A Primer on Coastal Transportation System Resilience and Adaptation to Sea Level Rise on O‘ahu Using Living Shorelines and Green Infrastructure

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Project Objective

This primer provides a methodology to identify relevant living shorelines and green infrastructure strategies for protection of various types of tropical island coastal built environments, illustrated through three sites in Hawai‘i. The goal is to slow coastal erosion and reduce flooding so that coastal transportation ways can remain operational during the coming decades. The primer is intended to inform and aid decision-making by Hawai‘i’s government planners and policy makers, private landowners, developers, design teams (urban planners, architects, landscape architects, civil engineers, transportation engineers, etc.).

Problem Statement

O‘ahu’s coastal hazards include accelerating erosion, sea level rise, annual high wave flooding, coastal storms, and groundwater inundation, which threaten to flood roadways, buildings, landscapes, and other infrastructure. When planning long-term infrastructure for 3.2 feet of sea level rise by mid-century, adaptations to Hawai‘i’s coastal built environment will be necessary to minimize damage from flooding. In the past, “hard” shoreline armoring was used to protect coastal communities, but the resulting detrimental erosion prompts us to consider green design alternatives, such as living shorelines and green infrastructure.

Research Methodology

This primer considers context-specific application of living shorelines for coastal protection by examining three economically and socially important site locations on O‘ahu. The study sites vary in their wave energy and density of coastal development. The replicable design research methodology includes:

1. Summarize coastal flood hazards at each site;
2. Identify the applicable living shoreline strategies and provide explanatory graphics;
3. Provide international built and speculative project precedents and literature review;
4. Describe effectiveness of each strategy, quantitatively where possible;
5. Visually communicate conceptual level design ideas for site-specific application of living shoreline strategies.

Results

Living shoreline and green infrastructure coastal protection strategies that may be relevant in Hawai‘i include restoration of coastal sand dunes, vegetation (groundcover, shrubs, trees), and coral reefs. Green infrastructure strategies include widening floodways adjacent to rivers, temporary water detention, and stream/river bank elevation and stabilization. This primer also discusses combining “gray” infrastructure where there is potential to provide ecological benefit, flood protection, and prolonged use of an occasionally flooded area. Gray infrastructure

strategies discussed include T-head groins, underground cisterns, multi-use berms, or elevated walkways. The research products include visualization of living shoreline and green infrastructure in drawings and interactive physical models used in an international workshop and university classrooms. In addition, training benefits include architecture and planning students who learned about coastal flooding and proposed design scenarios through coursework and research for this project.

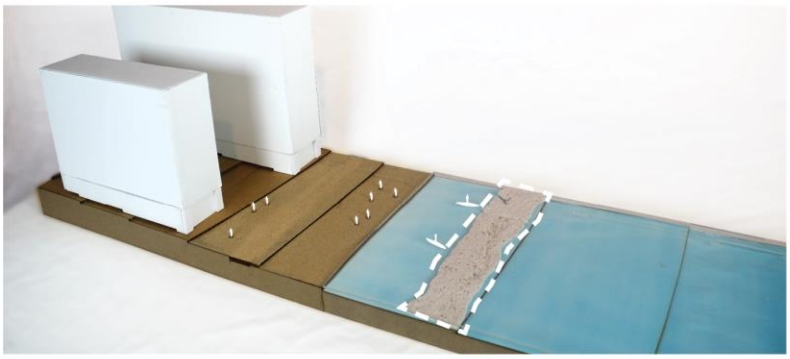

Fig. 1 Strategy proposal: Coral

Efforts to preserve and restore coral reefs can provide natural breakwaters to reduce wave energy that breaks on shore.
Dredging, treading, and chemical damage prevents natural replenishment of Waikiki's coral reef.

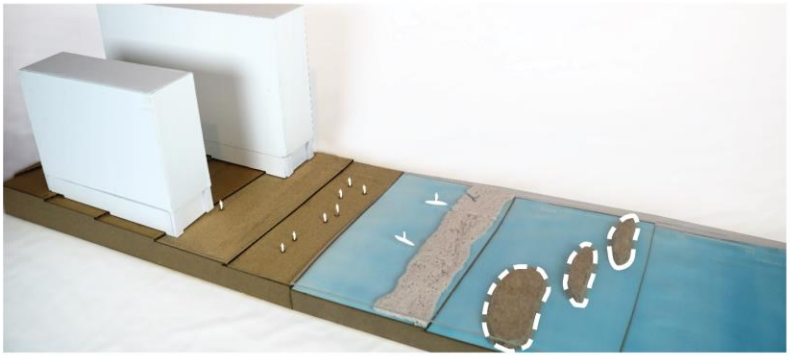

Fig. 2 Strategy proposal: Breakwater

Offshore breakwaters can provide additional wave energy dissipation benefits and provide a base for coral transplantation away from human activity.

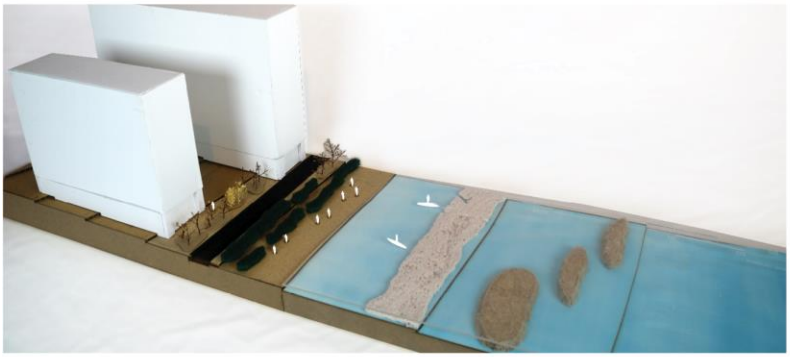

Fig. 3 Strategy proposal: Vegetation

Adding vegetation between the shoreline and built environment can help dissipate wave energy as it reaches the shore.

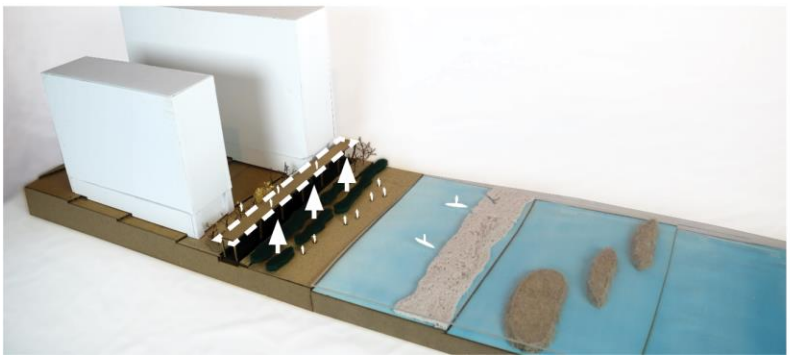

Fig. 4 Strategy proposal: Elevation

Additional infrastructure can be added as needed. An elevated boardwalk will provide dry pedestrian paths during flood events and allow vegetation to thrive at the ground level.