

Resilient Planning at Multiple Scales: Puerto Rico

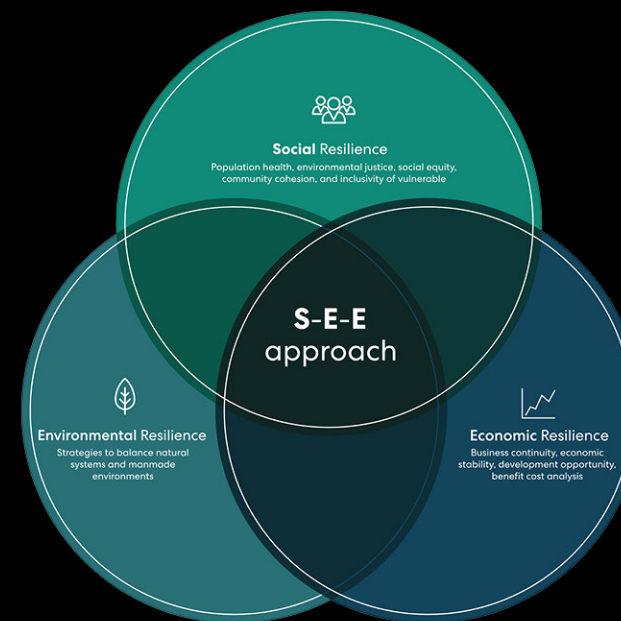


Resilient Planning at Multiple Scales: Puerto Rico

The challenges that Puerto Rico faces from a climate resilience perspective are complex and can't be solved in silos. The Island lacks a comprehensive analysis that contextualizes risks and vulnerabilities. At the same time, Municipalities, like Toa Baja, could benefit from an understanding of how they fit into the larger Island ecosystem and region and what are potential solutions that consider the granularity of community needs.

This analysis and design is part of a Resilient Framework Plan for the Autonomous Municipality of Toa Baja. It represents the development of a scalable and replicable resilient planning methodology with a S-E-E approach: Social, Environmental and Economic Resilience.

This framework plan is helping the Municipality build consensus, centralize existing information, identify gaps of data and analysis, synthesize analysis into overarching principles and think strategically about solutions that are implementable.

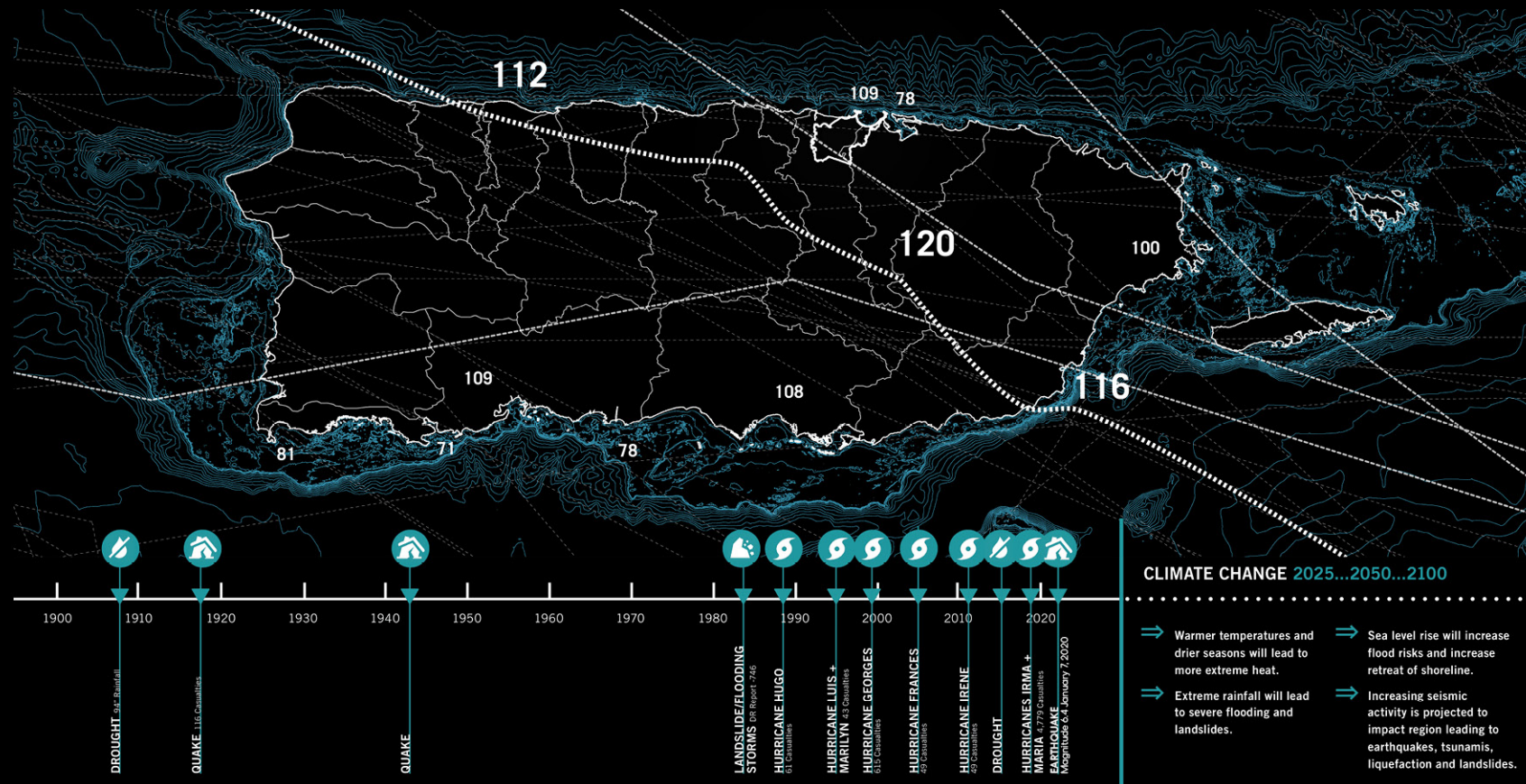


Through a collaborative initiative, a global and multidisciplinary “Alliance” was formed, committed to designing a sustainable and resilient world. The S-E-E framework – social, environmental and economic lenses, focuses on a data driven / scientific process founded on the principle that all systems are connected.

This process begins with understanding vulnerabilities and risks, dissecting the problem through different lenses, and overlapping these lenses to diagnose problems and find solutions through synergies. While the Alliance has a variety of efforts in different locations, this submission focuses on their work within Puerto Rico after Hurricane Maria.

Understanding the Vulnerabilities:

120 Years of Catastrophic Natural Events in Puerto Rico



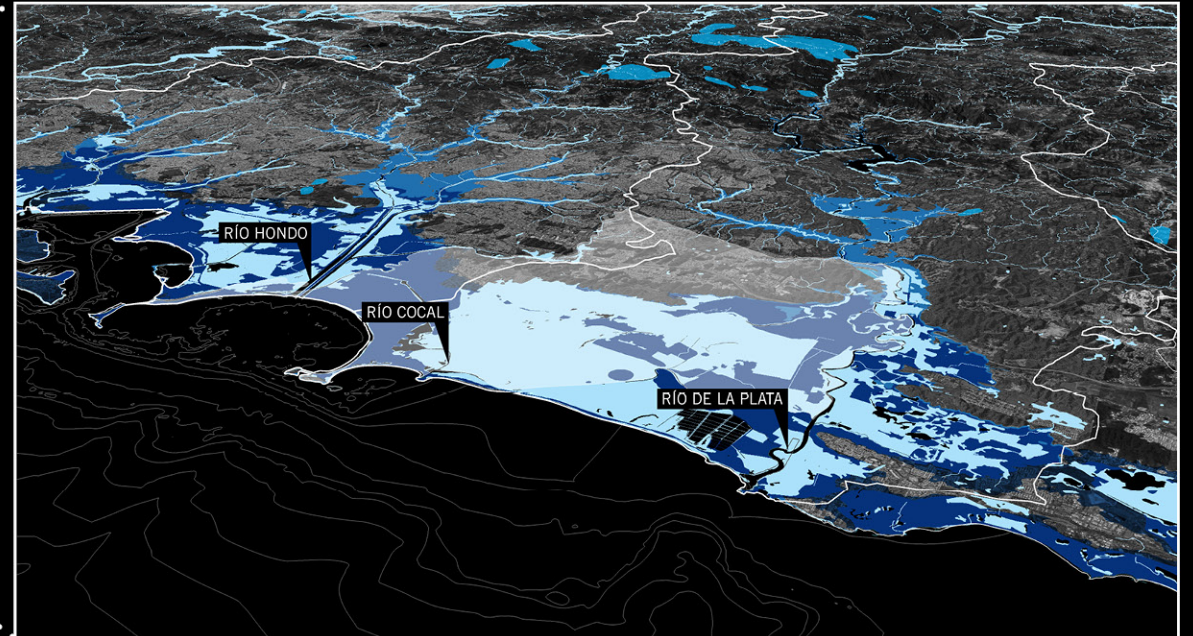
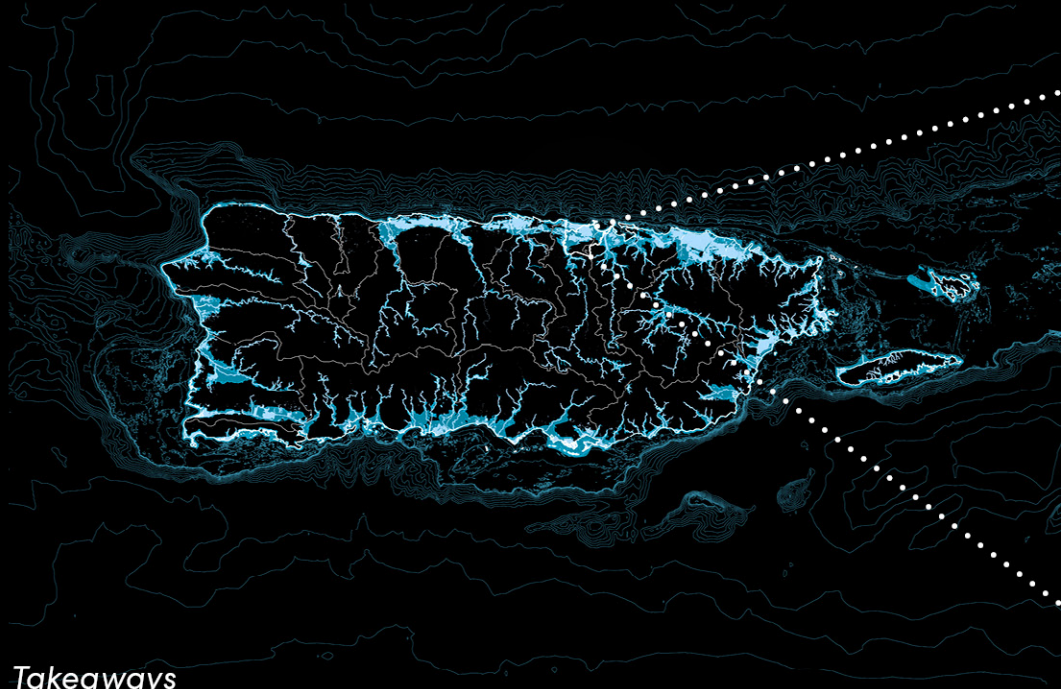
Climatically, Puerto Rico is susceptible to Atmospheric, Geologic and Hydrologic hazards.

Atmospheric (air) hazards include high winds, drought, fire and extreme temperatures. Geologic (land) hazards include coastal erosion, landslide, earthquake, subsidence and liquefaction. Hydrologic (water) hazards include heavy rain, storm surge and tsunami.

This diagram illustrates important events that have disrupted and impacted the Island.

Environmental Analysis: Hydrology Study

STREAMS
WATERSHED
WETLANDS
1% STORM FLOOD ZONE
1'-3"
6'-9"
MARIA STORM SURGE INUNDATION



Takeaways

Puerto Rico

55% of Puerto Rico's population is living in coastal municipalities

252,748 structures are at risk of flooding

500,000 people (15% of the population) live in areas prone to flooding

Toa Baja

\$500M have been invested for a flood control project in Río de la Plata

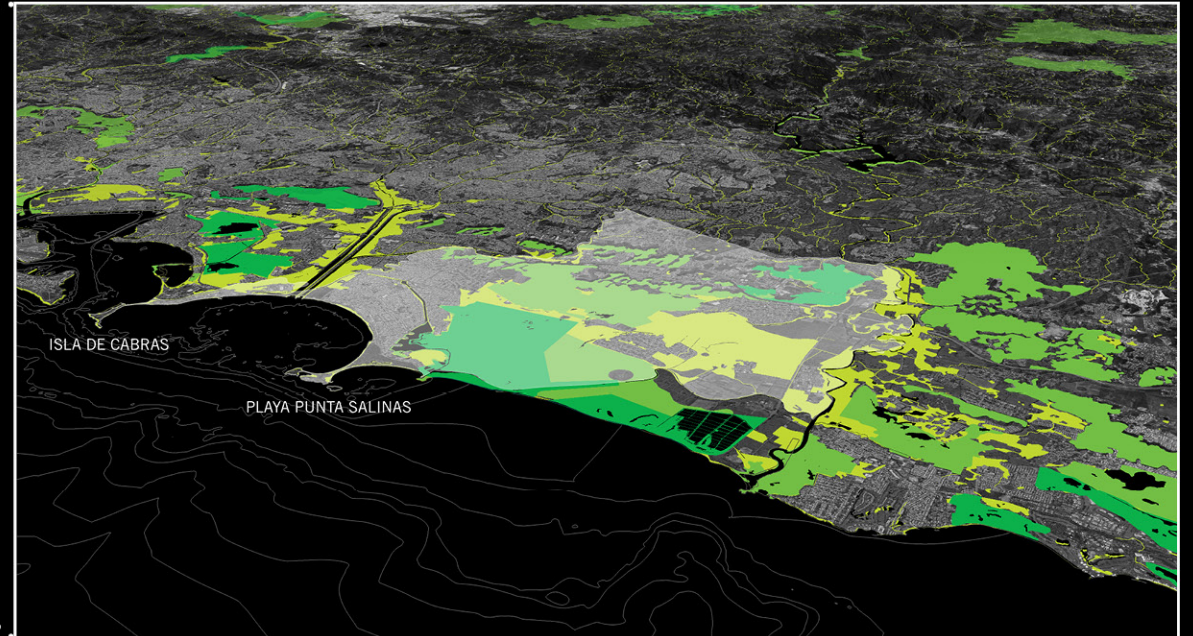
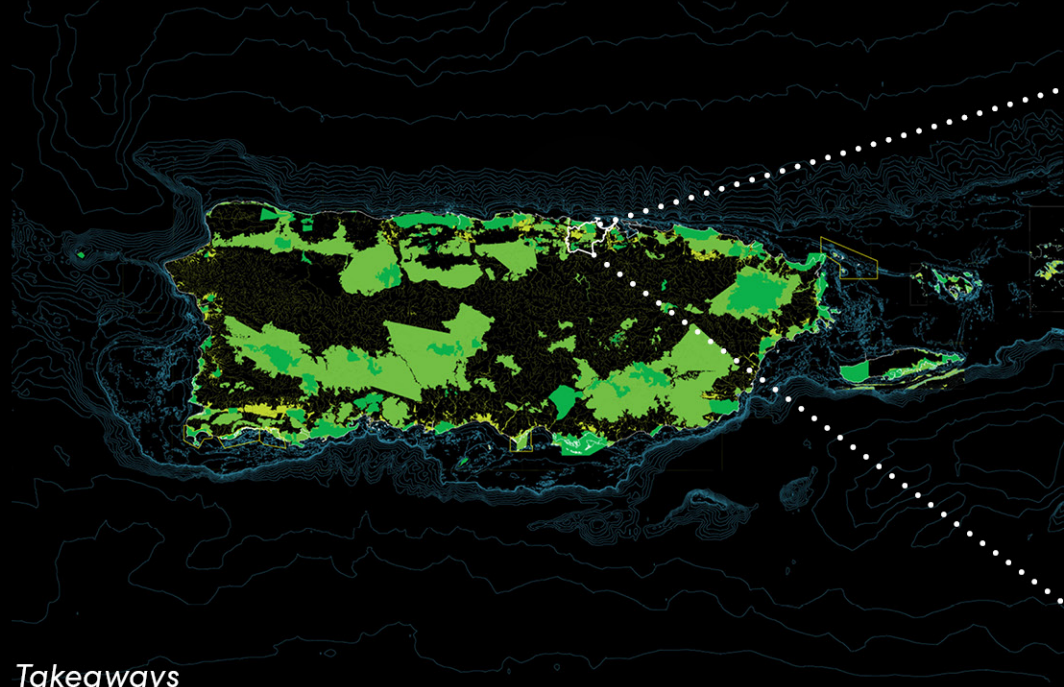
La Plata River floods Toa Baja every **6-10 years**

Environmental Analysis: Ecology Study

CRITICAL WILDLIFE AREA

CONSERVATION PRIORITY

WETLANDS



Takeaways

20%

Puerto Rico

of the island is karst zone and consists of alluvial and claylike surface, making it susceptible to landslides and liquefaction

60 years of natural tree fall happened in one day after Hurricane Maria

16%

Tao Baja

of land is developed

Loss of coastline

due to erosion and sea level rise, limiting public access to the coast

Fragmented

natural reserves

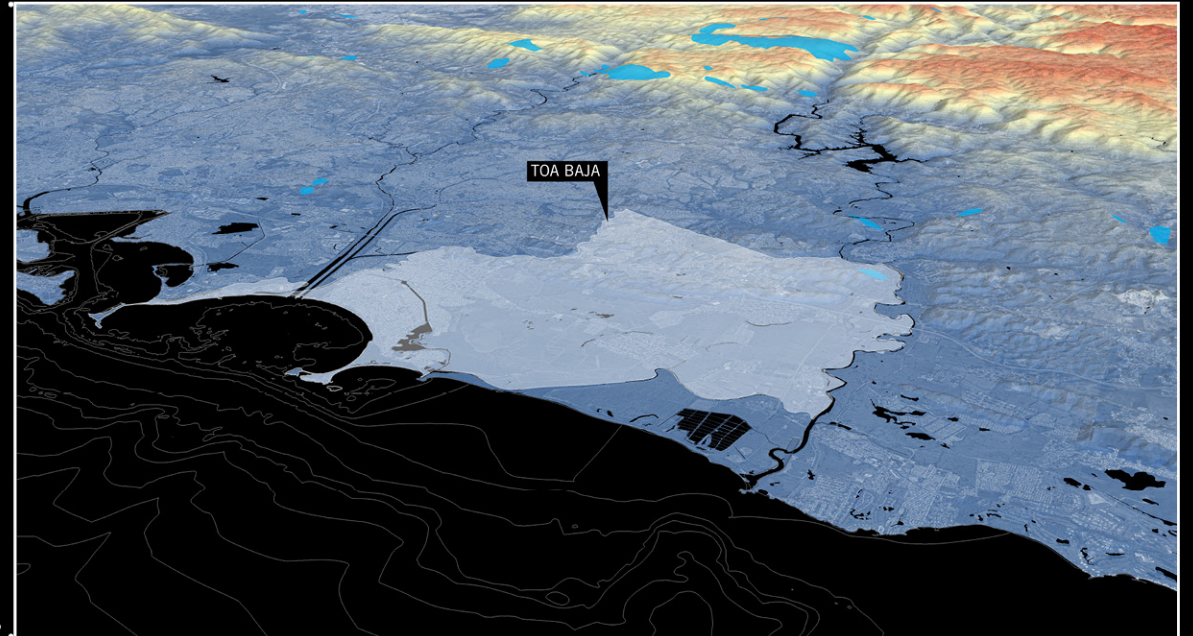
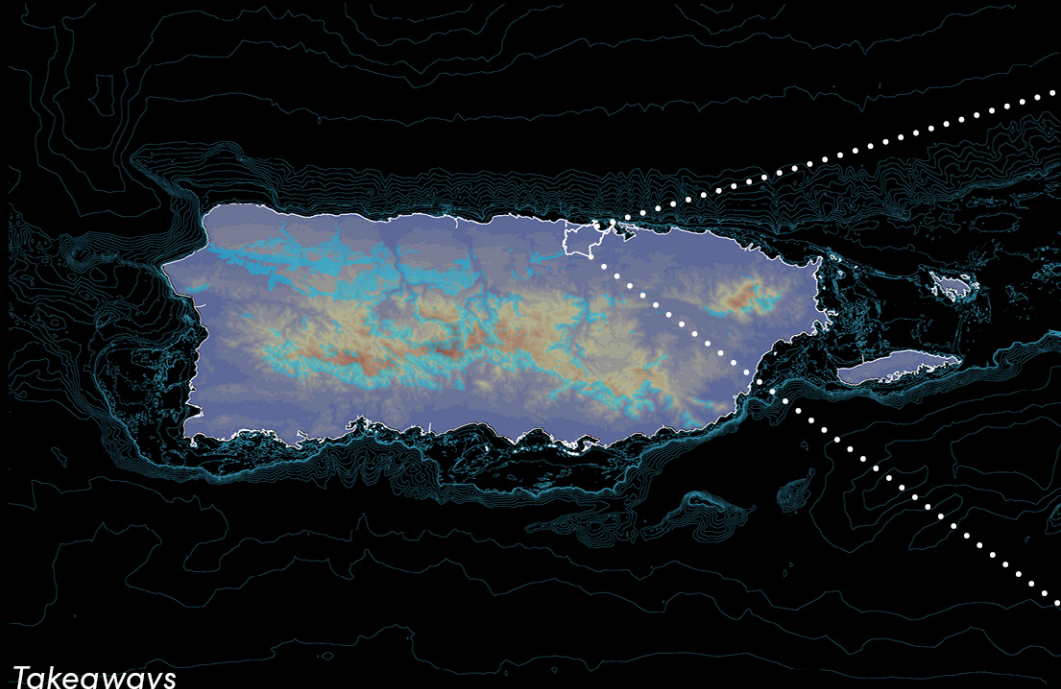
Environmental Analysis: Topography Study

HIGHEST LANDSLIDE RISK

+0'

+4400'

MARIA STORM SURGE INUNDATION



Takeaways

49%

Puerto Rico

of the population lives in areas ranging from moderate to high susceptibility for landslides

The coastline is being eroded at a rate of up to **3.3 feet / year**

Growing population density is **higher than Japan** resulting in more construction on vulnerable slopes

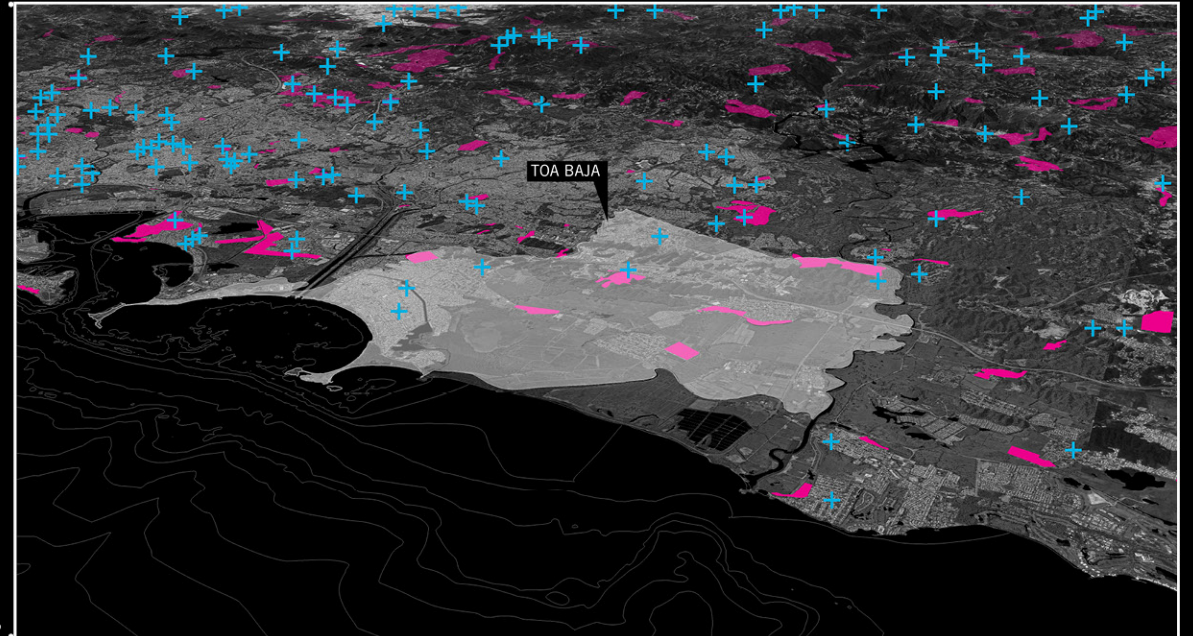
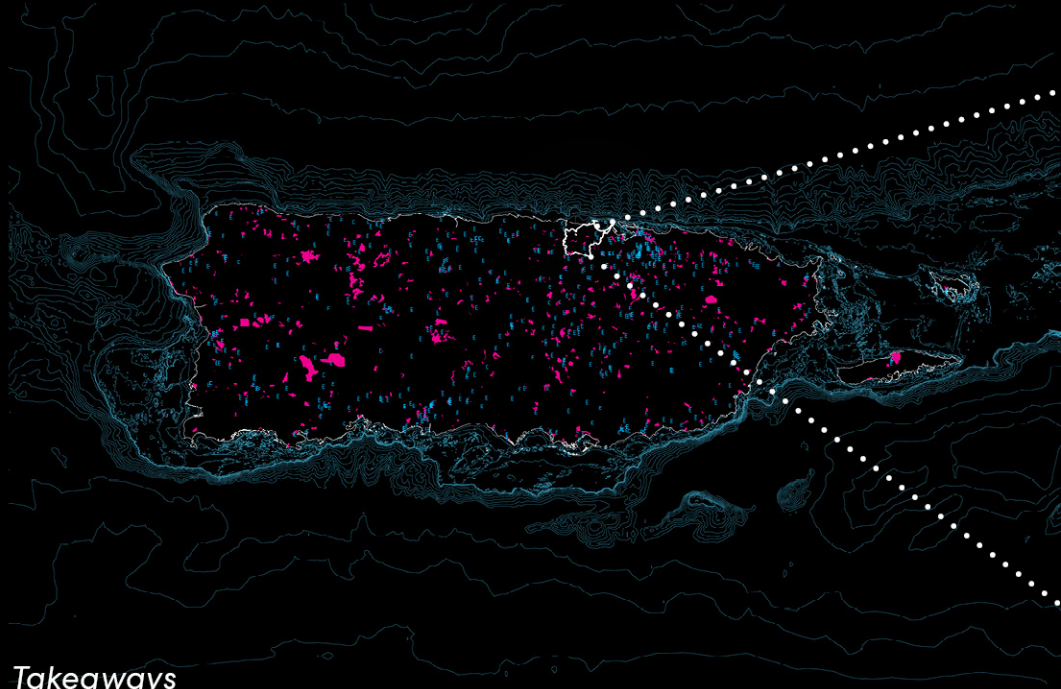
Toa Baja

Low lying areas of Toa Baja are subject to Subsidence and Liquefaction

Social Analysis: Social Study

HOSPITALS + EMERGENCY SHELTERS

SPECIAL COMMUNITIES



Takeaways

Puerto Rico

500,000 people (15% of the population) live in areas prone to flooding

250,000 homes severely damaged

Lack of emergency and medical facilities

Social Vulnerability to anticipate, prepare, respond, and recover

Toa Baja

Toa Baja has the highest unmet housing needs

4,000 housing units needed

14K + flooded homes

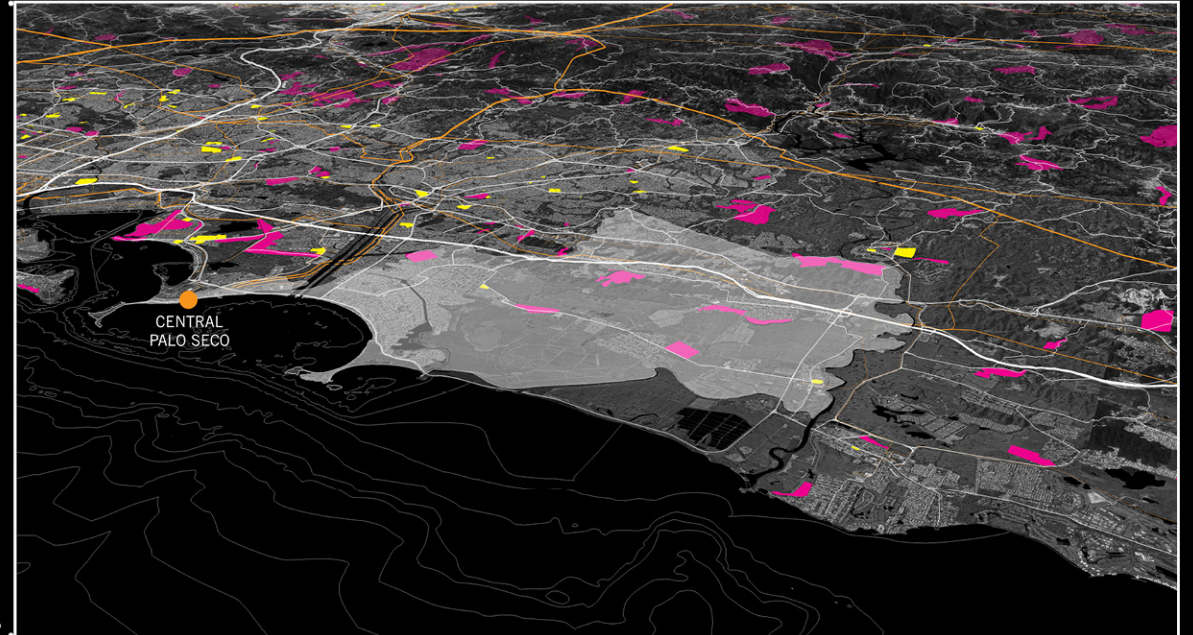
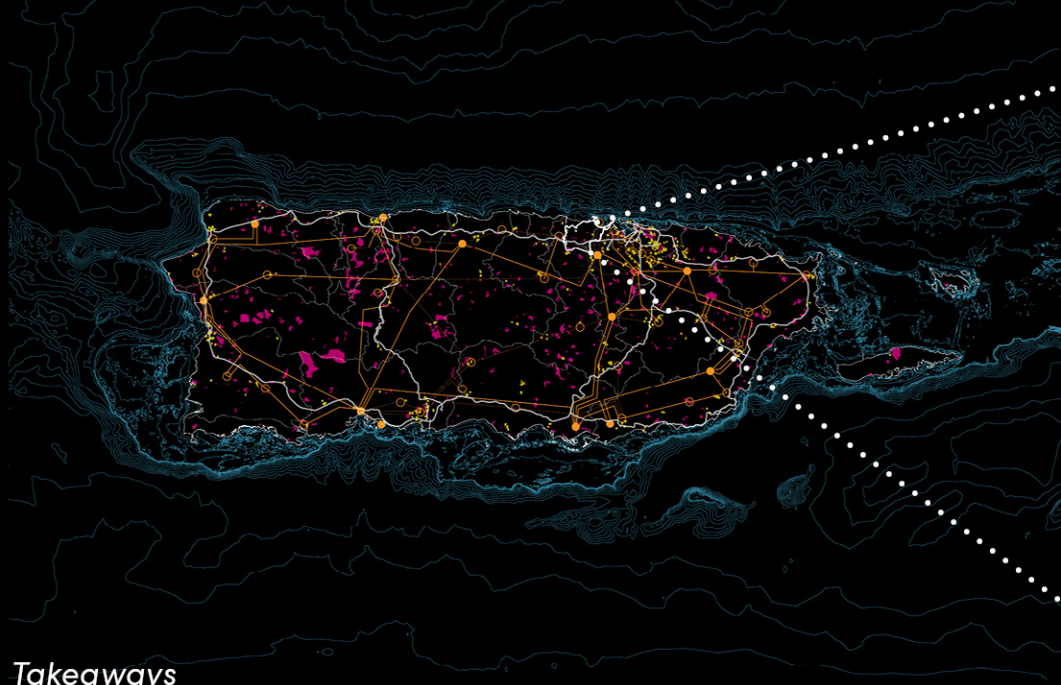
3 medical facilities

Economic Analysis: Infrastructure and Development Study

ELECTRICAL INFRASTRUCTURE

SPECIAL COMMUNITIES

PUBLIC HOUSING



Takeaways

Puerto Rico

\$80M total economic damages

2nd Largest blackout in US History

\$60M electric infrastructure damages

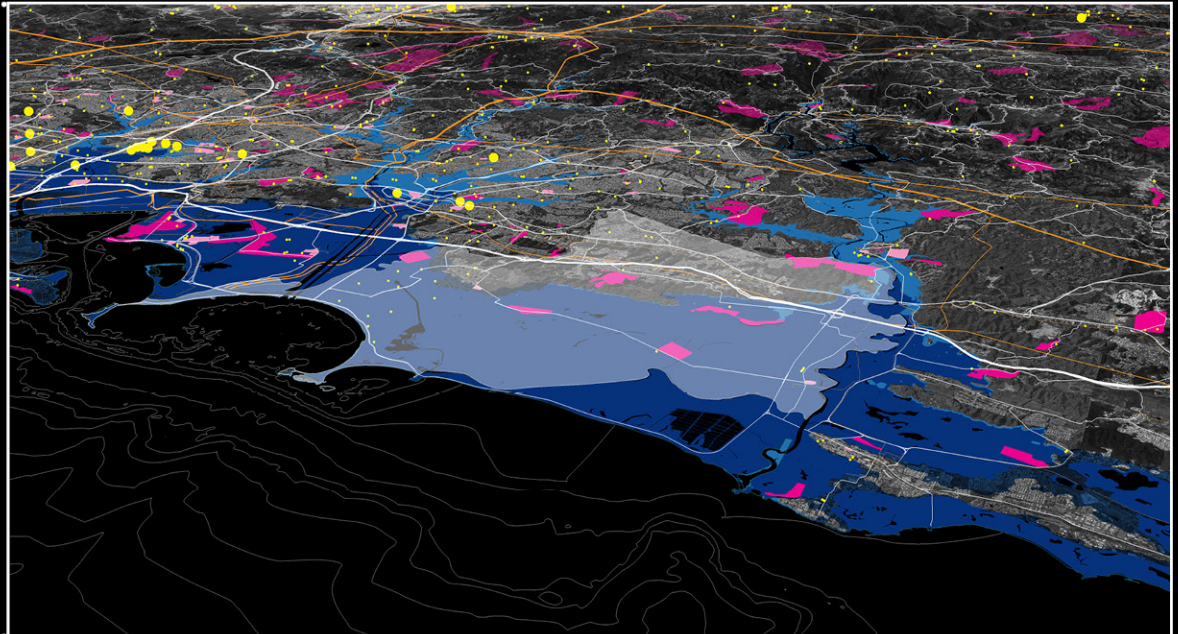
Toa Baja

Palo Seco is 1 of 2 plants that supply energy to PR and is located in Toa Baja

4,000 housing units needed

03 hospitals

Vulnerabilities:



Takeaways

Puerto Rico

\$65B

total economic cost

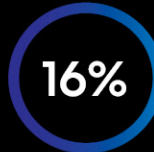
500,000

people (15% of the population) live in areas prone to flooding

250,000

homes severely damaged

Tao Baja



of land is developed

13k+

damaged properties

14k+

flooded hours

\$400M

property damages

\$1.3B

total economic cost

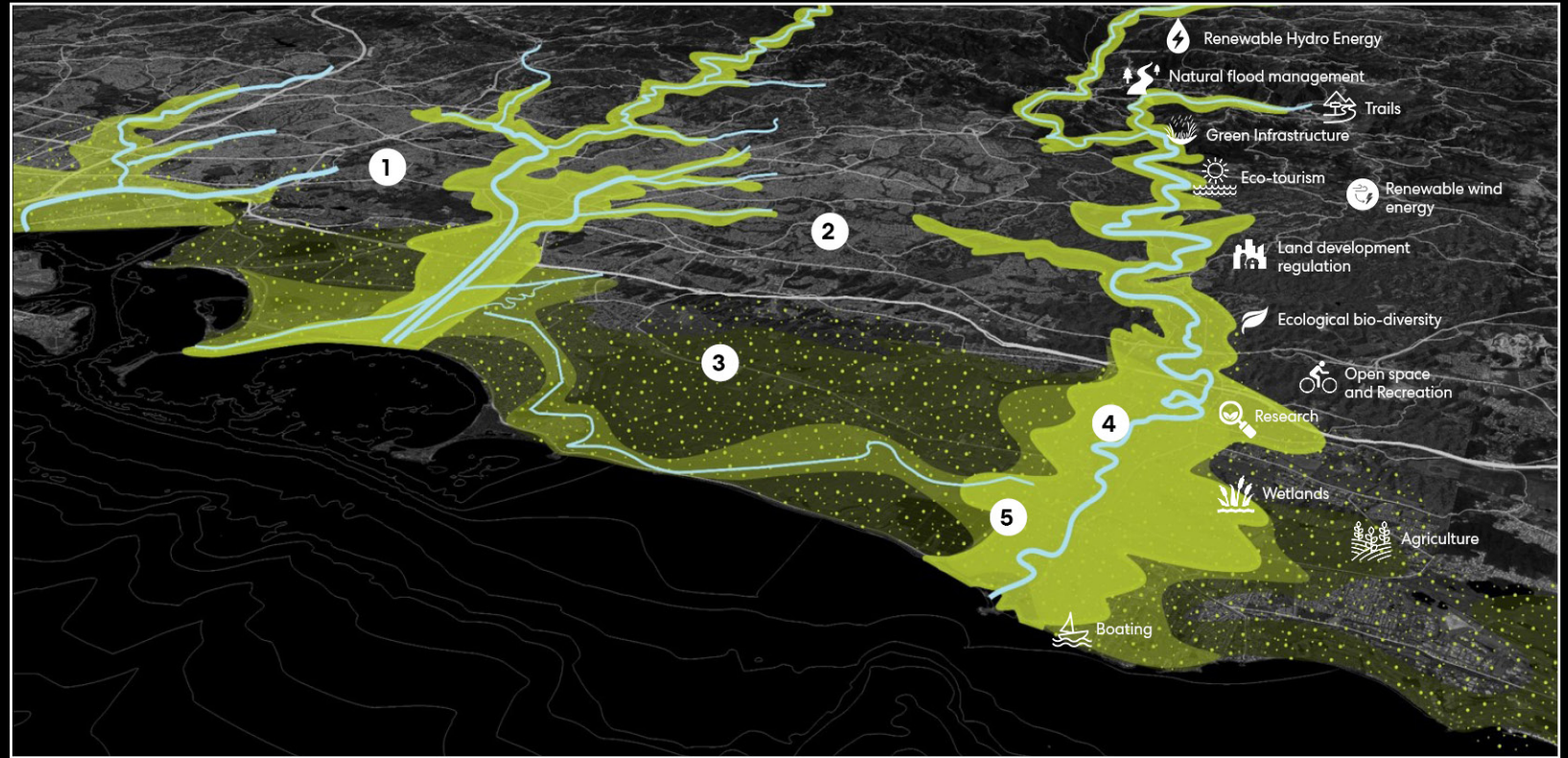
\$60M

total economic cost

Three Driving Principles for Toa Baja Moving Forward:

01 Restore The Ecology

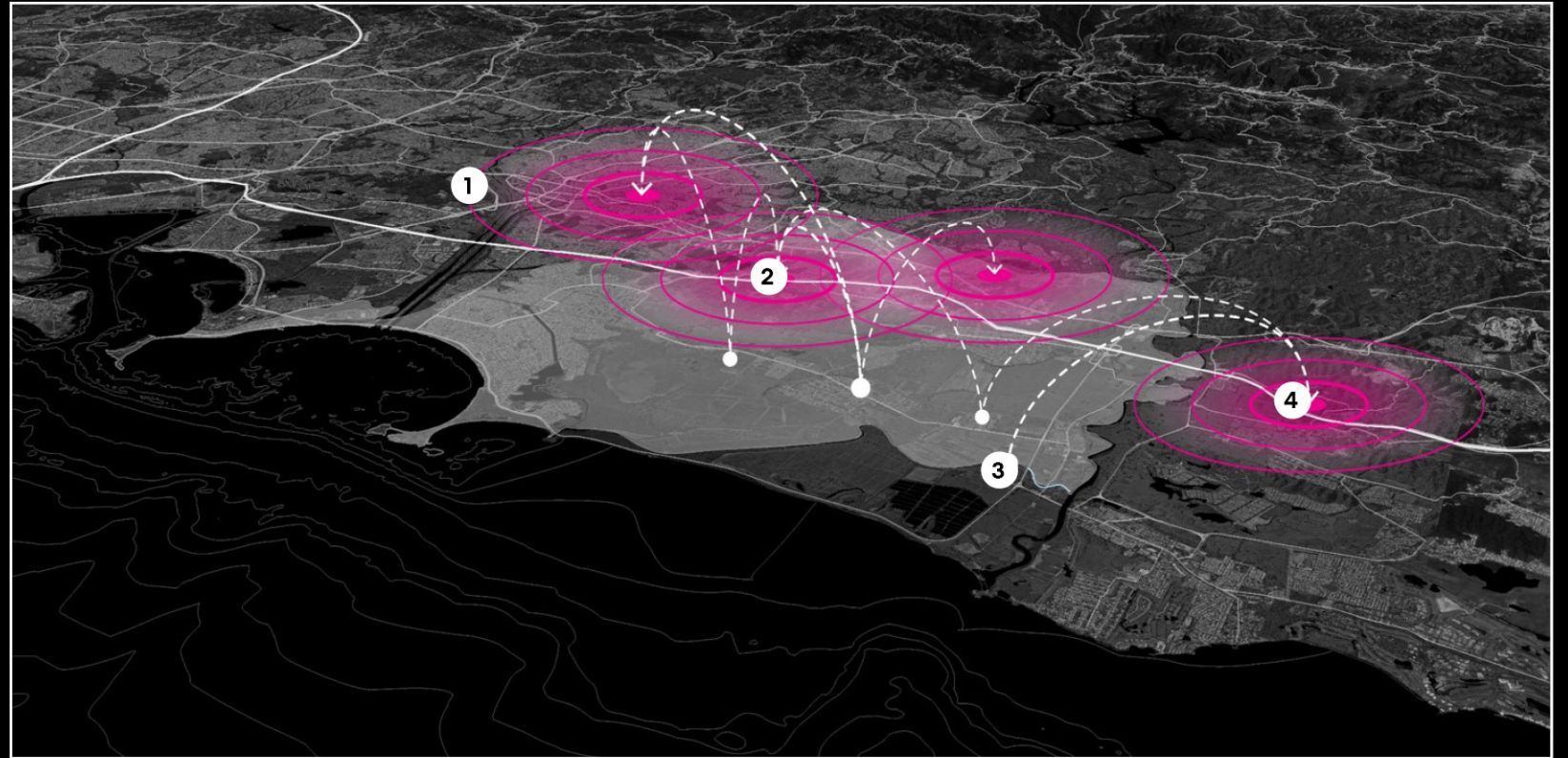
- 1 Cultural and Economic Transformation**
Ecological corridor for recreation, education, tourism and increase employment and development opportunities
- 2 Green Infrastructure**
Connect the ecology with green corridors of mobility and infrastructure
- 3 Ecological Landscape**
Performative landscapes that provide ecological and flood protection benefits
- 4 Regeneration of the River Corridor**
Enhance flood resiliency and water quality. Restore a functional and diverse ecosystem
- 5 Open Spaces and Recreation**
Create spaces for discovery and play that develop an identity for the region



Three Driving Principles for Toa Baja Moving Forward:

02 Develop a Social and Civic Infrastructure

- 1 Walkable Communities**
Robust multi modal corridors and design guidelines to promote a walkable community
- 2 Civic Anchors and Community Hubs**
Civic amenities, emergency shelters, community assembly spaces, culture and art centers as urban destinations
- 3 Social Health and Wellness**
Relocate developments from critically vulnerable zones and low lying flood plains
- 4 Urban Centers and Schools**
That support mixed uses, walkable communities and enliven public realm



Three Driving Principles for Toa Baja Moving Forward:

03 Build Smarter

The Alliance, in collaboration with many other partners led the development of a guide to build smarter community centers. Free to the public, 'Community Together: A Guide for Resilient Community Center Design in Island Communities,' is informing the design of resilient community centers to strengthen organizational capacity, promote year-round education, and withstand environmental, social, and economic changes. The guide offers practical suggestions, including how to develop operational ability and relevant physical assets—like solar panels and water cisterns—to achieve resilience. This Guide is an in-depth expansion of the Community Development chapter in the 'Keep Safe' guide.

