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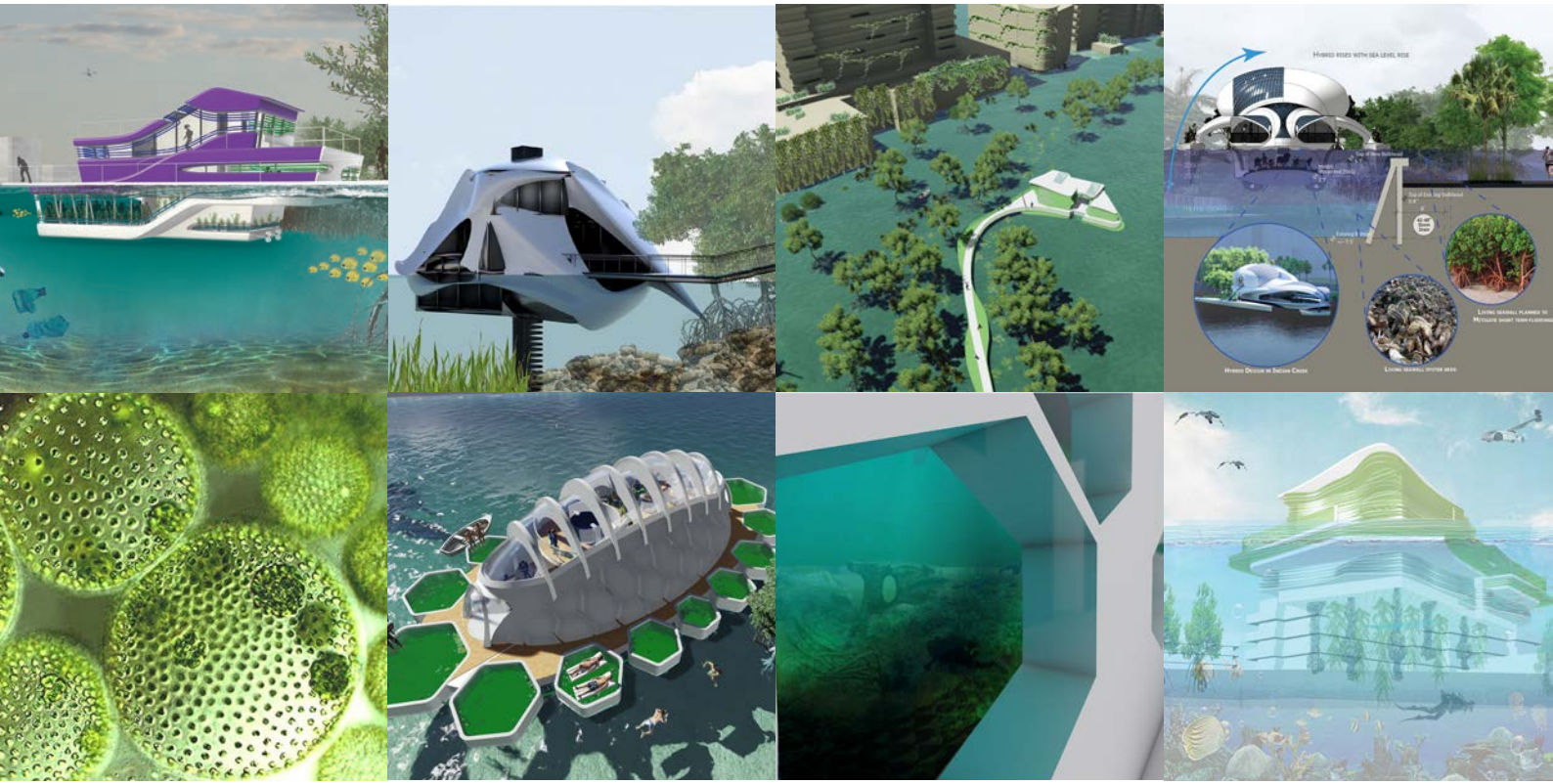

CRUNCH DESIGN RESEARCH

FOOD - WATER - ENERGY NEXUS

VOLUME 1 - URBAN HYBRIDS

Edited by Thomas Spiegelhalter and Darren Ockert

Nuova serie di architettura
FRANCOANGELI

Informazioni per il lettore

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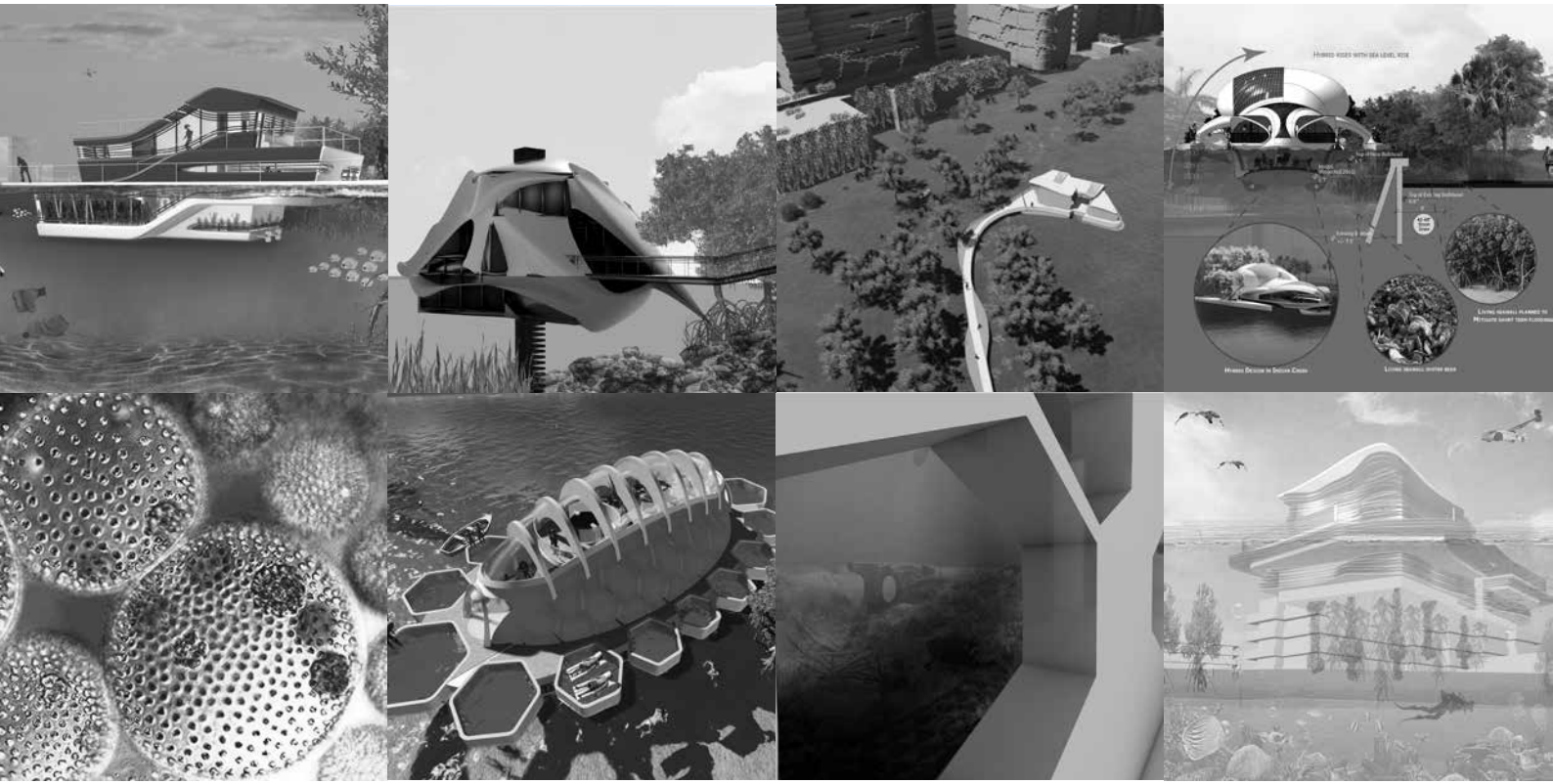

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MIAMI BEACH **2018**

FORWARD

JEFF MARCUS, PHD

STANTEC MIAMI

(Energy impacts to corals, mangroves and sea-grasses)

I had the honor of reviewing the innovative projects that were developed by Florida International University students in the School of Architecture (Miami Beach Urban Design Studio) taught by Professor Thomas Spiegelhalter. The projects were inspired and designed by the International CRUNCH program sponsored by the European Union and the National Science Foundation. CRUNCH stands for Climate Resilient Urban Nexus Choices and involves the nexus of food, energy and infrastructure as it pertains to the growing challenges of climate change and sea level rise. In this case, the focus is on the City of Miami Beach and projects in and along Indian Creek which is a low lying area prone to flooding during King Tides and major storm events. The projects were to be based on a Living Shoreline Design developed as part of a bigger program to combat sea level rise by raising roads, seawalls, and improve storm-water treatment infrastructure.

The students were divided into small groups, each presenting their vision of self sufficient resilient and adaptive structures. Many of the themes were based on marine animal forms, for example shelled organisms and different forms of jelly fish. The designs were based on approximately 50 years in the future where models place much of the existing infrastructure under water. Concepts included algal farms for food and protein and the use of structures that harness solar power. There were also design features to deal with solid waste and waste water. The students showed creativity and ingenuity in finding solutions to the many challenges presented in the project objectives.

JAMES BRASIL

ARCHITECT, BARCELONA-MIAMI

The projects herein presented in this publication, represent the first student design studio investigation of floating hybrid architectural prototypes along urban shorelines under the threat of rising sea levels within the 'CRUNCH' research framework. CRUNCH (Climate - Resilient - Urban - Nexus – Choices) is an international, three-year research project that explores the Food, Water, and Energy NEXUS to build an Integrated Decision Support System, which is an assessment tool for cities. Under the direction of CRUNCH's principal investigator and studio coordinator Prof. Thomas Spiegelhalter, students developed their projects as micro-infrastructural proposals that promote how the Food-Water-Energy Nexus can strengthen urban resilience, resource efficiency and environmental quality proposed by the original Indian Creek Greenway project.

Taking their inspiration from natural systems, student proposals deconstructed biological organisms and forms to understand the rules governing them. Successful projects discovered solutions they could adapt to all facets of their design, from structural organization to surface articulation and buoyancy control. This type of biomimicry is a popular contemporary philosophy in architectural discourse and investigation because it strives for a deeper form of sustainability that is evolutive and adaptive to the changing environment around us.

The studio then reiteratively simulated the performance of their biomimetic inventions as they developed their designs, engaging an impressive range of building simulation engines to refine morphological and tectonic design elements. The design rigor exhibited in final presentations are testament to the studios commitment to create new models of living urban ecosystems along 'endangered' shorelines that can be regenerative and self sufficient.

INTRODUCTION THOMAS SPIEGELHALTER & DARREN OCKERT

With the release of the United Nations IPCC (Intergovernmental Panel on Climate Change) 2018 report[1], it seems clear that we will be entering a new era of anthropogenic climate change that will adversely affect all life on our planet.

We can no longer haphazardly design and build in climate-vulnerable areas and expect such buildings to last a lifetime as has often been the historical case. We must now design with the knowledge that the impacts of climate change could bring devastating hydrological events to some of our planet's most populous places.

Miami Beach is one such city that has already experienced how the comparatively small rise in sea level over the last few decades, combined with increasing precipitation can have dramatic effects on the lives of those living in such vulnerable areas. In 2017, just after the completion of an immense infrastructure project to raise roads, build sea walls, and implement storm drainage back-flow prevention systems, an August afternoon rainstorm caused extensive flooding[2]. The combination of a high tide, seven inches of rain in an afternoon, loss of power, and inadequate backup power to the new pumping station infrastructure caused flooding damage to homes, businesses, and vehicles, disrupting the functioning of large portions of Miami Beach. This event proved that these defenses are also delicate and vulnerable. This happened the day before Al Gore premiered his second climate change documentary "An Inconvenient Sequel: Truth to Power" at the New World Symphony Hall in Miami Beach.

This book describes the research design project at Florida International University's Miami Beach Urban Studio exploring the nexus of food, energy, and infrastructure as it pertains to the growing challenges of climate change and sea-level rise in Miami Beach. Under the umbrella of the EU/NSF funded "CRUNCH (Climate Resilient Urban Nexus Choices)", the research focused on a low-lying area of the City of Miami Beach called Indian Creek, which is prone to sunny day flooding during King Tides. Based on a "living shoreline" strategy of biotechnological, adaptive ecosystems such as mangroves, oysters and coral clusters, projects were developed as part of a bigger citywide program to combat sea level rise by raising roads, building seawalls, and improving storm water management infrastructure.

All research designs were based on approximately 80-year scenarios (2020-2100) in which modeling by NOAA, NASA, and IPCC place much of the City of Miami Beach's existing infrastructure under water. The study includes eight different approaches each envisioning and testing self-sufficient, adaptive, and resilient hybrid structures (both under and above water). The hybrids were benchmarked against 100% carbon-neutrality using calibrated Autodesk Building Information Modeling (BIM) through cloud engines in Green Building Studio (GBS) and Insight 360. Many of the themes explored were based on marine animal and plant processes, for example, shelled organisms and different forms of jellyfish, algae, and corals. Other designs included: algae farms for food and protein; the use of structures that harness mixed and distributed renewable energy such as solar, thermal, and biomass; the conversion of solid and organic waste to energy; and waste water to potable water on self-contained live-work hybrids structures.

Many of the hybrid structures made use of biomechatronics — a combination of biology, mechanics, electronics, and information technology that enabled new, creative, and sometimes visionary solutions to support decarbonization in building systems. Other methods explored synthetic biology to develop new forms of blue-green architecture that respond to environmental changes by incorporating the dynamic properties of living systems such as growth, repair, sensitivity and replication.

The biomimetic principles and concepts, fitness tests, biotechnological research, and synthetic biology-oriented building and city systems used in the research focused on carbon-neutrality targets so as not to further burden our planet with the human-produced causes of climate change.

As designers, we need to turn our thinking from a defensive strategy to an adaptive strategy that always considers and mitigates any further harm to our planet and its inhabitants.

[1] *https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf*
[2] *https://www.washingtonpost.com/news/capital-weather-gang/wp/2017/08/02/the-miami-area-endured-an-absurd-flooding-event-tuesday-afternoon/*

MIAMI BEACH 1925

PHOTO CREDIT: AERIAL VIEW OF MIAMI BEACH. 1925. BLACK & WHITE PHOTO-PRINT, 10 X 8 IN. STATE ARCHIVES OF FLORIDA. FROM FLORIDA MEMORY.

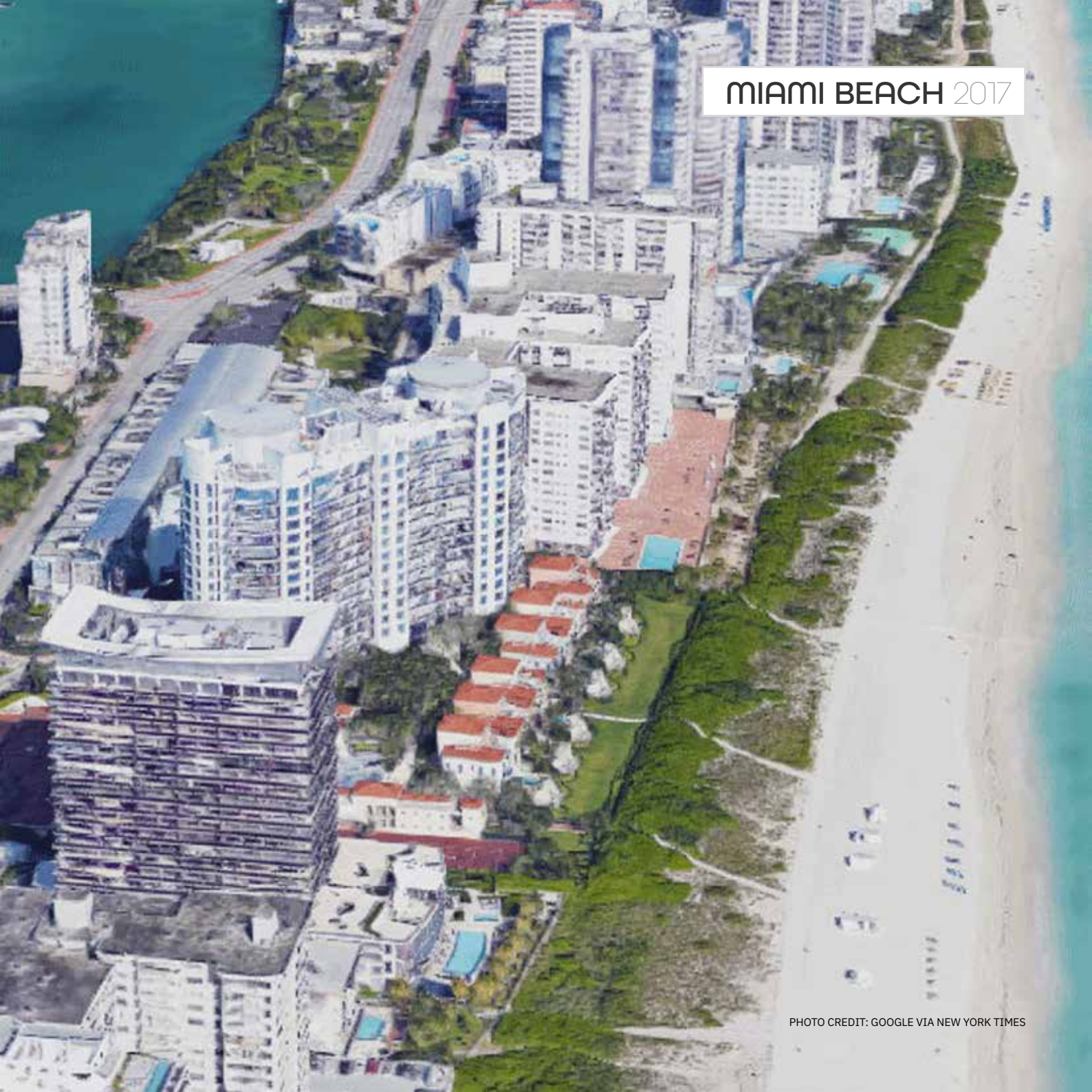


PHOTO CREDIT: GOOGLE VIA NEW YORK TIMES

2018 SITE CONDITIONS

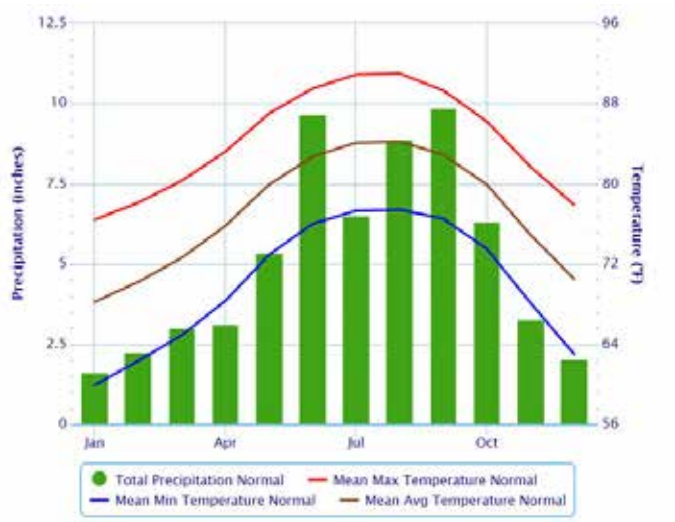
The average elevation for the City of Miami Beach is 4.5 feet sitting atop a permeable limestone/sand base. This puts the city in a vulnerable position with regards to sea level rise. Unlike cities such as Amsterdam which have the luxury of an impermeable bedrock, the foundation of Miami Beach will allow water to seep up through the limestone preventing any long-term attempts at building defensive seawalls moot.

The climate in Miami is hot and humid during the monsoon season (June-November) and mild and dry during the rest of the year and is prone to tropical cyclones with a history of land-falling major hurricanes.

King Tides exasperate the risk of flooding, particularly during the months of September to November, with high tides that can be several feet above normal high tides. Add to this tropical downpours that can produce 7+ inches an hour and it is clear that Miami Beach faces many hydrological challenges.

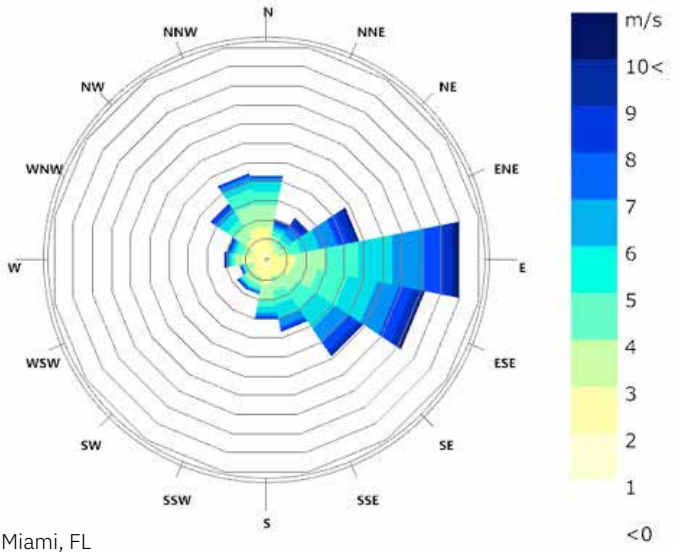
The images opposite show the NOAA Intermediate High Scenario for sea level rise in Miami Beach. By 2100, much of the island's infrastructure will be touched by ocean water.

NORMAL TEMPERATURES & PRECIPITATION



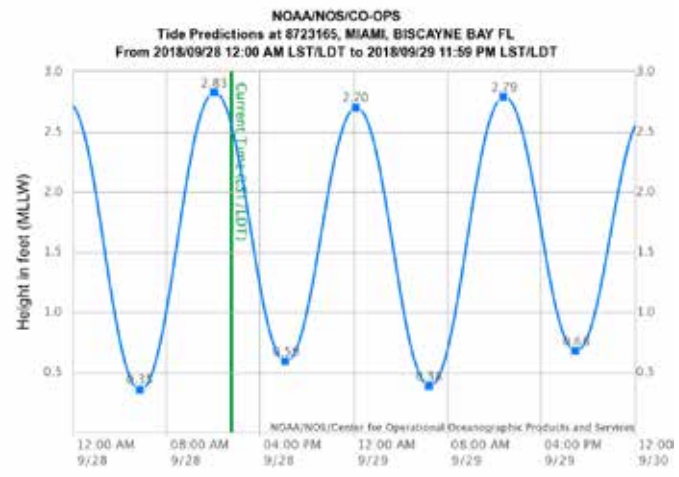
SOURCE: NOAA

ANNUAL WIND ROSE

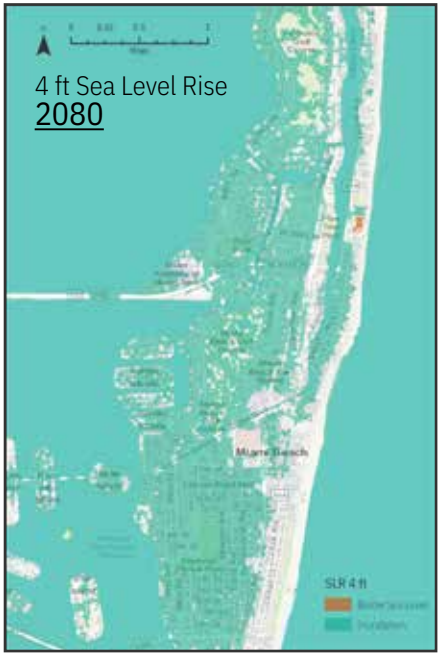


Miami, FL
1 Jan - 31 Dec
Hourly Data: Wind Speed (m/s)
Calm for 2.09% of the time = 183 hours

TYPICAL DAILY TIDAL PATTERN



SEA LEVEL RISE IN MIAMI BEACH



SOURCE: NOAA INTERMEDIATE HIGH SCENARIO

INDIAN CREEK DRIVE & PANCOAST LAKE

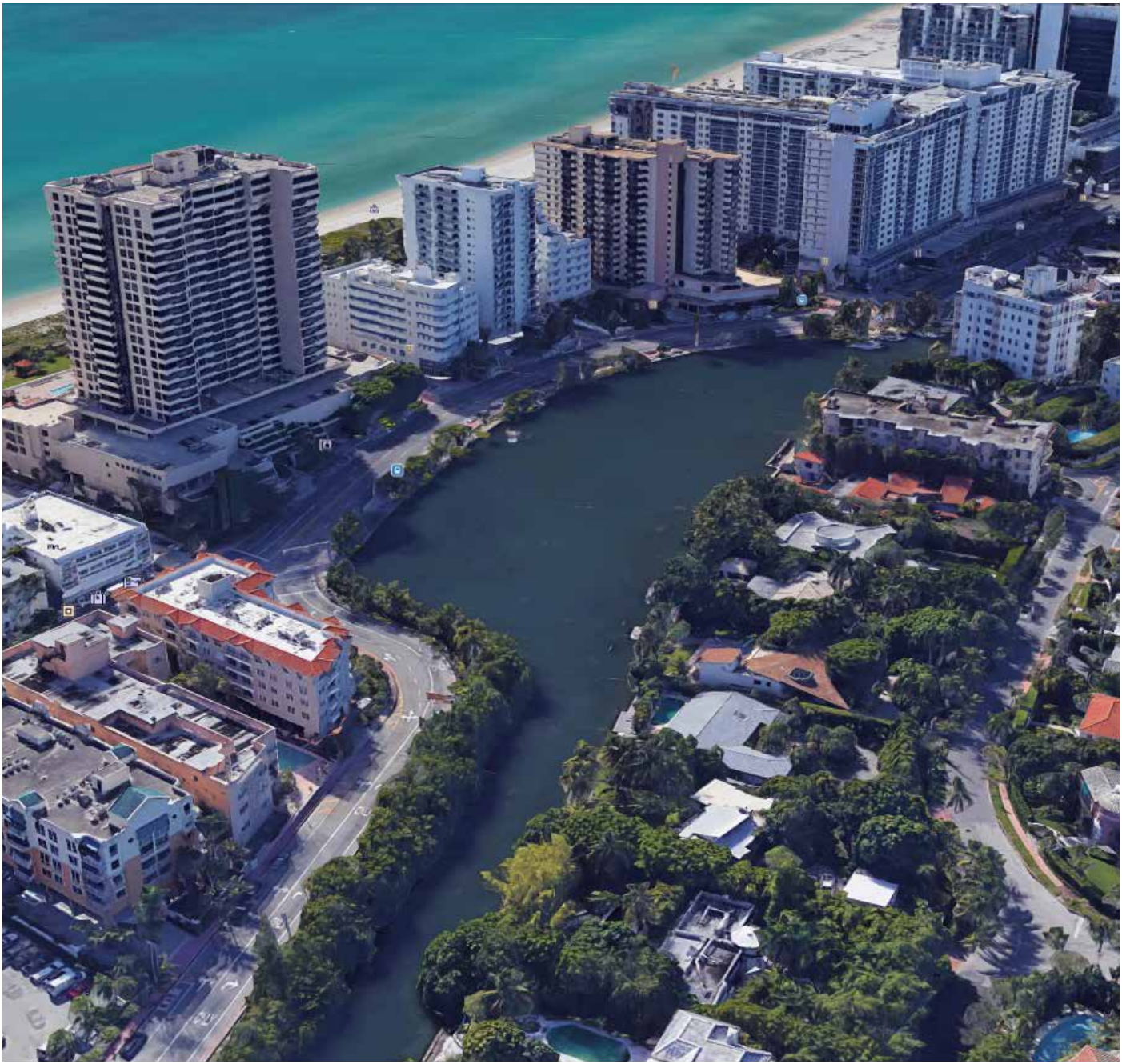


IMAGE CREDIT: GOOGLE EARTH

MIAMI BEACH "RISING ABOVE" 2017

The research design scenarios presented in this book focus on an area of Miami Beach called Lake Pancoast located on the intra-coastal waterways connecting the Biscayne Bay and the Atlantic Ocean. In 2017, the City of Miami Beach started the construction of an elevated seawall, storm drainage system and elevated roadway in an attempt to hold back sunny day flooding during King Tides. In addition, the project intended to add "living shorelines" to mitigate flooding. Unfortunately, the project has had many setbacks. The research design scenarios looked at ways to create structures that can adapt to changes in sea level rather than have an end life once a particular sea level has been reached. The emphasis was on adaptive blue-green infrastructure rather than defensive gray infrastructure.

IMAGES CREDIT: DMSI ON BEHALF OF CITY OF MIAMI BEACH WWW.DMSI.CO/INDIAN-CREEK/

LIVING SHORELINES NATIVE FLORA

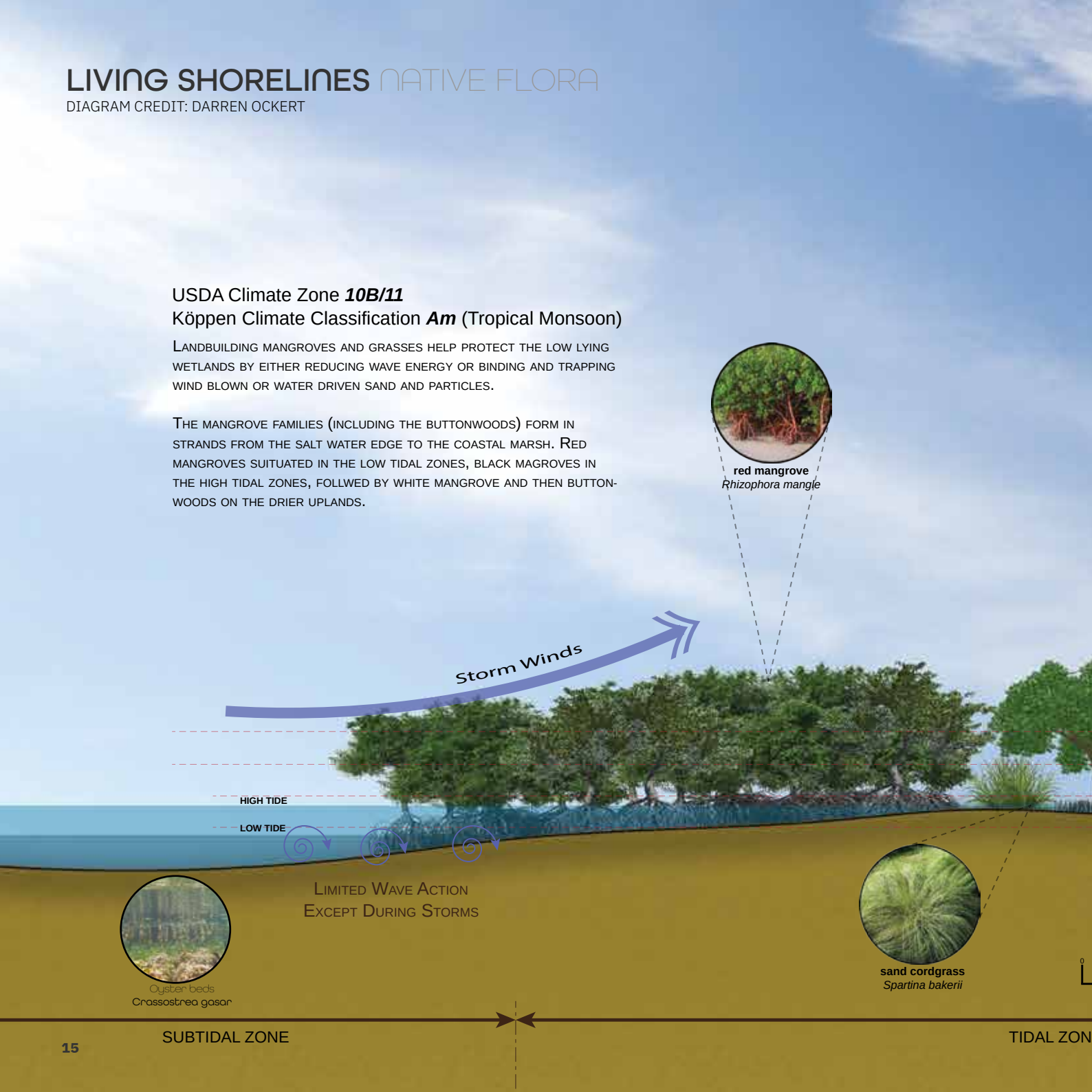
DIAGRAM CREDIT: DARREN OCKERT

USDA Climate Zone ***10B/11***

Köppen Climate Classification ***Am*** (Tropical Monsoon)

Landbuilding mangroves and grasses help protect the low lying wetlands by either reducing wave energy or binding and trapping wind blown or water driven sand and particles.

The mangrove families (including the buttonwoods) form in strands from the salt water edge to the coastal marsh. Red mangroves suituated in the low tidal zones, black magroves in the high tidal zones, follwed by white mangrove and then button-woods on the drier uplands.



EXAMPLE LOCATION: 25º53´27.90˝ N 81º29´02.01˝ W

black mangrove
Avicennia germinans

white mangrove
Laguncularia racemosa

green buttonwood
Conocarpus erectus

silver buttonwood
Conocarpus erectus
forma *sericeus*

marshelder
Iva frutescens

silver seaside daisy
Borrichia aborescens

saltwort
Batis maritima

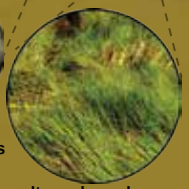
Vertical Height Exag

glasswort
Salicornia bigelovii

golden leather fern
Acrostichum aureum

green seaside daisy
Borrichia frutescens

saltmeadow cordgrass
Spartina patens



saltmarsh cordgrass
Spartina alterniflora

100
feet

E

UPLAND

TIDAL CITY DECIPHERING THE DATUMS

The research projects discussed in this book used data from engineering surveys conducted by Stantec.

Stantec used datums taken from NOAA Station ID 8723165 (figure 1) and conducted their own survey of the site using MHWL which is defined as follows:

The boundary of a tidally influenced surface water body is the "mean high water line", (MHWL). The MHWL is an elevation derived from Mean High Water Surveys or studies currently based on the National Tidal Datum Epoch 1983-2001 (NTDE 83-01). These surveys reference the North American Vertical Datum adjustment of 1988 (NAVD88) and the unit of measurement is feet. Determination of the MHWL requires an elevation which must be established by Professional Surveyors and Mappers.

The Stantec survey prepared by Atkins North America, Inc. produced the following data:

MHWL (Mean High Water Line): 0.11 ft (this would translate to 2.22ft using MLLW as the datum)

MLWL (Mean Low Water Line): -2.07 ft (this would translate to 0.04 ft using MLLW as the datum)

The sections show the height of the new seawall bulkhead at 5.7 ft NAVD88 which would translate to (7.81 ft using MLLW as the datum)

From this, one can deduce the median sea level based on this data is 1.09 ft.

It was recommend during the research that all data by convert to NAVD88 as this is the datum standard used by Stantec in their technical drawings and is a standard architectural and engineering datum.

Below is the Stantec Section B-B (figure 2) "living shoreline" with overlaid **high and low tides (in blue)** for the period of 9/27/2018 to 9/28/2018.

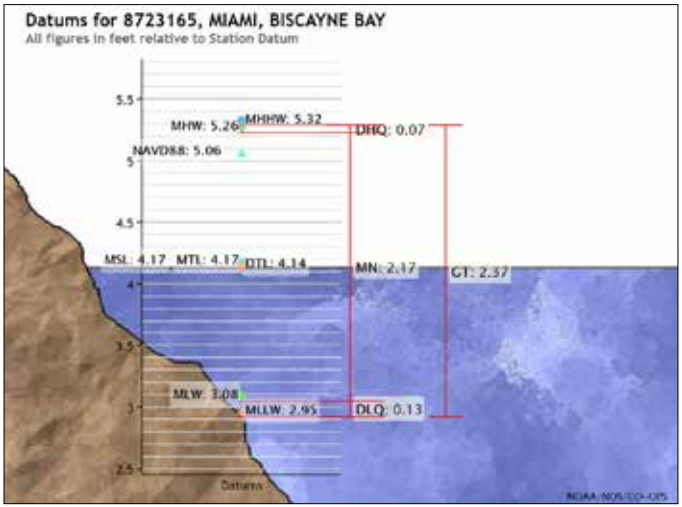


Figure 1

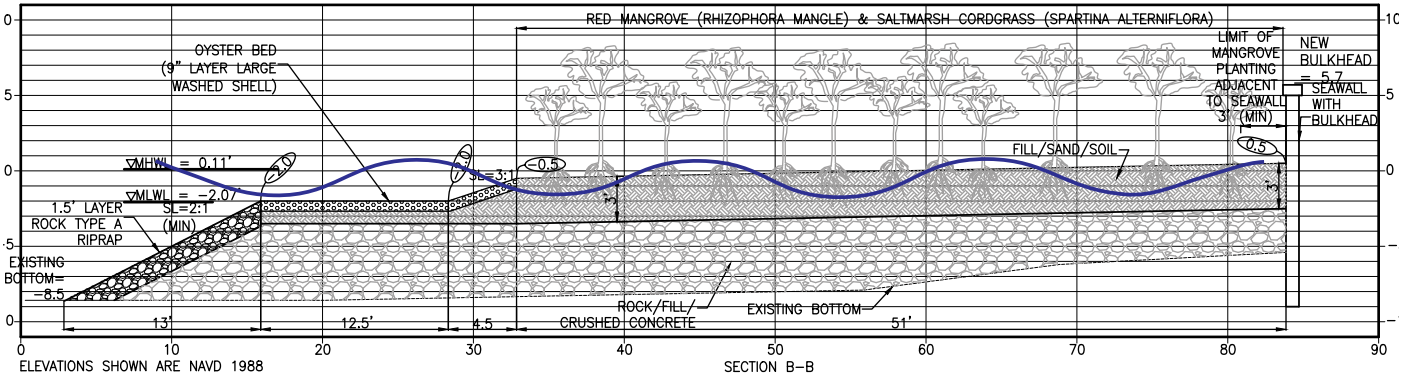


Figure 2

Note: Scale of tidal predications has been matched to drawing scale

CRUNCH researchers visit the arkup hybrid during its visit to Star Island in the City of Miami Beach. The arkup hybrid is a sustainable floating residence that can adapt to sea level rise and can withstand hurricane force winds and storm surge. https://arkup.com/