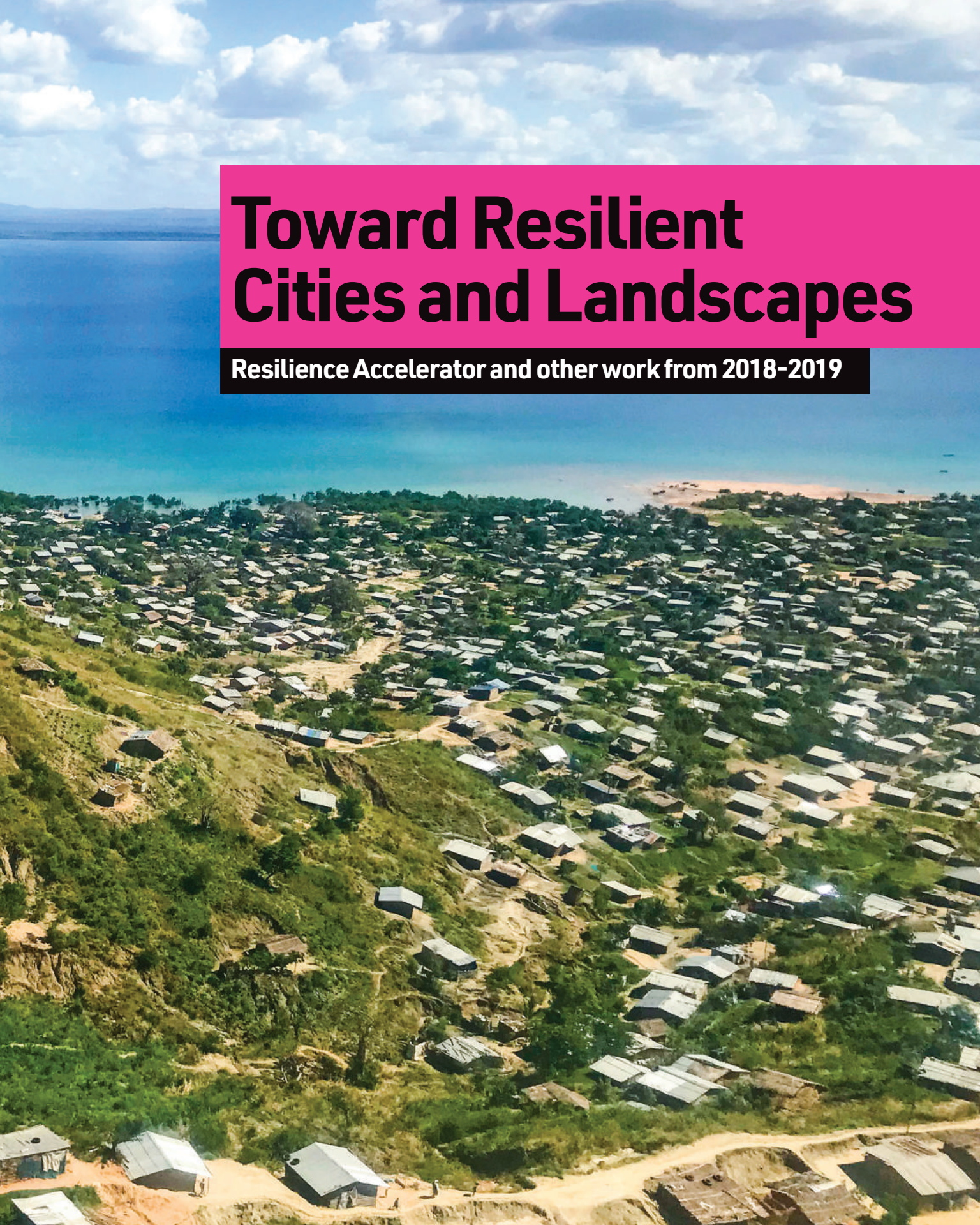
Toward Resilient Cities and Landscapes

Resilience Accelerator and other work from 2018-2019



COLUMBIA | Center for Resilient Cities and Landscapes

100 RESILIENT CITIES — Pioneered by the Rockefeller Foundation

COLUMBIA GSAPP — Columbia University Graduate School of Architecture, Planning, and Preservation

Toward Resilient Cities and Landscapes

Resilience Accelerator and other work from 2018-2019

COLUMBIA UNIVERSITY
Center for Resilient Cities and Landscapes

STUDENTS AND FACULTY FROM GSAPP AND LURIO UNIVERSITY LEARNING ABOUT RURAL LIVELIHOODS IN MOZAMBIQUE

MISSION: The Center for Resilient Cities and Landscapes (CRCL) uses planning and design to help communities and ecosystems adapt to the pressures of urbanization, inequality, and climate change. CRCL works with public, nonprofit, and academic partners to deliver practical and forward-thinking technical assistance that advances project implementation through interdisciplinary research, visualization of risk, project design scenarios, and intensive, facilitated convenings.

The 20th century saw the impact of human activity reach all corners of the earth. As a result of this technological and demographic leap, communities and ecosystems everywhere are now faced with unprecedented risks from the unwinding of natural systems on which all life depends. As climate patterns become more extreme and unpredictable, our outmoded infrastructure and urban systems are working against us. Critical natural resources like fresh water, productive soil and fisheries, and safe high ground are becoming increasingly rare, and in some cases, hoarded by the most wealthy. Competition for these resources is sparking conflicts and reinforcing historic patterns of oppression. The shockwaves from these conflicts are destabilizing entire regions in the form of migration crises, rampant nationalism and sectarianism, and a global sense of unease. We are more disconnected as a society – from each other and from the natural systems to which we are fundamentally connected.

While these challenges can seem overwhelming, the Center for Resilient Cities and Landscapes over the past year has become part of an emerging global network of resilience practitioners united in the belief that we must change how we plan and design our cities and manage the landscapes on which they depend. We've had the opportunity to travel to places around the world and work with local leaders and communities confronting these challenges head-on. We've seen how a sense of agency over the future—even hope—can emerge through deep listening, open collaboration and visualization of alternative futures.

HOUSES BUILT ALONG CANALS IN CAN THO, A CITY IN THE LOWER MEKONG DELTA

The Resilience Accelerator Program—a partnership between 100 Resilient Cities and CRCL supported by The Rockefeller Foundation—is an ongoing collaboration with chief resilience officers in eight cities to advance transformative projects in the built environment. Bringing interdisciplinary research and inclusive collaboration to these projects not only improves the project, but also creates pathways for all future projects in similar contexts. These pathways seek to cut across existing hierarchies and challenge the status quo. Our conception of resilience is founded in ecology and applied to urban systems and governance, where organizations that can survive shocks and adapt to changes are those that depend on diversity and complex interconnectedness; they are more network than hierarchy.

The Resilience Accelerator was developed because we know that applying the best available scientific understanding and high-quality design talent at the front end of resilience project development leads to better outcomes for cities and the communities they serve. Universities and scientific institutions have enormous capacity to support cities to become more resilient but lack the structures to do this. The Resilience Accelerator provides the membrane to do this.

In each instance of the Accelerator program, we began with research into the unique conditions of the place, how it has come to be and how it is changing today. Our research program varied based on what was needed for the project, but it included global case studies, geospatial analysis of changing land uses, remote sensing of land surface temperature, visual analysis of risk, and long-term scenario planning. We used this research to design interdisciplinary workshops in which a project concept was developed, critiqued and reconceived. These workshops not only advanced the projects, but also built a shared sense of agency and enthusiasm for moving forward together.

As a new Center founded at the Graduate School of Architecture, Planning and Preservation at Columbia University, we have brought these real-life challenges into the classroom where tomorrow's planners and designers are developing the tools of the professions and a sense of purpose. GSAPP students have been able to connect with their peers in the places we are working, learning together about what makes a place more resilient.

Our Team

Katherine Orff
Faculty Director

Thaddeus Pawlowski
Managing Director

Johanna Lovecchio
Associate Director

Sam Carter
Director,
Resilience Accelerator

Katherine Orff (Faculty Director, CRCL) is the founder of SCAPE and is an associate professor and director of the Urban Design Program in the Graduate School of Architecture, Planning, and Preservation at Columbia University. She is a MacArthur Fellow, and received a B.A. from the University of Virginia and an M.L.A. from Harvard University.

Thaddeus Pawlowski (Managing Director, CRCL) planned for disasters at the NYC Office of Emergency Management, worked to reduce the likelihood and impact of disasters at NYC Department of City Planning, and then helped the City recover from Hurricane Sandy at the NYC Mayor's Office. He received an MArch from University of Pennsylvania and was a 2015 Loeb Fellow at Harvard University.

Johanna Lovecchio (Associate Director, CRCL) worked as a Senior Analyst and Program Manager at HR&A Advisors, where she scaled resilience capacity-building models and developed climate adaptation plans. She has a MUP from the Robert F. Wagner School of Public Service and dual Bachelor of Arts degrees in Environmental Studies and Metropolitan Studies from the New York University College of Arts and Sciences.

Sam Carter (Director, Resilience Accelerator at 100RC). Before founding the Resilience Accelerator program with 100 Resilient Cities, Sam managed the Rockefeller Foundation's field-building work on resilience including National Disaster Resilience Competition and ongoing recovery and resilience efforts in New York, Louisiana and Puerto Rico. Before that he helped to found the Institute for Public Knowledge at NYU, where he also studied planning and policy.

THE ISLAND OF DOMINICA A FEW MONTHS AFTER HURRICANE MARIA CAUSED SIGNIFICANT DAMAGE TO HOUSING, INFRASTRUCTURE, AGRICULTURE AND FORESTS

Michelle Mueller is a program manager at 100 Resilient Cities, supporting member cities with their strategies and projects. Michelle worked at Acumen, a non-profit focused on poverty and as an AidData Fellow in Mexico City at Instituto Mora. Michelle has a BA from the University of Texas at Austin in Government and Latin American Studies and is now on her way to MIT to study urban planning.

Grga Basic is an associate research scholar focussing on critical, narrative, and investigative cartography. Grga previously worked at the Center for Spatial Research, the Harvard Urban Theory Lab and worked as an architect in Paris. He studied architecture and urbanism in Vienna and at Harvard.

Linda Schilling is an associate research scholar and graduate of GSAPP's MSAUD program, where she received the William Kinne Fellowship. She was trained as an architect in Chile.

Gideon Finck is a research scholar and graduate a Masters in Landscape Architecture from the Harvard Graduate School of Design. He has a background in studio art and previously worked as a letterpress printer.

Georine Pierre is an associate research scholar who studied architecture at California College of Arts where her thesis research e-waste recycling in Ghana received the Kaz Baba Memorial Travel Grant.

> **"This isn't just about these five projects, but the tens of thousands of projects in the years ahead... There is no such thing as just a transit project anymore, or just a water project... every project needs to build resilience in the places and communities it touches."**
>
> – SAM CARTER, DIRECTOR, RESILIENCE ACCELERATOR

BRICKELL BAY DRIVE IN MIAMI, ONE OF THE PLACES WHERE STORM SURGE ENTERED THE CITY DURING HURRICANE IRMA

MIAMI-DADE CRO JIM MURLEY EXPLAINING TRANSPORTATION PLANS FOR THE FUTURE

Facing the Rising Tide Together

FIVE PROJECTS IN SOUTHEAST FLORIDA

To start the Resilience Accelerator program, we traveled to the region considered the most vulnerable to climate change in the US. With over six million people today, Southeast Florida continues to grow fast despite mounting problems: increasingly unaffordable housing, aging infrastructure in poor repair, rising sea levels and more active hurricane seasons. These problems are experienced by all 99 municipalities in the region, but there are few vehicles for city officials to share knowledge and resources and collaborate on strategies.

Chief Resilience Officers (CROs) allied with the Southeast Florida Climate Compact selected five projects to demonstrate a new model for future infrastructure–from the beaches to the bayfront, from the densest urban areas to the down-and out exurban edges. We visited the project sites, met with locals and experts, and then designed an immersive multi-stakeholder forum for advancing the projects while simultaneously fostering regional collaboration. This immersive three-day event brought together a wide array of voices, from Mayor of Miami Beach Dan Gelber to the performance Artist Misael Soto, who live-streamed spontaneous interactions with the public from each site into the conference venue.

On the first day of the workshop, project leaders presented their current plans and the challenges they faced. Miami Beach was stuck in a process of elevating West Avenue to prevent tidal flooding. The City of Miami was ready to rethink a stretch of bayfront as a public amenity. West Palm Beach was seeking new solutions for a sea-wall that incorporates natural features like mangroves. Palm Beach County was trying to build support for transitional housing for its increasing homeless population. Miami Dade County engaged the Accelerator to develop ideas for how to make future transit stations "resilience hubs," public spaces that would attract people to transit-oriented development on higher ground.

Over the next three days, facilitators from CRCL and 100RC led project teams through a series of exercises to better understand the context for the projects, the root causes of the challenges they faced in design and implementation, and build consensus on pathways forward. Visiting experts offered critical perspectives and inspirational precedents. After an intense two and a half days of work, the project leaders presented again, this time to the public and the press. The projects had evolved in both design and implementation strategy to build momentum toward next steps.

BY THE NUMBERS

4
inches of sea level rise since 1992, with an additional 3–7 inches of expected sea level rise by 2030.

Over
85,000
people and 53,000 homes located less than 3 feet above high tide.

$21 billion
in assets at risk
due to sea level rise.

$2.9 billion
in damages from Hurricanes Katrina and Wilma in 2005.

$467 million
in estimated damages from Hurricane Irma in 2017.

PARTNERS

100 Resilient Cities
Southeast Florida Regional Climate Change Compact
The Miami Foundation
Resilient305
City of Miami Beach
City of Miami
Miami–Dade County
Palm Beach County
West Palm Beach

Nine months since the Accelerator Workshop:

Greater Miami & the Beaches Resilient305 strategy proposes to use the Accelerator process to drive transformational projects throughout the region.

MIAMI-DADE COUNTY

RESILIENCE HUBS

Miami-Dade County will include the Resilience Hubs concepts, as appropriate, in the planning and implementation of SMART Plan Corridor stations.

CITY OF MIAMI

BRICKELL BAY DRIVE

Planning and design is now funded via the first round of the Miami Forever Bond program, and the City of Miami is now updating its procurement processes to help attract a multidisciplinary team with strong community engagement skills.

CITY OF MIAMI BEACH

WEST AVENUE

Project is back on track with community support and a change order from the City Commission funding additional design elements and public benefits.

Miami Beach is also institutionalizing the lessons of the Accelerator Workshop, bringing a multidisciplinary design approach and enhanced community engagement to all new neighborhood improvement projects.

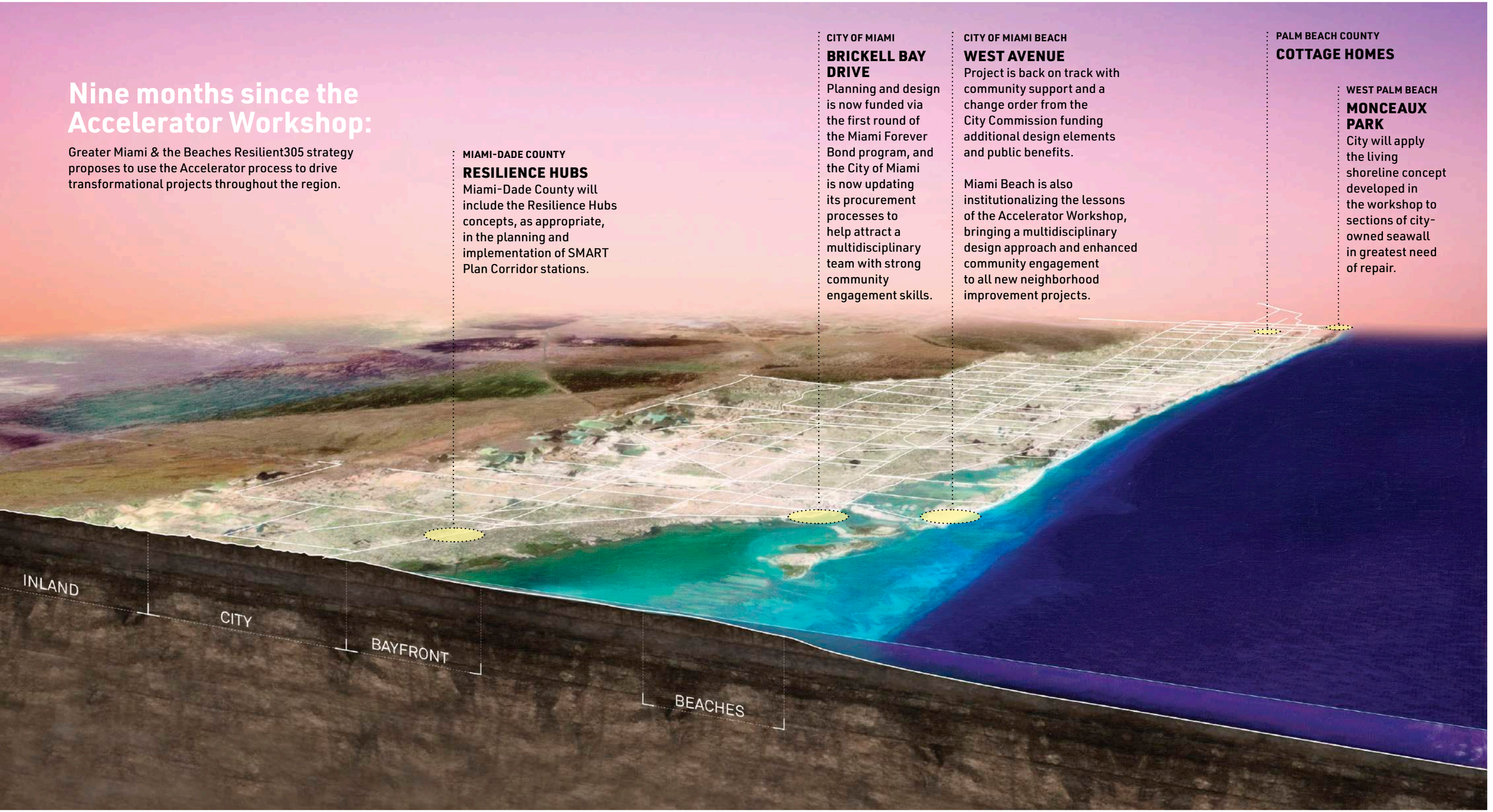
PALM BEACH COUNTY

COTTAGE HOMES

WEST PALM BEACH

MONCEAUX PARK

City will apply the living shoreline concept developed in the workshop to sections of city-owned seawall in greatest need of repair.



Changing Course along the Yaque River

EQUITABLE RELOCATIONS IN SANTIAGO DE LOS CABALLEROS

VIEW OF THE YAQUE DEL NORTE RIVER

Tucked between two mountain ranges, Santiago de los Caballeros is home to the second-largest urban population in the Dominican Republic and is a booming agricultural and industrial trade center. Winding through the heart of the city is the island's largest river, El Yaque, connecting Santiago to both mountains and sea. Yet to many today, the Rio Yaque remains forgotten and neglected. As Maria Isabel Serrano, the city's Chief Resilience Officer and Director of Risk explains, "Santiaguinos have turned their backs to the river."

However, many people have built their homes and raised their families in the river valley, often on unstable slopes and banks that flood and erode when the river swells during seasonal tropical storms. Many of these communities–some Haitian-Dominicans–have historically been disenfranchised which complicates any effort by the government to improve their conditions. The InterAmerican Development Bank has been working with the City and other stakeholders on a plan to relocate one of the most vulnerable communities in the City and build a levee to protect another. This effort also includes making public realm improvement to the waterfront and a market in the center of the City.

The Accelerator here began as an effort to advance this trio of projects, but during the course of our work, it became clear that these projects could only advance after establishing trust between the affected communities and the government. After site visits, meetings with community leaders, and two days of hands-on design and implementation exercises; the Accelerator offered one model of an open and transparent process that could build that needed trust.

Workshops can promote deep listening, a common understanding of the complex risk, and empathy and appreciation for the unique cultural and human values of communities. They can also demystify the intentions of government and other stakeholders and better define the public interest. Unfortunately, one workshop cannot reverse histories of injustice, but it can be an important step to help us all no longer turn our backs on our most vulnerable neighbors and embrace the natural systems on which we all depend.

BY THE NUMBERS

17
people lost their lives in Santiago during Tropical Storm Olga in 2007, and thousands were left without homes.

33,000
households in SDLC are located in informal settlements.

50,000
Haitian immigrants and descendants live in SDLC, which represents 5% of the total population of the city.

142
communities face flood risk from the Rio del Yaque and its tributaries.

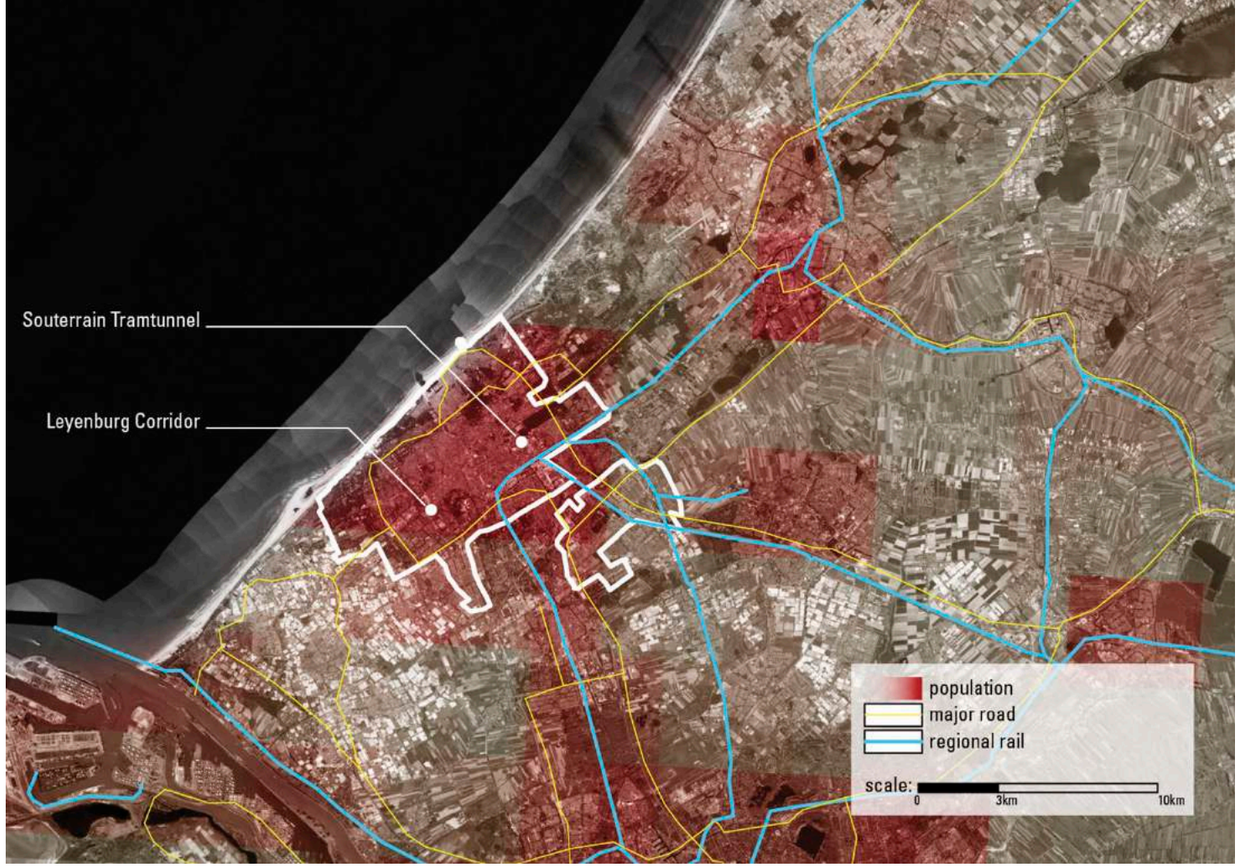
TAKE–AWAY: The Resilience Accelerator offered a model for how the City and residents can build trust in an open forum and work together to create safe housing on high ground for vulnerable communities. It also connected the City and their partners to experienced subject matter experts who have valuable lessons learned from relocation in other cities.

PARTNERS

100 Resilient Cities

Inter–American Development Bank (IADB)

Municipality of Santiago de los Caballeros



MAJOR TRANSPORTATION PROJECTS AND HOUSING DENSITY IN THE HAGUE

Planning for Equity in Transportation

PEOPLE-ORIENTED DEVELOPMENT IN THE HAGUE

Traveling to the Netherlands is like a guided tour of urban resilience in practice, with densely-clustered lively towns where sand engines replenish beaches and vast systems of canals, polders and dykes have been holding back the North Sea for a millennia. There are windmills, vertical farms, district geothermal, and bicycles everywhere. Most of all, the efficiency of the public transport in the Netherlands makes a trip across the country seem not much more arduous than a trip across town.

But resilience in practice is a constant process of learning from the past and striving for improvement. It was in this spirit that Anne-Marie Hitipeuw, the CRO of the Hague, invited the Resilience Accelerator to guide a long-term plan for a new transit line from the center of the Hague to the Escamp neighborhood in the Southwest. This neighborhood was built after WWII as worker housing, but many of the original inhabitants moved to suburbs long ago. Today the neighborhood is largely composed of recent immigrants who are much less wealthy than other neighborhoods in this affluent city.

Anne-Marie and her colleagues took us to Escamp and introduced us to community leaders of all kinds: teachers, police, entrepreneurs, imams, priests, and artists. Over a community dinner, we learned about the problems behind closed doors, and a pervading sense of loneliness and desire for greater community cohesion. Our question became, if the City makes this major investment in transportation, what will it do for the people here today? Transportation always brings more housing and more opportunities, but how will their interests be represented in that process?

After our visit, we worked with GSAPP urban planning students to compile relevant case studies of recent transportation projects around the world. What were the successes and failures from various points of view? How did the project help urban mobility in general and how did it help the people most affected? We delivered these case studies to The Hague along with recommendations for how this new public investment could help to make both the City and the people of Escamp more resilient to the stresses that affect them both behind closed doors and traveling across town.

TAKE–AWAY: How we plan infrastructure today is a matter of life and death for the planet. It can create and strengthen structural inequality in our societies, degrade trust between citizens and the governments that serve them, and lock in patterns of fossil fuel consumption and land use that will accelerate global warming.

A better model for planning infrastructure will strengthen trust between citizens and government, seek to be inclusive in planning and reverse structural inequalities, protect remaining wild areas, and drive us toward a just transition to a post fossil fuel economy.

BY THE NUMBERS

14%
of total global greenhouse gas emissions come from the transport sector alone,

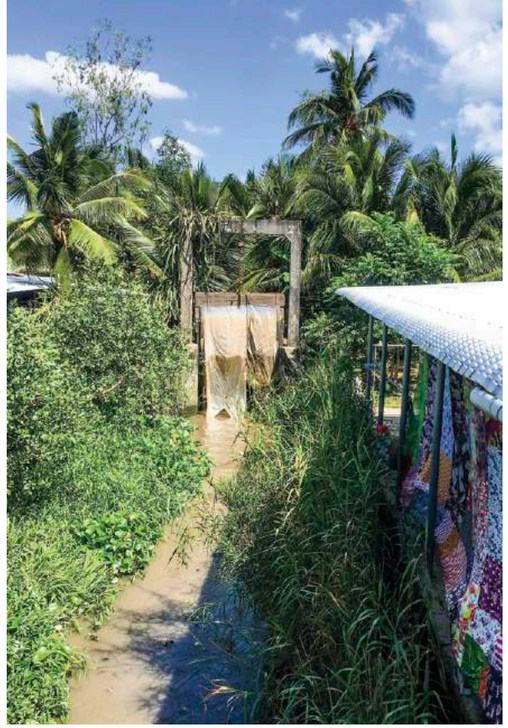
amounting to about
7B metric tons
annually, or roughly triple the amount of carbon offset by the world's forests, according to the Intergovernmental Panel on Climate Change.

PARTNERS

100 Resilient Cities
GSAPP Urban Planning Seminar
Resilient Den Hague

Urban Transformation Guided by Nature

CAN THO AT AN INFLECTION POINT



(TOP LEFT) A WOMAN SELLING LOCALLY GROWN FRUIT IN CAN THO'S FLOATING MARKET.
(TOP RIGHT) A SLUICE GATE, MANAGING FLOW OF WATER TO FRUIT ORCHARDS.
(BOTTOM RIGHT) DR. TRUNG DISCUSSES RESILIENCE WITH STUDENTS AND FACULTY

For thousands of years, the Mekong River's sediment deposits have created a vast delta which sustains some of the world's richest ecosystems, cultures, and agricultural practices. For centuries, humans have managed this watery land with canals, sluice gates, and agricultural practices finely tuned to the region's tropical climate and seasonal hydrology. Today these conditions are being radically re-shaped by climate change, sea level rise, urbanization and dam construction.

Can Tho, the largest and most economically important city in the delta, sits at a crossroads between the region's agricultural past and globally-connected future. As it transitions to an industrial and service-based economy, Can Tho's urban footprint is expanding rapidly, transforming canals into roads and agricultural land into new residential and industrial areas. These land-use changes are leading to widespread displacement of resident farmers, who are left without the means to support themselves in the new urban areas. These changes are also leading to increased dependence on groundwater for domestic, industrial and agricultural uses, as upstream dams, unpredictable weather patterns, and local water pollution have made local rivers and canals less reliable sources of freshwater. This has led to alarming rates of land subsidence and urban flooding, which put people and property at risk. The city's response to this flooding to date has been to add more hard infrastructure: levees, channels and pumps.

CRO Dr. Nguyen Hieu Trung invited the Accelerator program to propose new patterns of urban development utilizing a nature-based approach to water management. During a research trip in January 2019, Dr. Trung, led us through an investigation of the region's agriculture, heritage, infrastructure, recent urban development trends, and changing industrial economy. Alongside students from Can Tho University, we worked together to understand the culture and challenges of Can Tho, and define design principles and project concepts, including agro-urban housing models, district-wide renewable energy utilizing agricultural by-product as biomass, and canal-based and amphibious neighborhoods inspired by the region's heritage of floating housing and markets.

"The bamboo that bends is stronger than the oak that resists."

–DR. TRUNG

TAKE–AWAY: If the drive toward building a global, technologically-advanced city can be combined with traditional knowledge of sustainable agriculture and water management, Can Tho can help define what a sustainable, resilient, and equitable city looks like.

BY THE NUMBERS

18 Million
people in the Mekong Delta.

30 centimeters
of sea level rise
expected by 2050.

Average of
1-4 centimeters
of subsidence/year.

187
existing and planned upstream dams on the Mekong are diverting the city's water supply.

PARTNERS

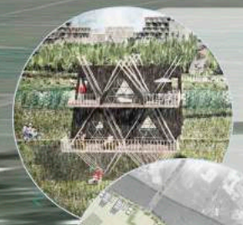
GSAPP Urban Design Studio

100 Resilient Cities

DRAGON Institute, Can Tho University

Can Tho Resilience Unit

IMAGES OF STUDENT WORK FROM THE GSAPP'S SPRING 2019 URBAN DESIGN STUDIO. THESE PROJECTS ILLUSTRATE DESIGN PRINCIPLES FOR NATURE-BASED URBANIZATION.

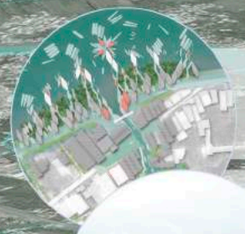


CAPITALIZE ON EXISTING LANDSCAPES TO CONSERVE WATER, SOIL, AND LIVELIHOODS

LEVERAGING LINEAR LANDSCAPES
Shuyuan Li | Sharvi Jain | Jianqi Li | Devaki Handa

COORDINATE GREEN INFRASTRUCTURE WITH NEIGHBORHOOD PLANNING

RECONNECT TO BIOSPHERE
Alaa Marrawi



ADAPT BUILDINGS AND INFRASTRUCTURE TO ADDRESS LONG TERM CLIMATE TRANSITION

AMPHIBIOUS CAN THO
Amanpreet Duggal | David Mauricio | Gabriel Vergara

COMPLEMENT URBAN GROWTH WITH CONSERVATION STRATEGIES THAT PROTECT RURAL LANDSCAPES, LIVELIHOODS AND COMMUNITIES

THE URBAN FRAME
Aniket Dikshit | Mariam Hattab | Burke Kalemoglu

USE TRADITIONAL AND NEW TECHNOLOGIES TO ENABLE PARTNERSHIPS BETWEEN INDUSTRIAL, INFRASTRUCTURAL, ECOLOGICAL AND SOCIAL INTEREST GROUPS

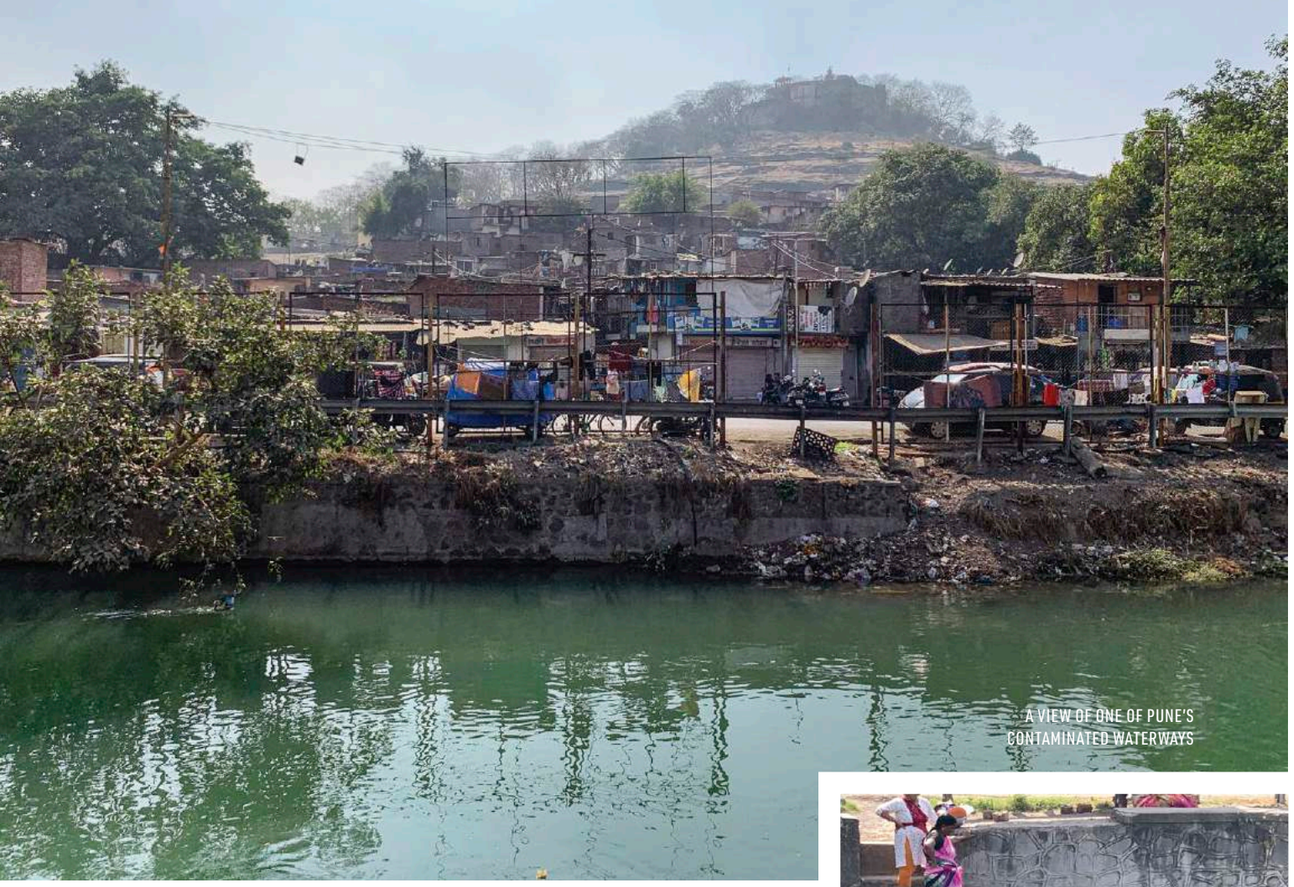
NEW ENERGY LANDSCAPE
Angela Crisostomo | Bohong Zhang | Peiqing Wang | Wenjun Zhang

CELEBRATE CAN THO'S IDENTITY AS A WATER CITY

LIFE AQUATIC
Junyu Cao | Zeyi Jiang | Ashley Louie | Dian Yu

USE WATER NETWORKS AND PUBLIC SPACE TO MODERATE FLOODING AND POLLUTION

[RE]FLOW CAN THO
Shivani Agarwal | Hsin Yi Chao | Greg Lemaire | Tanaya Kadam



A VIEW OF ONE OF PUNE'S CONTAMINATED WATERWAYS

Ecology and Equity on the Mula Mutha

PUNE'S RIVERS AS A FOUNTAIN FOR RESILIENT GROWTH

In the foothills of the Western Ghats, the most biodiverse region of India, the sprawling City of Pune is one of India's largest and most economically thriving cities. In the hills above Pune, four dams hold much of the water that once coursed through Mula and Mutha rivers when the City was the seat of the Maratha Empire and the birthplace of the Indian Independence movement. Today that water flows in pipes into homes, offices and factories and is discharged as (much of it untreated) sewage into its waterways.

WOMEN USING THE RIVER FOR HOUSEHOLD CHORES

The drought in 2018, as droughts before it, accelerated the movement of farmers from the countryside around Pune into the city seeking seasonal work as laborers and service workers for the tech campuses and luxury condos on Pune's periphery. Many settle in informal housing on public land along the banks of the Mula and Mutha Rivers where they lack even basic amenities and are exposed to flooding during the monsoon season.

MANGESH DIGHE FROM THE PUNE MUNICIPAL CORPORATION TALKING WITH STUDENTS

In the context of the mounting environmental and social crisis, the Pune Municipal Corporation commissioned a study for a Riverfront Project that follows precedents from around the world, where rivers have been channelized into concrete drains and waterfronts cleared to make way for landscaped promenades and real estate development. We were asked to consider this study and propose alternatives. Working with Columbia's Urban Design Studio, Pune College of Engineering, and Bharaati Vidyapeeth, we advocated taking a holistic watershed approach to the rivers, and integrating investments in transportation and sewage infrastructure with community-based planning to address long-standing environmental and social injustices.

Students and faculty worked alongside Chief Resilience Officer Mahesh Harare to understand the potential of Pune's riverlands. Through the course of the semester they developed conceptual designs for how the PMC could revegetate the river edge; value ecological features such as the basalt outcroppings along the river; and find engaging ways to connect the people of Pune back to the waters that flow down from the Western Ghats.

TAKE–AWAY: If Pune can grow ecological awareness, equitably manage water and provide safe housing and infrastructure for all its people, it will be a model for all cities. If it can't happen in Pune, it can't happen anywhere.

BY THE NUMBERS

Pune is the
9th
most populous city
in India and according to a government index, the most livable.

An estimated
40%
of the urban population
lives in slums.

During the recent drought, this number is thought to have grown from an estimated
1.2 million to 2 million
people, with an average of 300 families coming by train each day.

In 1961 the Panshet Dam burst, resulting in a flood that killed as many as
1,000
people in Pune.

PARTNERS

GSAPP Urban Design Studio

100 Resilient Cities

Pune Resilience Office

The Institute of Environment Education and Research, Bharati Vidyapeeth Deemed University (BVIEER)

College of Engineering Pune (COEP)

Pune | Ecology and Equity on the Mula Mutha

IMAGES OF STUDENT WORK FROM THE GSAPP'S SPRING 2019 URBAN DESIGN STUDIO. THESE PROJECTS SHOW HOW HOLISTIC WATER MANAGEMENT CAN BE INTEGRATED INTO THE FUTURE PUNE'S WATERFRONT.

A WATER ORIENTED NETWORK THAT CREATES A COMMON GROUND AT THREE SPECIFIC OLD CITY LOCATIONS FOR WASTEWATER MANAGEMENT

EX-PAUSING PUNE
Adi Laho I Carolina Godinho I Alexandros Hadjistyllis

LEVERAGING AND RE-INTERPRETING RITUALS TO ENHANCE PUNE'S ECOLOGY AND RESILIENCE

SANGAM
Keju Liu I Jinsook Lee I Shuo Yang

NATURE LED CBD
Yanli Zhao I Yinzhe Zhang I Huiwon Hong

A NEW URBAN LANDSCAPE INFRASTRUCTURE FOR HIGH DENSITY DEVELOPMENT THAT TAKES CARE OF THE EXISTING NATURE

A STEWARDSHIP STRATEGY THAT RELIES ON HOLDING, CLEANING, AND FILTERING THE WATER OF THE SAME WATERSHED

NALLAH-HOOD
Noah Shaye I Ryan Pryandana I Shouta Kanehira

HYPER MAIDAN
Pei-Jou Shih I Donghanyu An I Zilu He

UPDATES THE CONCEPT OF "MAIDAN" AS A NEW URBAN SPACE THAT SERVES CULTURAL AND INFRASTRUCTURAL USES

THE MIDDLE-GROUND URBAN ECOLOGY NETWORK
Richard Chou I Huang Qiu I Tina Pang

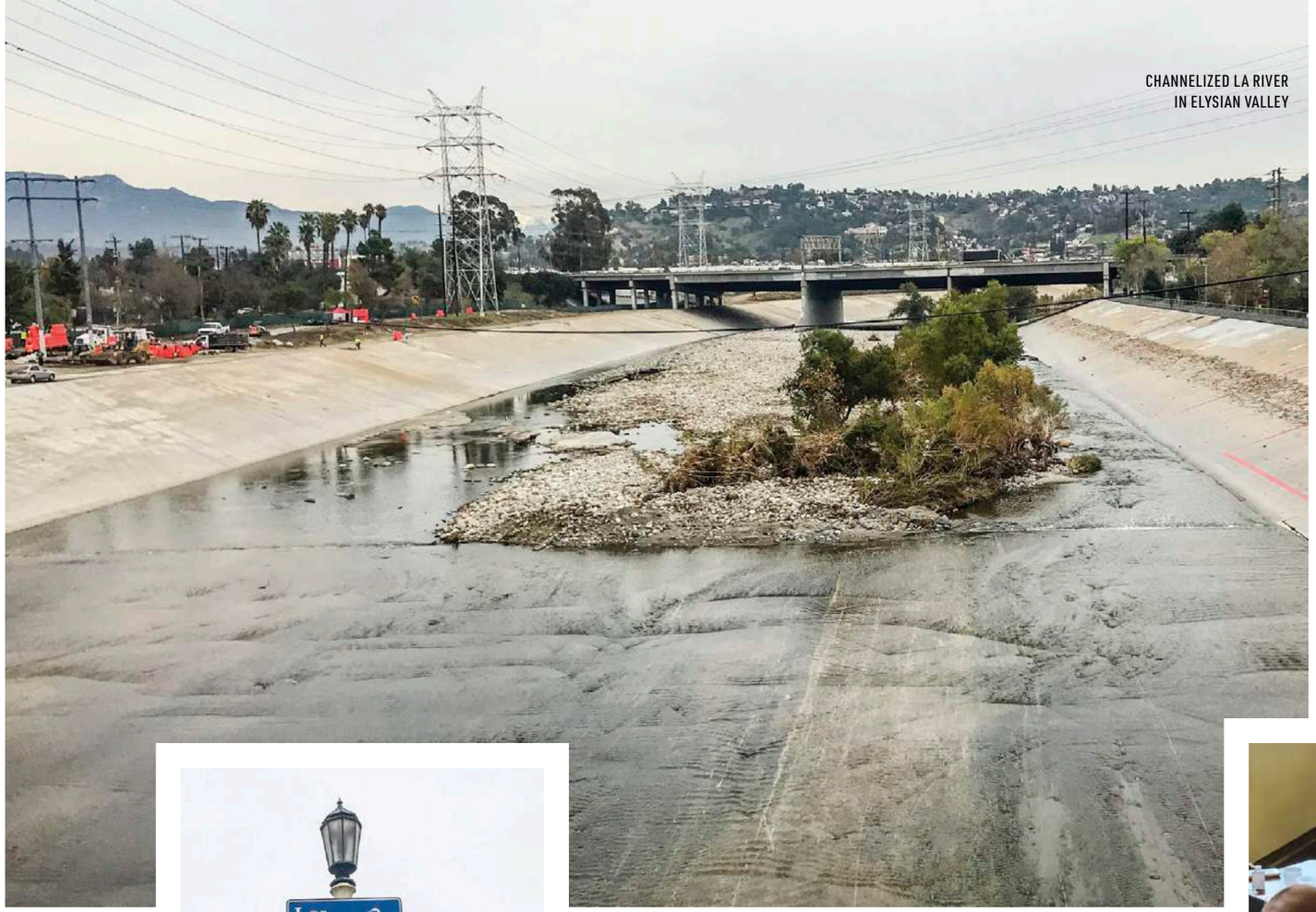
MODEL FOR BALANCING URBAN DEVELOPMENT WITH ECOLOGICAL AND CULTURAL ASSETS IN THE CITY'S PERIPHERY

METRO, MYNA & THE MULA-MUTHA
Alexandra Burkhardt I Lorena Galvao I Maria Palomares

PUNE'S METRO INFRASTRUCTURE AS AN INITIATOR OF ECOLOGICAL RESTORATION, LIVELIHOOD AND HABITAT EXPANSION

Realizing Value Along the LA River

A MODEL FOR COMMUNITY AND PUBLIC INVESTMENT



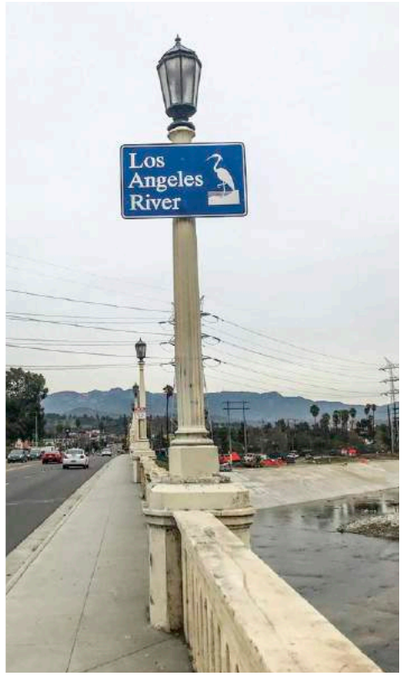
CHANNELIZED LA RIVER IN ELYSIAN VALLEY

With headwaters in the Santa Susana Mountains, the Los Angeles River flows from the San Fernando Valley through the City of Los Angeles, eventually emptying into the Pacific at Long Beach. Once an unconstrained and rich habitat that supported the Gabielino Indians over 1,000 years ago, the River became the primary source of freshwater for the City of Los Angeles. As the city grew, so too did the risk and damages of flooding during wet seasons. By 1960, the River was completely channelized for its entire 51-mile length, 32 of which are in the City of LA.

Today, communities along the LA River are some of the most densely populated and most vulnerable to the pressures of rising housing costs, job displacement, flood risk, and lack of accessibility to transit and open spaces. For these reasons, the LA River has been the site of numerous planning efforts that have intensified over the last decade. Most recently, the Mayor's Office recognized a need to advance the LA River Revitalization Master Plan in conjunction with the City's Resilience Strategy. With CRO's Marissa Aho (former) and Aaron Gross (current) of the Los Angeles Office of Resilience and Michael Affeldt of LA Riverworks, we used the Resilience Accelerator process to model and evaluate a more transparent development process for sites along the river. Together we asked, can communities along the river become more stable and livable in light of the increasing pressure of gentrification?

At a workshop in January 2019, we engaged over 30 public, private, NGO, and community-based stakeholders, including the Trust for Public Land and RiverLA. The workshop started with some common goals: rehabilitating the LA River should occur in alignment with natural systems, provide and encourage vibrant public spaces as well as equitable economic development, and address flood risk. We focused on a single, representative City-owned site with active municipal operations on the River, allowing participants to consider the challenges and opportunities posed by strategic redevelopment.

While the expectations of stakeholders will be different from one site to another, three action items emerged during the workshop as needed for all future development sites along the river. First, the City needs to devise a more transparent planning and procurement processes that balances city-wide goals with community-based needs. Second, engaging the private sector can help to deliver a range of benefits in alignment with the community and public. Finally, the City could better coordinate decision-making, planning, and investments by looking at theses city owned properties as one portfolio.



TAKE-AWAY: The Accelerator helped to set the stage for the City of LA and partners to explore new models for innovative redevelopment that balance an economic development agenda with community aspirations for social and environmental justice.

BY THE NUMBERS

One million
people live within one mile of the LA River.

60%
of those people are identified as Disadvantaged Communities by the State of California.

10%
of City-owned property is located within .5-mile of the LA River.

PARTNERS

100 Resilient Cities

LA RiverWorks, Office of Los Angeles Mayor Garcetti

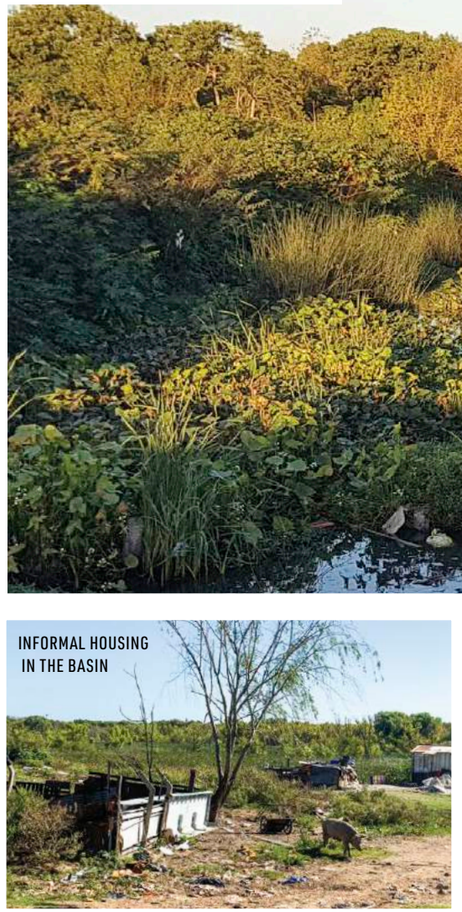
Office of Resilience, Office of Los Angeles Mayor Garcetti

Restoring Wetlands and Communities

ACTION PLAN FOR THE PANTANOSO BASIN IN MONTEVIDEO

The Uruguayan capital of Montevideo has accomplished much in recent years. Poverty has declined from 26% in 2006 to 8.3% in 2016. However, success is rarely evenly distributed. The 95,000 people who live in and around wetlands of the Patanoso Basin are still plagued with poverty, poorly constructed housing, regular flooding, lack of access to jobs and services, and a degraded environment from decades of industrial contamination and ongoing illegal dumping. The City has put forth a vision that the Pantanoso River Basin can become an attractive place for new investment while the social cohesion of the existing community can be strengthened. The City's plan calls for the relocation of flood-vulnerable households and wetland restoration, but this requires deep and sustained community engagement and creative design strategies.

The Resilience Accelerator Workshop sought to bring the City's vision to the ground by exploring specific design interventions for three neighborhoods. Building from the experience and observations of global experts from Brazil, the Netherlands and the US, the Accelerator workshop participants developed strategies for how to deal with ongoing illegal dumping and remediate toxic soil, how to reestablish a thriving wetland ecology, and how to stitch the existing urban fabric into a future park with a "rambla," a public walkway that would connect to Montevideo's other thriving waterfront neighborhoods. Together we charted a path to involve the whole community in this transformation with organized wetland plantings, educational programs and cleanups. Participants also made suggestions for how the city could leverage the park investment to ensure that relocated communities do not spiral back into poverty. This will take further investment in community facilities, transportation, and other services; as well as training in jobs in ecological stewardship.



INFORMAL HOUSING IN THE BASIN

A PATCH OF WETLANDS IN THE PATANOSO BASIN

TAKE–AWAY: With a design and planning process that simultaneously focuses on ecosystems and communities, the Patanoso Basin can be a model for cities facing the climate crisis around the world. The Accelerator Workshop developed and visualized specific design interventions that will be submitted in the next capital planning budget, and seed the transformation of the basin.

BY THE NUMBERS

87%
global wetlands have been lost since 1700, disappearing at a rate three times faster than natural forests, according to the Ramsar Convention, an international treaty on the conservation of wetlands.

9%
of the world's surface is covered in wetlands, which store as much as 35% of terrestrial carbon.

Wetlands
provide essential ecosystem services including storing and purifying water, providing habitat for fish and birds, recharging aquifers, and acting as a natural sponge against urban flooding.

ACCELERATOR WORKSHOP

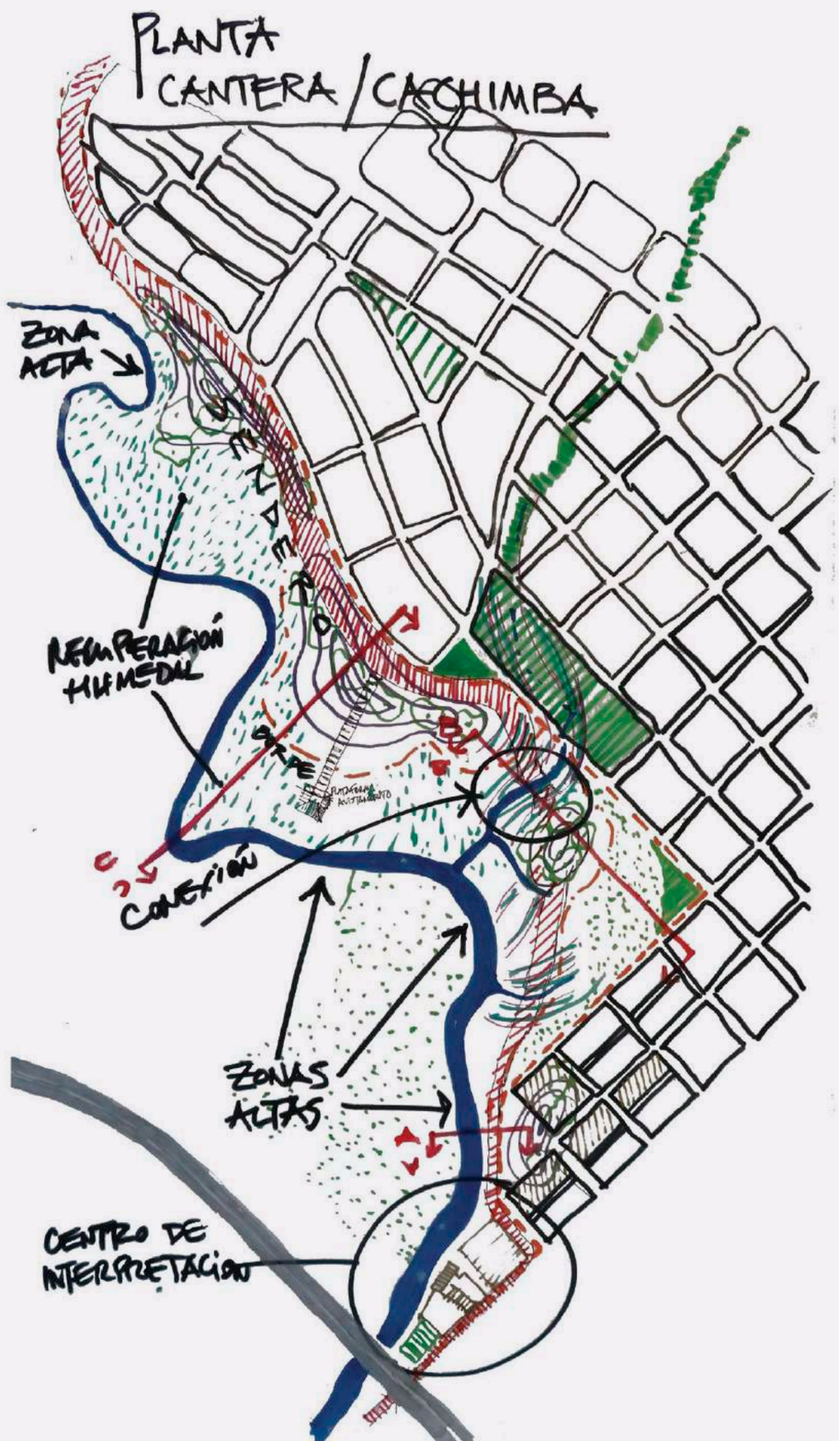
PARTNERS TEAM

100 Resilient Cities

Unit of Resilience, City of Montevideo

Department of Planning, City of Montevideo

Universidad de la República Uruguay, Urban Waters Interdisciplinary Group



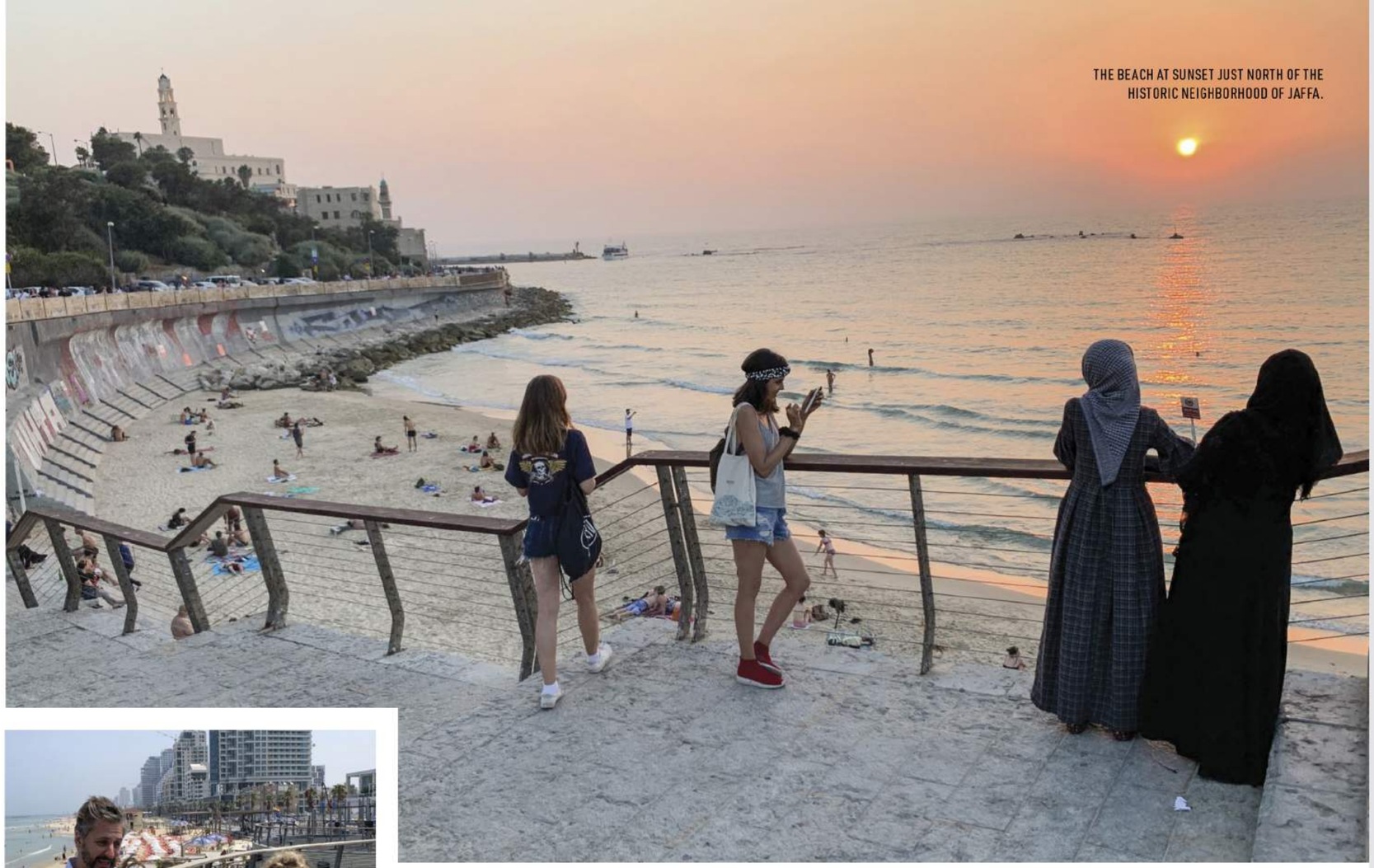
SKETCHES DONE DURING THE ACCELERATOR WORKSHOP SHOWING DESIGN CONCEPTS FOR WETLAND EDGES AND INTEGRATION WITH THE SURROUNDING COMMUNITY

Cooler Places for a Hotter City

A RESILIENT PUBLIC REALM IN TEL AVIV-YAFO

In this growing city where the desert meets the Mediterranean Sea, climate change is leaving Tel Aviv-Yafo hotter and drier. More heat means more energy to cool buildings, more people staying indoors or in their cars, and more older people becoming sick from heat exposure. In some neighborhoods, the streets were designed to channel the sea air down open boulevards and green spaces provide needed shade and evaporation of water to cool down the city. But in other neighborhoods, the streets are dense, narrow, and with limited vegetation and green spaces. These neighborhoods which typically also have less resources and amenities are the ones that feel the heat most.

Working with CRO Efrat Makin-Knafo, Deputy CRO Omri Carmon, and scientists from Columbia and Tel Aviv University, we are pioneering a new method of identifying and studying areas of the city most exposed and vulnerable to heat. The objective is to design pilot projects that not only mitigate the heat impacts but also build a network of community planners and leaders that can share knowledge and help scale best practices to achieve a more resilient Tel Aviv-Yafo.



THE BEACH AT SUNSET JUST NORTH OF THE HISTORIC NEIGHBORHOOD OF JAFFA.

MICHAEL BERKOWITZ, PRESIDENT OF 100RC AND TEL AVIV-YAFO CRO EFRAT MAKIN-KNAFO

Our data-driven approach starts with understanding the physical, social, and economic impacts of increasing heat on public, outdoor spaces, such as schoolyards, bus stations, and local commercial corridors. Using land surface temperature detected from satellite imagery overlaid with the demographics of vulnerable communities, we can visualize exposure to heat impacts. One of the most exposed neighborhoods, Shapira, is also facing increasing pressures from housing affordability and a recent influx of refugees from North Africa. During a site visit in June 2019, we surveyed and documented how the urban form of Shapira contributes to the heat island effect in public places. We are also coordinating with scientists from Tel Aviv University taking thermal images of these public spaces which will establish a baseline for monitoring heat in the future, with and without the proposed interventions.

This research will provide a platform for a workshop in September 2019 with City and community stakeholders, academic researchers, and civil society to co-design public realm interventions, and develop actionable goals for community engagement, energy conservation, and neighborhood networking.

TAKE-AWAY: The Tel Aviv-Yafo Resilience Accelerator has pioneered a method for identifying vulnerability to heat, which can help to target heat-mitigating urban design interventions in communities of greatest need.

BY THE NUMBERS

25%
increase in traffic-generated noise and air pollution in the last decade.

37%
population growth in Greater Tel Aviv between 1980 and 2014.

Only
5.9% and 3.7%
of land cover in Greater Tel Aviv is open areas or urban forest land.

40°C
average land surface temperature reached in Tel Aviv-Yafo's vulnerable neighborhoods summer of 2018.

PARTNERS

100 Resilient Cities

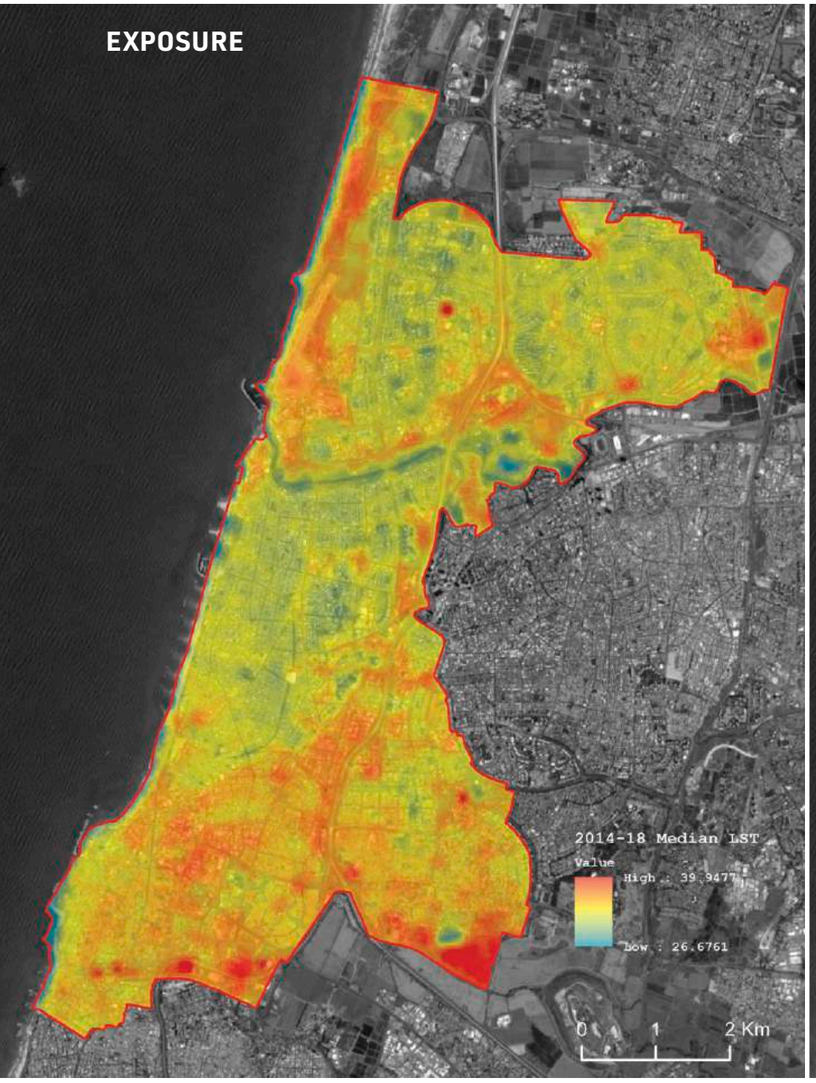
City of Tel Aviv-Yafo

Center for Climate Systems Research at Columbia University

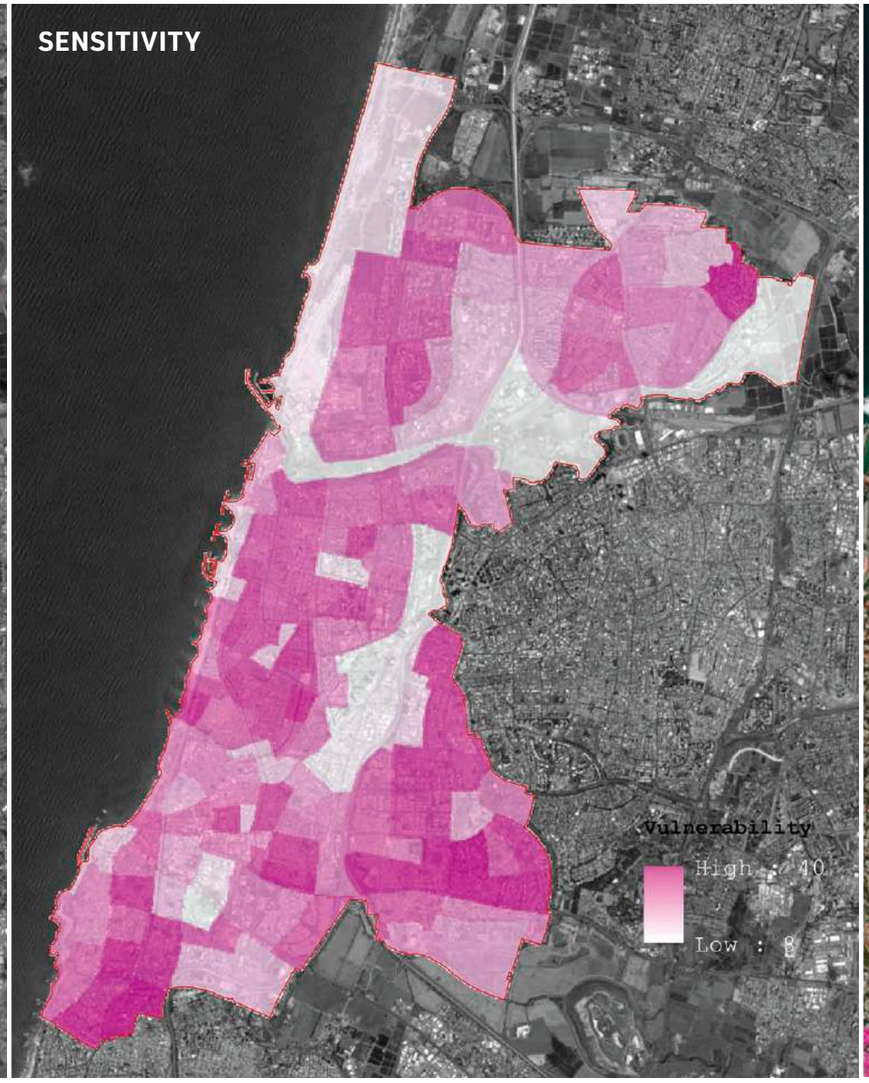
Tel Aviv University

Tel Aviv-Yafo | Cooler Places for a Hotter City

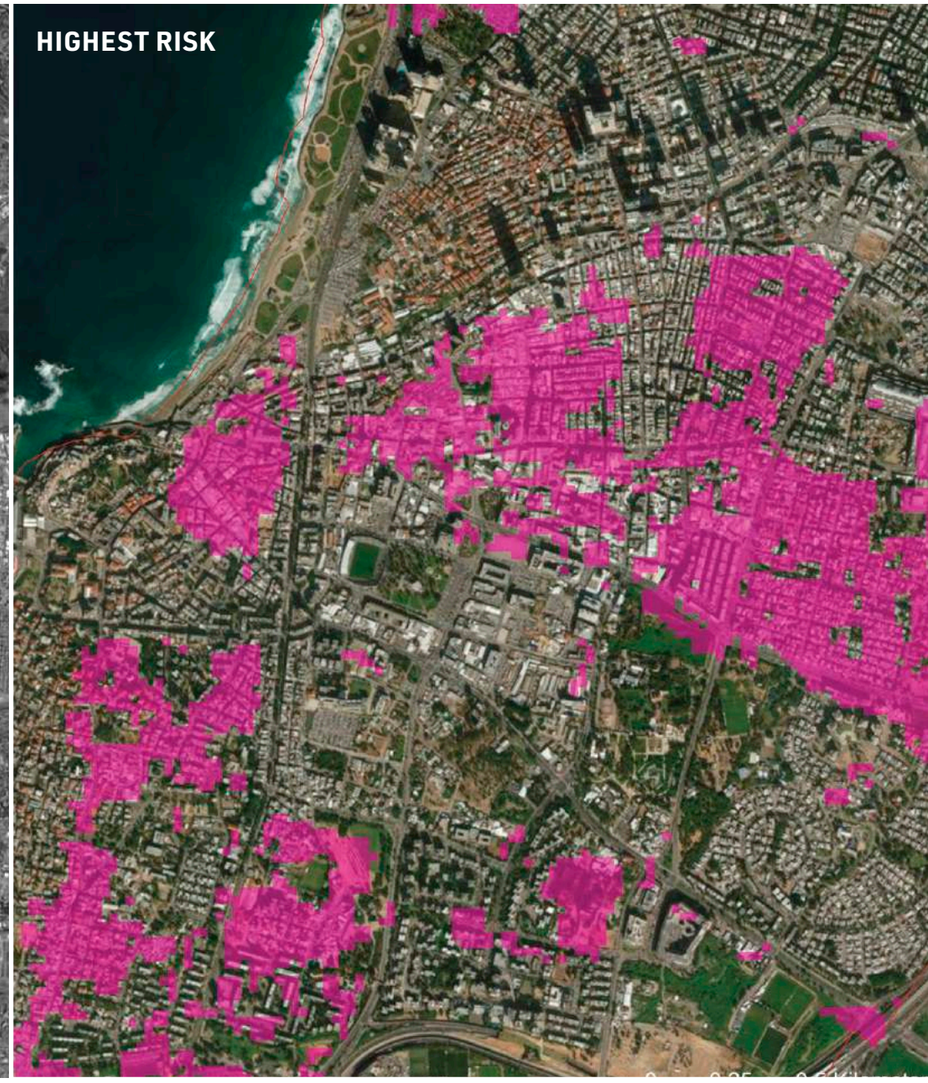
CRCL produced a set of maps analyzing heat risk for the City of Tel Aviv-Yafo.



COMPOSITE OF MEDIAN LAND SURFACE TEMPERATURE (JUNE -AUGUST 2014-2018)



DISTRIBUTION OF DEMOGRAPHIC FACTORS INCLUDING ELDERLY LIVING ALONE, UNEMPLOYED, HOUSEHOLDS OF 7 OR MORE, INFANTS, LOW EDUCATIONAL ATTAINMENT, SINGLE-PARENT HOUSEHOLDS, AND LOW INCOME (2008)



AGGREGATED EXPOSURE AND SENSITIVITY MAPS, SHOWING WHERE THESE FACTORS COMPOUND IN HIGH RISK COMMUNITIES.

ACROPORA CORAL IN THE GREAT BARRIER REEF

PURE SILICA BEACH AND SULFURIC STREAM AT WHITEHAVEN BEACH, WHITSUNDAYS, AUSTRALIA

Reefs of the World Unite

BUILDING A GLOBAL NETWORK OF REEF MANAGERS

Coral reefs are the largest living structures on earth, home to some of the earth's richest and most diverse ecosystems. Above the surface, nearly 1 in 6 people directly depend on reef ecosystems for their livelihoods or benefit from the protection they provide from coastal storms. There is a deep relation between reefs and humanity, forged, upheld, and stewarded by indigenous communities around the world for thousands of years.

While many reefs are already permanently damaged from overfishing, mining, tourism; today, climate change poses the most global and imminent threat to these fragile ecosystems with ocean acidification, sea level rise, and intensifying coastal storms. Combined with other impacts from urban sprawl and coastal deforestation, reefs are less able to rebound from shocks like bleaching events. Meanwhile, the communities, cultures, and economies that depend on reefs are at stake. The loss of indigenous communities and their generations of stewardship knowledge leave us further away from potential solutions.

Even as the reefs represent the precariousness of the earth's global ecosystems, they also are the seat of possible transformation. The Resilient Reefs Initiative--led by the Great Barrier Reef Foundation--will support five reef sites identified by UNESCO World Heritage for their Outstanding Universal Value with a multi-year resilience strategy development process and technical assistance in saving reefs and the communities that depend on them. Reef managers, and newly hired Chief Resilience Officers from New Caledonia, Ningaloo, Palau, Belize, and the Great Barrier Reef will work together to build local capacity for resilience planning and design and begin a global resilient reef network.

In Spring of 2018 we traveled to Airlie Beach, Australia to kick off the program with GBRF. Reef managers, scientists and other experts framed the critical questions about the future of reefs and set the stage for future site-specific Resilient Reef Accelerator Workshops. Together we established key priorities moving forward: the importance of community-based management strategies, coordinating research agendas across disciplines and institutions, incentivizing the private sector to join this work, and developing governance strategies to manage land uses across jurisdictions.

TAKE–AWAY: Starting in the Fall of 2019, Accelerator Workshops will be held at reef sites around the world to build capacity for place-based adaptation projects. These workshops will bring together reef managers and global experts to build on best practices while adapting to local conditions.

BY THE NUMBERS

25%
of all marine life
in the oceans supported by coral reef ecosystems.

101
countries have critical reef ecosystems.

$10 trillion
in ecosystem services provided by reefs
support 1 billion people globally every year.

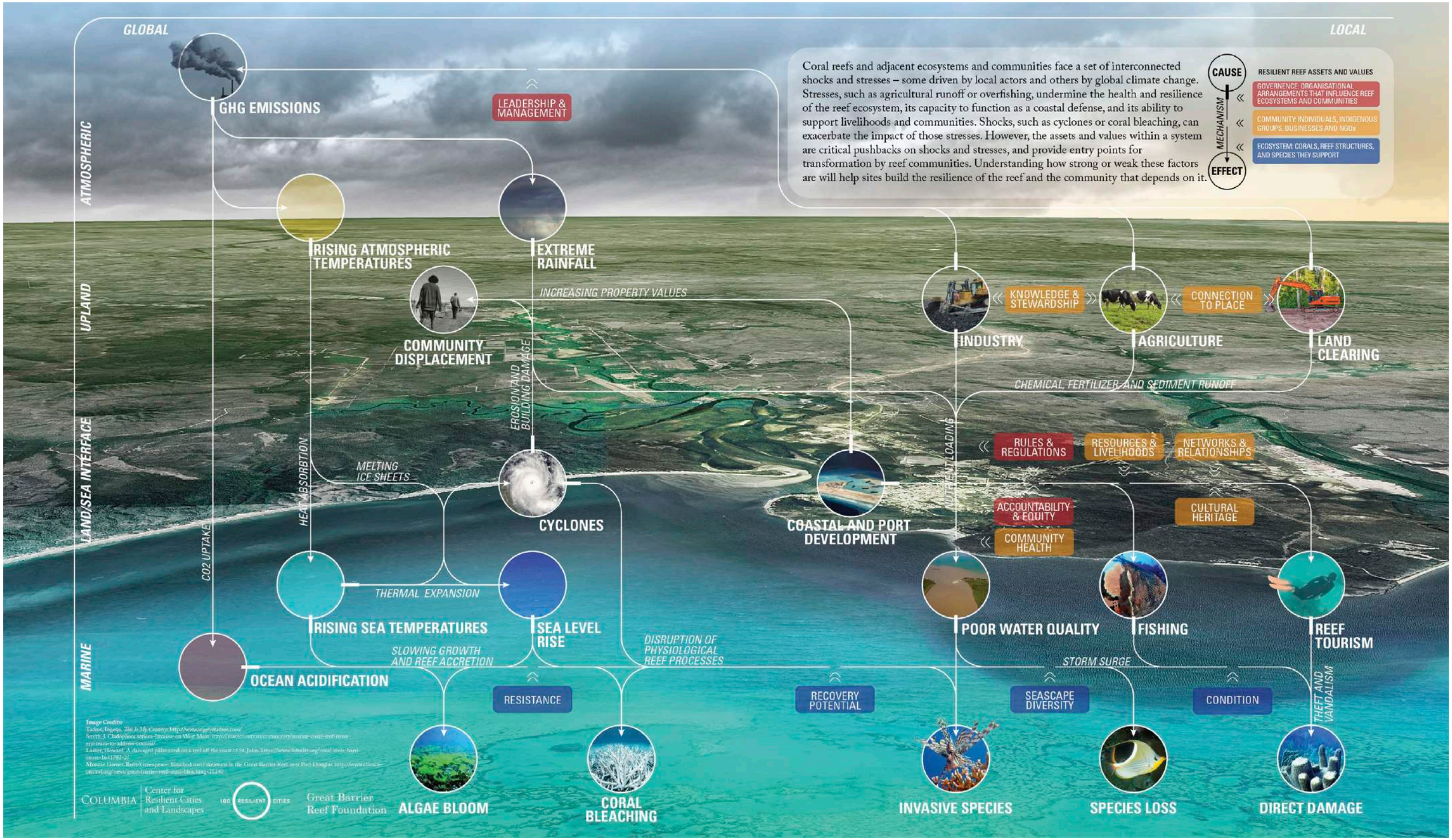
75%
of all coral reefs
are under threat from local stresses and climate change.

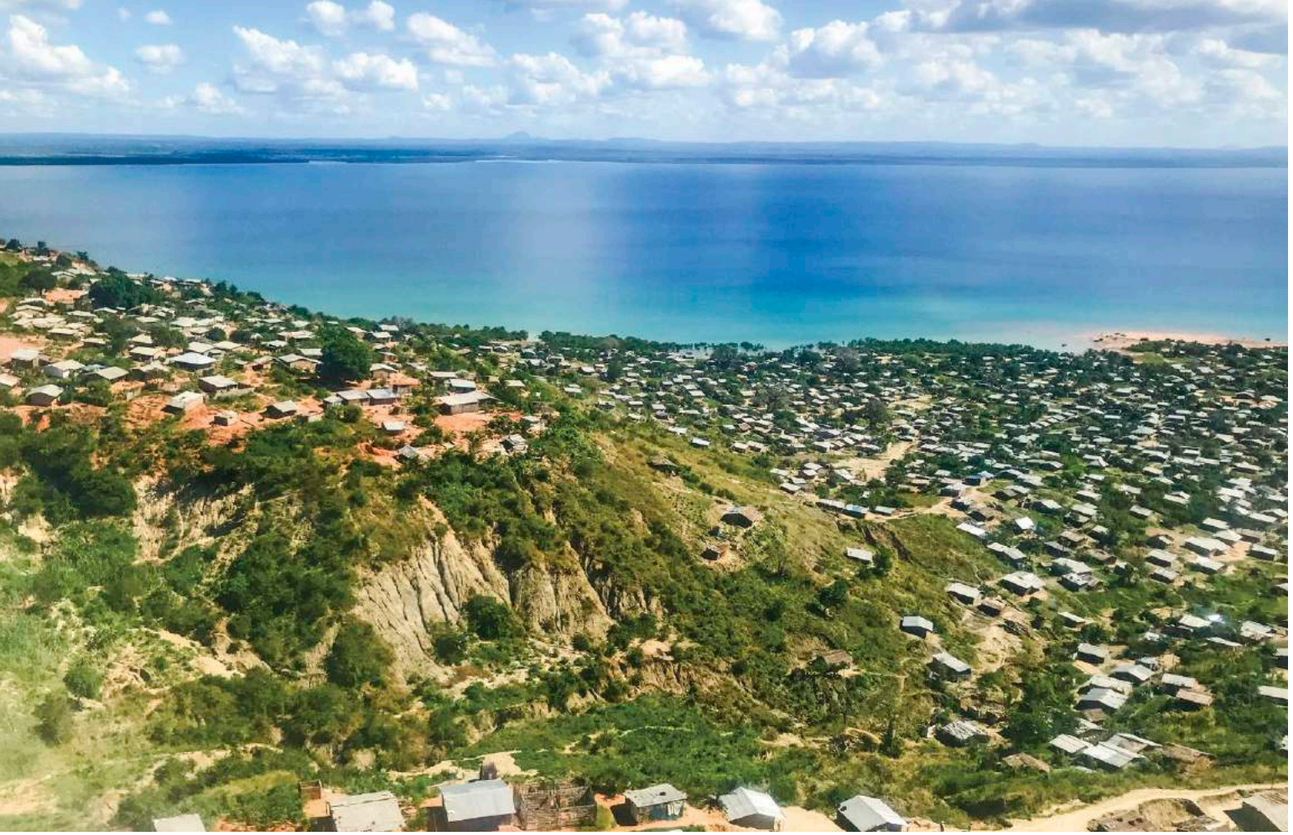
423,000 sq. kilometers
of catchment area upstream of the Great Barrier Reef;
much of these areas include agricultural industries that produce runoff.

PARTNERS

Great Barrier Reef Foundation
BHP Foundation
100 Resilient Cities
AECOM
UNESCO
The Nature Conservancy

Understanding Risk: Coral Reefs Under Stress





Visualizing Natural Capital in Palma

COASTAL MOZAMBIQUE CAUGHT BETWEEN RESOURCE EXTRACTION AND CLIMATE CHANGE

Mozambique is one of the poorest countries in the world and, as two recent cyclones demonstrated, is extremely vulnerable to the impacts of climate change. The discovery of natural gas off the coast of Cabo Delgado has ignited hopes for economic development for some. For others, it has stoked fears that resource extraction will cause irreparable harm to this ecologically-precious landscape of mangroves, seagrasses, and coastal reefs. There is also concern that gas exploration will deepen social unrest which has manifest in a series of recent terrorist attacks.

The World Wildlife Fund (WWF) invited us to help visualize scenarios for the future of the town of Palma, a collection of fishing and farming villages. This region will likely experience explosive urbanization with the development of a liquefied natural gas (LNG) facility to supply markets in China and India. In August 2018, we traveled with GSAPP architecture, planning and Columbia business school students and faculty from Lurio University to Maputo to learn about the cities and landscapes of coastal Mozambique. With WWF and representatives from Mozambican government and civil society, the students facilitated a workshop which explored how Mozambicans' water, energy, housing and food all come from "natural capital" -- the vast stock of forests, rivers, wetlands and coastal ecologies. Together we conceived strategies to enhance and protect the natural capital in perpetuity.

After the workshop, we worked with WWF International and WWF Mozambique to develop two scenarios for Palma. In the "business as usual" scenario, the natural capital is plundered while widening inequality leads to social unrest. In an alternative resilient scenario, ecological, social and economic growth are mutually supportive. A public priority is placed on mitigating fossil fuel emissions and adapting to the effects of climate change on people and the environment. In June 2019, we presented these scenarios to officials in Cabo Delgado and to the energy company Anadarko responsible for extracting the gas. A pamphlet of these scenarios is being sent to all the relevant government agencies, businesses, and NGOs involved in the gas extraction of Coastal Mozambique. We will continue to press the fossil fuel industry to be accountable for the social and ecological risks they pose to communities and ecosystems here and elsewhere.

(LEFT) VIEW OF THE CITY OF PEMBA IN CABO DELGADO. (TOP) STUDENTS AND FACULTY FOLLOW LOCAL FARMERS IN FIELDWORK. (RIGHT) LOCAL FARMER OFFERING US CASSAVA

"These scenarios allow us to see what we want to happen. It gives us hope because we can see it."

–ANABELA RODRIGUES, DIRECTOR OF WWF MOZAMBIQUE

BY THE NUMBERS

Mozambique ranks
180 out of 189
globally on the human development index
with almost 19 million Mozambicans living in extreme poverty.
25% of Mozambicans do not have access to electricity.

Cyclone Idai in April 2018 was the worst storm in Mozambique history.
It killed more than
1,000 people
and affected more than 3 million.
90% of structures in the City of Beira were damaged.
Just two weeks later Cyclone Kenneth brought further damage, this time to Cabo Delgado.

Anadarko and Exxon are expected to invest up to
$40 Billion
to extract 150 trillion cubic feet of gas from Cabo Delgado, enough to heat 150 US homes for 15 years. So far, they have pledged only $100 Million in corporate social responsibility to help the community that will experience the environmental and social impacts of this extraction.

PARTNERS

World Wildlife Fund (WWF) – International and Mozambique

National Ministry of Land, Environment and Rural Development, Mozambique (MITADER)

National Ministry of Economy and Finance, Mozambique (MEF)

Lúrio University, Mozambique

Business As Usual: What Is At Risk When We Don't Prioritize Natural Capital?

DEFORESTATION
for urban expansion, industrial agriculture and building materials.

DEPLETION OF AQUIFER
from groundwater pumping for industry, urban expansion and agriculture.

ENGINEERING OF WATER SUPPLY
and potential damming of the Ruvuma River for irrigation and increasing industrial uses.

UNREGULATED URBAN EXPANSION
from replication of road-based urban development strategies.

ENCLAVES OF PRIVILEGE
for housing and recreation for the elite.

FILLING OF WETLANDS AND WATERCOURSES
to create level ground for urbanization.

FLOODING
in poorly drained areas of self-built housing.

BOOMTOWN ECONOMY
profit-seeking and speculation dominates all economic activity.

DISPLACEMENT OF CULTURE AND LOSS OF LIVELIHOODS
from constraints on fishing and farming.

HARDENING OF SHORELINE
and loss of coastal habitats, biodiversity, and natural storm protection.

DREDGING AND CONTAMINATION OF COASTAL WATERS
for the deep-water port and industry.

DESTRUCTION OF CORAL REEFS AND SEAGRASS
to accommodate the gas pipeline.

Resilient Palma: How Do We Protect and Enhance Natural and Human Capital?

COOPERATIVE AGRICULTURE AND INSURANCE PROGRAMS
to provide subsidized locally- appropriate multi-cropping to ensure food security and job diversity.

RECREATION AND PARKS
to provide every community recreational opportunities suited to young and old alike.

ECOLOGICAL CORRIDORS, WATERSHEDS, WETLANDS AND RESERVOIRS
to provide freshwater resources, stormwater management, important wildlife migration routes, and public enjoyment.

FREE PUBLIC EDUCATION
to not only make Cabo Delgado 100% literate but a leading research and development center.

COMMUNITY BASED PLANNING
to ensure people have the right to make decisions about their land use and infrastructure.

LAND USE REGULATIONS
to promote dense, walkable urbanism around ecologically-functional open spaces.

BUILDING REGULATIONS
to promote climate-adapted, energy-efficient buildings made from local, renewable materials.

RENEWABLE ENERGY
to benefit from Cabo Delgado's abundant sunshine and wind.

SMART WASTE MANAGEMENT
to make Palma a regional leader in regenerative industries.

REGULATED WILD FISHERIES
to protect a culturally-significant source of protein and livelihood in perpetuity.

CONSERVATION AND RESTORATION OF MANGROVES AND SEAGRASS
to provide a nursery for young fish and buffer for communities against coastal storms.

PROTECTED AND MANAGED FORESTS
to provide carbon sequestration, aquifer recharging, sustainable forestry, flood risk reduction, soil conservation, and biodiversity habitat.

MOBILITY
to provide intra-city high speed transportation options to link Cabo Delgado to the other fast-growing economic centers in the region and reduce the demand for private car ownership.

HEALTH SERVICE
to serve Palma's current and future population with up-to-date medical technology and expertise.

URBAN GROWTH BOUNDARY
to prohibit unregulated development.

ECOTOURISM
to generate revenue to protect Palma's coral reefs, seagrass beds, coastal beaches, dunes, mangroves and maritime forests.

NATURAL COASTAL PROTECTION
to protect against more frequent and damaging coastal storms with vegetated dunes.

FLOATING OFFSHORE GAS EXTRACTION
to protect coral reefs, reduce the LNG footprint in the ecologically-sensitive coastal zone, and allow a reduced presence in less-vulnerable, deep water, also reducing costs of shipping and pipeline.

Thank you to all who join us in this work

100RC: Michael Berkowitz • Andrew Salkin • Eric Wilson • Peter Jenkins • Femke Gubbels • Jessica Hernandez • Helena Monteiro • Hector Cordero • Alvaro Soldevila • Anna Friedman • Corinne LeTourneau • Lauren Sorkin • Saurabh Gaidhani • Gemma Kyle • Konstantina Karydi • Harry Fellows • **GSAPP/Columbia:** Geeta Mehta • Dilip Da Cunha • Julia Watson • Linh Pham • Carmelo Ignaccolo • Lisa Dale • Christian Braneon • Meridel Phillips • **WWF:** Anabela Rodrigues • Ryan Bartlett • Kate Newman •Judy Ogglethorpe • Alima Taju • Antonio Serra • Hermínio Mulungo • Lara Mauves • **Subject Matter Experts:** Claire Bonham-Carter • Jason Hellendrung • Sonia Chao • Sanjukta Sen • Andrew Hayes • Margi Nothard • Shekeria Brown • Lauren Swan • Rod Braun • Lauren Ordway • Lymaris de Jesús • Fernando Granados • Shaney Peña Gomez • Jorge Rojo • Daniel Medina • Martín Quiroga • Matilde Olivero • Soledad Mantero • Guzman Robania • Isabel Marques da Silva • Bernardo Xavier • Cecilia Herzog • Mindert De Vries • Natalie Zappella • Christopher French • Theadora Trindle • Jennifer Samson • Helen Leung • Gio Aliano • James Anderman • Keegan McChesney • Marion McFadden • Edward Belden • Jessica Wackenhut • Sabrina Bornstein • Mark Goodson • Efrain Olivares • Josh Sawislak Sarah Castine • Fanny Douvere • Petra MacGowen • Kristen Maize • Suzanna Remmerswaall • Will Symons • Adam David • **Miami Beach:** Susy Torriente • Elizabeth Wheaton • Sabrina Baglieri • Kelly Hitzing • Luis Leon • David Hoot • Jose Gonzalez • Jose Ferrer • Miguel Anchia • Mike Fischer • Juan Meizoso • Monica Beltran • Luis Soto • Tom Mooney • **Miami:** Jane Gilbert • Jeremy Calleros Gauger • Steven Williamson • Keith Ng • Albert Gomez • Ana Benatuil • Kathryn Cabrisas • Alan Dodd • Douglas Thompson • Maria Molia • **Miami Dade County:** Jim Murley • Vine Seijas • Carly Grimm • Luiza Leite • Robert Piatkowski • Xu Zhang • Meg Daly • Carlos Cruz-Casas • **Palm Beach County:** Eric McClellan • Michael Arkin • Neha Martin • Carl Blencowe • Megan Houston • James Green • Michelle Finnernan • Bud Chenny • **City of West Palm Beach:** Matt Mitchell • Jennifer Báez • Chip Green • Kelly Martin • Suzanne Berglund • Michael Rittenhouse • **The Hague:** Anne-Marie Hitipeuw • Frances Brazier • Tina Comes • Erwin Cardol • Peter Hennephof • Jos van Leeuwen • Arnold Jan Quanjer • Niek Mouter • Rob Ruts • Rene Baron • Christine Carabain • Serge Eurlings • Dymphna Faas • Bastiaan ter Horst • David van Keulen • Mirjam van der Kraats • Maxime van Leeuwen • Bob van Meijeren • Erik Pruyt • Merijn Schik • Eline van Staalduinen • Marije Stelloo • Rene Teule • Matthijs de Vries • Palma • Adarito Watela • David Le Maitre • Lindie Smith-Adao • Susan Taljaar • Tomas Jaime Langa • Cesar Tique • Higino Rodrigues • Michel Matera • Leif Sandhop • **Santiago de los Caballeros:** Walkiria Estévez • Percy Alvarez • Jochy Nuñez • Hipólito F. 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Uma Bhavani • Nikhil Shetty • Huiwon Hong • Shuo Yang • Tina Pang • Tushi Agarwal • Rushikesh.V Dhumal • Keju Liu • Alexandra Burkhardt • Carolina Godinho • Aditya Varma • Mewada Yamini • Atharva Prabhune • Maria Palomares • Noah Shaye • Huang Qiu • Sakshi Darak • Atharva Vinay Prabhune • Zilin He • Ricahrd Chou • Shouta Kanehiva • Akash Mheta • Lorena Galvao • Adi Laho • Yanli Zhao • Vrushabm Gudade • Meet Sha • Divyu Dehcenker • Alexandraos Hadjistyllis • Ryan Pryandana • Jinsook Lee • Devika Pundkar • Puja Singh • Aashlesha Devlekan • Ashley Christine Louie • Angela Crisostomo • Alaa Marrawi • Devaki Handa • Hsin Yi Chao • Shivani Ajaykumar Agarwal • Sharvi Jain • Tanaya Kadam• Zeyi Jiang• Aniket Dikshit • Amanpreet Singh Duggal • Berke Kalemoglu • Bohong Zhang • David Mauricio • Greg LeMaire • Gabriel Vergara • Huiwon Hong • Mariam Samim Hattab • Peiqing Wang • Wenjun Zhang

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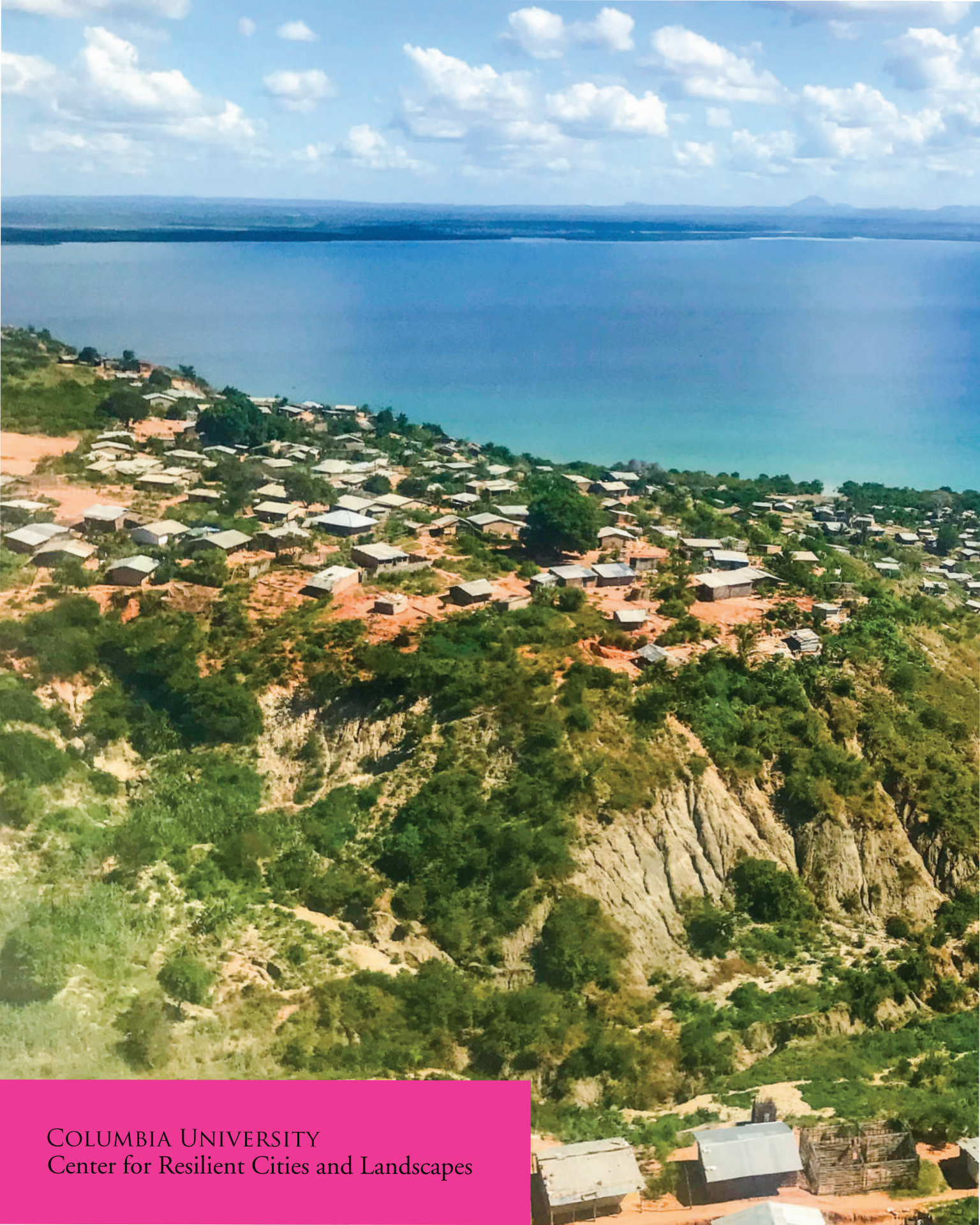

Columbia University
Center for Resilient Cities and Landscapes