FY25 Strategic University Research Partnership (SURP)

# Remote VSWIR Imaging spectroscopy for global aquatic environment monitoring

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**Objectives:** A shallow coastal ecosystem at the land-water interface is a critical component of the global ecosystem. It includes a majority of high biodiversity areas which support habitats like coral reefs, seagrass, and mangroves. Coral reefs, seagrass, mangroves, and associated shallow-water ecosystems provide habitat for thousands of species, offer a variety of goods and services (i.e., seafood, tourism, flood protection) to millions of people living in coastal regions, and support marine organisms. However, they have suffered a major recession in multiple ways including reductions in organismal richness, diversity, and structural complexity of habitat. New techniques including monitoring through Remote Visible / ShortWave InfraRed (VSWIR) imaging spectrometers are critically needed to increase the resilience of coastal environments in the coming decades. This project combines JPL's expertise in inversion theory with ASU's expertise in water optics to develop coastal benthic cover and coastal water products relevant to future NASA missions.

**Background:** Coral reefs, seagrass, mangroves, and associated shallow-water ecosystems provide habitat for thousands of species, offer a variety of goods and services (i.e., seafood, tourism, flood protection) to millions of people living in coastal regions, and support marine organisms. Global mapping of shallow coastal ecosystems is critical for the Surface Biology and Geology (SBG) investigation called for by the National Academies 2017 Earth Science and Applications Decadal Survey.

**Approach and Results:**

- Li and Ingalls published a paper on a novel deep learning algorithm approach to mapping seagrass extent. This work (Figure 1) uses a convolutional architecture to recognize spatial features of reefs and combine these with ancillary attributes for superior classification performance. Seagrass is an important but understudied shallow benthic ecosystem which is finally being reached by global imaging spectrometer missions like EMIT. Because the spectroscopic signal is more prominent than for many benthic ecosystems (coral reefs, e.g.) this provides a scientifically valuable and technically intermediate proof of concept for accurate remote sensing of benthic organisms.
- Separately, Ingalls, Li, Thompson and Luis have submitted a paper for review on the spatial properties of habitat in seascapes of the coast of Belize (Figure 2). This study of data over a decadal timespan from 1996 to 2020 exemplifies the use of remote sensing data for studying coastal benthic ecosystem. It finds that: (1) group-level habitat classifications gloss over important aspects of specific habitat types that influence their resilience and change over time; (2) that habitat diversity influences ecosystem stability, with more diverse habitats exhibiting less habitat extent change; and (3) that differences in habitat areas can affect the interpretation of extent changes. This manuscript illustrates the successful use of remote sensing in a coastal conservation setting, while carrying important lessons for the nuanced interpretation of satellite data.

**Significance/Benefits to JPL and NASA:** The project is well positioned to infuse new algorithms into the SBG-VSWIR mission workflow. The JPL SURP project has also played a role in advancing academic and research achievements within ASU.

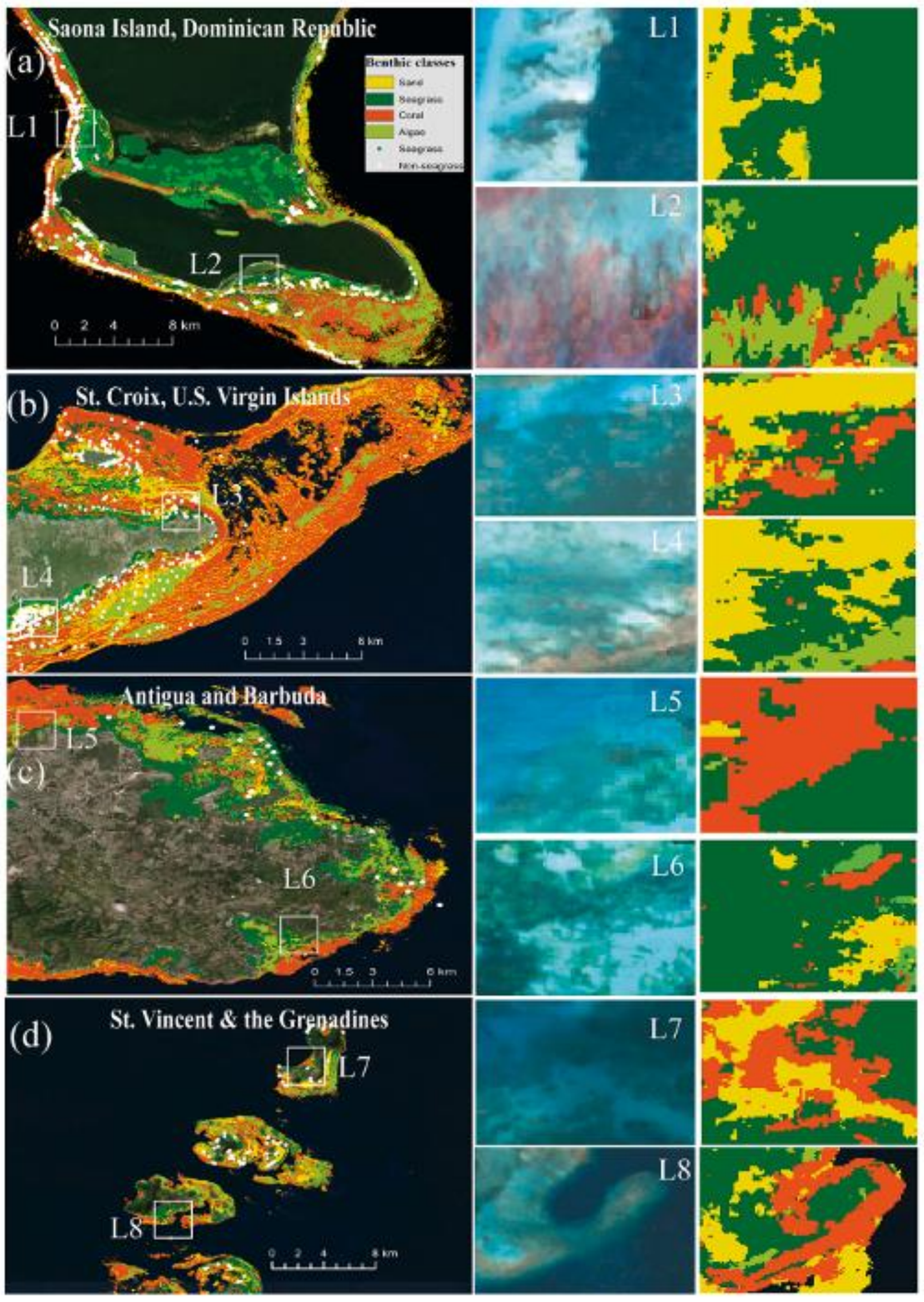


**Figure 1**: Benthic remote sensing of seagrass communities (Peng et al., 2025).

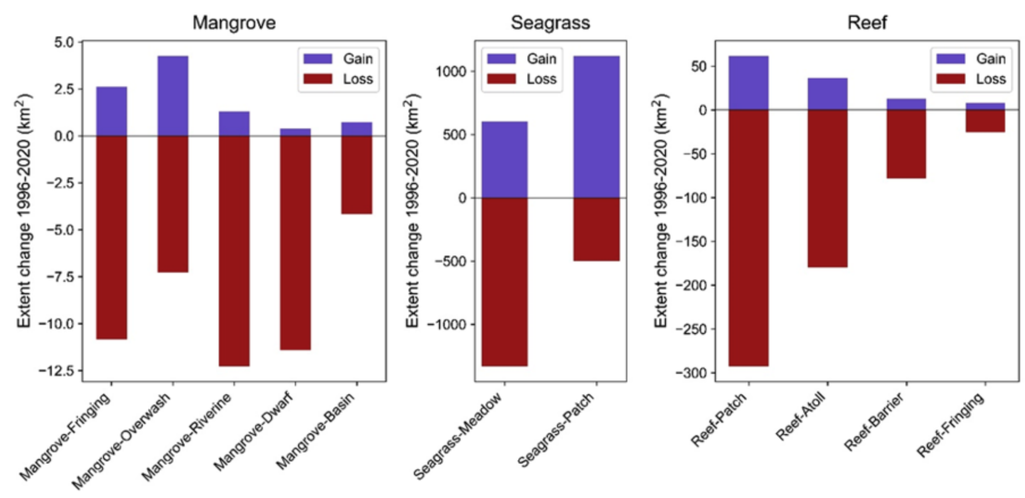


**Figure 2:** Coastal habitat change over time (Ingalls et al., 2025)

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## Publications:

Peng, Jianghai, Jiwei Li, Thomas C. Ingalls, Steven R. Schill, Hannah R. Kerner, and Gregory P. Asner. "A novel deep learning algorithm for broad scale seagrass extent mapping in shallow coastal environments. " *ISPRS Journal of Photogrammetry and Remote Sensing* 220 (2025): 277-294. IF:10.6

Ingalls, Thomas, Jianghai Peng, Kelly Luis, David R. Thompson, and Jiwei li, "Alterability of Coastal Poly- and Mono-Habitat Seascapes: A Belizean Case Study." Frontiers in Ecology and Environment, *in review.*

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