaptation strategies? Utilizing InVEST modeling software and community stakeholder workshops, the project identified areas in Belize where certain climate change adaptation strategies such as mangrove restoration or coral reef protection would generate the greatest return to communities in terms of ecosystem services.

“We are economically dependent on our coastal ecosystems and the services they provide: magnifying the impending vulnerabilities they face due to climate change”

RESOURCES
- Natural Heritage, Natural Wealth
- InVEST Scenarios Case Study: Coastal Belize
Manishka De Mel discussed her work at the Center for Climate Systems Research (CCSR) at Columbia University, a collaborative entity for the working relationship between NASA and Columbia University. She leads the CCSR Climate Impacts Group portfolio of Conservation and Development sector projects, collaborating with a range of partners including World Wildlife Fund, United Nations Development Programme and Wildlife Conservation Society. Her work centers on using climate risk information to inform adaptation planning and implementation. With this expertise she contributed to WWF’s Smart Coasts Project to generate climate risk information and guide the application of such information in the Mesoamerican Reef region.

“...mitigation is critical, because if you mitigate, then you can prevent.”

RESOURCES
• DRAFT: Assessing Climate Risk in Mesoamerica

Professor Josué Aké gave an overview of water quality management in Belize. He highlighted the importance of water quality in watersheds for rural water governance. He introduced the concept of utilizing watersheds as a management unit, reinforcing the need for a ridge to reef approach. Envisioning the way forward, professor Aké voiced a need for improved water quality, communication and data sharing, and capacity building efforts.

“...There is only this river that separates our two countries...my suggestion is that we establish a technical working group so that any projects regarding the Rio Hondo watershed can be accomplished...”

RESOURCES
• Healthy Reefs Map

Belize’s fishing sector contributes significantly to the nation’s socio-economic well being as an employer of over 2,500 and supporter of food security. The industry has traditionally included fisheries such as lobster, conch, sharks and sea cucumbers. Ms Cruz provided background information on mariculture developments in Belize, including policy and regulatory considerations, best management practices for seaweed cultivation and mariculture planning and design. Seaweed was largely focused on as it improves local water quality, absorbs carbon dioxide, and provides additional economic opportunities for Belizeans.

“(The) fishing industry contributed to socio-economic wellbeing in terms of employment, foreign exchange earnings, nutrition, and food security.”

RESOURCES
• Healthy Reefs Map

Established in 1987 as Belize’s first marine reserve, Hol Chan Marine Reserve protects diverse ecosystems within the Ambergris Caye and Caye Caulker region. The protected area is defined as multi-use, meaning that fishing and tourism activities are permitted in the area, but are regulated by zones to balance ecosystem health and economic livelihoods. As the most visited Marine Protected Area in Belize, the reserve faces multiple challenges including the loss of ranger staff, revenue loss due to COVID-19, coastal development, population growth and illegal fishing.

“It wasn’t management going and saying ‘we have to protect this area’, it was the local community coming to the management and saying ‘we need assistance to address certain issues.”
Monica Ortiz discussed Mexico’s plan for a new train system in the southeast of the country, Tren Maya. 1,554km in distance and equipped with 21 stations and 42 trains, Tren Maya will act as both a passenger and cargo train to connect areas of the region that previously were isolated in which people found it very difficult to commute to nearby urban centers. The train will be both electric and diesel powered depending on the location of the tracks, and is estimated to increase the population of the area from 15.1 million to 17.3 million. In the context of Belize, Tren Maya’s stops in Bacalar and the Chetumal Airport will likely bring more people and tourists to the border region of Mexico and Belize.

“Regions become richer and more prosperous with good connectivity infrastructure”

RESOURCES
- All Tren Maya Official Documents (Spanish)

ENERGY TRANSITION AND OFFSHORE EXTRACTION
Ryan Cobb, Belize Energy Unit

Ryan Cobb presented an overview of Belize’s current energy sector alongside a look into what energy may look like in future Belize. With a 92% accessibility rate, the majority of Belizeans have access to Belize’s electricity share which can be broken down into the following categories: 51% renewable energy share, 43% imported electricity share from Mexico (largely oil and gas), and 6% fossil fuel. Looking to the future, Belize is invested in energy security, not energy independence, as they don’t want to impose price increases on the public or compromise development. With this in mind, Belize has a current renewable energy goal of 75% and is exploring the following to reach this goal: rooftop solar, increasing efficiency in the public transit sector through electrifying the bus system, fuel quality standards, used vehicle regulation and alternative fuel blends.

“Energy has so many permeating effects, being that it creates jobs, it does economic transformation, [and] improves lives specifically within rural communities.”

RESOURCES
- Belize Ministry of Energy & Public Utilities Sustainable Energy Roadmap 2021-2040

WASTEWATER AND DEVELOPMENT IMPACTS
Jose ‘Pepe’ Garcia, Environmental Engineer Consultant

‘Pepe’ Garcia’s presentation illuminated the water quality issues still plaguing Belize today. Although Belize has appropriate legislation aimed to tackle wastewater and pollution management, the enforcement of these laws, according to Mr. Garcia, is very lacking. He documented this through photos that showed the impact of improper waste disposal on local environments that stemmed from a variety of activities including the burning of plastic pollution and other garbage, the release of effluent from large scale developments into waterways, sedimentation and chemical pollution from agriculture and mariculture, and adverse downstream impacts from hydroelectric dams. While sophisticated wastewater treatment centers do exist in Belize, Mr. Garcia advocates for potable water providers to also provide sewage and wastewater treatment. He also called for increased monitoring of local waters, as data regarding marine and water pollution is lacking.

“I refuse to swim in Placencia, I refuse to swim in Caye Caulker, and I refuse to swim in San Pedro”

“...let me tell you...we do not enforce our laws!”
The Ministry of Blue Economy and Civil Aviation has a strong vision: by the year 2030 Belize has a productive, resilient and vibrant blue economy that contributes to sustainability and to the socioeconomic well being of the country and its people. Established in 2020, the ministry has already developed many projects and programs aimed to increase GDP while protecting local environments. Importantly, the Ministry of Blue Economy played a key role in Belize’s Blue Bond, a debt restructuring aimed to dedicate funds towards marine protection and conservation. The creation of a Blue Economy Strategy and Plan is in its final phase of development, and will be a blueprint for continuous work.

**“We have a lot of other projects in the pipeline...and we have interest from several other organizations such as the World Bank”**

The Belize Conservation Fund was born out of the Blue Bond debt restructuring deal. This fund is split into three distinct uses: 1) Grants, 2) Government spending on conservation, 3) Overhead costs. Stakeholder engagement has been an important step in ensuring grant funding will go to projects that best represent the needs and wants of Belizean people. The $8 million dedicated towards the Conservation Fund will be managed by a board of nine representatives, four of which are tied to the government, five of which are not - all voted for by local stakeholders. Current progress indicates that the first round of funding will be available for applications in the fourth quarter of 2022.

**“The mission is to increase GDP through a thriving blue economy development pathway that is harmonized, innovative and socially just, supported by a robust science based management regime.”**

**FUNDING AND FINANCING FOR REEF HEALTH AND COMMUNITIES**

Angeline Valentine, MarFund

Established in 2004, MarFund drives regional funding and partnerships for the conservation, restoration and sustainable use of the Mesoamerican Reef. MarFund has five distinct programs: 1) Saving our protected areas, 2) Fishing for the future, 3) Climate change, 4) Clean water for the reef, and 5) Belize marine fund. Ms. Valentine highlighted the economic importance of the Mesoamerican Reef system, stating that the current value of the reef is estimated to be $4.5 billion per year. In hopes of contributing to a healthier reef environment, MarFund has begun looking into private investment and blended finance models to bring more substantial funding into a historically underfunded environment.

“If the MAR continues to decline, by 2030 the per annum value of the system could fall by $3.1 billion. Conversely, a shift towards healthy reefs by 2030 could unlock an additional $2.5 billion annually across the three sectors.”

**RESOURCES**

- Belize Blue Bond Press Release
- Belize Marine Fund Investment Strategy

**FROM THE WATERSHED TO THE REEF**

Liliana Garcia, Amigos de Sian Ka’an

Amigos de Sian Ka’an is a non-profit organization dedicated to conservation and sustainable development in the Yucatan Peninsula in the Mexican Caribbean region. The work carried out by the organization is grounded in scientific research and is practiced in collaboration with local communities and experts, all in the aim of promoting public policies that support people and the planet. When it comes to reef health, Amigos de Sian Ka’an takes a ridge to reef approach, acknowledging the water cycle as complex and holistic: what impacts water in high mountain areas will impact reef environments eventually. With this in mind they have promoted community governance for water management to reduce pollution at the watershed level and diversify economic activities.

“...the participation of different stakeholders along the watershed, especially local actors, is fundamental in all phases of the project...”
Supersudaca has closely followed the developments and impacts of mass tourism in the Caribbean, taking into account historical and political trends, market mechanism, branding, geography, urban planning, and typology. Research is conducted through several scales, from the food tourists eat to the way the Caribbean region has been used as a testing ground for cruise tourism and all-inclusive resorts. Case studies for both modes of mass tourism explore the implications and paradoxes of the so-called industry without chimneys.

"Resorts create an illusion of diversity. They are exclusive closed economies that keep locals out"

Caroline Oliver provided an overview of tourism in Belize, highlighting the importance the industry has on sustaining local livelihoods, a benefit that drastically decreased in the wake of the COVID-19 pandemic. She discussed the importance of reducing leakages in the tourism industry chain, often present in foreign-owned businesses such as cruise lines. She encouraged striking a balance between resource protection, ecosystem service health and promotion of livelihoods through tourism. Importantly, increasing local benefits through direct bookings, locally sourced supplies, and the hiring of women.

"Tourism in Belize is based on natural resources and protected areas and by managing those resources, the ecosystem and tourism will benefit"

"There is loss of income to outside economies...especially common in Foreign owned enterprises. There is also a loss in authenticity, causing commodification"

During the weeklong workshop, students from Columbia University and University of Belize were grouped into teams, each exploring major themes in Belize as they relate to six specific locations: The Chetumal/Corozal border region, Ambergris Caye, San Pedro, Caye Caulker, Belize City and Placencia.

After local expert presentations in the morning, student teams and local stakeholders broke out into their respective groups, engaging in facilitated discussion activities to promote place specific learning. Below are key takeaways from each group as it relates to these discussion sessions, intended to surface key issues and develop "What if" statements to guide the subsequent work of the student teams and inspire future planning in Belize.
The Tren Maya project could impact local communities
Lack of investment in resource monitoring to determine the state of coastal and marine ecosystems
Lack of transparency regarding available financial mechanisms for projects
Densifying urban zones or increasing efficiency in urban areas that exist
Diversifying economic reliance on tourism could mitigate negative impacts on ecosystems and livelihoods
Involving local communities is paramount in decision making
A proposed solution to address management of the Mexico-Belize border is a binational protected area between Mexico and Belize
What degree of responsibility do local municipalities have in mitigating the impacts of a project like Tren Maya?
What finance is available for conservation and adaptation projects in the region?
CHETUMAL

WHAT IF ...

the Rio Hondo watershed became a tool to unify, protect and uplift ecosystems and Indigenous communities by creating a transnational cooperation and resiliency zone that implements a unified plan to curb the impacts of mass tourism, development, and agriculture?

Belize and Mexico are divided politically by the Rio Hondo, an ineffective approach to conservation as it requires bilateral cooperation that has traditionally lacked. Additionally, the development of Tren Maya could impact the area in a negative way if protections aren’t implemented.

To address these concerns, students proposed the Yucatec Maya Ejido, a transnational conservation and resiliency zone held in communal ownership, to ensure health of the watershed from ridge to reef and connect Indigenous communities across borders.

DEISGN AND PLANNING PRINCIPLES

- Restoration of mangroves along the coast to promote resilient coastal infrastructure
- Mangrove protection to minimize destruction of existing ecosystems
- Promotion of sustainable agriculture and fishing practices through a knowledge center
- Introduction of small scale tourism in local communities
- Vertical densification of urban areas to limit land use in natural areas
- Improved water treatment and monitoring
- Removal of the Bacalar Tren Maya stop
- Establishment of a bilateral committee of Indigenous peoples to manage the watershed
- Preservation of archeological sites
There isn’t a formal system for solid waste management in Ambergris Caye.

Refined climate projections are not available to relate to key species or key ecologies that have a greater sensitivity to climate change in order to inform policy.

Development of coastal piers has both a formal and informal development process: The formal permitting process goes through the planning department with a letter of support required from the local council. The piers must be publically accessible and have certain design standards. In reality, these standards aren’t always met and often payouts occur to skirt around regulations.

Soft and hard development and design interventions are needed. Depending on climate impacts, designing for the short term and long term should be considered.

**WORKSHOP LEARNINGS**

**CHALLENGES**

- There isn’t a formal system for solid waste management in Ambergris Caye.
- Refined climate projections are not available to relate to key species or key ecologies that have a greater sensitivity to climate change in order to inform policy.
- Development of coastal piers has both a formal and informal development process: The formal permitting process goes through the planning department with a letter of support required from the local council. The piers must be publically accessible and have certain design standards. In reality, these standards aren’t always met and often payouts occur to skirt around regulations.

**OPPORTUNITIES**

- Soft and hard development and design interventions are needed.
- Depending on climate impacts, designing for the short term and long term should be considered.

**AMBERGRIS CAYE WORKSHOP BASE MAPS**

BASE MAPS (from top left to bottom right): ECOSYSTEMS, ECONOMICS, WATER, PROTECTED AREAS, LAND DEGRADATION, FIRE RISK

NOTE: Base maps for Ambergris Caye are the same as San Pedro.
AMBERGRIS CAYE

WHAT IF ...

Ambergris Caye developed according to water logic instead of real estate logic?

Much of Ambergris Caye, with the exception of San Pedro Town, is undeveloped land. With risk of unchecked development looming, students proposed a water driven zoning mechanism to prioritize conservation and minimize urban footprint on Ambergris Caye.

The establishment of “New Town” on the west of the island paired with conservation zones on the east side of the island aim to accomplish this.

DESIGN AND PLANNING PRINCIPLES

- Flood proofing of structures designed with hard infrastructure
- Promotion of aquaculture to diversify income for locals
- Utilization of timber construction, especially in elevated structures, for easy construction and low carbon footprint
- Restoration of mangroves to enhance storm protection and mitigate flooding
- Use of existing wetlands as a natural waste management tool to filter water
- Preservation of wetland through water driven zoning
- Establishment of offshore wind as a source of renewable energy
SAN PEDRO

PARTICIPANTS

COLUMBIA UNIVERSITY GSAPP STUDENTS
Zhifan Li
Rae Lei
Kenny Zhou
Jie Kong

UNIVERSITY OF BELIZE STUDENTS
Abdel Mai
Edwin Oliva

STAKEHOLDERS
Kirah Forman

SAN PEDRO WORKSHOP BASE MAPS

BASE MAPS (from top left to bottom right): ECOSYSTEMS, ECONOMICS, WATER, PROTECTED AREAS, LAND DEGRADATION, FIRE RISK

NOTE: Base maps for San Pedro are the same as Ambergris Caye

SAN PEDRO WORKSHOP BASE MAPS

WORKSHOP LEARNINGS

CHALLENGES
- A large amount of dredging takes place on and around San Pedro
- San Pedro will be impacted by Tren Maya, potentially attracting more tourists to the caye
- Green infrastructure related to energy and its distribution is lacking
- Water quality information isn’t reported and needs to be more available and transparent

OPPORTUNITIES
- A credit system for carbon was explored as a potential solution
- Seaweed farming is a possible tourism attraction and economic tool
- The personal experiences of University of Belize students working with NGOs/Department of the Environment/Larger institutions were key perspectives in informing student work

EMERGING QUESTIONS
- Does sustainable tourism exist?
- How can San Pedro generate social and economical capital locally?
- How can Belizeans add value to local resources and products before exporting them to other countries?
San Pedro diversifies its economy beyond tourism to generate social and economic capital locally - thus supporting long term growth?

As Belize’s most visited tourist destination, San Pedro has undergone rapid development to support foreign visitors. Yet, the COVID-19 pandemic impacted tourism across the globe, including in San Pedro, highlighting a need for economic diversity to support local livelihoods. Additionally, ecological challenges like sea level rise and coastal erosion are amplified due to poor infrastructure planning and lacking water and waste treatment.

To address these issues, students framed their work within the context of water urbanism, an innovative approach to design practice that joins natural and built environments, water and cities, to promote resilient communities especially in the wake of climate change. Students considered San Pedro’s impact beyond its local border, on Belize and the rest of the world. The design and planning principles generated by students reflected this holistic view.

### DESIGN AND PLANNING PRINCIPLES

#### MAHOGANY BAY
- Seaweed farming near Mahogany Bay Lagoons
- Mangrove restoration along erosion-prone areas
- Coral reef rehabilitation
- Development of fish farming ponds and mangrove dike systems
- Promotion of a more robust seafood industry
- Modification of the wastewater treatment
- Establishment a seafood production education center
- Placement wave elimination blocks on the east side of the island

#### SAN PEDRO TOWN
- Implementation of coral reef restoration and coral nurseries
- Replanting mangroves and seagrass
- Investment in alternative forms of energy such as solar, wind, and hydropower plants
- Repurposing of sargassum and utilize local building materials
- Promotion of efficient water treatment, anaerobic digestion, and waste to energy plants
- Encouragement ecotourism practices as well as the development of eco-friendly parks and hotels
- Enforcement of the use of smart vehicles such as electric cars and boats
- Design of elevated lands barriers and incorporate wave breakers
- Building of community spaces such as a cultural event plaza, educational facility, local market, and a space for capacity training

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**IMAGE. ZOOM SCREENSHOT OF STUDENT WORKSHOP PRESENTATIONS (FOR EDUCATIONAL PURPOSES ONLY)**
Excess nitrogen, waste water pollution and navigating small boats makes fishing hard in Caye Caulker.

The segregation of locals and tourists is harmful because it hides issues of poverty from people who are visiting.

The gap between law and enforcement of laws persists.

There are no schools or hospitals on the island, and people have to travel to Belize City or San Pedro to access these services.

Mangrove replanting can be used as a coastal defense.

More conscious tourism is needed, where it does not extract but work hand in hand with conservation.

Balancing ecology and economy requires national and international intervention.

Improved accessibility to healthcare and education.

Hearing the local experts and stakeholders speak generated optimism that there are people out there who have dedicated their time to sustainability and conservation.

Given the dichotomy between economy and conservation, is there a path forward for development on the island?
CAYE CAULKER

WHAT IF ...

Caye Caulker became a leader in defining resilient ecotourism?

A popular tourist destination, Caye Caulker faces challenges including coastal development, waste and water pollution, unsustainable fishing, and unregulated in-water construction. However, the student team imagined the future of tourism on Caye Caulker instead as an agent of ecological restoration, centering local industry and ownership.

Using a landscape first approach to zoning, ecology can be preserved and prioritized, supporting economic activities such as eco-tourism and fishing that sustain Caye Caulker.

DEISGN AND PLANNING PRINCIPLES

MANGROVE RESERVE
- Elevation of buildings and trails to adapt to sea level rise
- Protection and replanting of mangroves
- Restoration of coral reef and turtle rescue programs
- New and innovative farming methods towards the center of the island

CAYE CAULKER CENTER
- Reclamation of land for public use
- Sharing of community resources such as docks, boats, and vehicles
- Creation of a community kitchen space
- Improvement of access to education on the island
- Promotion of subsistence fishing
- Investment in better water management infrastructure
- Implementation of shoreline protection measures through hard infrastructure

MARINE PROTECTED AREA
- Mangrove restoration that includes and “adopt a mangrove” initiative
- Implementation of a carbon credit program to encourage sequestration and storage
- Creation of a community owned eco-village and research center
- Transformation of land use policy to transfer ownership to the local community
- Regulation of cruise line and shipping routes to promote responsible and conscious tourism
- Utilization of Indigenous fishing techniques
- Establishment a green corridor through the center of the caye
There is rapid development in Belize City, with the population doubling every 3 years.

COVID-19 had a substantial impact on the fishing sector in Belize, as many fishers transitioned back to subsistence fishing.

Laws are made without thought of enforcement.

Impervious surface coverage is greater than surface coverage from trees.

Belize city is highly impacted by climate change.

The potential impact of mariculture on national GDP is substantial.

Coral reefs are important sequesters of carbon.

Local people want to see more recreational opportunities, especially towards the west side of Belize city, as well as other infrastructure like electric buses.

Proactive disaster management planning is needed.

What role do NGOs play in regards to coastal development? What relationship do they have with real estate developers and the cruise ship industry?

With population growth, how are water resources being allocated to prepare for the future?

What is the role of the local government in protecting natural resources?

How and when is restoration funded?

Should intervention be proactive or reactive?
Belize City invested in its rivers, reefs and mangrove as drivers of its economy? How can we marshal its density for climate resiliency and maximum water quality benefit?

In Belize City, population growth and climate change impacts are two key considerations in planning and designing the future of coastal development. Ladyville, a village eight miles northwest of Belize City, hosts the country’s only international airport. With this in mind, students envisioned development in this region of the country to center ecology, water quality and sustainable land consumption, prioritizing dense urban centers compatible with the nation’s energy transition goals, a diverse economy that centers community, and implementing comprehensive climate adaptation interventions that build resilience to events like storms, flooding, and sea level rise.

DEISGN AND PLANNING PRINCIPLES

**BELIZE CITY**

- Retrofitting of buildings to adapt to sea level rise, flooding and storms in the short term
- Restoration of mangroves to adapt to sea level rise, flooding and storms in the long term
- Improvement of wastewater management facilities
- Restoration of riverbank at Haulover Creek
- Investigation of alternative forms of land ownership in the region

**LADYVILLE**

- Densification of development with climate adaptive housing
- Restoration and construction of wetlands to treat wastewater
- Implementation of sustainable agriculture and fishing practices in and surrounding built wetlands to promote economic well being and local livelihoods
- Coastal mangrove restoration
- Establishment of an eco park on either side of the Belize river
Urbanization is still rapidly occurring in Placencia. Because of how renewable energy is distributed, if power outages occur it’s hard to restore and use alternative paths of energy. There is lacking enforcement of rules and regulations as it relates to marine park management. Ecosystem health is not monitored sufficiently. Sargassum can be utilized as a beneficial resource, for example as fertilizer. The government must intervene to enforce laws. Identifying industries responsible for pollution and waste contamination is needed. Because the government owns a portion of Belize’s energy infrastructure, is it as cost effective as it could be? There is no difference between the categorization of international and local developers. Can incentivizing local development promote sustainable practices?
Placencia could model the blue economy and become an example of integrated natural and social capital across sectors?

Placencia is heavily reliant on the end stream of its water system to support tourism, shipping, shrimp aquaculture and agriculture. Taking a ridge to reef approach, students envisioned the local watershed as a unified unit of management itself, rooting ecological and technological design and planning interventions in the overall health of the watershed.

**DEISGN AND PLANNING IDEAS**

- Mangrove and seagrass restoration
- Prioritization of precision agriculture and crop rotation
- Restoration and protection of key ecological features such as big creek and preserved areas
- Transition of cruise ship industry towards biofuel
- Transferance of ownership of Big Creek Group to the local community
- Promotion of agivoltaic mangroves
- Improvement to wastewater treatment and monitoring
- Creation of locally owned shipping lines

What if the watershed became the model for resilient coastal development and a launchpad for Belize’s blue economy?
In keeping with the objectives of the workshop to both guide the subsequent work of the Urban Design Studio as well as the refinement of strategic planning and policy efforts in Belize, the workshop concluded with a discussion and synthesis of key planning and design principles for future coastal development in Belize.

These principles, organized by the emerging pillars of the Belize Resilience Strategy and the dimensions of the Reef Resilience Framework, represent a University of Belize and Columbia GSAPP faculty-led aggregation of the presentations, design sessions, and stakeholder breakout sessions and were validated and discussed by the full group of invited guests during the final review and presentation session.

**WORKSHOP FINDINGS: DESIGN PRINCIPLES AND NEXT STEPS**

**ECOSYSTEM**

- Improve watershed management with a focus on improving waste water treatment at source and upstream
- Restore and enhance mangrove and seagrass areas
- Protect biodiversity
- Prioritize nature based, decentralized infrastructure that can adapt to climate change and informality, over concrete infrastructure
- Reduce plastic usage and eliminate dumping
- Consider relocation strategies in areas expected to be severely impacted by sea level rise and increased storm surges
- Promote urban fabric and developments with the smallest possible footprints and discourage suburban sprawl
- Avoid sale of coastal public land, but allow for leased uses that are not detrimental to the environment and stay accessible to the public, with periodic reviews before renewal
GOVERNANCE

- Ensure balance of conservation of marine protected areas with commercial and local use
- Follow the Triple Bottom Line accounting in all projects, ensuring that ecological, social and financial reporting is done before project approval as well as annually. Social impact statements to be a part of the requirements
- Strengthen enforcement of regulations and transparency
- Create a stakeholder plan based on natural and social capital as well as corporate responsibility
- Cooperate with neighboring countries to set optimum flat pricing for Cruise-ships visits, international tour operators in order to protect habitat corridors
- Solidify the position of Belize as a leader in creative ways of funding ecological protection, such as Blue Bonds
- Strengthen relationship between academia and coastal management
- Consider local financial and political contexts when designing and implementing interventions

COMMUNITY

- Advance livelihood diversification within coastal communities and tourism dependent sectors
- Ensure decent living wages for fishers and farmers through value addition to produce as well as negotiations with international corporate agriculture operators
- Encourage incubators to launch employment generating knowledge businesses (information tech, fintech, others), possibly engaging the ex-pat community and leveraging remote work trends
- Create frameworks for responsible tourism, encouraging small operators, in order to control extractive multinational tour operators
- Ensure that all development plans and land rights are inclusive of and supporting native and indigenous populations, women and other marginalized populations
- Engage local communities and civil society organizations in the design and management of ecological protection plans and enforcement
- Forefront the cultural approach to coastal asset management
- Include indigenous communities in design development, governance of project design and implementation, benefit sharing, and collaborative work
This workshop report represents a moment in time and point of departure for a number of subsequent activities and opportunities, that include:

1. **RESILIENCE STRATEGY PROCESS**
   - The principles and topics represented offer a point of departure for the Belize Coastal Zone Management Authority, Ministry for the Blue Economy and Civil Aviation, and Department of Fisheries for further refinement, coordination, and engagement of the Resilience Strategy process. A core component of the work ahead includes action identification and prioritization.
   - The principles outlined are intended to be supportive of this effort both as a framework for action and engagement tool with local stakeholders. Further, the outputs of the Studio including research, design visualizations, maps, and narrative concepts can be used by the CZMAI and partners to advance engagement, advocacy, design, and policy as well as fundraising and development efforts with external partners.

2. **STUDENT AND STAKEHOLDER ENGAGEMENT**
   - Additional speakers and local experts, including the Planning and Lands Departments, local council, and local project proponents will be engaged in lectures, panels, and deep dive discussions with student teams throughout the Spring semester.
   - The lectures will intend to fill gaps in local knowledge and perspective and offer deepened engagement on topics such as land issuances, coral reef restoration, and hyperlocal place-based trends and issues.

3. **WATER URBANISMS URBAN DESIGN STUDIO**
   - GSAPP students will continue to work on intensive research questions emerging from the workshop and development of 11 place-based design scenarios and project concepts.
   - Students will present for critical feedback from experts, stakeholders, and faculty during mid-semester and end-of-semester reviews. This work will culminate in a publicly available Storymap and report that includes visualizations of research and designs.

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**CLOSING THOUGHTS**

The Resilient Coastal Development in Belize Studio Workshop represented an intensive exchange of faculty, students, stakeholders, program partners, and public agencies that uncovered the inherent relationships between culture, climate, natural resources, economy, and development. The Workshop format and intensive facilitated engagement offered a structured and methodical approach to viewing coastal development and its impacts free from singular silo of one stress or trend and therefore generated deeper and more complex questions and perspectives around multiple scales of pressures on the reef and vulnerable communities - from global corporate tourism activities to local water quality and legal context for wastewater treatment, for example. In so doing, the Team aspires to generate design and discussion that place local laws, projects, ecologies, built typologies, and perspectives in direct dialogue with global climate, social, economic, and financial systems.

Pressures in Belize are accelerating from powerful development and tourism interests that are driving rapid urbanization, impacts on sensitive habitats, water quality and environmental stressors correlated with coral diseases, and displacement of local communities; climate change impacts from sea level rise and coastal storms to marine heatwaves; and economic disruption from global events like COVID-19.

Our hope is that conversations such as this can activate local agencies and power at the intersection of design, policy, planning, science, and community to shape a new paradigm for coastal development and political will to ensure that Belize, the Belize Barrier Reef System, and the region not only adapt to a changing climate, but support thriving local communities and economies.
## I. PARTICIPANT LIST

<table>
<thead>
<tr>
<th>Participant</th>
<th>Institution</th>
</tr>
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<tbody>
<tr>
<td>Abdel Mai</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Abimael Requena</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Achmad Maulana</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Adriana Chavez</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Aishwarya Mathukumilli</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Ajay Williams</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Alexandra Grant Hudd</td>
<td>Columbia CRCL</td>
</tr>
<tr>
<td>Alissa Roches</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Amy Armstrong</td>
<td>Great Barrier Reef Foundation</td>
</tr>
<tr>
<td>Angeline Valentine</td>
<td>Mesoamerican Reef Fund</td>
</tr>
<tr>
<td>Anthony Mai</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Arlene Young</td>
<td>Coastal Zone Management Authority &amp; Institute</td>
</tr>
<tr>
<td>Astrid Iglesias</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Avani Agarwal</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Beverly Wade</td>
<td>Ministry of Blue Economy &amp; Civil Aviation</td>
</tr>
<tr>
<td>Bianca Bryant</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Brianne Teul</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Carla Patnett</td>
<td>Belize City Council</td>
</tr>
<tr>
<td>Carlie Gillett</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Carmen Yu</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Carolina Hernández</td>
<td>UN HABITAT</td>
</tr>
<tr>
<td>Caroline &quot;Caz&quot; Oliver</td>
<td>TIDE Eco-Tours</td>
</tr>
<tr>
<td>Cassandra Lewis</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Cecy Castillo</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Celso Sho</td>
<td>University of Belize</td>
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<tr>
<td>Celso Sho</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Cesar Delgado</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Changbin Kim</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Chantalle Clarke Samuels</td>
<td>Coastal Zone Management Authority &amp; Institute</td>
</tr>
<tr>
<td>Chelsea Perera</td>
<td>Belize City Council Planning Department</td>
</tr>
<tr>
<td>Cherie Wagner</td>
<td>The Nature Conservancy</td>
</tr>
<tr>
<td>Classidy Boland</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Craig Raffenberg</td>
<td>AECOM</td>
</tr>
<tr>
<td>Curan Zhang</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Daniela Deo</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Darrel Cansano</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Dawyne Pech</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Edwin Oliva</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Emilie Gomez</td>
<td>Ministry of Blue Economy &amp; Civil Aviation</td>
</tr>
<tr>
<td>Eusebio García</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Felicia Cruz</td>
<td>Belize Fisheries Department</td>
</tr>
<tr>
<td>Felix Madrazo</td>
<td>International Design</td>
</tr>
<tr>
<td>Galina Novikova</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Geeta Mehta</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Gianna Vasquez</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Glenda Chagas</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Gloria Mah</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Govardan</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Graciela Saldarfa Fraire</td>
<td>Secretaria de Ecologia y Medio Ambiente (Quintana Roo’s Ministry of the Environment (SEMA))</td>
</tr>
<tr>
<td>Hao Ma</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Howeie Jiang</td>
<td>Colombia GSAPP</td>
</tr>
<tr>
<td>Isarel Correa</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Jake Tiernan</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Javier Ortiz</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Jaygy Vargas</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Jeanne Solis</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Jen Chapman</td>
<td>Blue Ventures</td>
</tr>
<tr>
<td>Jiamin Huang</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Jiaxin Li</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Jiayi Zhao</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Jie King</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Jisoo Kim</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Johanna Lovecchio</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Jorge Nabet</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Jose Garcia</td>
<td>Tunich-Nah Consultants &amp; Engineering (TNEC)</td>
</tr>
<tr>
<td>Josue Ake</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Kalene Eck</td>
<td>Coastal Zone Management Authority &amp; Institute</td>
</tr>
<tr>
<td>Kalyssa Torres</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Kate Orff</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Kenny Zhou</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Kimberly Cardenas</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Kimberly Ramirez</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Kirah Forman-Castillo</td>
<td>Hol Chan Marine Reserve</td>
</tr>
<tr>
<td>Kris-An Hinds</td>
<td>USF Strong Coasts</td>
</tr>
<tr>
<td>Lamissa Haque</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Lenardo Ash</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Liana Santos</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Lila González</td>
<td>Previous Local director of the Mayan Train Part 6 - Chetumal &amp; Bacalar</td>
</tr>
<tr>
<td>Lilliana García</td>
<td>Friends of Sian Kiran</td>
</tr>
<tr>
<td>Lipeng Zhu</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Lorena Bello Gomez</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Lucas Coelho Netto</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Manishka De Mel</td>
<td>Columbia University, Center for Climate Systems Research</td>
</tr>
<tr>
<td>Marcia Itza</td>
<td>University of Belize</td>
</tr>
<tr>
<td>Maya A Trotz</td>
<td>University of South Florida</td>
</tr>
<tr>
<td>Melvin Myers</td>
<td>Belize City Council Planning Department</td>
</tr>
<tr>
<td>Meridel Phillips</td>
<td>SciSpace LLC (GISS Climate Impacts Group)</td>
</tr>
<tr>
<td>Minsung Kim</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Monica Ortiz</td>
<td>FONATUR - Mexico’s National Tourism Fund</td>
</tr>
<tr>
<td>Nadia Bood</td>
<td>World Wildlife Fund Mesoamerica</td>
</tr>
<tr>
<td>Nigel Encalada</td>
<td>Sustainable Heritage Consulting</td>
</tr>
<tr>
<td>Pradit Singh</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Rae Lai</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Rafael Robles de Benito</td>
<td>State of Quintana Roo</td>
</tr>
<tr>
<td>Rhea Pai</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Riya Chadha</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Rongxin Tang</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Rotina Tian</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Ryan Bartlett</td>
<td>WWF</td>
</tr>
<tr>
<td>Ryan Cobb</td>
<td>Belize Energy Unit</td>
</tr>
<tr>
<td>Safira Vasquez</td>
<td>Ministry of Blue Economy &amp; Civil Aviation</td>
</tr>
<tr>
<td>Salvador Poot</td>
<td>Quintana Roo’s Ministry of the Environment</td>
</tr>
<tr>
<td>Sam Dye</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Samir Rosado</td>
<td>Coastal Zone Management Authority &amp; Institute</td>
</tr>
<tr>
<td>Shannon Li</td>
<td>Columbia GSAPP</td>
</tr>
<tr>
<td>Shantel Escapes</td>
<td>Ministry of Blue Economy &amp; Civil Aviation</td>
</tr>
<tr>
<td>Shinnan Liu</td>
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# II. FULL WORKSHOP AGENDA

## THURSDAY JANUARY 20TH

**STUDENT FACULTY ORIENTATION**
2:00 - 4:00 CST
3:00 - 5:00 EST

**STUDENT INTROS: UB and GSAPP Student Orientation**
Review workshop objectives, schedule, exercises and assignment; introduce UB faculty and students and set up Whatsapp groups; Happy Hour following on OhYAY

## FRIDAY JANUARY 21ST

**RESILIENT REEF INITIATIVE: INTRODUCTION**
2:00 - 3:45 CST
3:00 - 4:45 EST

**RESILIENT REEF INITIATIVE**
Amy Armstrong, Program Director, Resilient Reefs Initiative
Overview of the Resilient Reef Framework, initiative goals and partnerships; Theory of applying urban resilience lessons to reef sites; Discussion of evolution of conservation field towards resilience; Key trends, challenges, and opportunities seen in reef sites and management (case studies?); Defining and measuring success; Perspective on the role of designers in this space

Kalene Eck, Chief Resilience Officer CZMAI
Introduce the role as the Chief Resilience Officer; Career path and background; Perspective on the role of designers in this space and how the RRI intends to leverage outputs of this effort

## MONDAY JANUARY 24TH

**INTRODUCTIONS + PLANNING EFFORTS + NATURAL AND CULTURAL LANDSCAPES**
12:00 - 1:00 CST
1:00 - 2:00 EST

**INTRODUCTION: LAYING THE GROUNDWORK**
Opening: Workshop Goals
Kate Orff, Director UD Program GSAPP
Water urbanisms studio and CRCL Accelerator process; Workshop goals and structure; Faculty introductions for UB and GSAPP

Building Resilience in Belize
Kalene Eck, Chief Resilience Officer CZMAI
Overview of resilience strategy process, initial challenges and opportunities and assessment findings; Key projects and plans; outreach and stakeholders overview, What’s most needed from this Workshop and how will it be useful?

## TUESDAY JANUARY 25TH

**WATER + FOOD + CLIMATE**
9:30 - 10:30 CST
10:30 - 11:30 EST

**WATER, FOOD AND CLIMATE SYSTEMS**
Climate Change Projections of the BBRS
Manishka De Mel, Center for Climate Systems Research, Columbia University

Watershed Ecology and Quality
Professor Josue Ake, University of Belize

**PRESENTATIONS: NATURAL AND SOCIAL LANDSCAPES**
Valuing Natural Capital of a Future Climate: Landscape, The Reef, Economy, Society
Nadia Bood, Senior Program Officer, Marine Science & Climate Change at World Wildlife Fund Mesoamerica

Social, Cultural, and Heritage Landscapes
Nigel Encalada, Sustainable Heritage Consulting

**STUDENT RESEARCH AND WORKING TIME**
5:00 - 7:00 EST
WEDNESDAY JANUARY 26TH

**INFRASTRUCTURE + ENERGY + LAND USE**

**PRESENTATIONS: INFRASTRUCTURE, LAND USE, ENERGY**

- Tren Maya Infrastructure Plan and Impacts
  - Mónica Ortiz, Academic and research coordinator at Tren Maya - FONATUR - Mexico’s National Tourism Fund
- Energy Transition and Offshore Extraction
  - Ryan Cobb, Belize Energy Unit
- Wastewater and Development Impacts
  - Jose ‘Pepe’ Garcia, Environmental Engineer Consultant

**OPEN DISCUSSION AND Q&A**

**BREAK**

**STAKEHOLDER ACCELERATOR BREAKOUT SESSIONS**

- Introduction and Transition to Breakout Teams
  - Johanna Lovecchio, Center for Resilient Cities and Landscapes
- Breakout Sessions
  - Who is involved in coastal development and how is it done today?

**BELIZE STAKEHOLDERS END / STUDENTS LUNCH**

**THURSDAY JANUARY 27TH**

**LIVELIHOODS + TOURISM + ECONOMY**

**PRESENTATIONS: FINANCE AND INVESTING LANDSCAPES**

- Planning for the Blue Economy
  - Shantel Espades, Blue Economy Director, MBECA
- Funding and Financing for Reef Health and Communities
  - Emilie Gomez, MBECA

**GSAPP FACULTY MINI LECTURES**

- Geeta Mehta, Social Capital Credits
- Thad Pawlowski, Natural Capital in Mozambique
- Kate Drift, Resilient Shorelines and Living Breakwaters
- Adriana Chavez, Coastal Resilience in Mexico

**STUDENT RESEARCH AND WORKING TIME**

**GSAPP DESK CRITS WITH FACULTY**

**THURSDAY JANUARY 27TH**

**INTRODUCTION AND TRANSITION TO BREAKOUT TEAMS**

**STUDENT RESEARCH AND WORKING TIME**

**BELIZE STAKEHOLDERS END / STUDENTS LUNCH**
FRIDAY JANUARY 28TH

12:30 - 1:00 CST
1:30 - 2:00 EST

1:00 - 4:00 CST
2:00 - 5:00 EST

5:00 - 6:00 CST
6:00 - 7:00 EST

5:45 - 6:00 CST
6:45 - 7:00 EST

BELIZE STAKEHOLDERS END / STUDENTS LUNCH

STUDENT RESEARCH AND WORKING TIME

PRESENTATIONS: TOURISM IMPACTS AND LIVELIHOODS

Livelihoods and Tourism Impacts
Caroline ‘Caz’ Oliver, TIDE EcoTours
Open Discussion and Q&A

PRESENTATIONS: PROBLEM DEFINITION AND OPPORTUNITIES

Al Caribe: Tourism industry in the Caribbean, Research by Supersudaca
Felix Madrazo, International Design

PRESENTATIONS: TOURISM IMPACTS AND LIVELIHOODS

Livelihoods and Tourism Impacts
Caroline ‘Caz’ Oliver, TIDE EcoTours
Open Discussion and Q&A

III. SPEAKER BIOS

JOSUÉ AKÉ
Professor, University of Belize

Josué Aké is a Lecturer at the University of Belize, in the Faculty of Science and Technology, within the Natural Resource Management Program. He is a graduate with two master’s degrees: M.Sc. in Environment and Resource Management focus in Water Resource Management, and M.Sc. in Environmental Science focus in Environmental Assessment.

He is a Belizean researcher in Water Quality Management in watersheds, rural water management, and Water Conservation Education. He participates with universities, environmental community organizations, national and international water entities, and researchers. He is also an academic national representative in regional and international conferences and seminars in water resources such as Global Water Partnership [GWP] Network, RISAF Network and DAAD Alumni Water Experts Seminars.

AMY ARMSTRONG
Program Director, Great Barrier Reef Foundation

Amy is an urbanist and conservationist with a 20 year track record of designing and leading ambitious programs that deliver environmental and social impact. She currently leads the Resilient Reefs Initiative—an AUD$14M global effort working at the intersection of community development and ecosystem restoration, partnering with UNESCO coral reef sites to build the resilience of their reefs and the communities that depend on them. This work draws on her previous experience helping to design and lead The Rockefeller Foundation’s 100 Resilient Cities initiative—a USD$164M effort to transform how cities understand risk, engage their residents, and plan for the future. At 100RC, she partnered with cities around the world to design and implement holistic resilience strategies, and led the initiative’s program design and monitoring & evaluation teams.

Prior to this work, she helped lead and grow two applied research centers at New York University, bridging research and policy to help cities make evidence-based decisions that deliver more equitable outcomes. Additionally, she has experience working for local governments and non-profits on program development, strategic planning, external affairs, and policy research and analysis.

She holds a B.A. in Political Science from Reed College and an MSc in Social Policy and Planning from the London School of Economics. She is an Edmund Hillary Fellow, and has been a Coro Leadership New York Fellow and a New York City Urban Fellow. A global citizen, she currently calls Bozeman Montana home where she is mom to a goofy and curious son who is also figuring out how to do well for the world.

NADIA BOOD
Senior Program Officer, Marine Science & Climate Change at World Wildlife Fund Mesoamerica

Nadia Bood discussed the Smart Coasts Project, a climate adaptation project aimed to answer the following three questions: 1) What benefits were people receiving from nature throughout the region? 2) How might climate change affect these ecosystem services? 3) Where should there be investment in adaptation strategies?

Utilizing InVEST modeling software and community stakeholder workshops, the project identified areas in Belize where certain climate change adaptation strategies such as mangrove restoration or coral reef protection would generate the greatest return to communities in terms of ecosystem services.

Josué Aké: Tourism industry in the Caribbean, Research by Supersudaca
Felix Madrazo, International Design

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RYAN COBB
Energy Director, Belize Energy Unit

Ryan Cobb presented an overview of Belize’s current energy sector alongside a look into what energy may look like in future Belize. With a 92% accessibility rate, the majority of Belizeans have access to Belize’s electricity share which can be broken down into the following categories: 5% renewable energy share, 43% imported electricity share from Mexico (largely oil and gas), and 6% fossil fuel.

FELICIA CRUZ
Fisheries Officer, Belize Department of Fisheries

Ms. Felicia Cruz is a Fisheries Officer within the Policy and Planning Unit of the Belize Fisheries Department with over 10 years experience in fisheries management and conservation. Ms. Cruz is responsible for various functions which includes but is not limited to providing technical expertise in Fisheries policy and sectoral management (national, regional and international perspectives), developing sectoral plans and policies, synthesizing project proposals and resource mobilization strategies, permitting of research and mariculture.

MANISHKA DE MEL
Senior Staff Associate, Center for Climate Systems Research, Columbia University

Manishka has a background in climate change, biodiversity conservation and environmental management. She has 15 years of professional experience, gained across some 20 countries worldwide. She is a Senior Staff Associate at the Center for Climate Systems Research (CCSR) at Columbia University’s Earth Institute, based at NASA GISS.

KALENE ECK
Chief Resilience Officer, Coastal Zone Management Authority and Institute

She serves as the point person leading comprehensive efforts on resilience, working across the reef system locally, and developing the resilience strategy for Belize. She holds a Master of Marine Management degree with a focus in Marine Policy and Law from the Marine Affairs Program at Dalhousie University, Nova Scotia, Canada. Kalene possesses a wealth of knowledge and over ten years’ experience in marine conservation, fisheries management, policy formulation, and of the legal framework governing marine affairs in Belize. Her goal is to work with a dedicated group of interdisciplinary personnel towards the implementation of sustainable environmental practices through research, and science communication with policy and decision makers.

MANISHKA DE MEL
Senior Staff Associate, Center for Climate Systems Research, Columbia University

She leads the CCSR Climate Impacts Group portfolio of Conservation and Development sector projects, collaborating with a range of partners including World Wildlife Fund, United Nations Development Programme and Wildlife Conservation Society. Manishka has a MA in Climate and Society from Columbia University, a MS in Biodiversity, Conservation and Management from the University of Oxford and a Certificate in Business Excellence from the Columbia Business School.

JOSE ‘PEPE’ GARCIA
Environmental Engineer Consultant, Tunich-Nah Consultants and Engingeering

Jose “Pepe” Garcia has served on many Boards such as The Belize Audubon Society, Belize Water Services, World Conservation Union/Central America Chapter, Ambergris Cage Planning Authority, Ladyville Village Council as well as many others. He is the founder of TNC/Blue Economy for Belize for the past 16 years and has worked in conservation and marine protected area management for close to 20 years.

KIRAH FORMAN-CASTILLO
Technical Manager, Hol Chan Marine Reserve

Her duties include overseeing the research and monitoring program and providing technical support for all other management activities, grant funding and project management. She is also responsible for ensuring that the HCMR meet all its conservation objectives. Her mantra is “lead by example”.

JOSE ‘PEPE’ GARCIA
Environmental Engineer Consultant, Tunich-Nah Consultants and Engingeering

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CAROLINE OLIVER
Director of Programs, Amigos de Sian Ka’an

Caroline (Caz) knew from a young age that her passion lay in wildlife and its protection. She earned a Bachelor’s degree in Environment, Economics and Ecology from the University of York (UK), and a Master’s degree in Conservation and Tourism from the Durrell Institute for Conservation and Ecology at the University of Kent (UK). As part of her studies, she conducted coral reef research in a marine reserve in the Bahamas and completed a valuation of tourism strategies in a national park in Rwanda.

She returned to the Bahamas to work as a project scientist for 15 months, where she taught volunteers how to conduct coral reef surveys and was responsible for reporting research findings to the Bahamas National Trust. In 2013, Caz volunteered at TIDE as a Development Intern, and fell in love with Belize. She returned to TIDE after her internship, to help develop TIDE’s Ridge to Reef Expeditions program in 2014. She focused on this program for two years, before taking on the role of Sales and Marketing Manager for TIDE Tours, where she was able to share her passion for Belize and education with travel planners from around the world. In 2019, she divided her time between TIDE’s educational tour programs, developing and leading educational trips in the field, and project management, managing one of TIDE’s large projects.

FELIX MADRAZO
Founding Partner, International Design

Felix Madrazo (Saltillo, Mexico 1972) is an architect, Conservation and Tourism from the Durrell Institute for Environment and Natural Resources (SEMARNAT). She conducted research and legislative analysis to design legal frameworks in implementing sustainable projects in collaboration with the Commission for Environmental Cooperation.

EMILIE GOMEZ
Coordinator and Liaison Officer, Ministry of Blue Economy and Civil Aviation

Emilie is currently working as a consultant at the Blue Economy Unit for the Ministry of Blue Economy & Civil Aviation where she inputs her expertise in the development of this new innovative sector for Belize. A 27-year-old, Emilie majored in science at her local high school, San Pedro High School.

SAMIR ROSADO
Coastal Planner, Coastal Zone Management Authority and Institute

He has spent the last 11 years promoting the sustainable development of this new innovative sector for Belize. A 27-year-old, Emilie majored in science at her local high school, San Pedro High School.

Samar Rosado is the Coastal Planner at the Belize Coastal Zone Management Authority & Institute (CZMAI) and head of the Coastal Planning and Monitoring Unit. He has spent the last 11 years promoting the sustainable use and management of Belize’s coastal resources through the development and implementation of the Belize CZM Plan 2016.

CAROLINE OLIVER
Sales and Marketing Manager, TIDE EcoTours

Caroline [Caz] knew from a young age that her passion lay in wildlife and its protection. She earned a Bachelor’s degree in Environment, Economics and Ecology from the University of York (UK), and a Master’s degree in Conservation and Tourism from the Durrell Institute for Conservation and Ecology at the University of Kent (UK). As part of her studies, she conducted coral reef research in a marine reserve in the Bahamas and completed a valuation of tourism strategies in a national park in Rwanda.

She led the MARTI Guide, aimed at real estate developers and investors and high-impact projects with a basin-to-reef approach, integrated water, and wastewater management, using innovative solutions in the Mesoamerican Barrier Reef System (MBRS). Liliana was Deputy Director of Environmental Management at the Ministry of Environment and Natural Resources (SEMARNAT). She conducted research and legislative analysis to design legal frameworks in implementing sustainable projects in collaboration with the Commission for Environmental Cooperation.

MÓNICA ORTIZ ÁLVAREZ
Director of the Scientific, Environmental and Cultural Area at Tren Maya Project within FONATUR, the National Tourism Development Fund

In addition, she has coordinated governmental entities and high-level professional affiliations and established and developed institutional and political links with the Federal and local Legislative Branches and liaison between the academic and governmental, national, and international sectors. She has also taught several courses and workshops on the national science and technology system. Currently, she is the Director of the Scientific Area of the Mayan Train.

FELIX MADRAZO
Founding Partner, International Design

Felix Madrazo (Saltillo, Mexico 1972) is an architect, researcher and lecturer. He is a founding partner of the architecture studio IND [Inter National Design], co-founder of the research collective Supersudaca and lecturer in various universities. With Supersudaca he has carried several research projects related to the impacts of mass tourism in the Caribbean with special emphasis on cruise tourism and all inclusive resorts. He has published several articles with Supersudaca and is co-author of the books City Shock and Cozy Pastes done at the Why Factory and published by Na010 Press.

ANGLINE VALENTINE
Project Officer, Mesoamerican Reef Rund

Angeline currently works as Project Officer for the Belize Marine Fund program of MAR Fund. She holds a Master’s Degree in Environmental Management from Duke University, as well as a BSc in Biology and Natural Resources Management from the University of Belize. She is the recipient of several awards and honors such as an OAS-Fulbright Fellowship to pursue graduate studies at Duke.

Following the decline in tourism in 2020, Caz transitioned to a full-time role in project management, and was appointed as TIDE’s Program Director in 2021. In this role, she is responsible for overseeing project implementation, organizational and project budgets, meeting desired targets and objectives, and reporting to funders and TIDE’s Board of Directors. Through her varied experiences at TIDE over the years, Caz has continued to be inspired by her dedicated team of colleagues and the rich diversity of southern Belize. At a time of unprecedented environmental change and challenges, she is humbled to be part of an organization that is leading the way in natural resource management and community participation in conservation.
IV. ENDNOTES

CULTURAL HERITAGE


LAND USE AND COASTAL DEVELOPMENT


"Repositorio de Documentos Oficiales." Tren Maya. https://www.trenmaya.gob.mx/repositorio-de-documentos-oficiales/

TOURISM IMPACTS AND PLANS


COASTAL ZONE MANAGEMENT


CLIMATE CHANGE, ADAPTATION AND NATURAL CAPITAL


“Surging Seas Mapping Choices.” Climate Central. https://choices.climatecentral.org/#/17.725/-88.371?compare-temperatures&carbon-and-gr-2=1000&scenario-1=89.8&scenario-2=89.8&scenario=89.8


De Mel, Manishka. “Assessing Climate Risk in the Mesoamerican Reef Region. 2020. https://docs.google.com/presentation/d/1oSz04tzRQjdK9ZHoukumOccn2HDPaC/eid#slide=id.p1


ENERGY


Global Coral Reef Alliance. https://www.globalcoral.org/

50 Reefs Map. https://www.50reefs.org/map

Allan Coral Atlas. https://allencoralatlas.org/

REEF RESILIENCE TOOLS AND FRAMEWORKS


71
V. EXISTING PLANS REVIEW
WORKSHOP PRE-READ
In 2015, the Belize Barrier Reef Reserve System (BBRRS) was added to the List of World Heritage in Danger in 2009 and to date remains on the UNESCO’s in danger list based on threats related to the removal of mangrove cover, unsustainable coastal development, and more recently, offshore oil prospecting. The study assessed four of Belize’s seven MPAs and determined that the total tourism economic value of these four areas is estimated to be up to US$88.8 million. There is potentially much greater additional value associated with the MPAs through other ecosystem services (see images).

Based on the findings of the report, the authors call for the Belizian government to: 1) Enact the proposed legally binding indefinite moratorium on offshore oil exploration; 2) Implement a ban on further sale and lease of public lands within the BBRRS; and 3) Enact the revised Mangrove Regulations; 4) Invest in the management of the BBRRS; 5) Enhance land-use and development regulations.

Note: All resources are hyperlinked in the titles.
InVEST Scenarios Case Study: Coastal Belize
Contributors: Natural Capital Project, World Wildlife Fund, Stanford University

**Purpose:** To develop and analyze management scenarios to inform Belize’s Integrated Coastal Zone Management Plan (ICZMP)

- Utilized Integrated Valuation of Environmental Services and Tradeoffs (InVEST), an evaluation software used for mapping, quantifying and valuing ecosystem services under different scenarios.
- 3 scenarios considered: (1) conservation (preservation of existing ecosystems), (2) development (rapid economic development), and (3) informed management (blends environmental conservation goals with current needs for coastal development).
- It was determined that “informed management” scenario better achieved the goals of the ICZM mandate than either “conservation” or “development.”


Assessing Climate Risk in Mesoamerica (Draft)
Contributors: WWF and the Columbia University Center for Climate Systems Research (CCSR)

**Purpose:** Integrate climate risk information into conservation, development, and disaster management policy and practice

- Methodology: use RCP scenario 8.5 to assess “low estimate” and “high estimate” scenarios (25th and 75th percentile, respectively) for climate change risk in 2050 in the Mesoamerican reef system region compared to the 1980-2005 baseline data.
- Mean temperature, number of extreme heat days, sea level rise, sea surface temperature, all projected to increase across the region.
- Precipitation and number of rainy days are projected to decrease, consistent with drought that is experienced across the region.
- Key considerations: (1) using ranges of climate projections to discuss all possibilities, (2) integrating climate risk into ecosystem service modeling, (3) future technologies (e.g., NASA PACE program to advance the assessment of ocean health by measuring the distribution of phytoplankton).

Belize Marine Conservation and Climate Adaptation Project
Contributors: Protected Areas Conservation Trust, World Bank Group

**Purpose:** To implement priority ecosystem-based marine conservation and climate adaptation measures to strengthen the climate resilience of the Belize Barrier Reef System

- The MCCAP is currently in its third year of execution and has reached the mid-term of its implementation, and as such, a Mid-Term Evaluation is now required (this document).
- The geographic focus includes three Marine Protected Areas (MPAs): Corozal Bay Wildlife Sanctuary, Turneffe Atoll Marine Reserve, and South Water Caye Marine Reserve, and targets 12 fishing communities (Concejo Village, Consejo Village, Corozal Town, Hopkins Village, Sarteneja Village, Belize City, Dangriga Town, Sittee River Village, Sarteneja Village, Sarteneja Village, and Placencia Village) to act as champions for the management of these protected areas.
- The main components are: (1) Improving the Protection Regime of marine and coastal spatial planning, to inform Belize’s Integrated Coastal Zone Management Plan (ICZMP), (2) Methodology: quantified ecosystem-service returns now and in the future under three management scenarios (development, conservation, informed management by assessing risk to habitats from a suite of human activities), (3) The process was designed to understand how the nine planning regions in Belize contribute to a portfolio of national benefits from ocean ecosystems and to incorporate regional differences in stakeholder preferences for the future.
- Higher value of coastal protection and tourism under the Informed Management scenario, compared with the Conservation scenario, serves as a reminder that ecosystem-service values depend on a combination of both biophysical and social variables.


Women in Fisheries Forum
6-7 August 2019
Westin West End
Belize City, BZ

Belize, Central America.
This study focused specifically on vulnerability and capacity assessment in the Water Sector and Coastal Zone Sector. The plan also highlights the importance of equal participation and representation of women in the fight against climate change (gender mainstreaming).

"Mainstreaming" adaptation means to systematically include climate risk and adaptation considerations in regular decision-making and planning processes, instead of only implementing "stand-alone" adaptation measures. The level of climate change adaptation mainstreaming includes:

- Sector specific adaptation

Purpose:

- To assess the scope of Belize's climatic vulnerability assessment
- To work with stakeholders towards developing robust impact scenarios with the available data
- To understand the expectations concerning the medium-low, medium, and high vulnerability mapping throughout the report
- To provide integrated vulnerability and adaptation assessment

Central Region Coastal Zone Management Plan

Contributors: CZMAI

Purpose: To encourage and promote sustainable development, protect and preserve traditional way of life of stakeholders, and ensure sustainability of coastal resources in the Central Belize region.

- The Central region is known as the historic gateway to modern Belize - believed to be situated on one of the ancient Maya trade routes.
- It's the most populous and economically productive region, home to Belize City - the main hub for ground, water and air transportation, and point of entry and exit for the vast majority of cruise and overnight international visitors.
- Despite the central region representing one of the most important areas for lobster fishing in Belize, many no longer fish in the region, possibly because of reducing fishing stock. But there is still much dependency on fish resources by local fishermen and potential displacement by rapid growth in the tourism sector.
- Detailed recommendations are provided for the following 10 sectors: Fishing, Marine Tourism, Land-Use, Marine Dredging, Sensitive Habitats, Utilities, Pollution Control, Infrastructure & Social Amenities, Conservation, & Scientific Research & Education.

Coastal Zone Management Plan: Ambergris Caye

Contributors: CZMAI

Purpose: To encourage and promote sustainable development, protect and preserve traditional way of life of stakeholders, and ensure sustainability of coastal resources in the Ambergris Caye Region.

- Unique habitats exist in Ambergris Caye (mangroves, sea grass, coral reefs) that support biodiversity, tourism and fishing (essential for the functioning of the people and place).
- Yet, tourism (the largest industry on the caye) is predicted to increase, placing increased pressure on local resources.
- Recommendations are provided for the following 10 sectors: Fishing, Marine Tourism and Recreation, Land-Use, Marine Dredging, Sensitive Habitats, Utilities, Pollution Control, Social Amenities, Conservation, and Research & Education.
- Recommendation: Low-impact, environmentally-sensitive nature-based tourism - avoiding practices that destroy habitats.
- Recommendation: Solid waste management - a new dump site.


Coastal Zone Management Authority and Institute (CZMAI), 2016. Belize Integrated Coastal Zone Management Plan. CZMAI, Belize City.
Coastal Zone Management

Coastal Zone Management Plan: Caye Caulker
Contributors: CZMAI

Purpose: To encourage and promote sustainable development, protect and preserve traditional way of life of stakeholders, and ensure sustainability of coastal resources in the Caye Caulker Region

- Unlike Ambergris Caye, where tourism is the primary industry, most of those living on Caye Caulker support themselves through the fishing industry [Lobster]. However, tourism is increasing partly due to declining fishing stock in the region.
- Caye Caulker Village, unlike San Pedro on Ambergris Caye, is almost totally locally owned, and it is highly recommended to preserve it as such through informed management.
- Detailed recommendations are identified and provided for the following 10 sectors: Fishing, Marine Tourism, Land-Use, Marine Dredging, Sensitive Habitats, Utilities, Pollution Control, Social Amenities, Conservation, and Research and Education.
- Implementation of these coastal management guidelines will be undertaken through two mechanisms: (a) centralized statutory control through the various Government departments, and (b) localized community and stakeholder participation.

Contributors: MAFSESDE, CZMAI

Purpose: To give a synoptic picture of the present and future development in the coastal zone, and a review of the coastal zone management actions under the ICZM Plan.

- Urban development, tourism development, sediment transport, beach erosion, nutrient pollution and poor waste management practices are causing high or very high impacts on Belizean ecosystems, especially coral reefs, seagrass, littoral forests, and mangroves.
- There is a current moratorium on offshore oil exploration in Belize. However, transportation of oil is still a risk factor for oil spills in Belize.
- In order to have sound Integrated Coastal Management Plan, the following are needed:
  - Better defined and centralized research data
  - An integrated approach at the national level to get the desired data for decision making
  - Intergovernmental cooperation
  - Multisectoral cooperation
  - Enforcement of development regulations (e.g.: 1000ft spacing between piers)

National Sustainable Tourism Master Plan (NSTMP)
Contributors: Belize Tourism Board, Ministry of Tourism, Civil Aviation and Culture, Tourism & Leisure Europraxis Consulting

Purpose: To explain what Belize tourism industry is like today, the objective Belize tourism situation for 2030 and the strategies & actions to reach that goal

- Tourism contributes anywhere from 18% to 25% of the total GDP, and accounts for about 28% of total employment.
- Main constraints on tourism identified are poor accessibility by land & air, lack of tourism services, scarce Belizean made handicrafts, inadequate (natural & heritage) asset management, deficient promotion of tourism assets, insufficient waste/disposal issues, lack of urban planning & land use regulation, lack of public awareness programs, lack of integration of local communities.
- Development strategies are to contain development and consolidate for Belize Reef, Ambergris Caye & Placencia Peninsula, promote tourism growth in San Ignacio, Northern Belize & Southern Belize, add new development in Stann Creek, and facilitate urban renovation in Belize City.
- The following macro plans were developed to focuses on the core components of the tourism sector: (i) Tourism Governance (ii) Tourism Sustainability and Quality Assurance (iii) Tourism Infrastructures (iv) Tourism Marketing (v) Tourism Product development.

Caye Caulker Shoreline Stabilization Study
Contributors: Smith Warners International

Purpose: To design a shoreline stabilization system including nature-based solutions, stormwater drainage, and recreational sites

- Used satellite imagery to study the shoreline and designed vegetated sand dunes, breakwaters and groynes to stabilise newly-constructed beaches, a pedestrian walkway, and a novel hybrid rock revetment with a mangrove barrier.
- Part of a countrywide study mapping Belize’s coastal hazard vulnerability.
- A cost-benefit analysis was also conducted.
Caye Caulker Tourism Development Plan

Contributors: Inter-American Development Bank, Ministry of Tourism and Civil Aviation

Purpose: In response to the National Sustainable Tourism Master Plan and through the establishment of Local Tourism Committees to identify priority needs and projects for Caye Caulker

- 2 major bottlenecks exist that hinder tourism growth: 1) The lack of a spacious and well maintained beach for general recreation purposes and light sports; 2) The split that divides the main island from the north island is impeding the development of new amenities such as a nature park, higher quality lodging and recreational or entertainment services

- The vision statement: a high-quality marine tourism destination with healthy ecosystems, friendly people, and a low-key island charm sustainably harnessed by a progressive, thriving and prosperous community

- This plan also details six major objectives and assigns specific responsibilities to each objective as well as provides a timeline for implementation


Belize Blue Bond


Purpose: To highlight an innovative financial mechanism that allows for greater ocean conservation and reduced national debt in Belize

- The new loan enables Belize to restructure and retire existing external commercial debt, create significant annual cash flows for conservation through 2040, and establish an endowment to fund conservation.
- In exchange, Belize has pledged to protect approximately 30% of its ocean, including coral reefs, mangroves, and fish spawning sites.
- Working with the Belizean government, The Nature Conservancy will facilitate a participatory, stakeholder-driven Marine Spatial Plan (MSP).
- The transaction restructures US$553 million of Belize’s debt, leading to an overall debt reduction of approximately US$250 million, more than US$200 million in debt service savings, and an estimated US$180 million in funding for conservation over the next 20 years.


Belize Marine Fund Investment Strategy

Contributors: Belize Marine Fund, Wildtracks Belize

Purpose: to guide the Belize Marine Fund in making future investments into marine conservation in Belize, based on a theory of change model

- Belize Marine Fund will distribute $500,000 US per year to invest in organizations and projects that will provide impactful conservation returns.
- 3 Themes of funding:
  1. Improved management effectiveness of marine protected areas across the national seascape
  2. Reduced pressures on the marine resources
  3. Effective marketing of Belize's reef at national and international levels
- BMF niches: consolidation (nurturing, growing & consolidating stable organizations & program areas), scaling (moving successful projects towards financial sustainability), and building supply chains (moving projects to functional, profitable industries). Less focus on funding grassroots organizations.
- Other key funders in Belize: Protected Area Conservation Trust (PACT) & GEF Small Grants Programme.

VI. CASE STUDY BOOKLET

WORKSHOP PRE-READ
COASTAL DEVELOPMENT AND LAND USE PRACTICES IN REEF COMMUNITIES
RESILIENT COASTAL DEVELOPMENT BELIZE BARRIER REEF UD STUDIO AND STAKEHOLDER ACCELERATOR

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1. REEF UD STUDIO AND STAKEHOLDER ACCELERATOR

Johanna Lovecchio, Associate Director
Alexandra Grant-Hudd, Graduate Research Assistant
PREPARED BY
Roatan, West End, Honduras
Fort Lauderdale, Florida
Seaside, Florida

2. LAND USE PRACTICES IN REEF COASTAL DEVELOPMENT AND LANDSCAPE ARCHITECTURE

Land Trusts and Affordable Housing
Deerfield Beach, Florida
Wastewater Treatment and Fishing Legislation
Tuas, Singapore
Coral Relocation and Port Infrastructure
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4. ABOUT THE PROJECT

Lauola Bay is located on the south eastern side of Saipan, with three major waterways flowing into the bay. It is a popular location for local residents and tourists alike to take part in fishing and diving activities. However, rapid population growth and development on Saipan has resulted in increasingly degraded marine environments. This is especially true for Lauola Bay, as some pollution sources have contributed to diminished water quality and health as well as vessel noise pollution and runoff pollution issues that need to be addressed. The community is faced with a challenge to sustainably manage Lauola Bay and the local economy.

In response, the Lauola Bay Conservation Action Plan was created. Specifically addressing Lauola Bay’s coastal and island communities, the plan presents a clear strategy for improving water quality and biodiversity in the bay. The plan was developed through a comprehensive process that involved community meetings, stakeholder workshops, and public hearings. The plan includes recommendations for the protection and restoration of Lauola Bay’s marine and coastal ecosystems, as well as strategies for improving water quality and reducing pollution sources.
Comprehensive Watershed Improvements

MAJOR LEARNINGS

- Land Use Planning
  - Design standards and local use planning
  - Tourist and Livelihoods
  - Policies, Legal, and Governance Structures
  - Funding and finance

OUTCOMES AND RESULTS

- Reduce sediment inputs from agriculture and land clearing
- Expand local drinking water supply
- Enhance biodiversity of marine species
- Increase fish stocks
- Improve fishery management

ADDITIONAL SOURCES

- Laolao Bay –Vertical Management Plan
- Coral Reef Alliance – Ensuring the Sustainability of Wastewater Operations in West End, Roatan, Honduras
- Reef Resilience – Ensuring the Sustainability of Wastewater Operations in West End, Roatan, Honduras

Wastewater Pollution

MAJOR LEARNINGS

- Caracoles BMFP, especially those designed with community input, generated revenues, improved cost and benefits and reduced the need for external assistance.
- Rehabilitation of WWTPs is a local key to engaging those such as young female politicians in the water and sanitation value chain.

OUTCOMES AND RESULTS

- 2,000 ft of road paved
- 8000 tons of concrete, filled to 80%
- 1.6M native plants across 12 parcels were planted by 35 community members, with 96% overall survival rate
- 32 schools received informational materials
- Turbidity levels were much less in 2015-2016 than in 2013-2014, indicating improved marine health

ADDITIONAL SOURCES

- Laolao Bay –Vertical Management Plan
- Coral Reef Alliance – Ensuring the Sustainability of Wastewater Operations in West End, Roatan, Honduras
- Reef Resilience – Ensuring the Sustainability of Wastewater Operations in West End, Roatan, Honduras

Wastewater Treatment and Fishing Legislation

MAJOR LEARNINGS

- Strengthened local and national management of water quality programs and policies
- Ensured better enforcement of water quality regulations

OUTCOMES AND RESULTS

- 100% of homes and businesses in the West End are treated by the WWTP
- WWTP treats 26 million gallons of wastewater per year
- Wastewater treatment costs are lower than expected
- Wastewater treatment reduces nutrient loads

ADDITIONAL SOURCES

- Laolao Bay –Vertical Management Plan
- Coral Reef Alliance – Ensuring the Sustainability of Wastewater Operations in West End, Roatan, Honduras
- Reef Resilience – Ensuring the Sustainability of Wastewater Operations in West End, Roatan, Honduras

ABOUT THE PROJECT

In Honduras, only 3% of human wastewater reaches treatment facilities. This poses a significant barrier to socio-economic development, social equity, and environmental sustainability. The topics of water and sanitation are critical in this context. The WWTP is a critical component of the comprehensive approach to improving water quality in the area. The WWTP treats 26 million gallons of wastewater per year, ensuring that the area's water quality is significantly improved.

ADDITIONAL SOURCES

- “You Care about Bonaire.” Global Islands Network.
- “Because You Care about Bonaire.” Global Islands Network.
Wastewater Treatment and Fishing Legislation

**MAJOR LEARNINGS**

- Design standards and Land Use Planning
- Tourism and Livelihoods
- Policies, Legal and Governance Structures
- Funding and Finance

**OUTCOMES AND RESULTS**

- A holistic view of the legislation and how it can be used to prevent wastewater treatment plant failures.
- Increased awareness among coastal residents about the importance of wastewater treatment and plant infrastructure.

**ADDITIONAL SOURCES**


Nature Based Coastal Resilience

**MAJOR LEARNINGS**

- Design standards and Land Use Planning
- Tourism and Livelihoods
- Policies, Legal and Governance Structures
- Funding and Finance

**OUTCOMES AND RESULTS**

- The following were mentioned as potential opportunity areas in Grenada:
  - Reef enhancement
  - Gray/green shoreline stabilization with land grading and vegetation
  - Updating and enforcing building and land use regulations (increasing setbacks and elevation)

**ADDITIONAL SOURCES**

- **Source:** Nature Based Coastal Resilience, Reef Resilience.

Nature Based Coastal Resilience

**MAJOR LEARNINGS**

- Design standards and Land Use Planning
- Tourism and Livelihoods
- Policies, Legal and Governance Structures
- Funding and Finance

**OUTCOMES AND RESULTS**

- Nature Based Coastal Resilience:
  - Reef Baseline Analysis
  - Reef Enhancement
  - Gray/green Shoreline Stabilization
  - Updating and enforcing building and land use regulations (increasing setbacks and elevation)

**ADDITIONAL SOURCES**

- **Source:** Nature Based Coastal Resilience, Reef Resilience.

Community members constructing 3D models of the area

**MAJOR LEARNINGS**

- Design standards and Land Use Planning
- Tourism and Livelihoods
- Policies, Legal and Governance Structures
- Funding and Finance

**OUTCOMES AND RESULTS**

- Participants were able to develop comprehensive models of physical interventions that community members identified as potential solutions within local and development frameworks. Additionally, the high participatory culture used in this project is a strong example of what community engagement is all about, decision making processes can look like.

**ADDITIONAL SOURCES**

- **Source:** Nature Based Coastal Resilience, Reef Resilience.

Coral Relocation and Port Infrastructure

**MAJOR LEARNINGS**

- Design standards and Land Use Planning
- Tourism and Livelihoods
- Policies, Legal and Governance Structures
- Funding and Finance

**OUTCOMES AND RESULTS**

- Coral relocation efforts began in 2013, with port development scheduled to be complete in the 2040s.
- The Nature Conservancy, Government of Grenada, Grenada Red Cross funded the project.
- Coral nurseries underwater to cultivate and grow corals were developed.
- coral nursery habitats were established.

**ADDITIONAL SOURCES**

- **Source:** Coral Relocation and Port Infrastructure.
MAJOR LEARNINGS

- The high-value real estate sites in the province highlight that coastal relocation, even with new ideas, is inconceivable without a cost. This could help mitigate the impacts of climate change and sea-level rise.
- The World Bank has introduced the cost of developing $10 billion to $20 billion over a 10-year period, which may seem expensive, but in the context of what the project is entering into, it is not. It may put a strain on the ecological health of coastal areas.
- Monitors have been key in ensuring the success of future relocation projects between the government of Singapore and Malaysia, as acts that threaten rights have certain actions, stemming from conflicts in the 1970s. In 2010, they reached a legal agreement to mutually suspend their overlapping port efforts and not authorize or suspend commercial activity in that area.

OUTCOMES AND RESULTS

- 3,000 units moved, 2,000 of which survived.*
- 50 volunteers engaged in relocation activities.*

OUTSTANDING QUESTIONS

- What will the future role of coral be in the future?
- How will the costs of coral be for the long term?
- What legislation is in place to support coral restoration?
- How will the success of this program inform coastal development in other locations?
- What are the specific design plans for the retired ports?

ADDITIONAL SOURCES

- Article: Singapore spends $6m to relocate corals
- Article: South Florida Community Land Trust
- Article: Affordable Homes Being Constructed in Deerfield Beach, Florida
- Article: Affordable homes being constructed in Deerfield Beach
- Article: Seaside Research Portal.

ABOUT THE PROJECT

The high-value real estate sites in the project highlight that coastal relocation, even with new ideas, is inconceivable without a cost. This could help mitigate the impacts of climate change and sea-level rise.

OUTSTANDING QUESTIONS

- What is the ethicality of building affordable housing in 80% or less of the county's median income households?
- How will the city of Deerfield fit into this new development plan?
- What is the expected time frame for the project to be completed?
- How will the city of Deerfield fit into this new development plan?

ADDITIONAL SOURCES

- Article: Affordable homes being constructed in Deerfield Beach, Florida
- Article: Seaside Research Portal.

ABOUT THE PROJECT

Seaside, Florida

In 1978, Robert Davis inherited a 80-acre plot of land located on the Florida panhandle near his home in Panama City. With a goal to transform the area into a neighborhood, the Seaside Code allows for the restriction of building form and size to a maximum of 80 square feet, but also recognizes that needs and economies of scale vary depending on family income, and requires certain planning measures to mitigate the effects of coastal development and marine life. This code allows for the restriction of building form and size to a maximum of 80 square feet, but also recognizes that needs and economies of scale vary depending on family income, and requires certain planning measures to mitigate the effects of coastal development and marine life.
MAJOR LEARNINGS

Seaside, Florida

- Design standards and Local Planning

- The plans for Seaside were designed on transparent paper so that they could be layered on top of each other for comparison.
- Site analysis: Document the physical, cultural, and social aspects of the design.
- Master Planning: Through an on-site workshop the vision of the design is created and its elements are decided on in detail to guide further.
- Design Development: Refine the specific elements, design character, spatial relationships, and budgeting information.
- Construction Documents: Technical drawings drafted in 3D & plan view.
- Implementation: Cadence assists in locating contractors & provides construction observation of work.

These three urban design projects highlight how innovative design and infrastructure can enhance coastal landscapes from residential to public spaces. Additionally, process of design that involves local stakeholders not only is decision making that the process of design itself can offer interesting elements to consider, specifically in the Jefferson Parish Canal example.  

OUTSTANDING QUESTIONS

- How can coastal design examples be modified and adopted for alternate geographical locations with varying social, cultural and economic landscapes?
- Cadence: The Oceanage
- Cadence: Cut Walk Jetty, Bal Harbour Village
- Cadence: The Oceanage

ADDITIONAL SOURCES:

- Cadence: The Oceanage
- Cadence: Cut Walk Jetty, Bal Harbour Village
- Cadence: The Oceanage

ENDNOTES


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