

# RESILIENT PALMA, MOZAMBIQUE

WORKSHOP REPORT  
DESIGNING TO PRESERVE NATURAL CAPITAL

AUGUST 2018



COLUMBIA | Center for  
Resilient Cities  
and Landscapes

# CENTER FOR RESILIENT CITIES AND LANDSCAPES

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 uncertainty. Through interdisciplinary research, visualization of risk, project design scenarios, and facilitated convenings, CRCL works with public, nonprofit, and academic partners to deliver practical and forward-thinking technical assistance that advances project implementation. Through academic programming, CRCL integrates resilience thinking into design education, bringing real-world challenges into the classroom to train future generations of design leaders.

Founded in 2018 at the Columbia University Graduate School of Architecture, Planning and Preservation with a grant from The Rockefeller Foundation, CRCL extends Columbia’s leadership in climate-related work and support of the interdisciplinary collaborations and external partnerships needed to engage the most serious and challenging issues of our time. CRCL is allied with the Earth Institute’s Climate Adaptation Initiative and works across the disciplines at Columbia by bridging design with science and policy to improve the adaptive capacity of people and places.

## WWF

The World Wide Fund for Nature (WWF) is one of the world’s largest and most experienced independent conservation organizations, with over five million supporters and a global network active in more than 100 countries. WWF’s mission is to stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature, by conserving the world’s biological diversity, ensuring the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

### Mozambique Natural Capital Program

The goal of the Natural Capital Program is to integrate Nature-Based Infrastructure (NBI) such as rivers, forests, and mangroves in the planning, design, and operation of built infrastructure, industries, and cities for lasting, shared human prosperity, economic productivity, and climate resilience. NBI is the interconnected ecological structural elements and processes in a landscape or seascape that deliver critical services and benefits to people, businesses, and biodiversity.

**This project was made possible by the generous support of WWF.**

## CONTRIBUTORS

WWF-Mozambique  
WWF-US  
Center for Resilient Cities and Landscapes (CRCL)  
Columbia University Graduate School of Architecture, Planning and Preservation (GSAPP)  
Columbia University Business School  
Lúrio University

### With Special Thanks and Contributions from Collaborating Agencies and Partners

**Government of Mozambique:** The Ministry of Land, Environment and Rural Development (MITADER), and the Ministry of Economy and Finance (MEF), Ministry of Sea, Inland Waters and Fisheries (MIMAIP), Ministry of Public Works and Water (MOPH), District Services for Planning and Infrastructures (SDPI) from Palma, District Services for Economic Activities (SDAE) from Palma, National Institute for Disaster Management (INGC)

**Public Sector:** WWF, African Development Bank (AfDB), Council for Scientific and Industrial Research (CSIR), UNHABITAT, Columbia University, and Lúrio University

**Workshop Participants:** Eni S.p.A., Exxon Mobil, Association of the Environment (AMA), Kreditanstalt für Wiederaufbau (KfW), The World Bank, National Road Administration (ANE) Mozambique, INFATEC, Centro Terra Viva (CTV)

### Project Team

**Columbia University:** Kate Orff (Associate Professor-GSAPP, Faculty Director, Center for Resilient Cities and Landscapes), Thaddeus Pawlowski (Managing Director, Center for Resilient Cities and Landscapes), Carmelo Ignaccolo (Columbia GSAPP Adjunct Research Associate), Georine Pierre (Associate Research Scholar, Center for Resilient Cities and Landscapes), and Lisa Dale (Faculty Affiliate, Earth Institute)

**WWF:** Ryan Bartlett (Lead, Climate Risk Management, WWF-US), Alima Taju (Natural Capital Senior Officer, WWF-Mozambique), António Serra (Landscape Coordinator, WWF-Mozambique), Hermínio Mulungo (Freshwater Programme Manager, WWF-Mozambique), and Lara Mauves (Marine Senior Officer, WWF-Mozambique)

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Palma,  
Cabo Delgado Province,  
Mozambique

Maputo,  
Mozambique

Ponta do Ouro,  
Mozambique

Map of Africa

#### KEY QUESTIONS:

- Is it possible for Palma and the region to support food, water, energy, housing for sudden rapid growth, while maintaining its natural capital?
- What are the opportunities or actions to improve planning for Palma / Cabo Delgado's future development plan?
- What are the most important risks to Palma's future development and how could natural capital buffer those risks?
- How can government, society, and the private sector work together to incentivize investments in natural-based infrastructure to reduce risks or build resilience?

## EXECUTIVE SUMMARY

*How will the development of liquefied natural gas and associated urbanization impact Mozambique's natural and social capital?*

Cabo Delgado, Mozambique is a place of great ecological and cultural wealth. It also contains Africa's fourth-largest known deposit of liquefied natural gas offshore. The extraction of this gas and subsequent urban growth is assured in the years to come. The town of Palma is expected to grow from 20,000 to at least 200,000. How these developments will affect the country's existing natural and social capital remains to be seen.

On August 20 and 21, 2018, the World Wide Fund for Nature (WWF) and Columbia University's Graduate School of Architecture Planning and Preservation (GSAPP) conducted a five-day workshop in Maputo. The workshop brought together faculty and students in architecture, urban design, planning, business, and environmental management from Columbia University; architecture students and faculty from Lúrio University (Pemba, Cabo Delgado); and other participants from local and international NGOs, public, and private sectors. This diverse group from many places and many sectors came together to build an understanding of the interconnected risks to the flows of natural capital in northern Mozambique. By describing how the existing forests, rivers and bays provide food, water, shelter and energy today, they began to sketch a future vision of sustainable, resilient development based on harnessing and enhancing natural capital.



Resilient Mozambique Workshop participants on day four

This workshop provided a forum for the major stakeholders in the economic development of northern Mozambique—government, civil society, communities, and the private sector—to collectively understand the threats and opportunities that gas exploration, rapid growth, climate change, and related factors pose to the region. The workshop featured presentations from each stakeholder on proposed development plans, followed by breakout group discussions. On the last day, students from GSAPP, the Columbia University Business School, and Lúrio University made short presentations of what they learned and developed visualizations of potential future development in northern Mozambique.

The Center for Resilient Cities and Landscapes at Columbia University will use the resulting knowledge and information to develop visualizations of potential futures for Palma. One will show the business-as-usual consequences of resource extraction and unmanaged growth; the second will consider climate resilience, social justice, and circular and sustainable economies based on the region’s natural capital and the many benefits it provides to local communities.

**KEY PRINCIPLES FOR FUTURE PLANNING IN PALMA:**

- **Understanding existing vulnerabilities and anticipate future shocks**
- **Protect and enhance existing assets**
- **Consider mobility, equity and land use simultaneously**
- **Cluster housing around public space and social infrastructure**
- **Invest in infrastructure with multiple benefits**
- **Establish collaborative planning processes**
- **Blended finance to match public & private investment**



Water working sessions on day four of the workshop



Housing/settlement working sessions on day four of the workshop

**OBJECTIVE AND NEXT STEPS:**

- **Visualizing potential risks and dependencies between built infrastructure, industry, settlements, livelihoods, climate dynamics and ecological infrastructure for the future of Palma**
- **Planning framework for the region of Palma outlining principles and decision-making steps to drive investments that optimize the health and climate resilience, social justice, and circular and sustainable economies.**
- **Further stakeholder engagement to sensitize draft results and solicit feedback.**



Palma, Mozambique. Image: Google Earth

## Natural Capital in Mozambique

### Mozambique Risk Profile

In 2017, Mozambique ranked third among African countries<sup>1</sup> most exposed to multiple weather-related hazards. Key climate change hazards for Mozambique include drought, warming ocean temperatures, flooding risks, tropical cyclones, and rising sea-levels. These climate hazards present serious threats to food and water security, community livelihoods, built infrastructure, and human settlements. In addition to climate change, anthropogenic pressures driven by population growth, urbanization, industrialization and expansion of

built infrastructure are stressing ecosystems' capacity to provide critical goods and services such as food, water, energy, and shelter.<sup>2</sup>

Mozambique ranks 180 out of 189 globally on the human development index with almost 19 million Mozambicans living in extreme poverty.<sup>3</sup> After a colonial system akin to apartheid in South Africa collapsed with the overthrow of the Portuguese dictator Salazar in 1974, Mozambique suffered a civil war from 1977 to 1992 in which one million people died and social and physical infrastructure was either destroyed or inhibited from development.

The Cabo Delgado Province in northern Mozambique spans the Niassa Wildlife Preserve along the Rovuma River and the Swahili Coast. Despite Portuguese conquest, Swahili enclaves continued to exist along the coast of northern Mozambique from Pebane to Palma.

From 2002-2003, the Cabo Delgado Province had a poverty level of 63.2 percent, the third-highest level in the country.<sup>4</sup> Poverty levels in the province decreased by 37.4 percent by 2008 due to improvements in agriculture, access to public services, and infrastructure, which led to increased access to trading networks.<sup>5</sup>

### WHAT IS NATURAL CAPITAL?

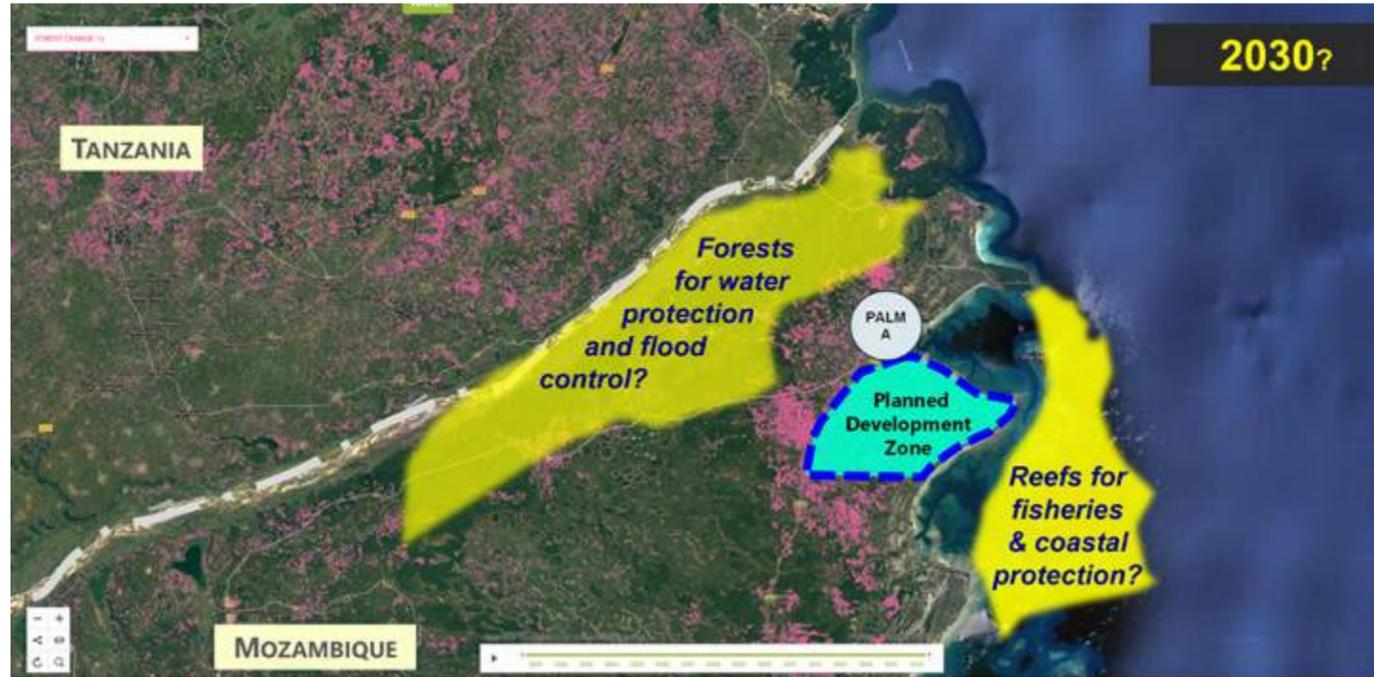
“The goal of the Natural Capital Program is to integrate Nature-Based Infrastructure (NBI)—such as rivers, forests, and mangroves—in the planning, design, and operation of built infrastructure, industries, and cities for lasting, shared human prosperity, economic productivity, and climate resilience. NBI is the interconnected ecological structural elements and processes in a landscape or seascape that deliver critical services to people, businesses, and biodiversity.”

— WWF

Coastal Communities in Palma

Image: WWF/ Green Renaissance Photography

OVERVIEW



Map: Global Forest Watch/WWF

## Can the Mozambique government protect and enhance ecological and social infrastructure while benefiting from economic growth and responsible gas extraction?

In 2012, the Italian multinational oil and gas company Eni S.p.A. discovered the world’s fourth-largest natural gas reserve off the coast of Cabo Delgado near the Rovuma River Delta. Oil extraction fields are proposed to be constructed in these coastal areas in coming years, especially around the town of Palma where facilities for liquefying natural gas are being built onshore along with a deep-water port and associated housing and industry. This development will attract thousands of people from other provinces in Mozambique and abroad, in search of jobs in natural gas and related industries. The Liquefied Natural Gas (LNG) processing facility will allow the gas to be made ready for export

via supertankers to the high-demand markets of East Asia. According to the U.S. company Anadarko Petroleum, these events would see Mozambique become one of the world’s top natural gas exporting countries.<sup>6</sup>

Two leading oil and gas companies will operate in the newly-discovered natural gas blocks within the Rovuma Basin: Anadarko (Area 1 occupation) and Eni East Africa (Area 4 occupation). The initial development for the U.S. \$25-30 billion invested in the LNG project will be both offshore and onshore within the Palma district’s Afungi Peninsula.<sup>7</sup> The first floating LNG trains are expected to be constructed by 2023.<sup>8</sup>



Map: Global Forest Watch/WWF

For a nation struggling to enter the global economy, the ability to develop a natural gas export market seems like a game-changer. Indeed, Mozambique’s economy has been growing at a remarkable 8.28 percent since the vast coal reserves in the Tete Province were opened in 2011.<sup>9</sup> This injection of foreign capital is even more critical at present: The national government is in debt after \$2 billion worth of secret loans supported by Mozambique’s financial minister were made to three state companies.<sup>10</sup> But the new mining operations have social and environmental costs in addition to economic benefits. Lessons can be learned from the negative impacts of the coal mining industry in the Tete Province, where local populations are being marginalized due to “the loss of land, decent housing, food security, and other sources of livelihood.”<sup>11</sup> The mining company also failed to execute an approved resettlement plan, leaving households to reside in the polluted environment of the mining concession areas.<sup>12</sup>

Mozambique’s new gas development project has brought feelings of exclusion and marginalization in communities reliant on informal economies.<sup>13</sup> Nearly 95 percent of Mozambique’s rural inhabitants are self-employed in the informal sector.<sup>14</sup> In October 2017, Cabo Delgado experienced its first jihadi terror attack. The violence continued to escalate in the Palma district due to rebellion against “local grievances of unemployment, social erosion, and lack of public services.”<sup>15</sup> Many acts of terrorism are driven by concerns about the region’s projected economic prosperity and the lack of adequate compensation provided to local people.<sup>16</sup> This has been disputed by officials who report the recent violence is the product of “inter-tribal” tensions related to

the recent religious radicalization of disenchanted youth.<sup>17</sup> There has also been speculation that insurgency started by some radicals coming from Tanzania linked to other groups of East Africa, which are also related to trafficking contraband.

According to a 2016 Royal Dutch Shell study on the environmental impacts of a proposed LNG plant, the current population of 60,000 people in Palma is expected to exceed 200,000 by 2030. Construction has commenced on a “pioneer camp” that will house 700 workers and be completed in 2018. These workers will construct a temporary port and housing for an additional 10,000 people who will build the rest of the gas production and export facilities.<sup>18</sup>

The district government of Palma created a spatial plan showing where industrial activities, agriculture, tourism, and housing are likely to occur. However, this plan is very general and its potential for implementation is unclear. It also fails to account for the unplanned housing growth that is likely to occur both around Palma and outside the fences of the industrial complex. Although the national government has recognized “natural capital” as an organizing principle of its development strategy, the concept doesn’t appear to have informed the spatial plan for Palma.<sup>19</sup> The forested Rovuma River Basin and coral-rich coastal waters are already struggling with deforestation and overfishing. The natural capital that supports the current population will increasingly be threatened by rapid urbanization. And climate change will be a threat multiplier: As the Rovuma Basin faces greater fluctuations in wet and dry periods, groundwater may become increasingly salinated, ocean acidification will lead to coral

bleaching and loss of fish habitat, and the low-lying coastal areas now home to mangrove forests, which buffer storm surge during seasonal monsoons, could be replaced by hard infrastructure or informal settlements.

### The Challenges Ahead

The gas companies and Mozambique officials express optimism about the national prosperity that could be brought by the gas exploration. Both have said that gas revenues have the potential to “catalyze investments in ecological infrastructure and cultural connectivity for a resilient, inclusive future society.”

But how and for whom and at what cost? Other African nations—including Nigeria and the Democratic Republic of Congo—have suffered from a “resource curse” where the benefits of resource extraction accrue for a powerful elite and the mounting environmental and social costs are born by the land and people.

# Workshop Agenda

Planning for the Resilient Mozambique Workshop began in late 2017 with the goal of bringing Columbia University students to Palma for a one-week intensive design and planning workshop. However, reports of violence in Palma in June 2018 prompted a rapid redesign of the workshop. Instead of travelling to Palma, we chose to spend more time in the capital city of Maputo learning about Mozambique’s history, culture, and institutions. We also made an excursion outside the city to better understand the relationships between Mozambicans and their natural capital.

## Meetings in Maputo

The faculty team arrived in Maputo two days early to tailor the workshop structure and meet with stakeholders from USAID, the Mozambique Ministry of Land, Environment and Rural Development (MITADER), and the African Development Bank (AfDB) (meetings are summarized on page 32). We also met with Carlos Santos, U.S. Ambassador to Mozambique, who encouraged students to be visionary; he also emphasized the nation’s openness to new ideas and the potential of this work to address the challenges ahead. Santos discussed how he learned lessons from Aberdeen, Scotland and Botswana about absorbing growth without losing the natural and cultural capital of a place.



**MEETING**

*Dinner with Carlos Santos, U.S. Ambassador to Mozambique, in Maputo, Mozambique*

## Field Trip to Ponta do Ouro

Students and faculty from Columbia University, Lúrio University, and WWF staff travelled together from Maputo to Ponta do Ouro for three days of site visits and an internal work session. Ponta do Ouro is an ecologically-sensitive area, home to the world’s largest planted dunes. Ponta do Ouro used to be more remote, about six to ten hours south of Maputo by four-wheel vehicle, until the recent construction of a paved road reduced that travel time to two or three hours. A new bridge over the Espirito Santo Estuary to link Maputo and Catembe reduced this travel time to one hour and thirty minutes by car and likely lead to intensive development of this coast.

## Workshop Structure

The two-and-a-half-day workshop in Maputo was structured around expert presentation followed by facilitated discussions. In addition to WWF, Columbia University, and Lúrio University, active participants included more than 60 people from the national and local government, international NGOs and civil society organizations, and representatives from ExxonMobil. Students and faculty were divided into four themes based on what natural capital provides to society: water, food, energy, and shelter; participants joined the theme most aligned with their interest.



*Entry to Mozambique’s Ministry of Land, Environment and Rural Development (MITADER) office in Maputo, Mozambique*

# Day One

Students and faculty from Columbia University, Lúrio University, and WWF staff travelled together from Maputo to Ponta do Ouro to explore fishing and farming villages, charcoal production, and local irrigation systems.



*Columbia University and Lúrio University students have a communal meeting with local farmers and fishermen during site visits*



*Columbia University and Lúrio University students have a communal meeting with local farmers and fishermen during site visits*



**SITE VISITS**

*Columbia University, Lúrio University, and WWF staff visiting local farms*

## Day Two

The second day featured presentations and work sessions with Columbia University and Lúrio University students. Presentations included an Introduction to WWF's Natural Capital program by Antonio Serra and Ryan Bartlett, an ArcGIS tutorial from Carmelo Ignaccolo about Mozambique's land use planning and Temporary Octopus Closures in Quirimbas National Park in Mozambique by Isabel Marques da Silvia. Students broke out into four teams concentrating on water, food, energy, and shelter. The students later presented their initial research and interests regarding these concentrations in the city of Palma.



Antonio Serra, Landscape Coordinator from WWF-Mozambique, presenting the Introduction to WWF's Natural Capital program



Ryan Bartlett, Lead, Climate Risk Management from WWF-US, presenting the Introduction to WWF's Natural Capital program



**WORKSHOP**

In Ponta do Ouro, Columbia University and Lúrio University students and faculty listen to presentations during an internal work session to encourage the initial research for student work regarding Palma.

## Day Three

Students, faculty, and WWF staff participated in a field day that involved snorkeling along a reef in the Strait of Madagascar. Students learned about marine ecology, coral reefs, and sea life and how these ecosystems could be applied to envisioning futures for Palma's investment in natural capital.



Coastal conditions along the Ponta do Ouro beachfront



Whale sighting while returning to shore



**FIELD DAY**

Columbia University and Lúrio University faculty and students, and WWF staff after snorkeling in Ponta do Ouro

## Day Four

Presentations by experts from the National Directorate of Land Use Planning and Resettlement (DINOTER), District Service of Economic Activities of Palma (SDAE Palma), Lúrio University, Association of the Environment of Mozambique (AMA), Council of Scientific and Industrial Research (CSIR), National Institute of Disaster Management of Mozambique (INGC), and the World Bank encouraged conversations about gaps and opportunities in spatial planning in Palma. A series of workshop exercises framed questions about the ability of Palma and the region to support food, water, energy, and housing for sudden rapid growth while maintaining its natural capital; the three key opportunities or actions that can improve planning for Palma/Cabo Delgado's future development; the important risks to Palma's development; and how natural capital can buffer those risks.



*Cesar Tique of African Development Bank during breakout group discussions at the water table*



*Carmelo Ignaccolo facilitating conversation during breakout group discussions at the food/agriculture table*

## Day Five

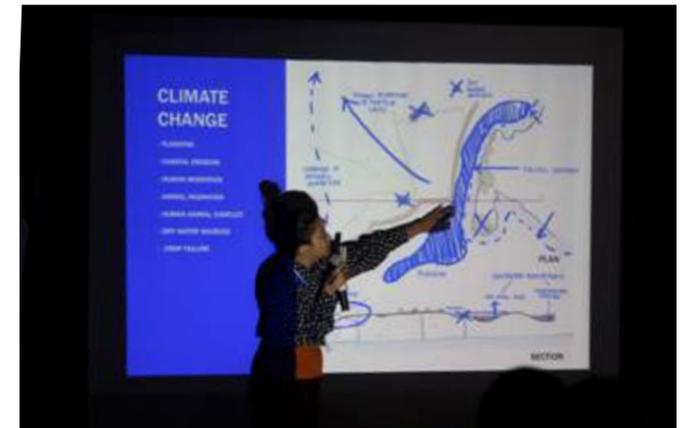
Presentations by experts from Third Way Africa, the African Development Bank, and Kate Orff encouraged opportunities for future development in Palma regarding Nature-Based Infrastructure and investment.

A workshop exercise framed a conversation about blended finance (public and private sector) investment projects in nature-based infrastructure.

Students then gave presentations focused on water, agriculture/food, energy, and housing settlements. Their goal was to develop a vision for sustainable, resilient development in Palma through visualization techniques and scenario planning implementation.



*Elisa Xavier de A F Carvalho, John Plaisted, Anna Stokes, and Emerson Zeferino Joao presenting student work from the energy team*



*Camille Esquivel presenting student work from the water team*



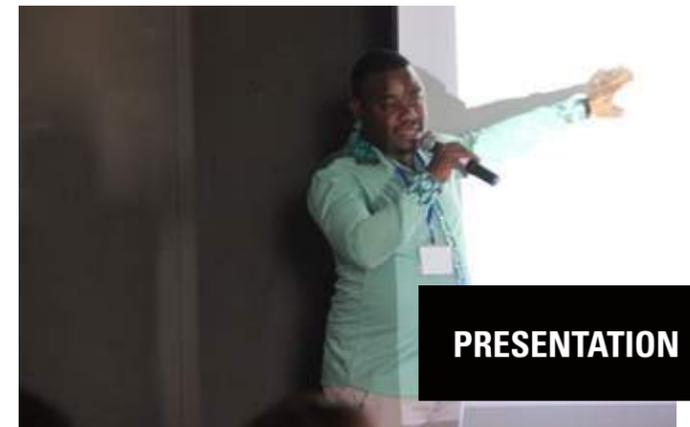
*Kate Orff referencing a diagram produced by the water team during a breakout group discussion*



*Lisa Dale recording the conversation during a breakout group discussion at the energy table*



*Emily Po, Charles Drain, Keir Senda, and Laura Postarini presenting student work from the housing team*



*Samito Joao presenting student work from the water team*

**WORKSHOP**

**PRESENTATION**

# Workshop Schedule

## Monday, August 20, 2018

<b>8:30 AM</b>	<b>Arrival and Registration</b>
<b>9:00 AM</b>	<b>Official Opening</b> Adarito Watela, National Director of Spatial Planning and Resettlement, Government of Mozambique Anabela Rodrigues, Country Director, WWF Mozambique Kate Orff, Associate Professor and Faculty Director of the Center for Resilient Cities and Landscapes, Columbia University
<b>9:30 AM</b>	<b>National Directorate of Land Use Planning and Resettlement (DINOTER)</b> National Territorial Development Plan
<b>9:45 AM</b>	<b>District Service of Economic Activities of Palma (SDAE Palma)</b> Palma Development Plan
<b>10:00 AM</b>	<b>Breakout Group Discussion 1</b> Gaps and Opportunities in Spatial Planning of Palma
<b>10:30 AM</b>	<b>Break and Group Photo</b>
<b>11:00 AM</b>	<b>Lúrio University Presentation</b> Challenges and Opportunities in Executing Urban Spatial Development Plans; Social and Ecological Profile of Northern Mozambique
<b>11:15 AM</b>	<b>Association of the Environment of Mozambique (AMA)</b> Civil Society Perspective on the Challenges and Social Stresses of Development in Palma
<b>11:30 AM</b>	<b>Breakout Group Discussion 2</b>
<b>12:30 PM</b>	<b>Lunch</b>
<b>1:30 PM</b>	<b>Analyses of Nature-Based Infrastructure</b> Coastal Ecosystem Services and Strategic Water Source Areas Preliminary Results from the Council of Scientific and Industrial Research (CSIR)
<b>1:45 PM</b>	<b>National Institute of Disaster Management of Mozambique (INGC)</b> Profile of Climate Risks to Mozambique
<b>2:00 PM</b>	<b>World Bank</b> Experiences with Nature-Based Infrastructure in Mozambique: Beira Case Study
<b>2:15 PM</b>	<b>Breakout Group Discussion 3</b>
<b>3:00 PM</b>	<b>Break</b>
<b>3:30 PM</b>	<b>Close Day 1</b>

## Tuesday, August 21, 2018

<b>8:30 AM</b>	<b>Arrival and Registration</b>
<b>9:00 AM</b>	<b>Third Way Africa</b> Potential for Investments in Northern Mozambique that will be Dependent on Nature-Based Infrastructure
<b>9:15 AM</b>	<b>African Development Bank</b> Pemba Lishinga Corridor Development (North/South trade with Tanzania) How Investments Can be Aligned with Nature-Based Infrastructure
<b>9:30 AM</b>	<b>Kate Orff, Columbia University</b> Resilient Landscapes: Avoiding the Resource Curse
<b>9:45 AM</b>	<b>Breakout Group Discussion</b> Blended Finance (Public and Private sector) Investment Projects in Nature-Based Infrastructure
<b>10:30 AM</b>	<b>Official Government Closing</b> Thanks and Next Steps, Nemani from FNDS



Mafalala, Maputo, Mozambique



## Learning from Mafalala

The Center for Resilient Cities and Landscapes team visited Mafalala, an informal residential area in Maputo, Mozambique. Standing at an intersection of Avenida Marien N’guabi and Rua da Goa, one can see evidence of Mozambique’s divided history. One side contains the formal Portuguese colonial city of wide avenues, parks, and grand hotels. On the other side, an informal neighborhood of zinc-covered, one-story houses crowd along lanes interspersed with gathering places under majestic Banyan trees. From this neighborhood, a cultural and political vitality emerged along with the poets and politicians who were born there, while on the other side of the wall once lining this avenue, a political order of exclusion and exploitation reined. The wall is long gone, but will a future Mozambique suffer similar divisions?



Sketches of local housing in Mafalala



# Agriculture and Fisheries

## Site Visits to Pedro and Jocue

During the first day of the workshop, students and faculty from the Columbia University and Lúrio University, and staff from WWF visited agricultural and fishing communities in Pedro and Jocue.



Farmer handing out harvested cassava to visitors



Local farmers planting and watering crops near an irrigation well



Harvesting of cassava crops



Produce sold at market near new road development



Farmers traveling with produce to local market



Fishing boats utilizing local construction methods and materials



Local fisherman explaining their fishing methods to students from Columbia

# Irrigation Well

## Site Visits to Pedro and Jocue

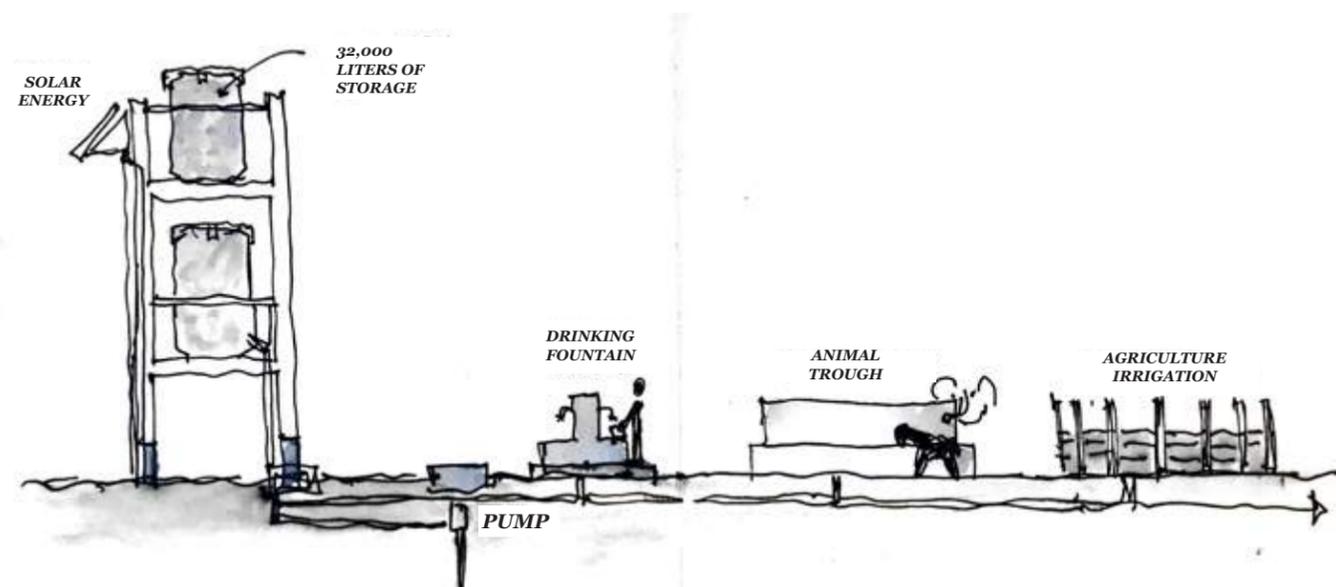
During the first day of the workshop, students and faculty from the Columbia University, Lúrio University, and WWF staff visited the irrigation systems in Pedro and Jocue.



Manual hand pump for irrigation well



Drinking trough for cattle



Sketch of irrigation system



Solar power and storage for irrigation well



Solar power and storage for irrigation well



Display for the process of weaving reed mats for building construction



Locally-made cement blocks available for purchase near new road development to Ponta do Ouro



Reed mats and bags of charcoal available for purchase near new road development to Ponta do Ouro



## Local Building Materials

### Site Visits to Pedro and Jocue

During the first day of the workshop, students and faculty from Columbia University, Lúrio University, and WWF staff visited local building construction methods in Pedro and Jocue.



Roof construction detail for housing structures



Roof construction detail for housing structures



Vernacular construction featuring reed mats for a housing structure used for cooking



Local housing constructed with cement (limestone and clay), water, and sand from rivers

# Charcoal Production and Energy Sources

## Site Visits to Pedro and Jocue

During the first day of the workshop, students and faculty from the Columbia University, Lúrio University, and WWF staff visited a rural production site for charcoal in Pedro and Jocue.



Rural charcoal production site where stumps and roots from trees are left to facilitate forest regrowth



Charcoal and firewood shop in Ponta do Ouro



Bags of charcoal ready to be sold at local markets



Local electrical line connecting to the Mozambican National Electric Grid



Handmade solar-powered charger



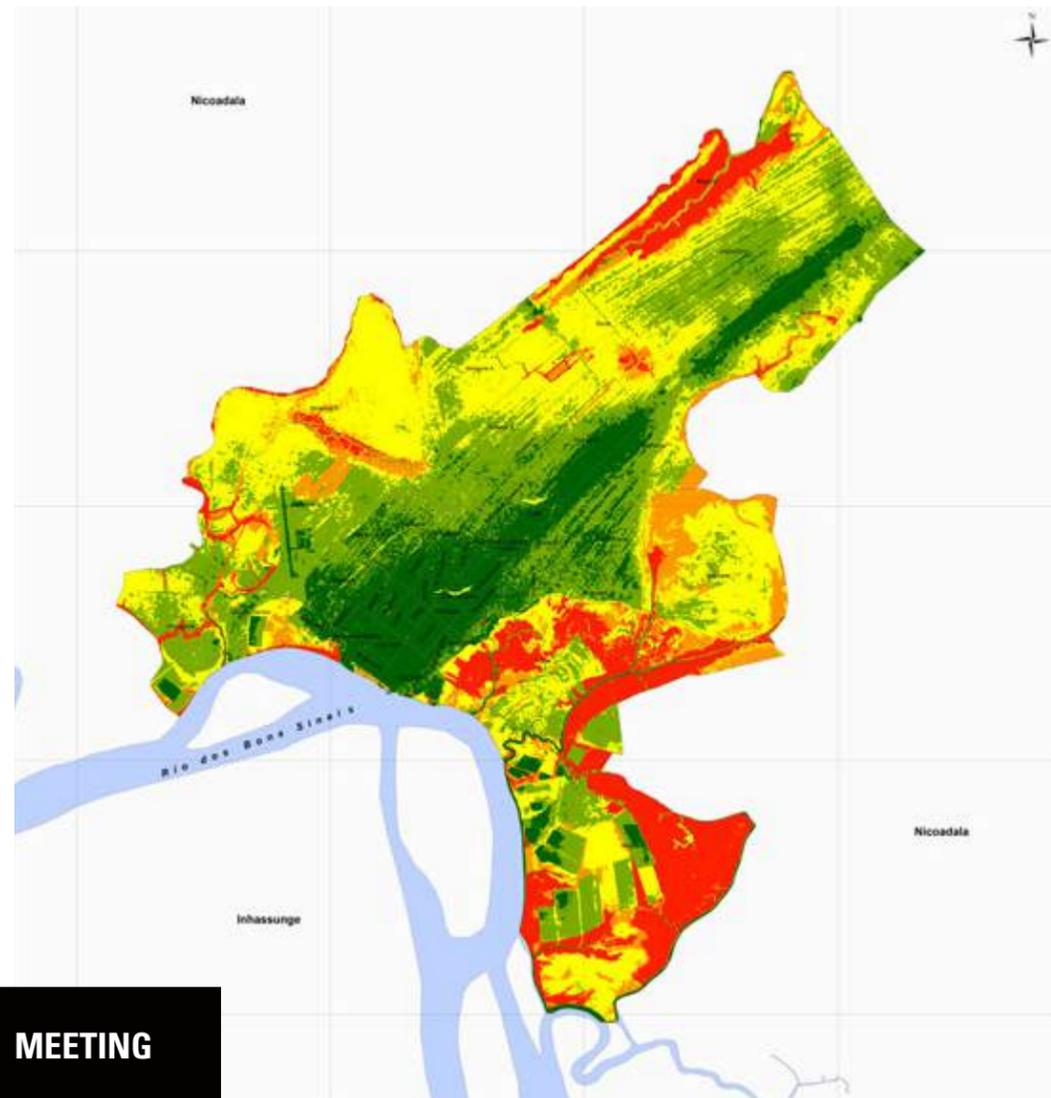
Sketch of the cycle of charcoal production and consumption

The team from the Center for Resilient Cities and Landscapes (CRCL) and WWF arrived in Maputo two days early to tailor the workshop and meet with stakeholders. These meetings are summarized in the following section.

## USAID: Coastal Adaptation Plan

### Meeting with Olivia Gilmore and Zachary Bailey

The Coastal City Adaptation Project (CCAP) was started in 2013 by the United States Agency for International Development (USAID). Its interests include community development, capacity building, and technology transfer in the Mozambique cities of Pemba and Quelimane. Vulnerability maps and local adaptation plans serve as a platform for conversation with the international adaptation world. Other studies involved insurance markets, mangrove plantings, and benefits for tourism. The project succeeded in bringing together municipal staff and planners.<sup>20</sup>



February 2015 USAID map produced with the following parameters: Topography, vegetation, and mangrove on a scale of very low exposure to very high exposure in Zambezia Province in southern Mozambique

MEETING

## USAID: Climate Resilient Houses Brief

### USAID / Coastal City Adaptation Project

The USAID Coastal City Adaptation Project (CCAP) is working to provide alternative model construction techniques that promote urban adaptation to climate change in Mozambique's coastal cities. These communities face challenges such as flooding, unstable slopes, contaminated water supplies, and storm damage. CCAP collaborated with UN-Habitat to ensure the proposed construction materials and techniques are cost efficient and culturally appropriate for the local context of the region.<sup>21</sup>

The key design elements developed by CCAP and UN-Habitat's model homes in Mozambique are housing site selection, raised foundation, reinforced walls, and a secured roof. The impact of climate-risk hazards can also be reduced through proper site selection, which means building in areas that do not have increased exposure to flooding, high winds, or land with a slope greater than 45 degrees.<sup>22</sup> The foundations of these houses are platforms constructed with cement bricks, reinforced concrete, or large stones and elevated above flood levels and able to withstand intense rain.<sup>23</sup>



Finished houses ready for community outreach on resilient techniques

The walls of the houses are made of coconut, small stake ripping, or bamboo. They're reinforced with diagonal poles and finished with mortar plaster. The roofs are made of waterproof material and used to harvest water for drinking and household uses, which helps reduce drought-related water shortages.<sup>24</sup>

CCAP model houses provide a modular design that can be applied based on the severity of local hazards, affordability of construction, and resources available. CCAP works to help local communities better understand long-term resilient building techniques and is collaborating with strategic partners such as the National Directorate of Housing, Mozambique National Association of Municipalities (ANAMM), and private sector actors to enable access to improved resources and more vigorous structures.<sup>25</sup>

The Baseline (Traditional) House		Estimated Labor Cost	Estimated Materials Cost	Estimated Total Cost	
Foundation		\$ 38.27	\$ 458.33	\$ 496.60	
Walls	Using local materials and vernacular techniques	\$ 68.88	\$ 1,458.33	\$ 1,527.21	
Roof		\$ 45.92	\$ 1,037.50	\$ 1,083.42	
Options for Resilient Construction Techniques		Estimated Labor Cost to Construct the Baseline (Traditional) House with the More Resilient Technique	Estimated Materials Cost to Construct	Estimated Total Cost to Construct the Baseline (Traditional) House with the More Resilient Technique	Percent Cost Increase over vernacular Technique
RAISED FOUNDATION	Raised Foundation Built with Local Materials	\$ 221.74	\$ 595.83	\$ 817.58	65%
	Raised Foundation Built with Optimal Materials	\$ 295.66	\$ 2,195.26	\$ 2,490.92	402%
REINFORCED WALLS	Reinforced Walls built with Local Materials	\$ 416.75	\$ 1,822.92	\$ 2,239.67	47%
	Reinforced Walls built with Optimal Materials	\$ 555.67	\$ 2,339.91	\$ 2,895.57	90%
SECURE ROOF and RAINWATER CAPTURE	Secure Roof built with Local Materials	\$ 94.95	\$ 1,193.13	\$ 1,288.07	19%
	Secure Roof that Captures Rainwater Built with Optimal Materials	\$ 189.89	\$ 1,816.75	\$ 2,006.64	85%
		<b>Total Vernacular (baseline)</b>	<b>\$ 3,107.24</b>		
		<b>Total Resilient with local materials</b>	<b>\$ 4,345.32</b>		<b>40%</b>
		<b>Total Resilient with Optimal materials</b>	<b>\$ 7,393.13</b>		<b>138%</b>

Comparing costs associated with building a traditional house with vernacular techniques and local materials to the costs associated with adopting more resilient construction techniques (for CCAP model T2 house only). All costs are in U.S. dollars.

Images: United States Agency for International Development (USAID)

## Ministry of Land, Environment and Rural Development (MITADER)

### Meeting with MITADER

The WWF Natural Capital program is a priority for the Mozambique government and our work will provide guidance for development. The timing is especially good, as the current five-year plan will terminate in 2019. This is an opportunity to assess progress and identify new goals. The planning for the National Territorial Plan began in February 2018 and it will be an 18-month process. A consulting firm is taking the lead on planning and a technical group has been identified to connect government institutions. Natural capital themes will be embedded in this plan, which will be high-level and intended to guide local planning.

In Palma, Anadarko has 7,000 hectares for industrial development and EHN has 18,000 hectares; there is also a separate Palma Development Plan. Harmonizing the various plans will be important. MITADER is working with Anadarko on the resettlement process, including implementation and monitoring. During our conversation, we were shown a map where resettlement will occur.

Mozambique has many good plans, but it is difficult to assess their potential for success. Capacity weaknesses—economic limitations, weak technical skill base, and poor institutional coordination—are the main reason for incomplete implementation. There are design plans to build a solar factory and green infrastructure in Maputo, but implementation will be limited by capacity weaknesses. There is also an emphasis on improving public transportation in Mozambique. In each case, identifying natural assets is not enough. The government needs to incentivize and finance protection.



Meeting with Ministry of Land, Environment and Rural Development (MITADER) in Maputo, Mozambique

## African Development Bank (AFDB)

### Meeting with Cesar Tique and Yolanda Arcelina

Only 33 percent of Mozambique's rural population lives within 2 km of an all-season road. Even though the country exports electricity, 76 percent of households do not have access to on-grid electricity, and only 50 percent of the population is directly connected to water. Most of the focus on infrastructure to date has been in the south of the country, in Gaza and Maputo Provinces. The African Development Bank (AfDB) currently wants to pursue development in northern provinces and the Pemba-Lichinga Corridor.<sup>26</sup>

Possible projects for AfDB include power backbone infrastructure and major development corridors. For example, through the Pemba-Lichinga Corridor, there is high potential for the development of a power generation and logistics hub through modernization of port facilities and rail and road networks. There are opportunities for public utilities reform at the financial and governance level which could open opportunities to ambitious, bankable projects. The Pemba-Lichinga Corridor focuses on the rehabilitation of Mueda-Nengomano Road, which will connect Mozambique and Tanzania. AfDB has established the Green Economy Strategy and Natural Capital Program Framework in partnership with WWF and provided financing for road construction to link Cabo Delgado and Niassa to Cuamba-Lichinga. AfDB's partnerships focus on co-financing opportunities for resource mobilization, building a debt management framework, Foreign Direct Investment (FDI), and blended finance.<sup>27</sup>



Meeting at the African Development Bank with Cesar Tique and Yolanda Arcelina, Maputo, Mozambique

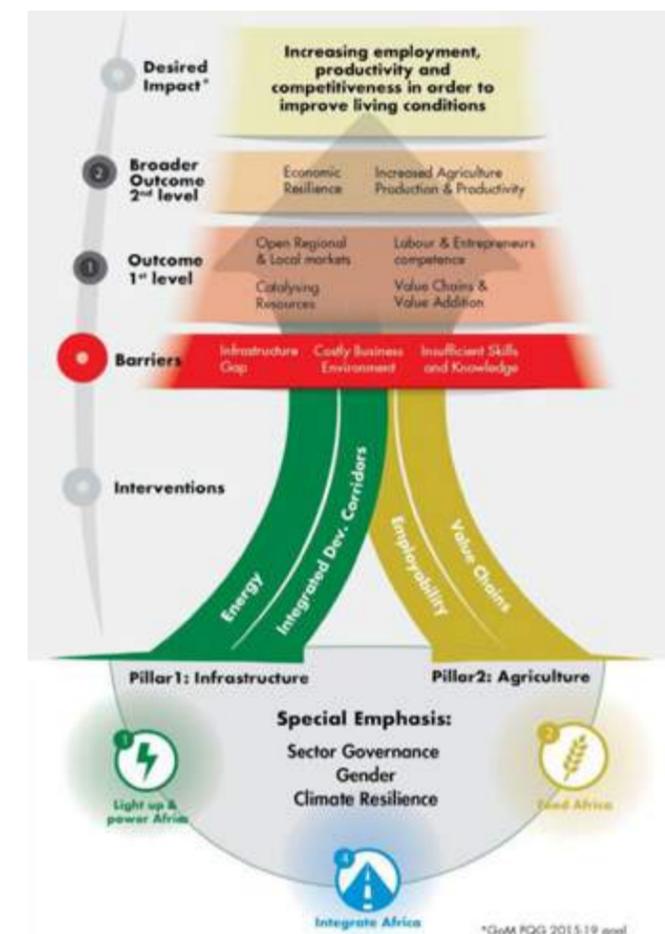


Diagram of African Development Bank's role and support in Mozambique's infrastructure and agriculture. Image: African Development Bank



Palma, Cabo Delgado Province, Mozambique

Image: U.S. Geological Survey (USGS) Earth Explorer Sentinel-2 data



**Palma, Cabo Delgado Province, Mozambique  
Deforestation Mapping**

*Image: U.S. Geological Survey (USGS) Earth Explorer Sentinel-2 data*

## Water Resources in Palma

Like any river delta, the region around Palma has water on all sides: The Rovuma River is to the north, the Indian Ocean to the east, and a vast forest pocked with wetlands and kettle hole ponds is to the west. Drinking water comes from municipal pumps fed by an underground aquifer, recharged by the forests and open spaces to the west. Wastewater is disposed of in pit latrines. Unlike in Maputo, the water supply in Palma is secure at current population and usage levels.

Anadarko's EIA report explains the water supply for their proposed operations, where "groundwater will be the only source of fresh water" during the construction phase. This may result in "the lowering of groundwater levels in and around abstraction boreholes" on site.<sup>28</sup> However, the report does not

explain the source of the population's future water supply or consider associated urban development.

Can the aquifer support this growth or could it be compromised by an increase in untreated sewage and saltwater infiltration from rising sea levels?

Would future water supply shocks compel the hasty construction of reservoirs, and perhaps the damming the Rovuma River, leading to ecological impacts and increased exposure to flooding and infrastructure failure? And as with all urban infrastructure systems, who will make the decisions about how this resource is protected? And will the most vulnerable have a voice in those decisions?

**CAN ECOLOGICAL  
INFRASTRUCTURE  
REDUCE RISK OF  
CLIMATE CHANGE  
IMPACTS INCLUDING  
EXPOSURE TO  
FLOODING AND  
INFRASTRUCTURE  
FAILURE IN THE  
ROVUMA RIVER?**

# WATER

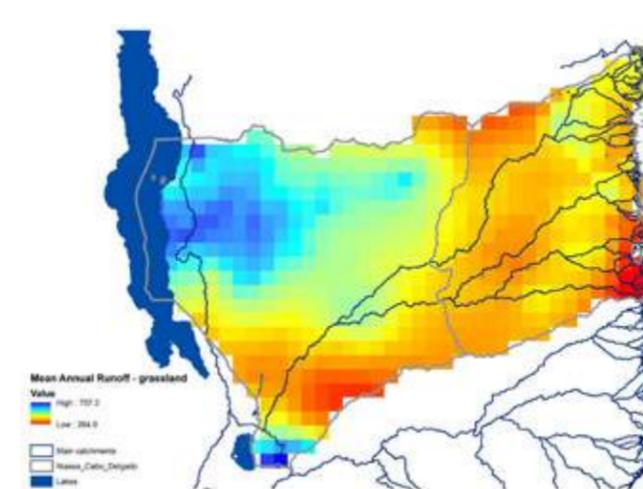
# Critical Natural Capital for Water Security in Mozambique

**Presentation by Dr. David Le Maitre and Lindie Smith-Adao (CSIR)**

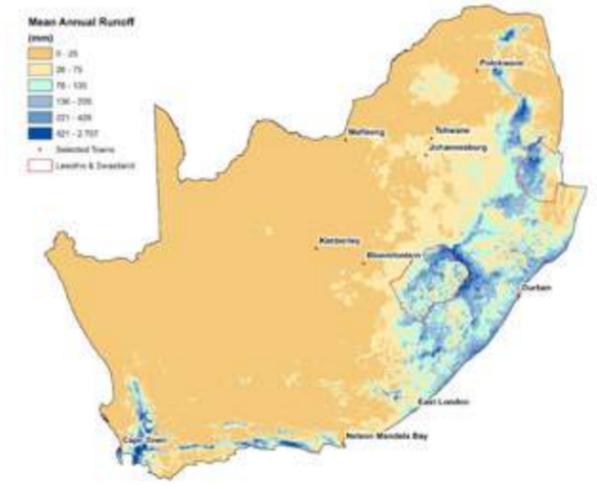
The Council of Scientific and Industrial Research (CSIR) initiated a pilot study in Mozambique that looked at two areas of interests: the Umbeluzi River Basin (in Maputo Province) and the Rovuma and Lúrio River Basins (Niassa and Cabo Delgado Provinces). CSIR studied rainfall and runoff relationships in the Umbeluzi River Basin in Maputo Province, and in the Rovuma and Lúrio River Basins in Niassa and Cabo Delgado Provinces. CSIR generalized the relationship between rainfall and actual evaporation. CSIR mapped those numbers to identify key Strategic Water Source Areas (SWSAs). Conclusions from the report suggest SWSAs are critical and require effective protection. This is a significant challenge and it will require a multi-government level, multi-sectoral approach, and bottom-up participation. CSIR promotes a focus on high strategic areas with high Mean Annual Runoff (MAR) areas.<sup>29</sup>



Principal Researcher David Le Maitre presenting on the fourth day of the workshop



CSIR analysis of Mean Annual Runoff (MAR) in Niassa and Cabo Delgado Provinces



CSIR analysis of South Africa's rainfall based Mean Annual Runoff (MAR) and Strategic Water Source Areas (50% of MAR from 8% of the land area)

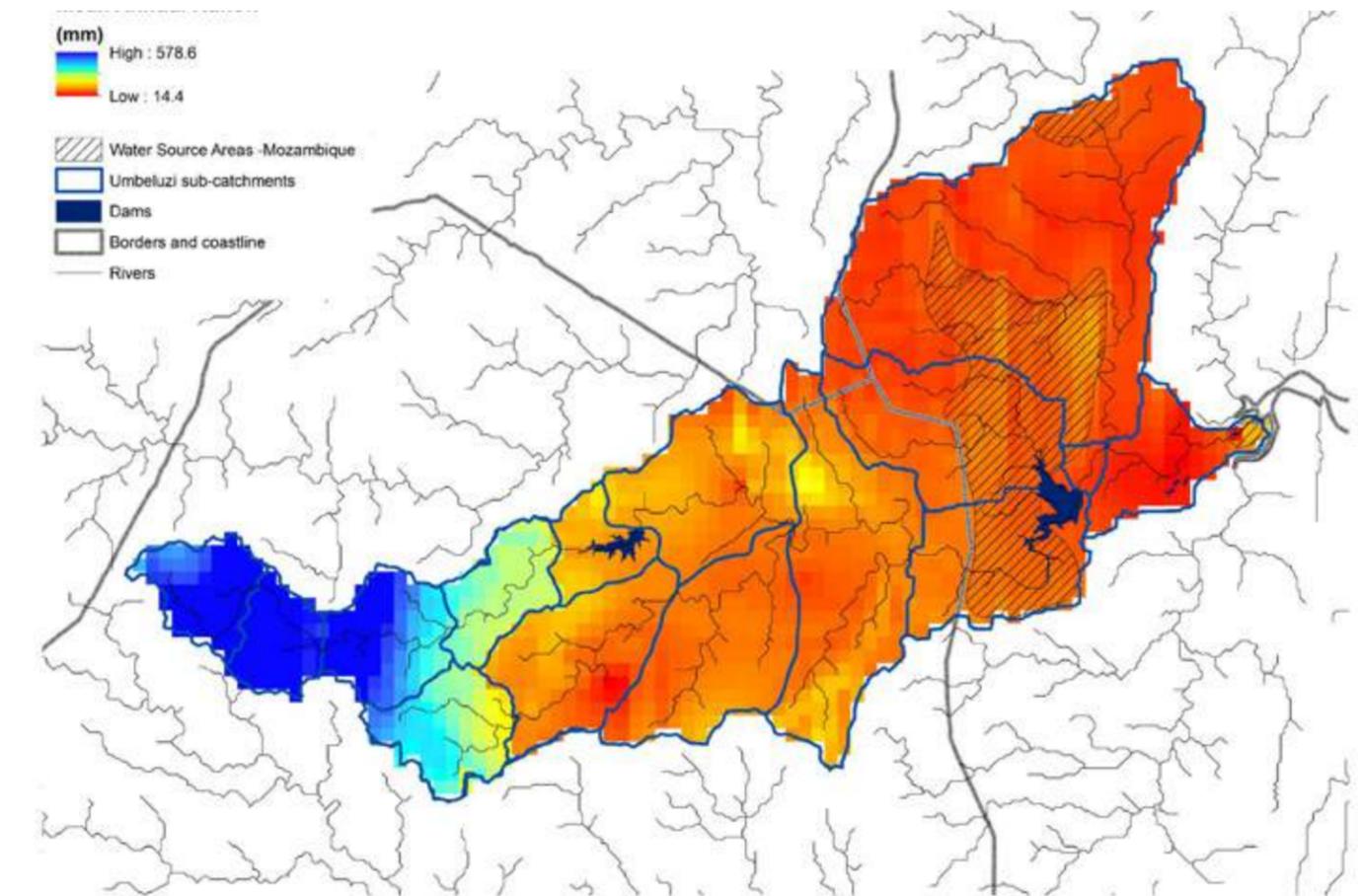
# Preliminary Assessment of Coastal Ecological Infrastructure in Cabo Delgado

**Presentation by Dr. Susan Taljaard (CSIR)**

CSIR helped the Mozambique Government produce tier one maps of Nature-Based Infrastructure. The preliminary study will map key coastal habitats focused on the importance of coastal protection, artisanal fisheries, freshwater supply, and tourism, and take into account climate risks. CSIR's methodological approach involves data sources, risks, and opportunity-linked benefits from key coastal habitats such as coral reefs, mangroves, seagrass beds, coastal dunes, beaches, sandbanks, and estuaries and lagoons.<sup>30</sup>



Principal Researcher Dr. Susan Taljaard presenting on the fourth day of the workshop



CSIR rainfall and Mean Annual Runoff (MAR) in the Umbeluzi Basin, demonstrating Strategic Water Source Areas and Umbeluzi sub-catchments

Images: The Council of Scientific and Industrial Research (CSIR)

# Green and Gray Infrastructure to Enhance Flood Protection in Beira

**Presentation by Michel Matera (The World Bank)**

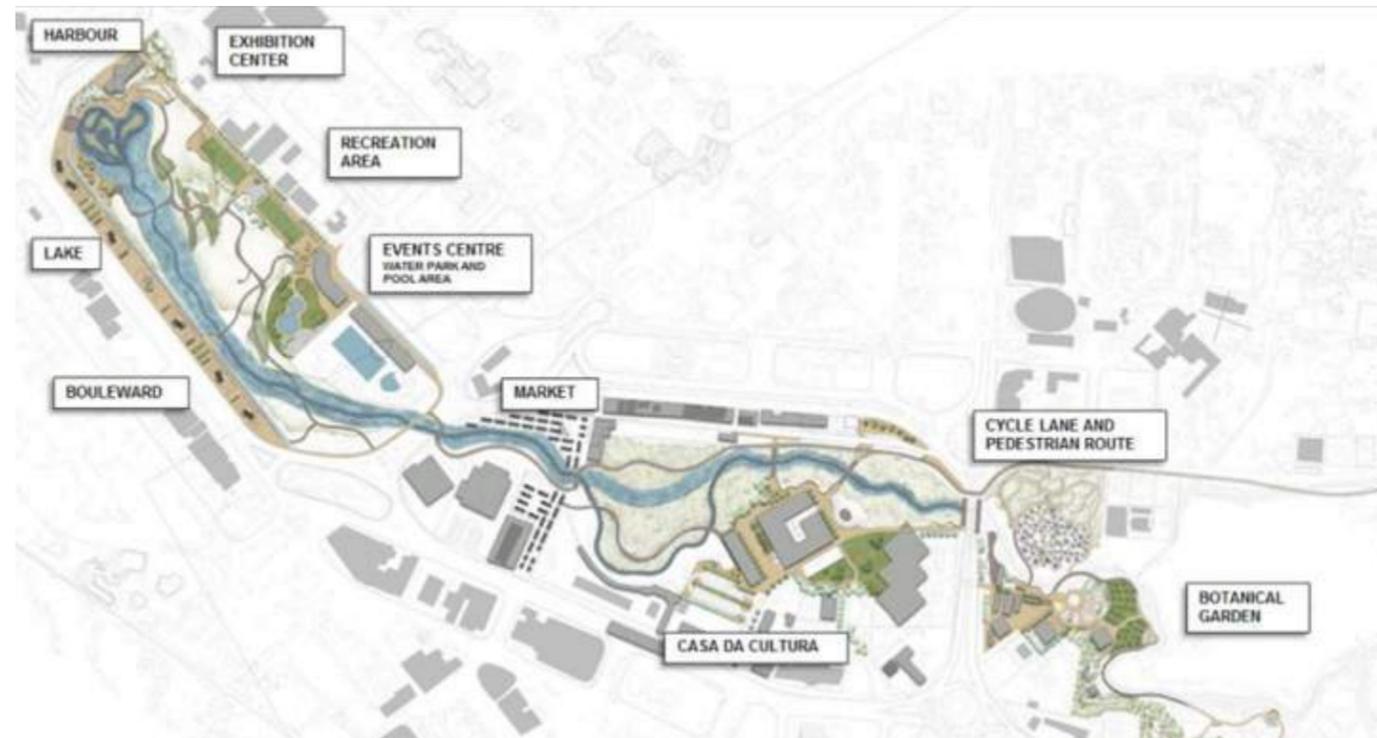
Beira is the fourth-largest city in Mozambique. It has approximately 530,000 inhabitants and is highly exposed to flooding in vulnerable neighborhoods. The World Bank and consultants in the governments of the Netherlands, Kreditanstalt für Wiederaufbau (KfW), Nordic Development Fund (NDF), and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) developed an urban master plan for it in 2013. Through the rehabilitation of a storm water drainage and flood control system in Beira, the risk of flooding was reduced by 70 percent for more than 250,000 people. The results from the rehabilitation of Chiveve River include widened riverbed and riparian zones; restored natural draining function with a water retention area; and reduced flooding risk for the city. The World Bank is currently developing new landscaping and parks along the Chiveve River. The green infrastructure includes a municipal market, multi-purpose garden center, urban garden area, planning for over 7,000 indigenous fruit and shadow trees, restaurant and events venues, and recreation space.<sup>31</sup>



Michel Matera, Senior Disaster Risk Management Specialist, presenting on the fourth day of the workshop



Development of green urban infrastructure plan along the Chiveve



Development of green urban infrastructure plan along the Chiveve River. Images: World Bank

# The Risk of Natural Disaster in Mozambique

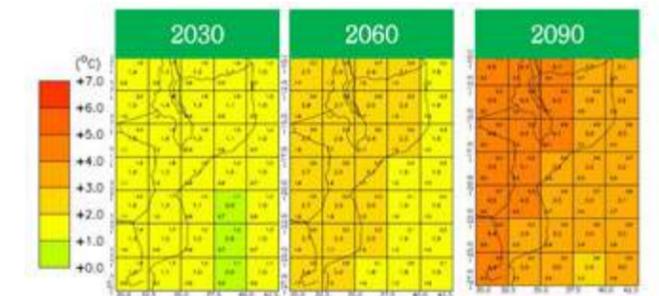
**Presentation by INGC (National Institute of Disaster Management of Mozambique)**

A number of human settlements and infrastructures located in coastal areas are very vulnerable to the effects of climate change. The INGC Risk Report identifies the disaster risks in Cabo Delgado's coastal and main river basin districts as floods, high winds, tropical cyclones, and erosion.<sup>32</sup> Floods are the biggest problem, leading to communication failure, electricity cuts, and bridge destruction within urban areas.<sup>33</sup>

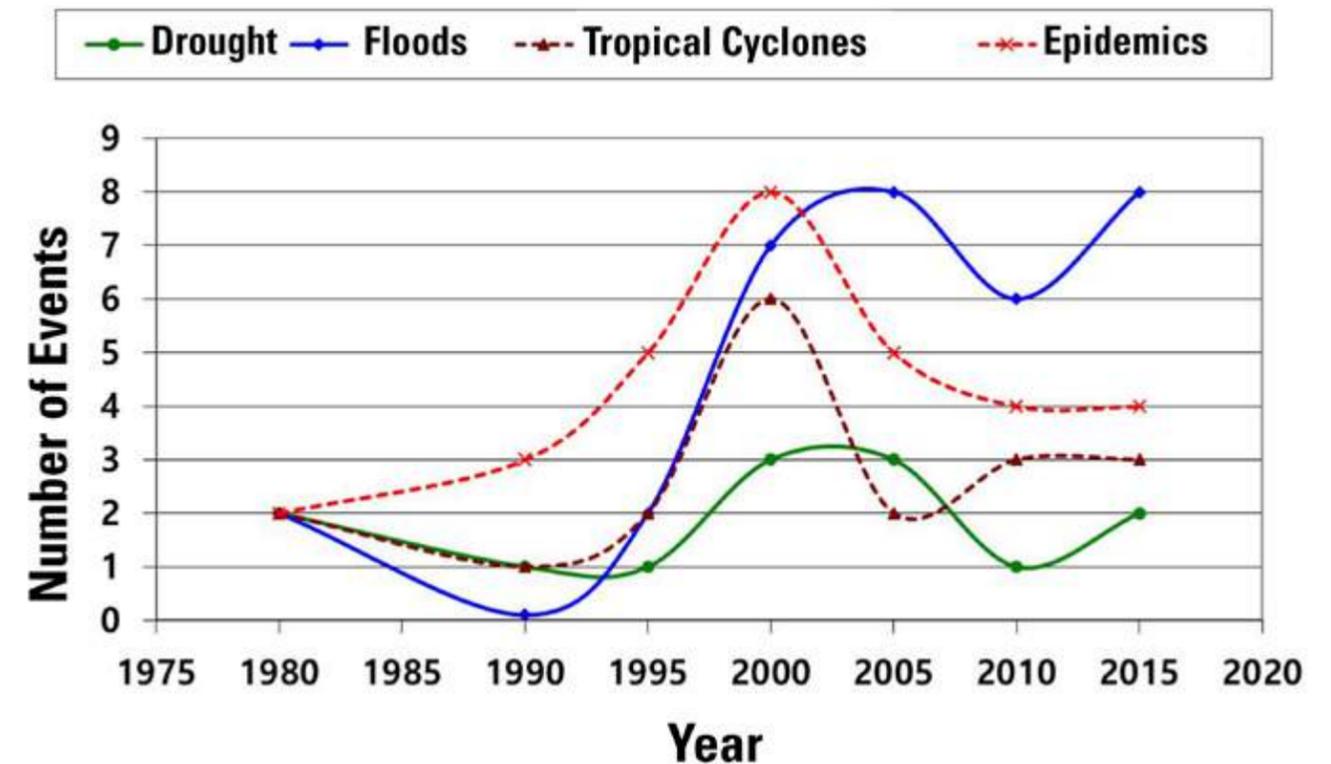
INGC suggests the government of Mozambique needs to accelerate the process of systematic and permanent integration of disaster risk reduction actions into the plans and budget of sectoral activities at all levels. The Disaster Risk Reduction Indicators Framework, approved by the Council of Ministers, is a good starting point for this integration. In the case of Cabo Delgado, due to the new concentration of investments, attention to the reduction of vulnerability is necessary.<sup>34</sup>



Higino Rodrigues, Director of the Coordination Office for Reconstruction Post Disasters, presenting on the fourth day of the workshop



Future temperature projections point to an increase of 2-2.5°C by 2030 and 5-6°C by 2090. Image: INGC



Mozambique's historical trend of natural disasters from 1980-2016. Image: INGC. Data provided by Center for Epidemiological Research on Disasters, EM-DAT

# Workshop Exercises

## Breakout Group Discussions



Water working sessions on the fourth day of the workshop

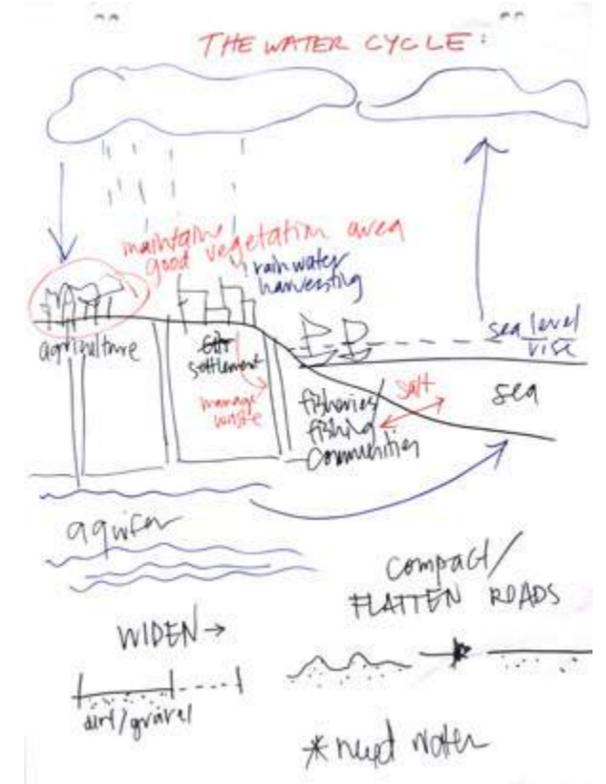


Water working sessions on the fourth day of the workshop

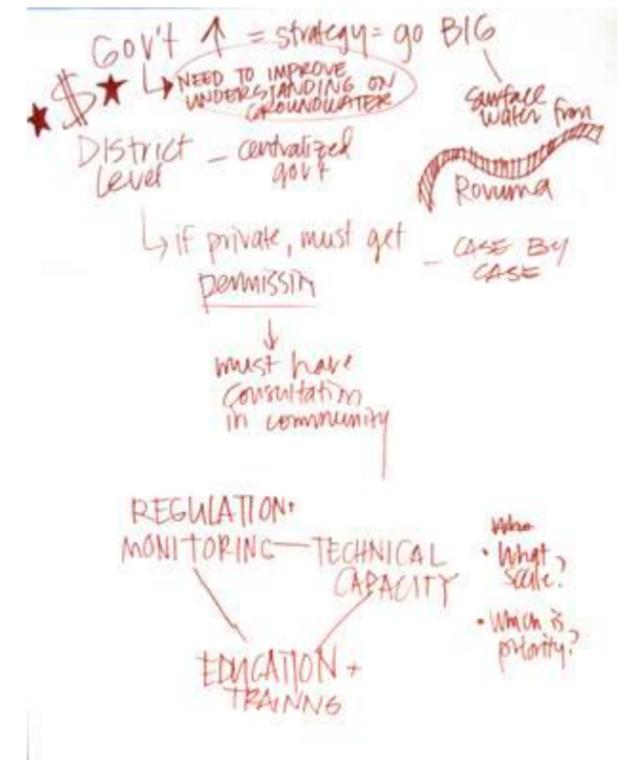
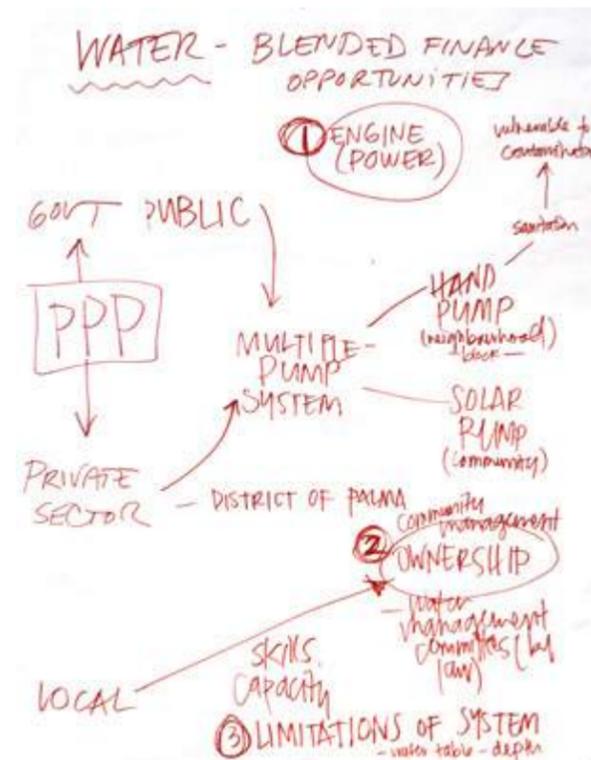


Water working sessions on the fourth day of the workshop

What are important risks to Palma's development? How could natural capital buffer those risks?



How can blended finance (public and private sector) investment projects become integrated into nature-based infrastructure?



# What if water supply initiatives were integrated on local and neighborhood scales to support the future growth of Palma?

*Project by Camille Esquivel (MUP), Conor Barry (MArch), Samito Joao (Lúrio University)*

Students explored a water supply initiative integrated across three scales (local, neighborhood, and regional) for the town of Palma. This activity was prompted by a potential supply strategy of building a large dam in the Rovuma River. The dam would be highly detrimental to the surrounding river delta ecology and potentially result in an unreliable water source given the increasing frequency of dry river conditions as a result of climate change.

The students speculated whether it would be possible to integrate three existing water bodies, located west and north of the existing settlement, into the town's water supply system. Water storage units that extract groundwater from an aquifer below would be located at each water source and a looped network of underground pipes to connect all three water sources to the town. This type of storage would ensure a steady supply of water during periods of drought. The multiple locations of extraction reduce the risk of the entire system becoming contaminated in the event of sudden and unexpected pollution of one source. On a local scale, hand pumps would provide convenient access to water for residents and a regional scale water treatment plant would provide support for the future growth of Palma. These sources are located on higher ground, an added benefit that would encourage the town of Palma to develop northward, limiting development in low-lying coastal areas and reducing the potential impact of future flood events.



Proposed neighborhood scale approach

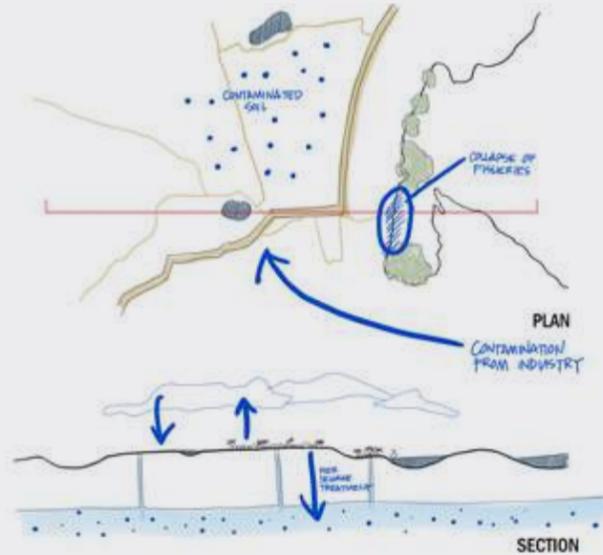


Diagram of the risks from pollution through contamination from industry, collapse of fisheries, poor sewage treatment, and contaminated soil

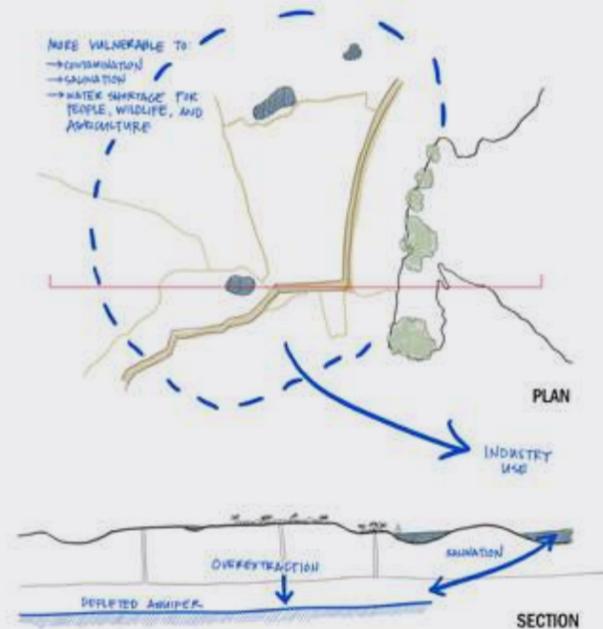


Diagram of the risks from poor management through water shortages and the over extraction and salinization of aquifer

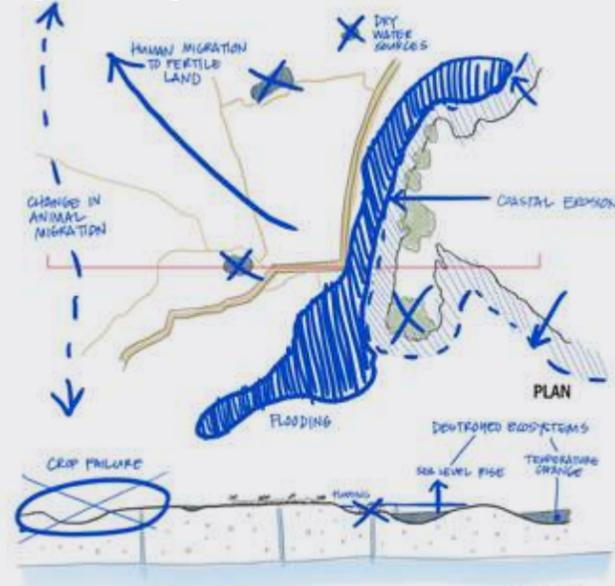


Diagram of the risks from climate change through flooding, coastal erosion, and crop failure

## RISKS TO WATER

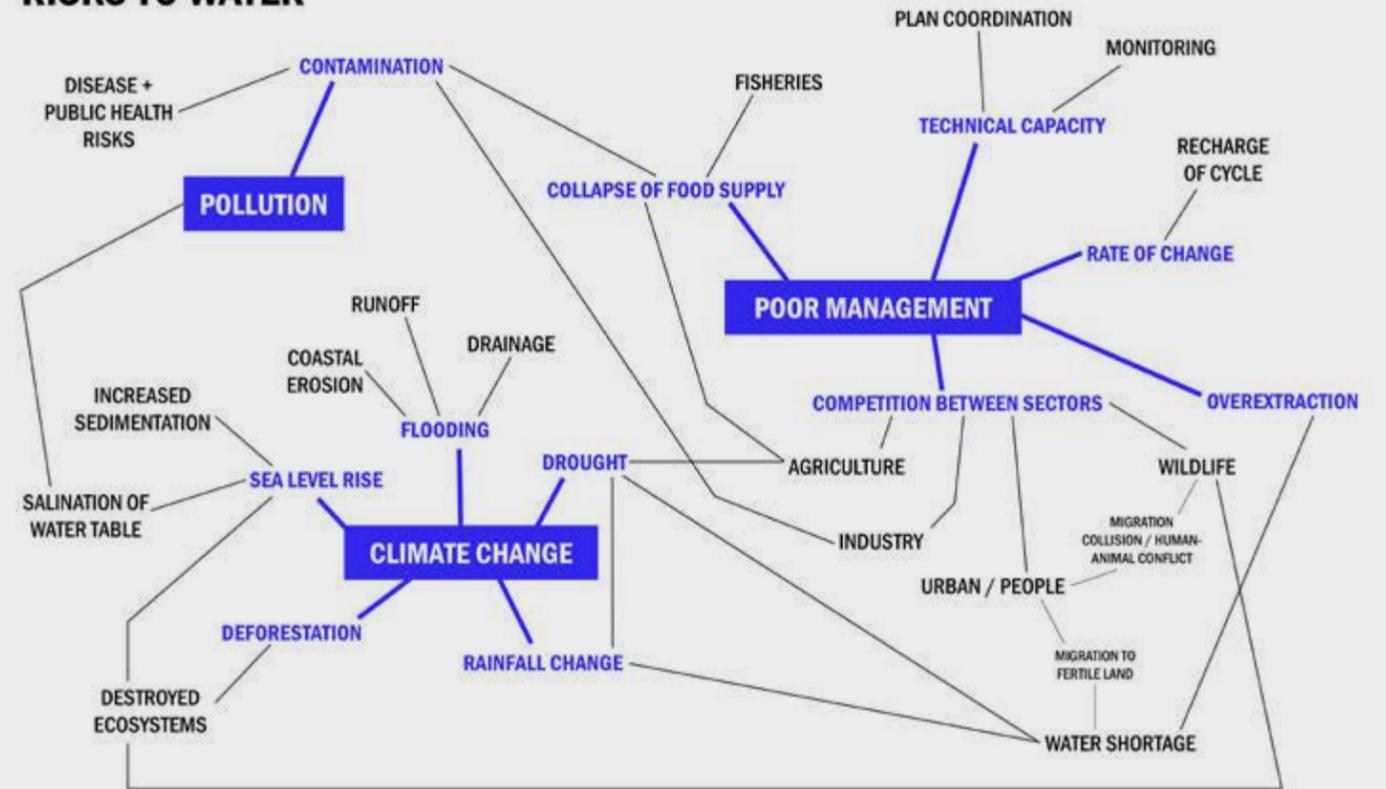
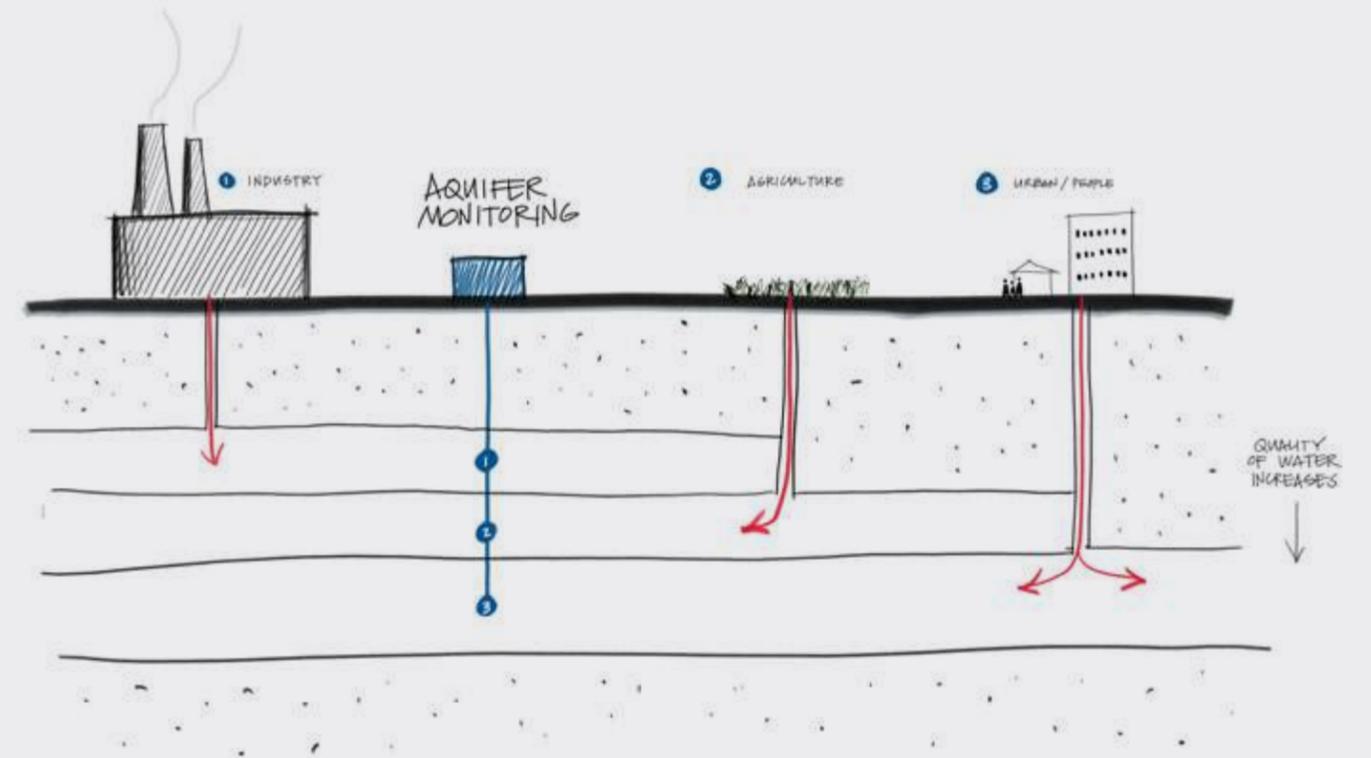


Diagram of water risk analysis in Palma



Proposed shared aquifer management and monitoring

## Agriculture and Fisheries in Palma

Palma is a subsistence economy where people depend on small-scale farming and fishing for nutrition and livelihoods. In the villages located on the high ground of the Afungi Peninsula, people grow cassava, sorghum, maize, and peanuts. Lowland villages have more productive soils, where people grow rice, sweet potatoes, bananas, and sugar cane. Farming in the region is usually small scale, dependent on the manual labor of households and impacted by limited access to irrigation. Fishing also provides a major source of income, attracts tourism, and subsistence protein.

The LNG project in the Afungi Peninsula will jeopardize the livelihoods of the fishermen and many of them will be relocated from their homes along

the coast. The waters in which they fish will be dredged and the reef disturbed by pipelines. Without investment in the local food economy, the future of food in Palma will likely depend on imports with lower nutritional value and higher costs.

Can regional planning and conservation support long-term agriculture and fishing in Palma? How can fertile soil and agricultural productivity be maintained without reverting to unsustainable practices? Can the traditional livelihoods in the Palma region be maintained and continue to provide a reliable source of income? And can new development provide resources to protect agricultural lands, while reducing environmental degradation such as deforestation and pollution?

**WILL FARMING AND FISHING PROVIDE NUTRITION AND LIVELIHOODS IN PALMA IN THE FUTURE?**

# FOOD

# African Development Bank: Agriculture Value Chain and Market Development Along Pemba-Linchinga

## Presentation by Cesar Tique

Agriculture is the source of income for 72 percent of the population in Mozambique. It is a key to transforming the economy and poverty reduction. However, only 6.5 percent of farmers have access to extension services, so the majority lack connectivity to markets and services. Agricultural concerns include high poverty coincident with low land fertility and the finding that yields of rice, maize, and cassava are among the lowest in the region.<sup>35</sup>

African Development Bank (AfDB) has actions to improve the agriculture sector by promoting capacity building, access to markets, expansion of value-chains, and climate resilience. Through AfDB, the objectives of the Pemba-

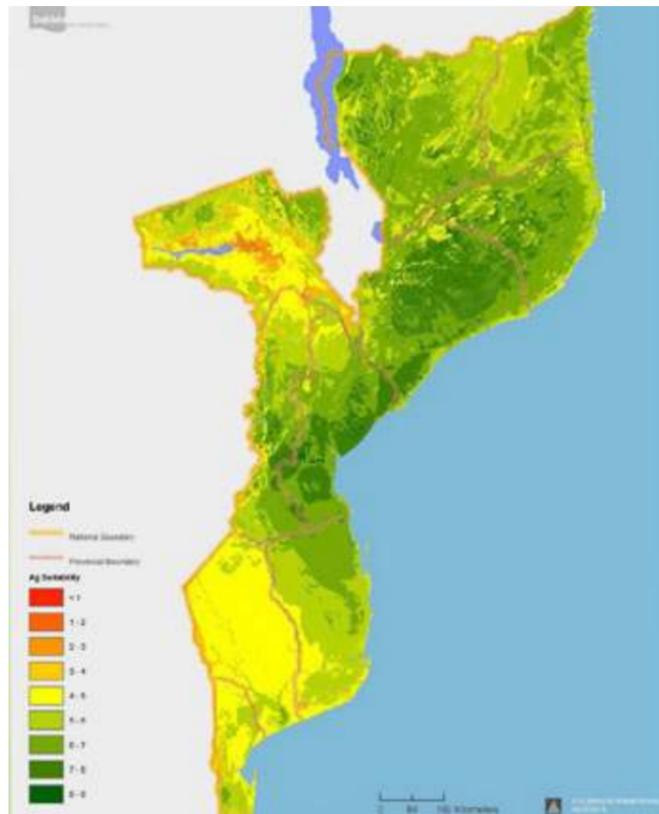


Cesar Tique, Senior Agriculture and Rural Development Specialist, presenting on the fifth day of the workshop

Linchinga Agriculture Development Corridor, an east-west corridor across the northern part of the country, are agricultural transformation from subsistence to wealth creation; focus on value chains (cereals, beans, vegetables, and poultry); issues of Natural Capital; and the rehabilitation of the Mueda-Nengomano Road that will connect Mozambique to Tanzania.<sup>36</sup>



Map provided by African Development Bank for new infrastructure development projects in Mozambique



Map showing sustainability for agriculture by number of crops within Mozambique. Image: African Development Bank

# Reopening: Temporary Octopus Closure in Quirimbas National Park

## Sources: WWF

In 2002, Quirimbas National Park, with the support of WWF, intended to “conserve marine resources and benefit local users, particularly fisherman.”<sup>37</sup> The park instated temporary octopus fishery closures in the Songossawe and Tchamba reef flats on December 5, 2017. After nine months of octopus fishery closures, the total catch on the Songossawe reef flat was 3,500kg of octopus and 850 kg of fish; the total catch in Tchamba reef flat was 805 kg of octopus and 720 kg of fish. If these results continue, Ibo Island, located in the Quirimbas Archipelago, could receive almost two tons of octopus.<sup>38</sup>

António Serra, WWF Rovuma Landscape Coordinator, reflected on the first initiative of the octopus closure in Quirimbas. “We believe that with these results, communities will embrace the program. However, we still need to support them and many other stakeholders involved in the process including the park and provincial or district government authorities. All of this is necessary to ensure the ownership and sustainable management of the octopus fishery.”<sup>39</sup>

Catches were poor in quantity and quality due to frequent overfishing. The octopus closure has created a positive impact on the profitable economic opportunities in the Quirimbas National Park. Raiva Ismael, local octopus fisherman and trader, reflected on the significant change in the area. “Prior to the closures, the situation was harmful to the octopus trade. Our income was reduced significantly. But I can see that the closures will bring improvements to the trade of octopuses. With good income, we will be able to pay the school fees for our children to buy food and other needs in our daily life.”<sup>40</sup>

Abdul Razak Assane, Provincial Press of the Natural Resources Management Committee, also emphasized the need to conserve local resources for future generations. By implementing these temporary closures, local fishing communities can benefit by maintaining a more reliable, sustainable food source.



Fishing boats near the Quirimbas Archipelago



Local fishing communities gathered for the reopening ceremony



An improvement in the octopus catch after temporary fishing closures in Quirimbas National Park



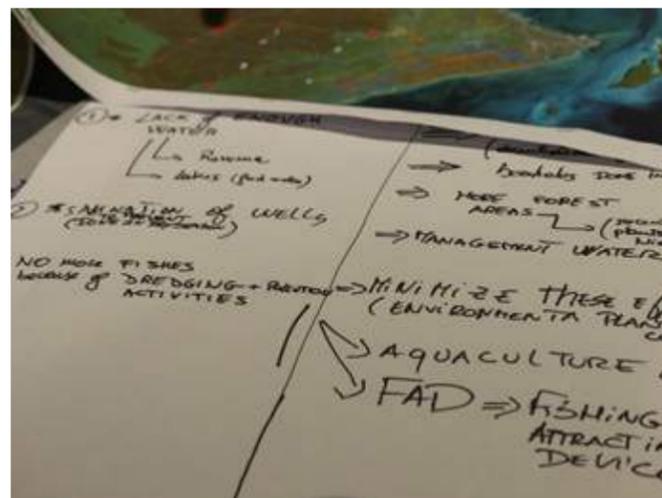
Fisherwomen retrieving octopus and fish at Quirimbas National Park

# Workshop Exercises

## Breakout Group Discussions



Food working sessions on the fourth day of the workshop



Food working sessions on the fourth day of the workshop



Food working sessions on the fourth day of the workshop

What are three key opportunities or actions to improve planning for Palma/Cabo Delgado's future development plan?

# WHAT IF...

**① What if we invest in capacity building + collective capital for a decentralized system of agriculture?**

Example → invest in co-op system between farms that allow small scale farms to be successful in an industrial scale market

Risks Addressed:

- Capital Access
- Human Capacity Building
- Poverty Reduction
- Climate Resilience
- Water Access

Diagram: A flowchart showing 'CO-OP' (tractors, common services, education) leading to 'Small scale farm' and 'large company'. 'Education' leads to 'Products' which go to 'Market = \$'. A side note says 'tractors education' and 'common services'.

**② What if we invest in Capacity Building + Collective Capital for a decentralized system of aquaculture?**

Example →

Risks Addressed:

- Capital Access
- Pollution
- Climate Resilience
- Human Capacity Building
- Cultural Loss

Diagram: A flowchart showing 'CO-OP' (tractors, common services, education) leading to 'Small scale farm' and 'large company'. 'Education' leads to 'Products' which go to 'Market = \$'. A side note says 'tractors education' and 'common services'.

**Impact Inv. Path**

Corporate Buyer + Impact Capital \$

Corporate M&A

Ongoing Market Activ.

Education Capital Inv.

**③ What if we invest in establishing a sustainable and collaborative food corridor between Palma and Olombe?**

Example (what does this look like?)

- Road access between these cities to decrease need to trade w/ Tanzania

## What if Palma's agricultural production is linked to broader, country-wide and regional development corridors?

Project by Katinka Bosh (MArch), Pauline Claramunt (MUP) and Robert Zochowski (MBA)

The students explored a decentralized food production network that links Palma's agricultural and aquaculture production to broader, countrywide and regional development corridors. A decentralized production system based on cooperative organizations (co-ops), integrated with small-scale organizations of local farmers and fishermen, would preserve the traditional family organization and culture related to food production, and increase access to new income sources for communities and strengthen ecological protection.

The students speculated whether advancements could be made through contextual design strategies seeking to improve water use, waste management, soil quality, commercialization, and distribution processes. The impact of this strategy aims to avoid deforestation and pollution related to the use of pesticides, while creating incentives for communities through impact investment opportunities that promote climate adaptation.

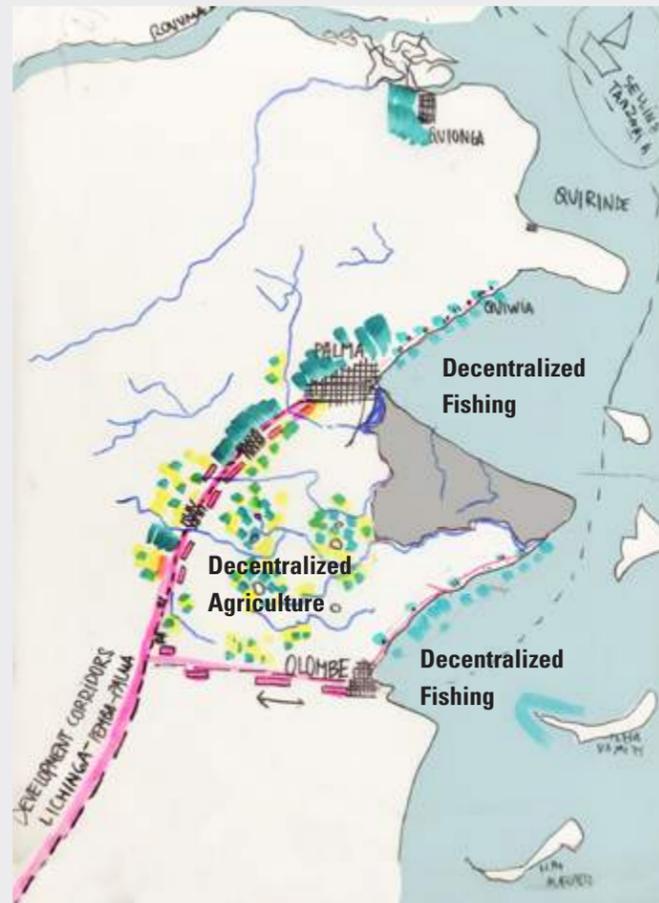


Diagram of decentralized food production strategy based on the initiative for the Pemba- Lichinga transport corridor



Illustration of local agriculture production located in open markets near the transport corridor

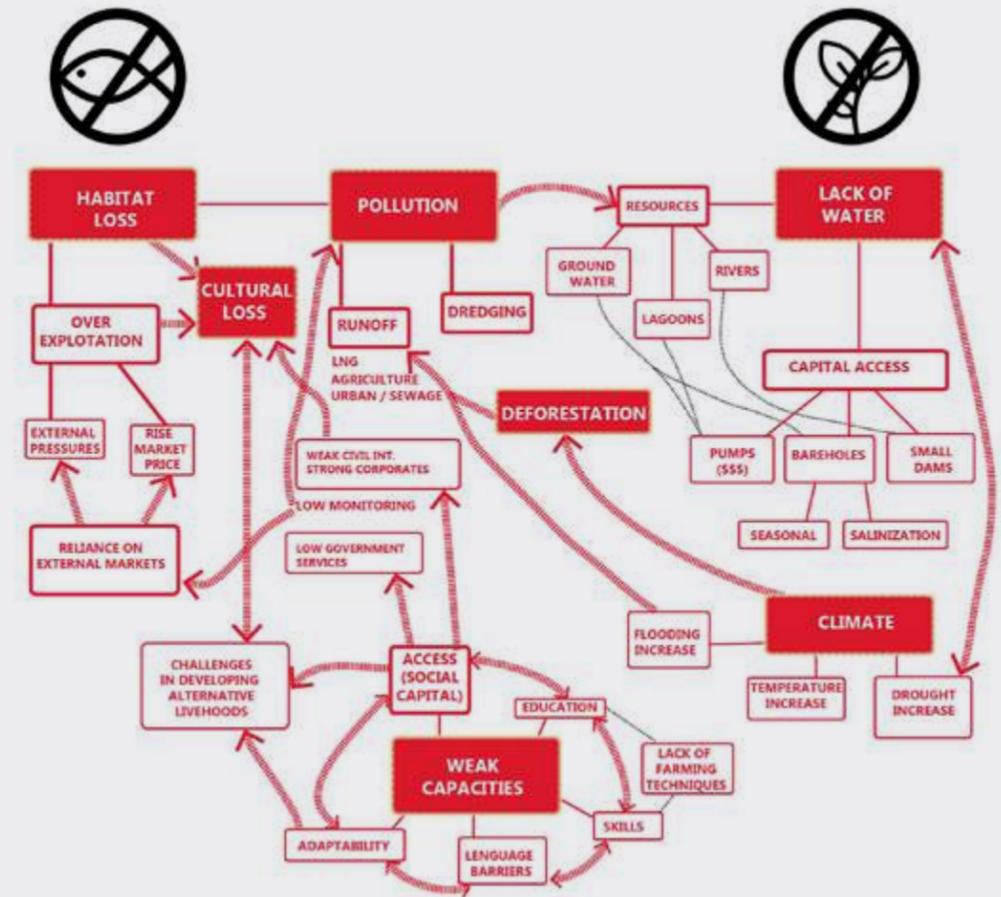


Diagram of food security root cause analysis



Illustration of proposed borehole design strategy considering seasonal change and climate adaptation

## Settlements in Palma

According to Anadarko Petroleum, the LNG project located on Afungi Peninsula will occupy 7,000 hectares of land, with approximately 137 hectares occupied by settlement areas.<sup>41</sup> These small, scattered communities tend to be located near agricultural and coastal areas, as well as fishing centers. The local construction methods in Palma rely on the region's access to natural resources: Wood is typically used for housing construction, along with coconut, palm tree leaves, and grasses. With the region's population projected to quadruple in the next 30 years, how will natural resources be impacted by this rapid growth?

It is likely that new construction will rely on imported labor and materials, river sand will be dredged for concrete production, and the housing created

will not respond to the local traditional construction methods and climate. However, most of the future population of Palma will not live in formal housing. Instead residents will live in informal settlements, exposed to risk factors including flooding, pollution, landslides, and poor waste management.

Is it possible to mitigate these risks by incorporating traditional construction methods, employing local workers, incentivizing reforestation (including mangroves), and regulating land use to integrate tourists, foreign workers, and local residents?

IS IT POSSIBLE TO MITIGATE THE RISKS ASSOCIATED WITH RAPID URBANIZATION IN AND AROUND THE AFUNGI PENINSULA AND THE TOWN OF PALMA BY INCORPORATING TRADITIONAL CONSTRUCTION METHODS, EMPLOYING LOCAL WORKERS, INCENTIVIZING REFORESTATION, AND REGULATING LAND USE AND CONSTRUCTION?

# HOUSING

# Plan of the Development of the District of Palma

## Presentation by District Service of Economic Activities (SDAE), Palma

The zoning strategy of the District Land Use Plan of Palma (PDUT) includes the integration of local communities, ecological preservation, and connecting the industrial zone with the LNG factory. The land uses in the PDUT area are subdivided into three categories: community, urban, and green spaces with programmatic divisions of industry, business, housing, commerce, tourism, and infrastructure. According to the District Service of Economic Activities (SDAE) Palma, the strategic objectives of the PDUT are “affirming Palma as a national and continental reference in the natural gas processing and export sector; planning the industrial area within the development of the LNG cluster in direct connection with the gas factory; programming the infrastructure and occupation of the territory, predicting the expected economic and population growth; preserving the existing natural resources and ecological values; and safeguarding the experience of local populations in the region.”<sup>42</sup>



Proposed service/business center



Proposed commercial/residential area



Proposed Menguene River Park



Proposed green spaces to protect the water and lagoon lines



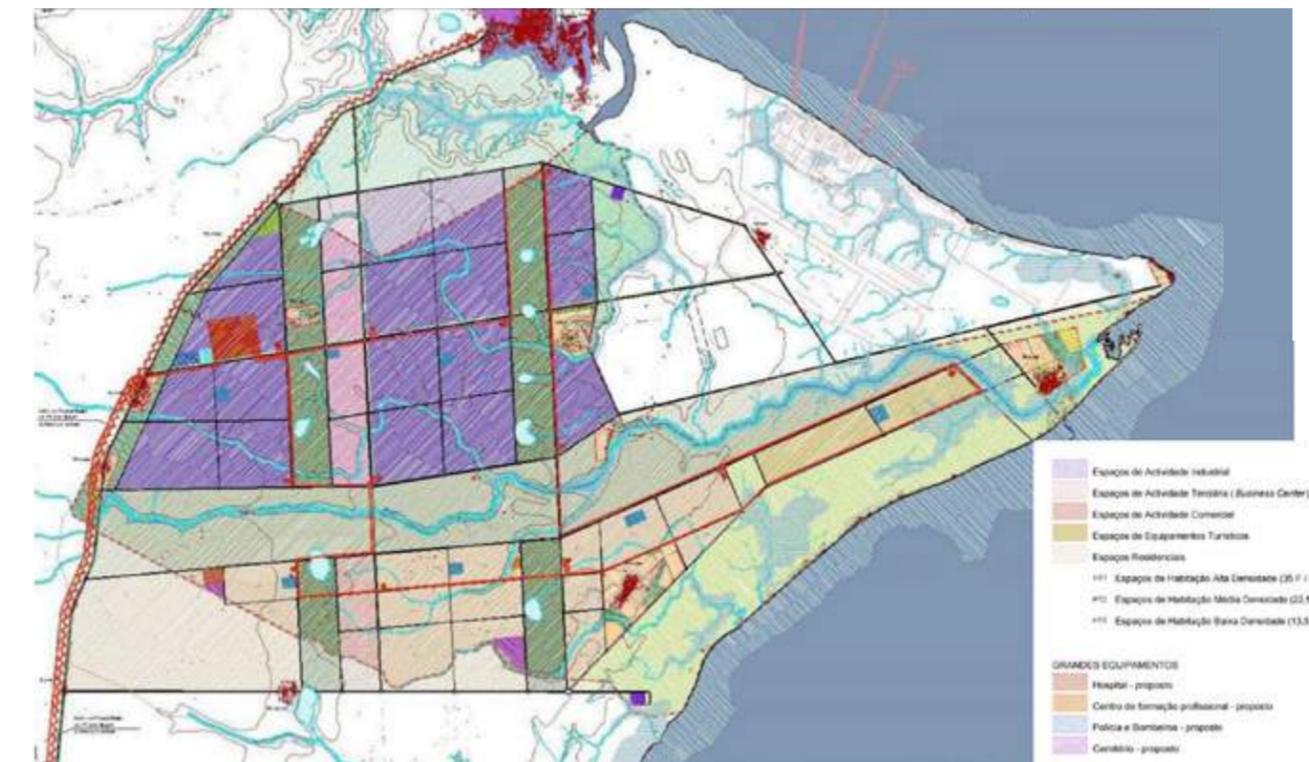
Proposed linear water park



Proposed linear water park



Perspective of proposed Urbanization Plan of the District of Palma and LNG operations in the Afungi Peninsula. Images: Republic of Mozambique, Government of the District of Palma



Proposed Urbanization plan of the district of Palma and LNG operations within the Afungi Peninsula. Images: Republic of Mozambique, Government of the District of Palma

# National Territorial Development Plan: Work Plan and Methodology

## Presentation by National Directorate of Land Use Planning and Resettlement (DINOTER)

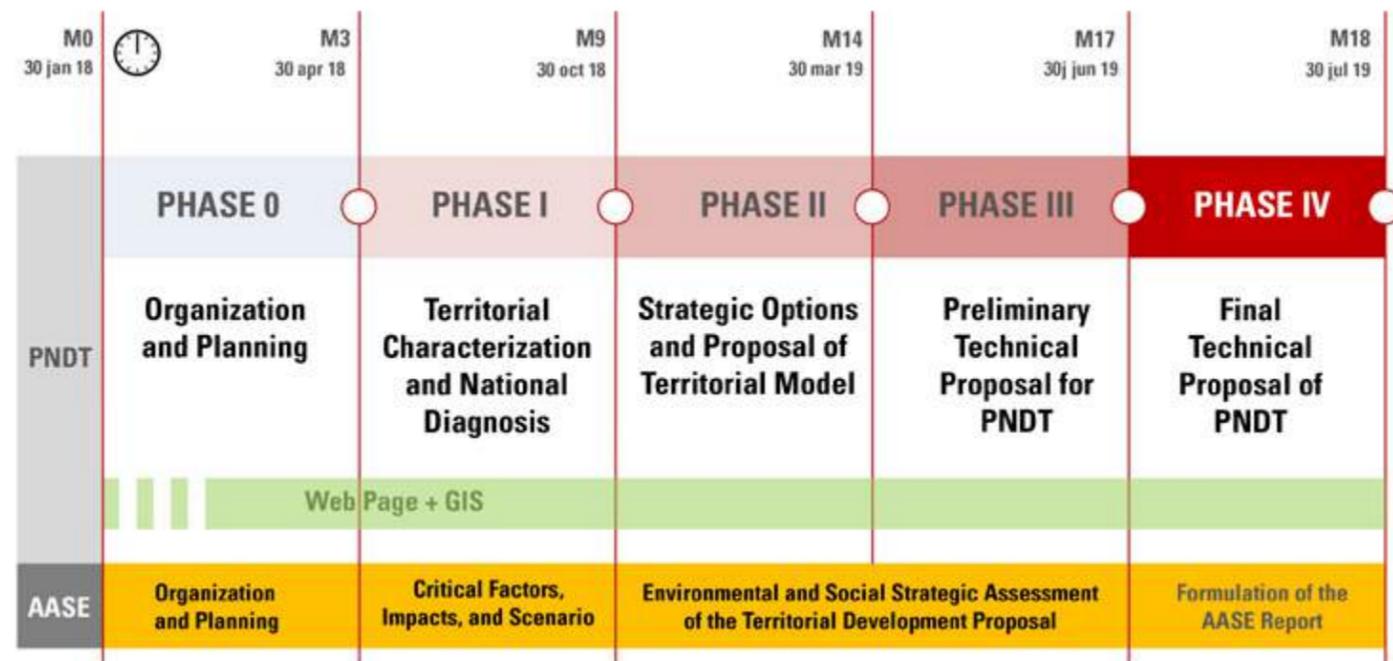
According to DINOTER, “the National Territorial Development Plan (PNDT) is a strategic and programmatic instrument, which establishes a medium and long-term vision of the organization of Mozambique’s territorial planning for economic and social development.”<sup>43</sup> The elaboration of the PNDT is determined by a Council of Ministers and approved by the Assembly of the Republic. “The PNDT binds all public entities, citizens, local communities, and legal persons under private law. Its guidelines establish the formulation, execution, and evaluation of the land planning policy, the spatial coordination of sectoral policies with territorial impact, and large public investments for territorial development.”<sup>44</sup>

The material content of the PNDT “includes a territorial model, guidelines, and orientations including plan of action



DINOTER representative presenting on the fourth day of the workshop

with estimates and priorities, monitoring and evaluation system, and a Strategic Environmental and Social Assessment Report (AASE).<sup>45</sup> The preparation phase of the proposal of PNDT began in April 2018 with consultation in the Niassa Province. Later phases include organization and planning, territorial characterization and national diagnosis, and strategic options and territorial model proposal. The final phase will deliver the AASE report and the technical proposal of the PNDT by July 2019. Subsequent consultations will be held in the provinces of Cabo Delgado, Nampula, Zambézia, Tete, Manica, Sofala, Inhambane, Gaza, and Maputo.



Timeline for the preparation of the Technical Proposal for the National Territorial Development Plan (PNDT).  
Image: National Directorate of Land Use Planning and Resettlement (DINOTER)

# Anadarko: Resettlement Plan

## Mozambique Gas Development Project

The Mozambique Gas Development Project Resettlement Plan describes “the policies, principles, procedures, roles, and responsibilities for managing physical and economic displacement impacts caused by the construction and operation of the Liquefied Natural Gas (LNG) Facility and the export terminal” on the Afungi Peninsula of Palma.<sup>46</sup> Developers for the Mozambique Gas Development Project include Anadarko Moçambique Área 1, Lda (AMA1) and Eni East Africa, S.p.A. (EEA). The Resettlement Plan was developed in consultation with local, affected communities, civil society organizations, and the Government of the Republic of Mozambique (GoM). These consultations will be ongoing throughout Resettlement Plan implementation, monitoring, and evaluation.<sup>47</sup>

Development of the LNG facility will result in the physical and economic displacement of 1,508 agricultural and fishing households on the Afungi Peninsula. The goal of the resettlement plan is to “undertake resettlement in a manner that gives physically and economically displaced households the opportunity to improve or at least restore their livelihoods and standards of living.”<sup>48</sup> A total of 556 displaced households will receive new homes at a replacement village in Quitunda.<sup>49</sup> An additional 952 households will “experience loss of use of cultivated land, fallow or bushland and other terrestrial assets.”<sup>50</sup> According to the Resettlement Plan, “all displaced households will receive compensation, replacement agricultural land, and the opportunity to participate in livelihood programs.”<sup>51</sup>



The Mozambique Gas Development final Resettlement Plan executive summary



Proposed Resettlement Plan. Image: U.S. Geological Survey (USGS) Earth Explorer Sentinel-2 data.

## AMA: Social Stresses in Palma

*Presentation by Tomas Jaime Langa*

The Association of the Environment (AMA) identifies the social stresses in Palma as a lack of banks, education, health, businesses, civil society organizations, right to information, agriculture, languages, and water resources. AMA provides opportunities for improvement related to these social stresses. Tomas Jaime Langa said there is a need to “invest in vocational technical education, provide local training in various medical professions, improve sanitary conditions in health facilities, promote local business partnerships within the hotel industry; and establish international communication platforms.”<sup>52</sup> With agricultural crops and forest resources, there is an opportunity to “promote market-oriented production; encourage local entrepreneurship, promote the defense of fair prices to the local producer, promote taxation and financial education for producers.”<sup>53</sup>



*Tomas Jaime Langa presenting on the fourth day of the workshop*

Other general proposals include promoting public access to electricity through economic activities that can potentially support operating costs. AMA also encourages the promotion of community tourism such as handcrafted items, local cuisine, ruins, complexity of languages, cultural dances, and passing rituals.<sup>54</sup>

## The Social and Ecological Profile of Northern Mozambique

*Presentation by Isabel Marques da Silva (Lúrio University)*

Approximately 51,439 people live in Palma. According to Isabel Marques da Silva, the main ethnic groups in Palma are Maconde and Kimani; 80 percent of the population is Muslim and 16 percent is Catholic. Immigrant populations migrate from Macuas and Tanzania. However, many Palma residents relocate to Tanzania for educational opportunities. Macue and Swahili are the two predominantly spoken languages, and Portuguese is spoken mostly in urban areas.

Palma’s ecology includes mangroves and coral reefs, which



*Isabel Marques da Silva, Professor of Natural Sciences, presenting on the fourth day of the workshop*

are needed for coastal protection. Pipelines and other gas exploration have a major impact on these ecosystems. The residential resettlement plan would also result in harmful effects of pollution in Palma. Marques da Silva stated that “using the right methodology, feather cutting and sedimentation would have a reduced effect.”

## Opportunities in the Implementation of Urban Spatial Development Plans

*Presentation by Bernardo Xavier (Lúrio University)*

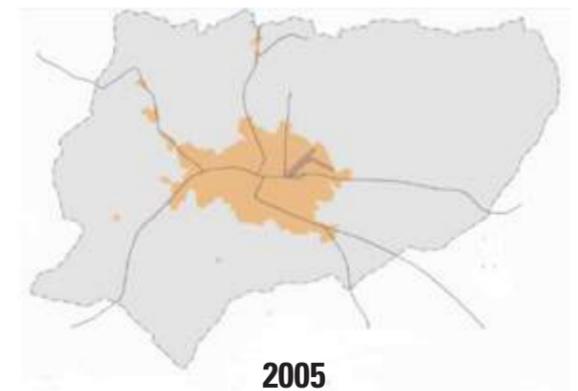
A study was conducted on the urban area characteristics associated with the growth of the city of Nampula. According to Bernardo Xavier, the city’s population increased by 20 percent between 2005-2015. Due to rapid population growth, basic urbanization requires efficient water supplies and road infrastructure. Intermediate urbanization requires an open drainage system for rainwater and planting of trees and green areas.

Lúrio University questioned how municipalities could respond to formal and informal occupation patterns. Most laws and regulations in the Nampula Province exist, but are not reinforced. There is an opportunity to “define strategies with clear urbanization standards in accordance with national laws and regulations.”<sup>55</sup> There is also a poor technical capacity in most municipalities and towns, which contributes to “the weak domain of procedures for the elaboration of the Internet of Things (IoT) included in the Territorial Planning Legislation.”<sup>56</sup>

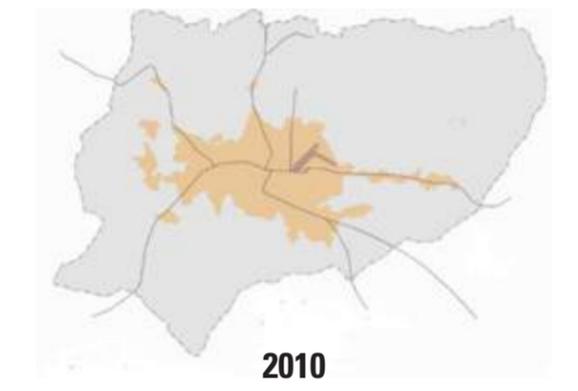
There should be continuous planning of sustainable and viable urban spaces that respond to the growing demand for various land uses in Nampula. Xavier concluded his presentation with the opportunities offered by the implementation of urban spatial development plans. Opportunities exist to organize urban plans, especially where density is lower. There is a need to integrate more formal areas with newly planned urban development. Other opportunities include the integration of communities in the decision making for land-use planning, capacity building for local leaders, vocational training institutions for the management of IoTs, and the increase of more income generating projects in urban areas.



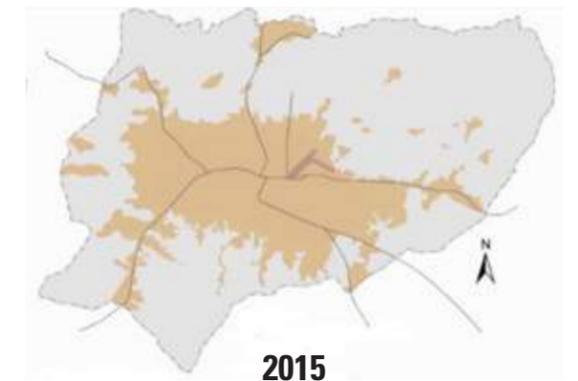
*Bernardo Xavier, Professor of Architecture and Physical Planning, presenting on the fourth day of the workshop*



2005



2010



2015

*Urban Sprawl within the Nampula Province in northeast Mozambique. Image: Lúrio University*

# Workshop Exercises

## Breakout Group Discussions



Housing/settlement working sessions on the fourth day of the workshop



Housing/settlement working sessions on the fourth day of the workshop



Housing/settlement working sessions on the fourth day of the workshop

What are three key opportunities or actions to improve planning for Palma/Cabo Delgado's future development plan?

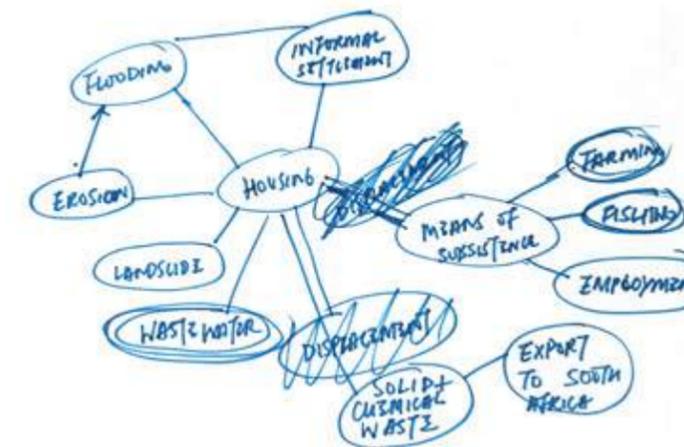


How can blended finance (public and private sector) approaches support investment in nature-based infrastructure?

1. How to incentivize investments in natural capital?

- Law enforcement/ rule of law
- Educate young people importance of protecting natural capital
- including urban plans + monitoring/protecting infrastructure
- who monitors?
- Example: Uni Lurio students/faculty monitor and report on extraction activity + natural capital protection
- Protecting natural capital → Long-term profits
- Leverage industries other than extraction (eg. tourism to agriculture)
- civil society influence decision makers

What are important risks to Palma's development?



# Can green infrastructure, local governance, and waste management mitigate the impacts of the increased demand for housing?

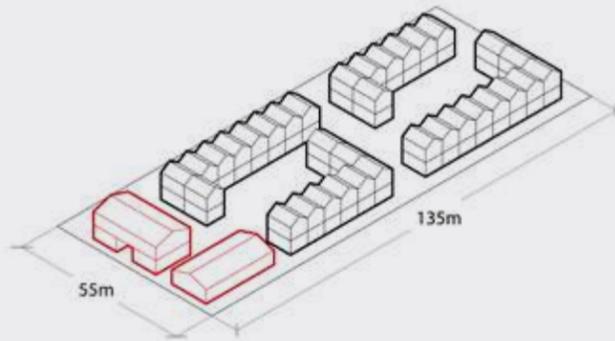
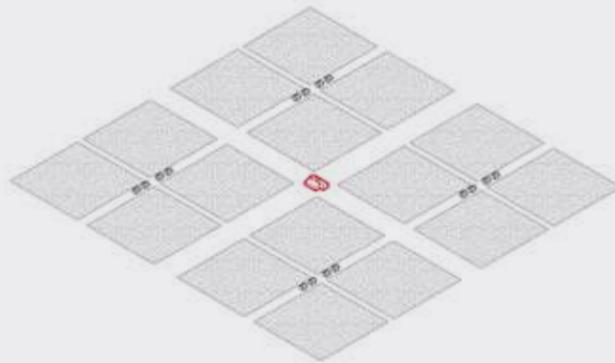
**Project by Emily Po (MArch), Charles Drain (MBA), Keir Senda (Lúrio University), Laura Postarini (MUP)**

As Palma's population grows, so will the need for housing. This will generate formal and informal housing settlements, which carry many risks that can harm a region's population and the environment. The students identified the most challenging risks for the district of Palma: flooding, erosion, poor waste management, and deforestation. After analyzing Palma's current footprint and housing, the students explored three different approaches, which could be put in practice to mitigate the effects of increased demand for housing.

The first approach focuses on implementation of natural green water barriers and retention areas that prevent flooding and landslides. The local workforce would construct these, which would provide community participation in the process and allow people to learn the importance of conserving these areas. The second approach proposes two types of subsidized housing programs. The first consists of implementing a government program, which would provide affordable, multi-family housing in Palma to densify the urban area. The second program would be implemented near the coastline in rural areas, where the government could provide affordable, single-family housing to people who will maintain the green infrastructure, such as the existing coastal fisheries and mangroves. The third approach seeks to promote and develop a recycling industry for waste from LNG and other industries that can be repurposed into construction materials for housing.



Existing housing and block typology



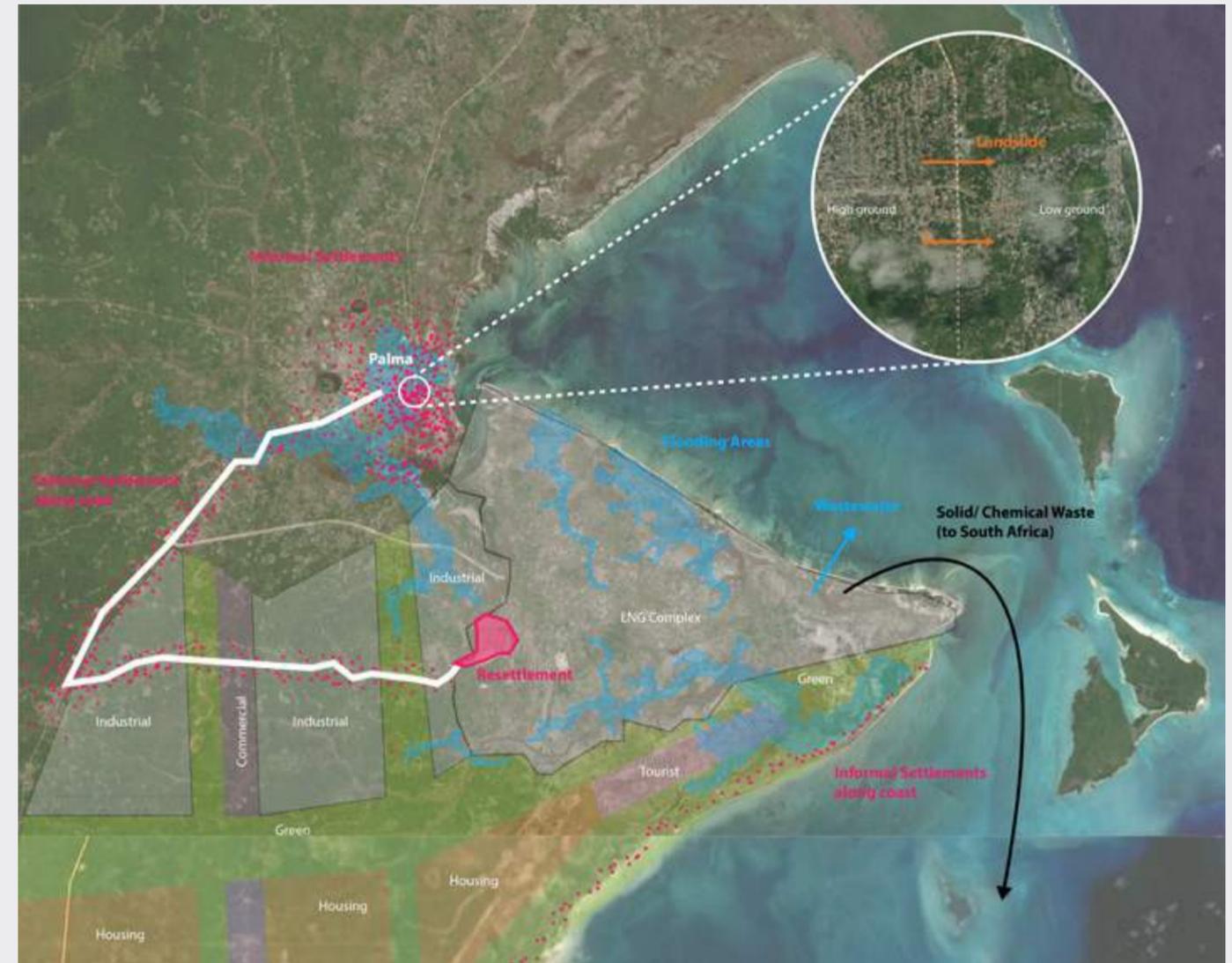
Proposed housing footprint



Proposed Masterplan to mitigate the effects of increased demand for housing



Existing urban footprint



Current LNG masterplan proposal with landslide risk



Proposed housing development with landslide protection

## Electricity and Energy Sources in Palma

Few residents in Palma use electricity from the Mozambique national electric grid, which extends to the district of Mocimboa. Electricity comes from dams located far away, such as the Cahora Bassa, situated in the Tete Province. The cost of electricity is often out of reach of the average local resident and power generation also tends to be unreliable. The majority of Palma's population uses other energy sources: fuel oils such as petroleum, paraffin or kerosene, as well as generators, gas, and solar panels.<sup>57</sup> Many local people burn firewood and charcoal for cooking.

According to Anadarko's EIA Report, there is no electricity at the LNG Afungi project site and there are no plans to connect the project site to the national grid. With the development and construction of the industrial complex, power generation is expected to occur through local natural gas and fossil

fuels. As a result, residents outside the industrial zone could potentially have limited access to electricity. The rapid population growth and continued reliance on firewood and charcoal could result in deforestation, which will impact access to key resources like drinking water. Burning fossil fuels will also contribute to increased climate change impacts in the region.

Through the Afungi project's anticipated investments, how will the impending LNG production affect Mozambique? What are the impacts of energy access on built fabric, regional forests, and resilience? Will Palma become a reliable energy source for Mozambique or just be a global fuel exporter for the rest of the world? How can energy boom profits be reinvested for local benefit? And what will happen to Palma's energy economy after gas extraction expires?

**CAN NON-RENEWABLE ENERGY PROFITS BE REINVESTED FOR LOCAL BENEFIT IN THE PALMA REGION, WHILE REDUCING THE ENVIRONMENTAL IMPACTS OF DEFORESTATION AND CLIMATE CHANGE?**

# ENERGY

# Introduction to ThirdWay Africa and the Concept of Blended Finance

## Presentation by Leif Sandhop

ThirdWay Africa (TWA) is addressing “the need to mobilize innovative financing and sustainable development through frontier thinking, blended financing, and impact investing.”<sup>58</sup> TWA was founded to “support the convergence of the worlds of finance and development with its extensive relationships with strategic presence internationally and locally; multi-disciplinary team with management, finance, and development expertise; and blended approach for sustainable development.”<sup>59</sup> TWA leverages business drivers and relationships to create a cohesive stakeholders’ ecosystem to provide solutions such as ecosystem leverage, private capital, development capital, grants and philanthropic funds, and rural community development.<sup>60</sup>

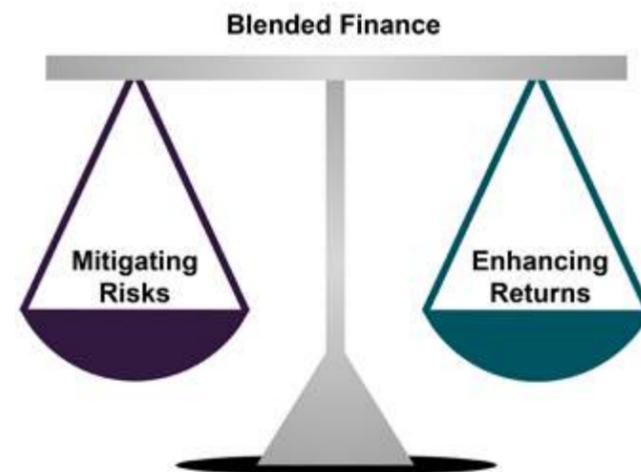
Blended Finance is a sustainable investment paradigm that utilizes diverse sources of capital to enhance returns for private capital and positive impact.<sup>61</sup> Leif Sandhop encourages Blended Finance as an innovative approach to catalyze private capital necessary to achieve Sustainable Development Goals (SDGs) with estimated annual funding of US \$3.76 trillion.<sup>62</sup> Although insufficient investment-ready opportunities and high costs of doing business hindered the flow of capital to Africa, Blended Finance has emerged as a solution that reduces costs and risks and increases returns in emerging and frontier markets.<sup>63</sup> ThirdWay Africa’s interest in the Cabo Delgado Province presents plenty of opportunities for development investing across sectors with high potential for economic, social, and environmental development returns.



Analyst Leif Sandhop presenting on the fifth day of the workshop



Hindered flow of capital to Africa diagram: ThirdWay Africa



Blended Finance Diagram: ThirdWay Africa

# Resilient Landscapes: Avoiding the Resource Curse

## Presentation by Kate Orff (SCAPE Studio)

The natural capital framework offers a way to consider resource extraction. The book, *Petrochemical America*, by Kate Orff and Richard Misrach, uses the Mississippi Delta as a case study because Mississippi was one of the first U.S. states to discover oil and gas offshore. Today the area is an impoverished landscape.

According to Kate Orff, “the risk exists in creating a landscape and settlement pattern that creates a dependency on petrochemicals for survival” in the Mississippi Delta. The landscape becomes a machine for consuming oil and petrochemicals. Work on *Petrochemical America* included the mapping and anticipating cycles of extraction, consumption waste, and displacement. These mapping techniques were used to offer “alternative models, policies, and visions to transition away from fossil fuel and localize benefits of the extraction industry.”<sup>64</sup> In Mississippi, all of the resources were exported but the impacts remained local. Due to the development of industrial infrastructure in flood-prone areas, there was increased vulnerability to sea level rise. Resettled, fence-line communities were created in the immediate impact zone of industry.<sup>65</sup>



Kate Orff, Associate Professor and Faculty Director of Center for Resilient Cities and Landscapes, presenting on the fifth day of the workshop

These cautionary tales can help promote “the integration of natural capital into a looped and living infrastructure pattern with co-benefits.”<sup>66</sup> Orff said there is an opportunity in Palma to “integrate basic planning principles of understanding existing vulnerabilities and anticipate future shocks and stresses; protect and enhance existing assets; consider mobility, equity, and land-use simultaneously; cluster housing around public space and social infrastructure; invest in infrastructure with multiple benefits; protect water bodies and focus on waste management; establish collaborative planning processes and blended finance to match public and private investments.”<sup>67</sup>



Intact productive ecosystem and economy. Image: *Petrochemical America* by Kate Orff / SCAPE Studio and Richard Misrach

# Workshop Exercises

## Breakout Group Discussions



Energy working sessions on the fifth day of the workshop

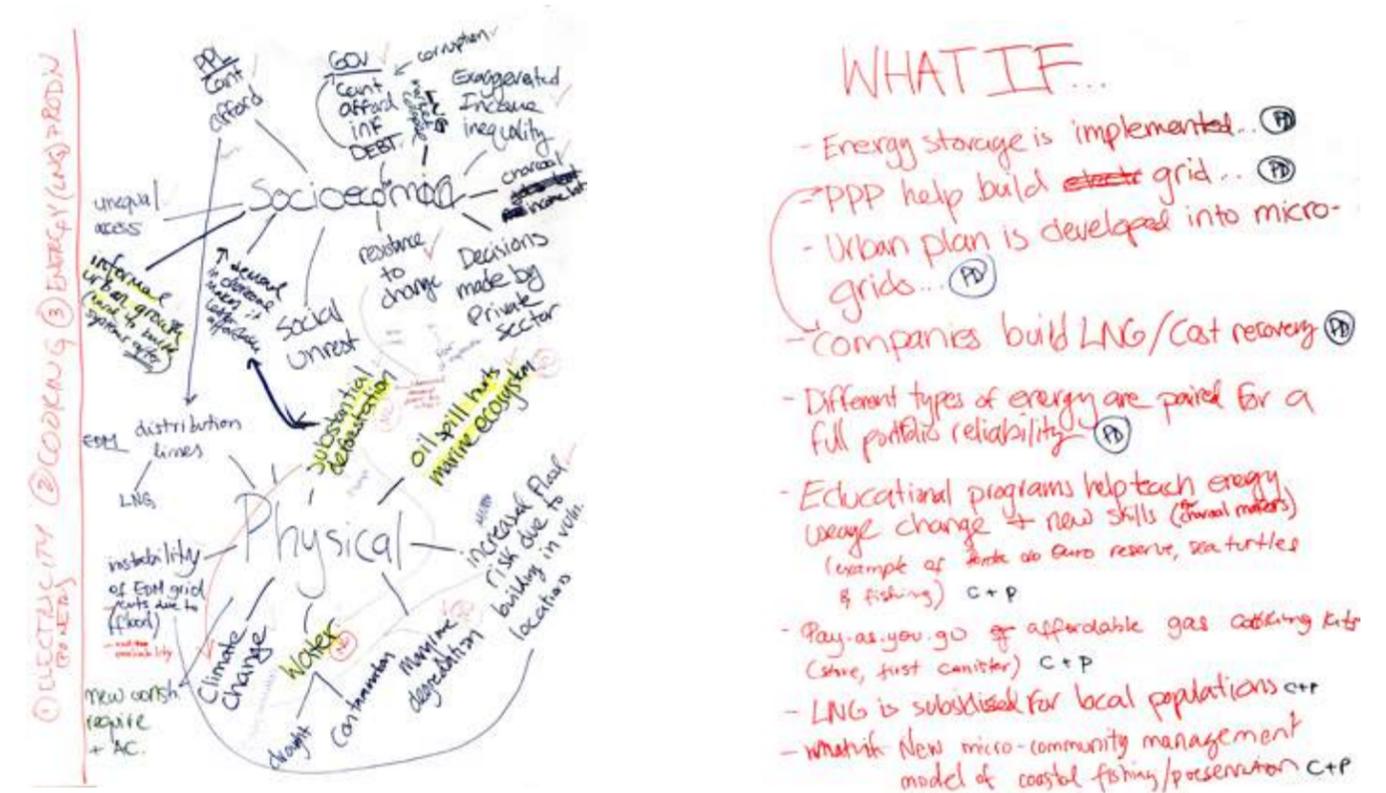


Energy working sessions on the fifth day of the workshop

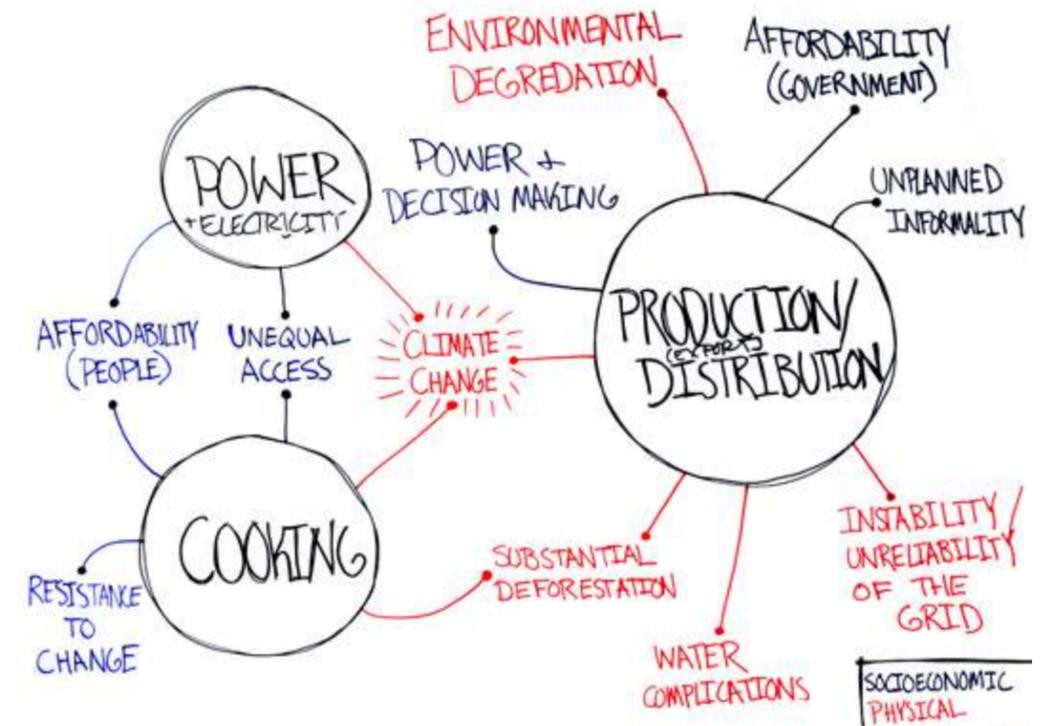


Energy working sessions on the fifth day of the workshop

What are important risks to Palma's development? How could natural capital buffer those risks?



What are three key opportunities or actions to improve planning for Palma/Cabo Delgado's future development plan?

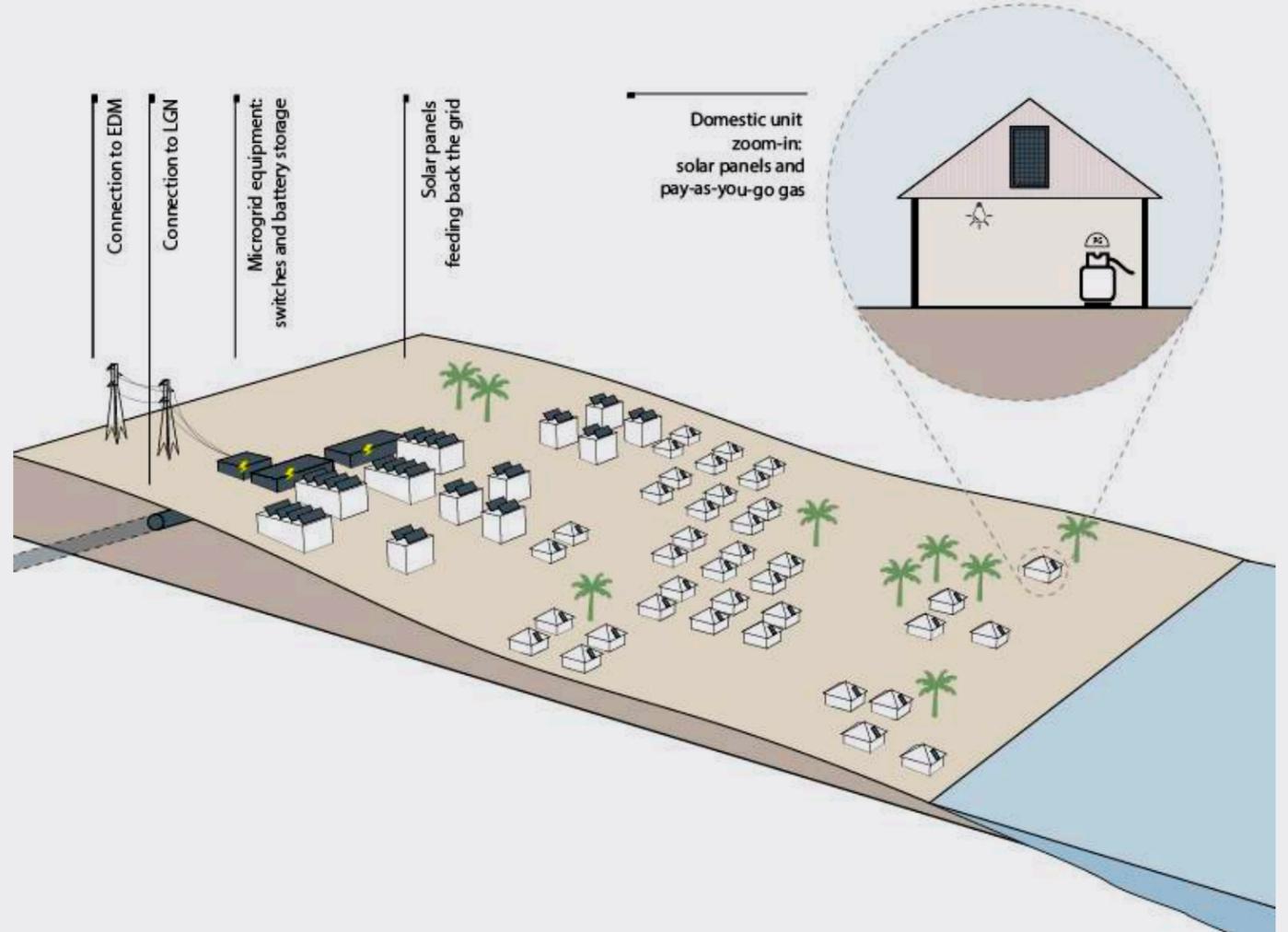
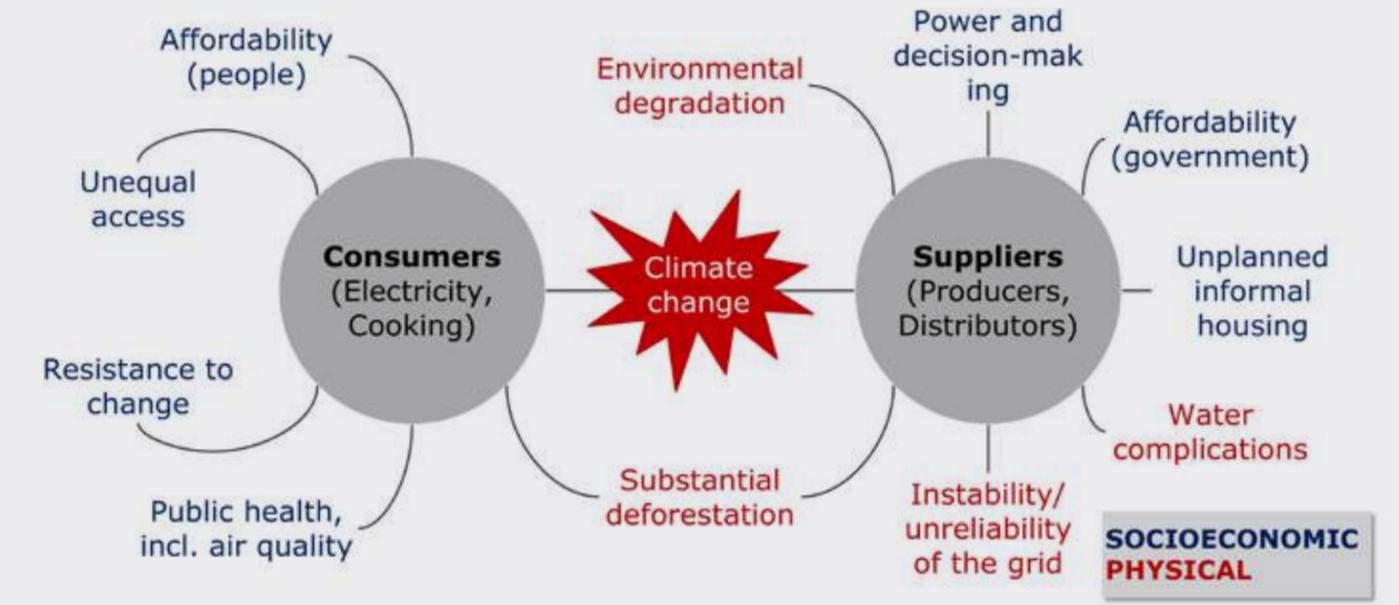
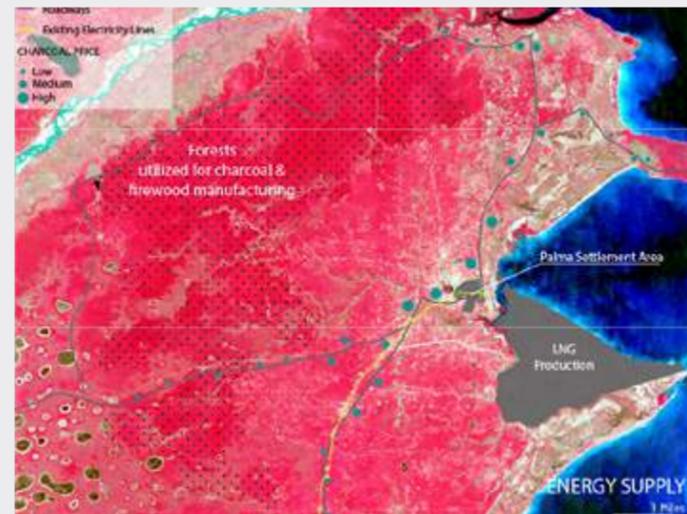
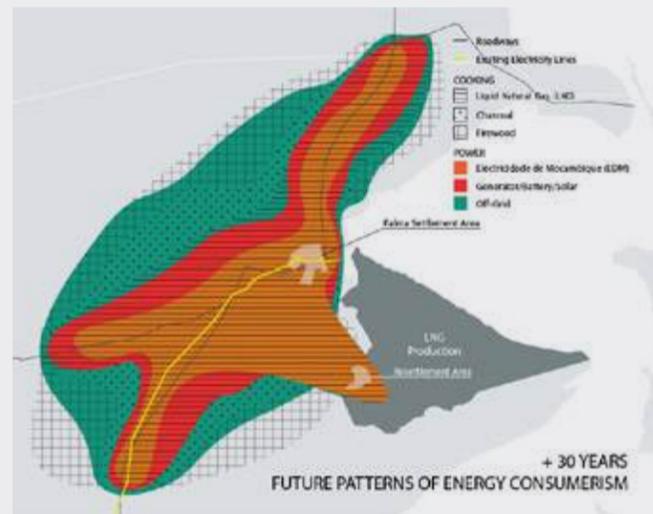
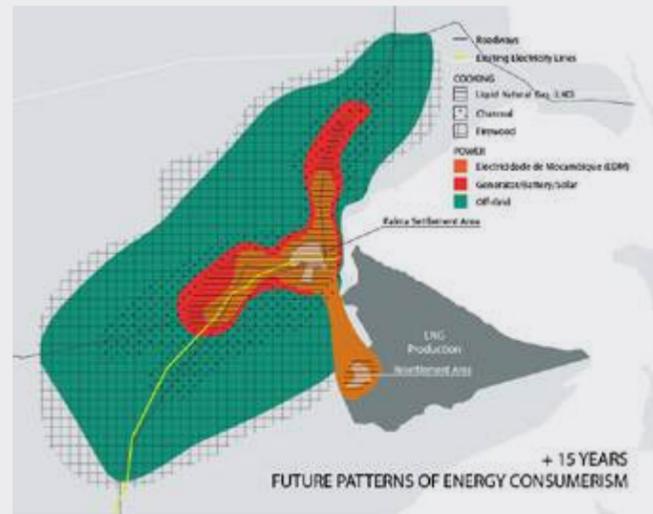
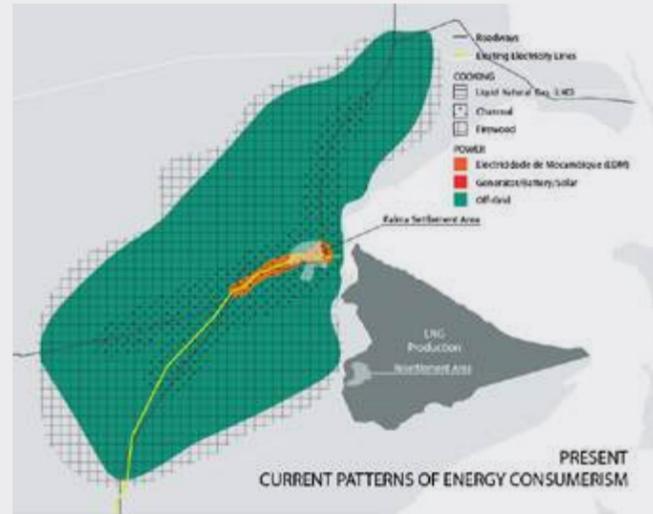


# What if renewable energy markets and distribution systems could incentivize a resilient city model in Palma?

*Project by Elisa Xavier de A F Carvalho (MArch), John Plaisted (MBA), Anna Stokes (MUP), Emerson Zeferino Joao (Lúrio University)*

Few Palma citizens currently have access to electricity from the formal grid due to a lack of infrastructure and the high cost of electricity. Most people burn oil, kerosene, paraffin, charcoal, and firewood at home to meet their daily energy needs. When Palma's population booms in the coming years as a result of the LNG production facility, so will its population's need for energy. Without formal planning, Palma is likely to develop informally along its major arteries and roadways. If access to energy issues is left unaddressed, economic inequality will continue to grow and the population will continue to rely on traditional energy sources such as charcoal for cooking, resulting in major deforestation.

The students proposed alternative strategies where Palma is able to transition to resilient energy infrastructure as it grows and urbanizes. A series of smaller micro-grids that use renewable resource technology, including solar energy and battery storage, will ease the transition from traditional energy sources like kerosene to the formal electric grid of Electricidade de Moçambique (EDM). The students also speculated "pay-as-you-go" natural gas solutions for cooking will be developed, which will transition consumers from traditional cooking fuels to more long-term, sustainable fuel sources.



## Workshop Team

### Center for Resilient Cities and Landscapes

**Kate Orff** - Associate Professor and Faculty Director  
**Thaddeus Pawlowski** - Managing Director  
**Carmelo Ignaccolo** - Adjunct Research Associate  
**Georine Pierre** - Associate Research Scholar  
**Lisa Dale** - Faculty Affiliate

### WWF

**Ryan Bartlett** - Lead, Climate Risk Management, WWF-US  
**Alima Taju** – Natural Capital Senior Manager, WWF-Mozambique  
**Antonio Serra** - Landscape Coordinator, WWF-Mozambique  
**Hermínio Mulungo** - Freshwater Programme Manager, WWF-Mozambique  
**Lara Mauves** – Marine Senior Officer, Oceans, WWF-Mozambique

## Student Participants

### Columbia University GSAPP

**Conor Barry** – Master of Architecture Candidate  
**Katinka Bosh** - Master of Architecture Candidate  
**Pauline Claramunt** - Master of Urban Planning Candidate  
**Anna Stokes** - Master of Urban Planning Candidate  
**Camille Esquivel** – Master of Urban Planning Candidate  
**Emily Po** – Master of Architecture Candidate  
**Laura Postarini** – Master of Urban Planning Candidate  
**Elisa Xavier de A F Carvalho** – Master of Architecture Candidate

### Columbia University Business School

**Charles Drain** - Master of Business Administration Candidate  
**John Plaisted** - Master of Business Administration Candidate  
**Robert Zochowski** - Master of Business Administration Candidate

### Lúrio University

**Isabel Marques da Silva** – Professor, Faculty of Natural Sciences, Pemba, Cabo Delgado  
**Bernardo Xavier** – Professor, Faculty of Architecture and Physical Planning, Nampula  
**Samito João** – Student, Faculty of Architecture and Physical Planning, Nampula  
**Keir Senda** – Student, Faculty of Architecture and Physical Planning, Nampula  
**Emerson Zeferino** - Student, Faculty of Natural Sciences, Pemba, Cabo Delgado

## Speakers and Presenters:

**Adarito Watela** - National Director of Spatial Planning and Resettlement, Government of Mozambique  
**Anabela Rodrigues** - Country Director, WWF-Mozambique  
**Kate Orff** - Associate Professor and Faculty Director, Center for Resilient Cities and Landscapes, Columbia University  
**Dr. David Le Maitre** - Principal Researcher, The Council of Scientific and Industrial Research (CSIR)  
**Lindie Smith-Adao** - Researcher, The Council of Scientific and Industrial Research (CSIR)  
**Dr. Susan Taljaard** - Principal Researcher, The Council of Scientific and Industrial Research (CSIR)  
**Tomas Jaime Langa** - Association of the Environment (AMA)  
**Isabel Marques da Silva** – Professor, Faculty of Natural Sciences, Lúrio University  
**Bernardo Xavier** – Professor, Faculty of Architecture and Physical Planning, Lúrio University Nampula  
**Cesar Tique** - Senior Agriculture and Rural Development Specialist, African Development Bank  
**DINOTER** (National Directorate of Land Use Planning and Resettlement)  
**SDAE Palma** (District Service of Economic Activities of Palma)  
**Higino Rodrigues** - Director of the Coordination Office for Reconstruction Post Disasters, INGC (National Institute of Disaster Management of Mozambique)  
**Michel Matera** - Senior Disaster Risk Management Specialist, The World Bank  
**Leif Sandhop** - Analyst, Third Way Africa

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