UNIVERSITY OF MIAMI

ULINK

University of Miami's Laboratory for INtegrative Knowledge (ULINK) supports teams of scholars from multiple disciplines in collaborative, problem-based inquiry to address the complex challenges of society.

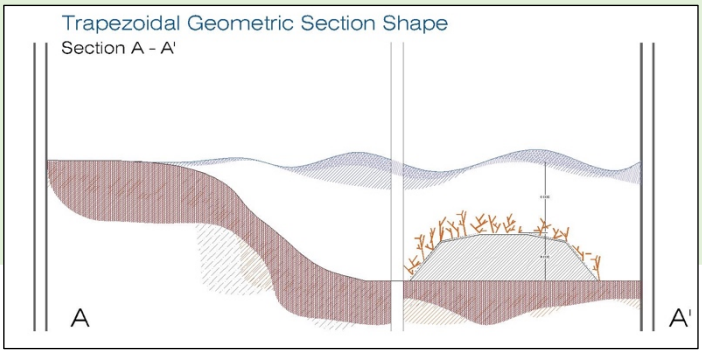
The **ULINK Coastal Resilience** team merges expertise from ocean sciences, structural & coastal engineering, marine ecology & biology, architecture & urban planning, and communications, building a truly interdisciplinary approach to find solutions at the intersection of shoreline, humans, and habitat. Our goal is to create a science-based **design framework** to develop and test **coral restoration strategies that combine gray (cement-based) and green (nature-based) defenses** to reduce the vulnerability of coastal communities to the impacts of ocean waves and wave-driven flooding. Our project has several components, described below.

Experiments in the SUSTAIN wind-wave tank

Housed at the Rosenstiel School of Marine and Atmospheric Science, **the SUrge STructure Atmosphere Interaction (SUSTAIN) laboratory** is home to the world's largest wind-wave tank capable of simulating up to a category 5 hurricane. This facility allows us to investigate at a fine scale the physical dynamics of waves as they interact with corals and model breakwater structures. As waves travel from one end of the tank to the other, they carry energy towards the model shoreline. By measuring the wave height before and after the breakwater model, we can determine the amount of energy that is reduced by the breakwater. To date, we have run over 50 experiments to test the reduction in wave energy under different wind and wave conditions, and have found that we can make engineered structures *more* effective at protecting our coasts **by at least 15%** by adding corals to their surface!

Testing structures in the field

Combining our laboratory findings with field measurements is critical to ensuring that these hybrid structures are practical and effective in the real world! We are currently working towards the deployment of a **coral-breakwater hybrid artificial reef** that will lie offshore of Miami Beach. If deployed, this artificial reef will not only provide insight on how much a coastline can be protected by a hybrid reef, but has the potential to create habitat for fish, attract divers and snorkelers, enhance biodiversity, and stabilize sediment nearshore. All these benefits and more will be rigorously monitored by our research team.



Bolstering thermal resilience of corals

Thermal bleaching is a process in which corals lose their algal symbionts as a stress response to higher water temperatures. This process can be fatal for the coral, because they rely heavily on their symbionts for energy and survival.

It's not always enough to simply restore corals back to an environment in which they are still threatened. Our biologists are in the process of building strains of corals that are themselves resilient to thermal bleaching. By bleaching and recovering corals in controlled settings, these corals may become "**stress-hardened**" to real-world bleaching events, and thereby more resilient to climate changes. These are the corals that will be prioritized in our restoration work and in our artificial reef hybrid structures.

Modeling urban vulnerability to coastal hazards

What are the human benefits to coastal protection measures such as our hybrid artificial reef design? In order to answer this question, we need to better understand the residents and stakeholders that live and work in our coasts. Our team's urban planning experts are creating **urban vulnerability models**, layering our community's physical vulnerability and risk to flooding with demographic data. In this way, we can both target more vulnerable populations that could stand to benefit from coastal protection, and quantify benefits from a modeled restoration scenario.

Communicating with stakeholders

Our work is contingent upon the support and engagement of our communities. For this reason, we are developing a full-scale **communications strategy** to **inform, engage, and win support** from stakeholders in the City of Miami Beach. Currently, we are in the formative research phase, distributing surveys and conducting stakeholder focus groups. Once this stage is completed, we will develop a series of outreach materials to be distributed, including a short film, handouts, and even a virtual reality experience!

Partnerships

Our research would not be possible were it not for the support of the partners we have made. **The City of Miami Beach Sustainability and Resiliency Committee and Communications Team** have been our champions, whether it be helping launch our permitting discussions or facilitating communications research with residents. Experts from **The Nature Conservancy** have also consulted with us to model the benefits of restoration for coastal protection in Miami Beach. We look forward to continuing to grow these relationships and achieve our mutual goals.

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