Towards assessing the contribution of far and near field wave families on coastal erosion and flooding in the Gulf of Panama

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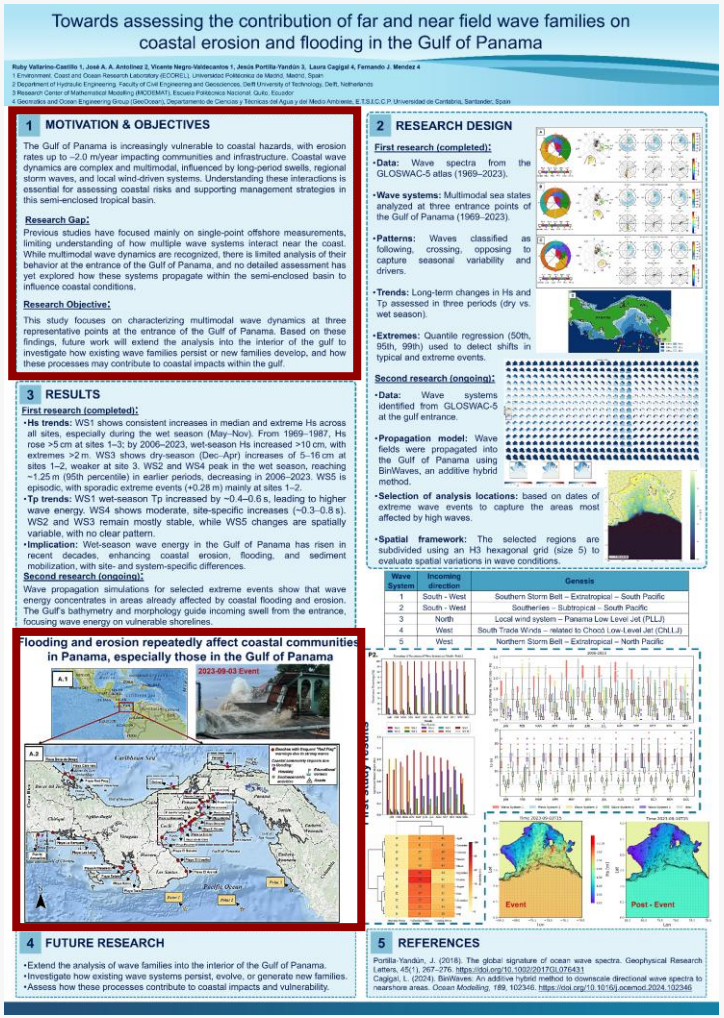
MOTIVATION & RESEARCH GAP

Gulf of Panama, is a semi-enclosed tropical basin in Central America

Beaches experience shoreline erosion of up to 2.0 m per year

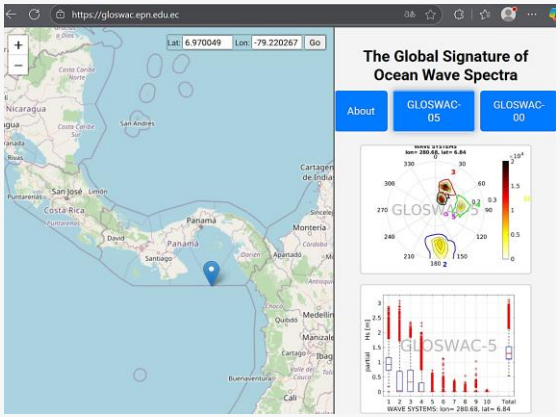
Most of the beaches affected are major contributors to Panama's tourism economy

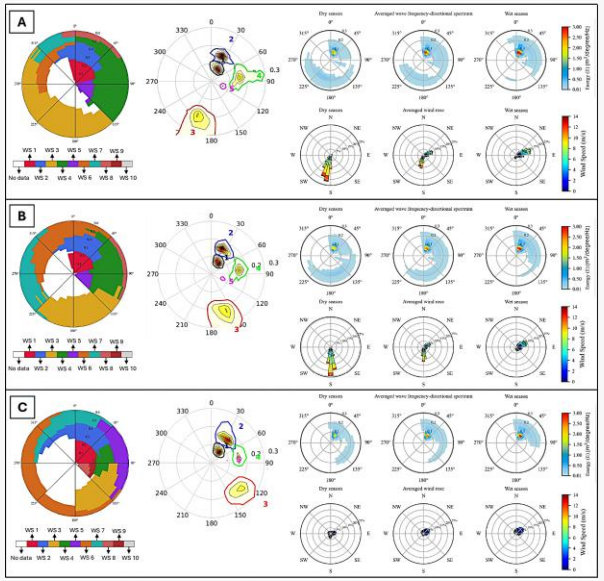
Research gap:
Exploring wave climate multimodality at the Gulf of Panama



RESEARCH DESIGN

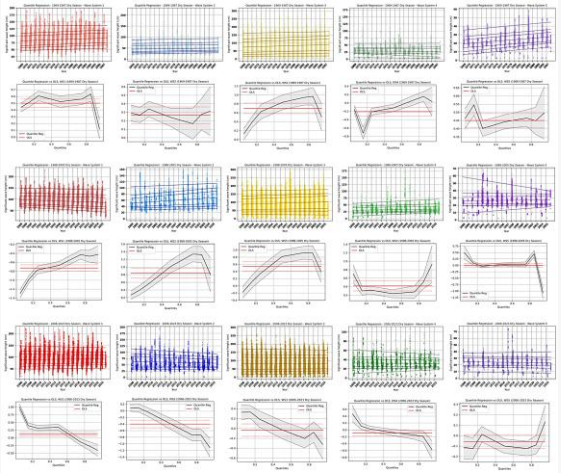
First research (completed):





GLOSWAC-5 Atlas

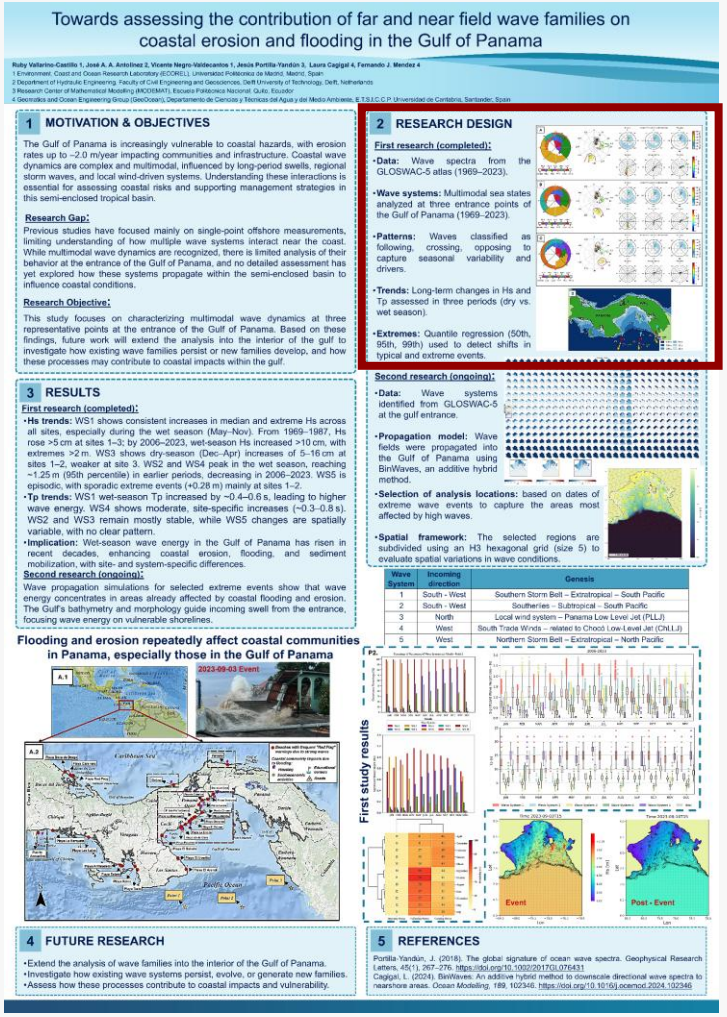
https://gloswac.epn.edu.ec/



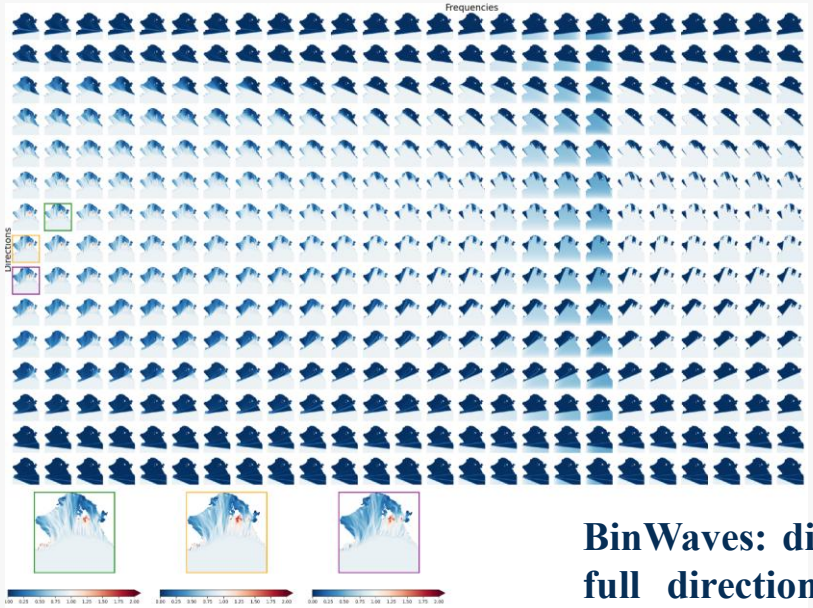
Wave system patterns shaped by seasonality and Gulf of Panama geomorphology

Quantile regression to analyze long-term changes, between three periods and season

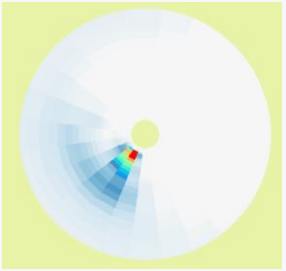
Quantile regression captures changes across the whole distribution



Second research (ongoing):

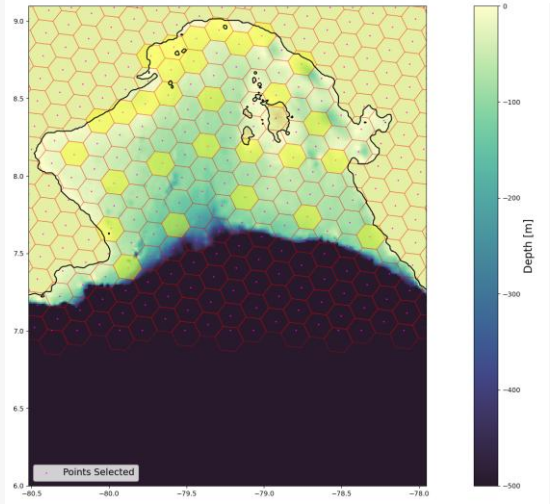


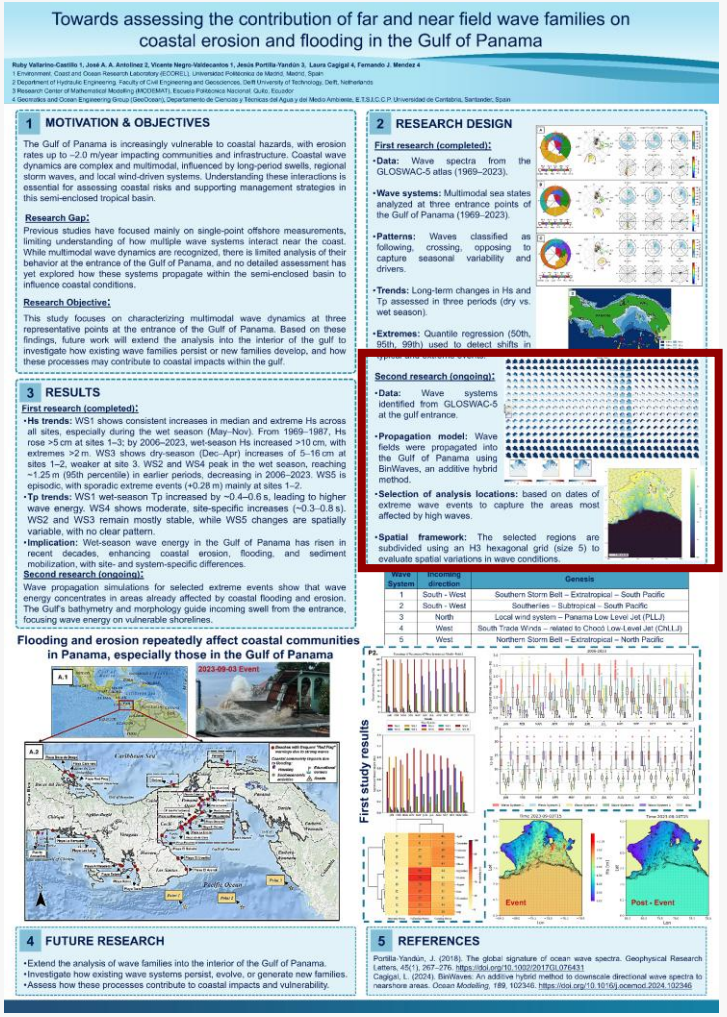
Offshore directional wave spectrum



BinWaves: disaggregation of the full directional wave spectrum into monochromatic bins, simulation with SWAN to derive propagation coefficients (Kp), and superposition of bins to reconstruct nearshore spectra

After reconstruction, we used the H3 grid to select hindcast points for spatial wave variability analysis.

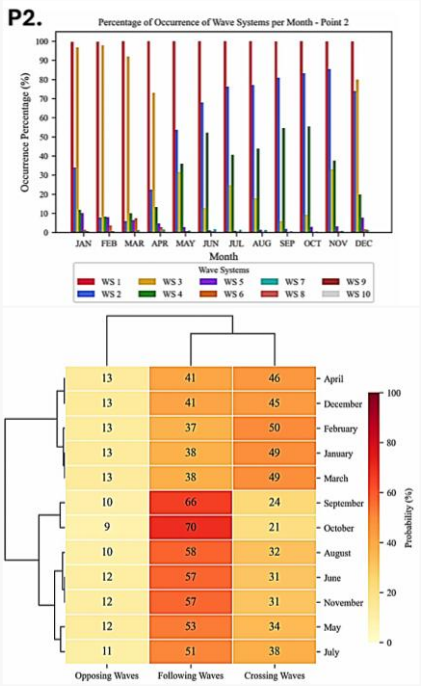




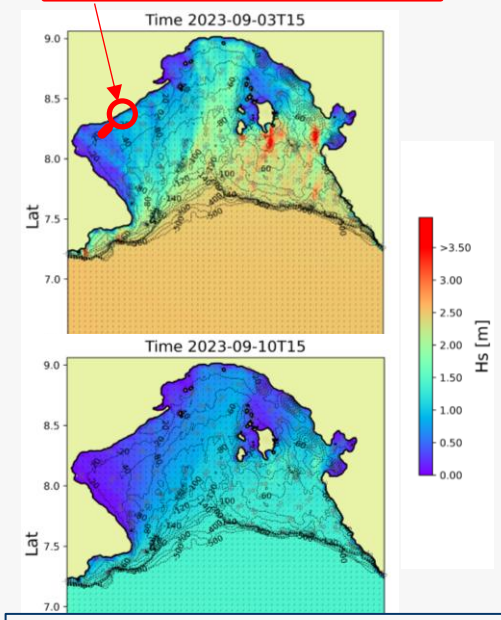
RESULTS:

First research (completed):

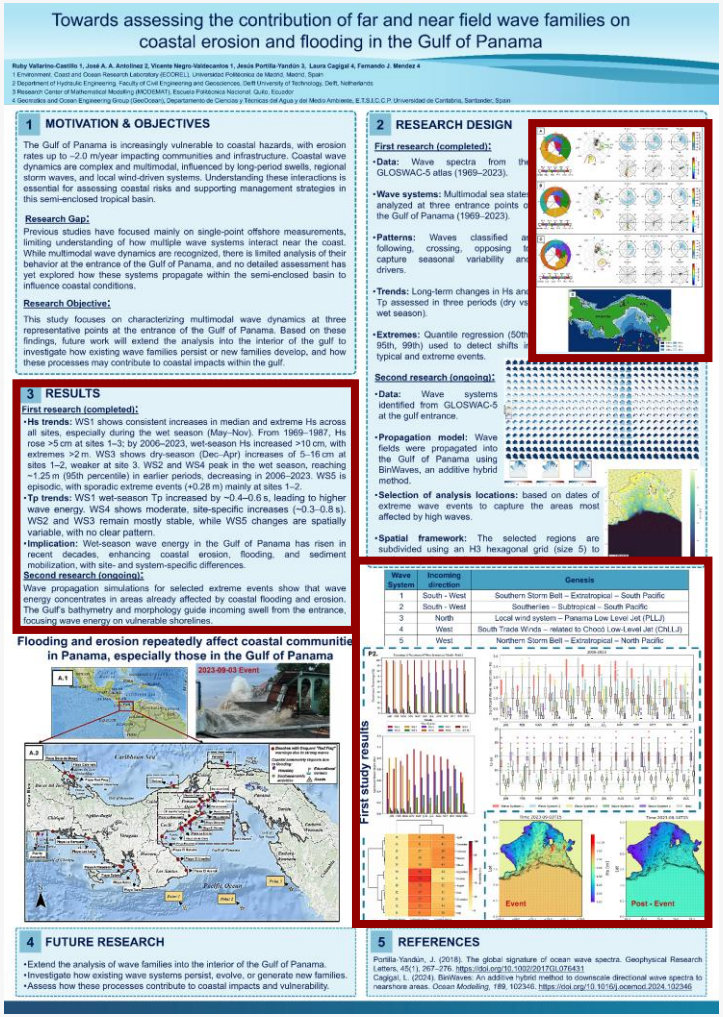
- **WS1 dominates year-round.**
- **WS2–WS4 are strongly seasonal.**
- **Wave trains reflect monthly and seasonal climate.**



Second research (ongoing):

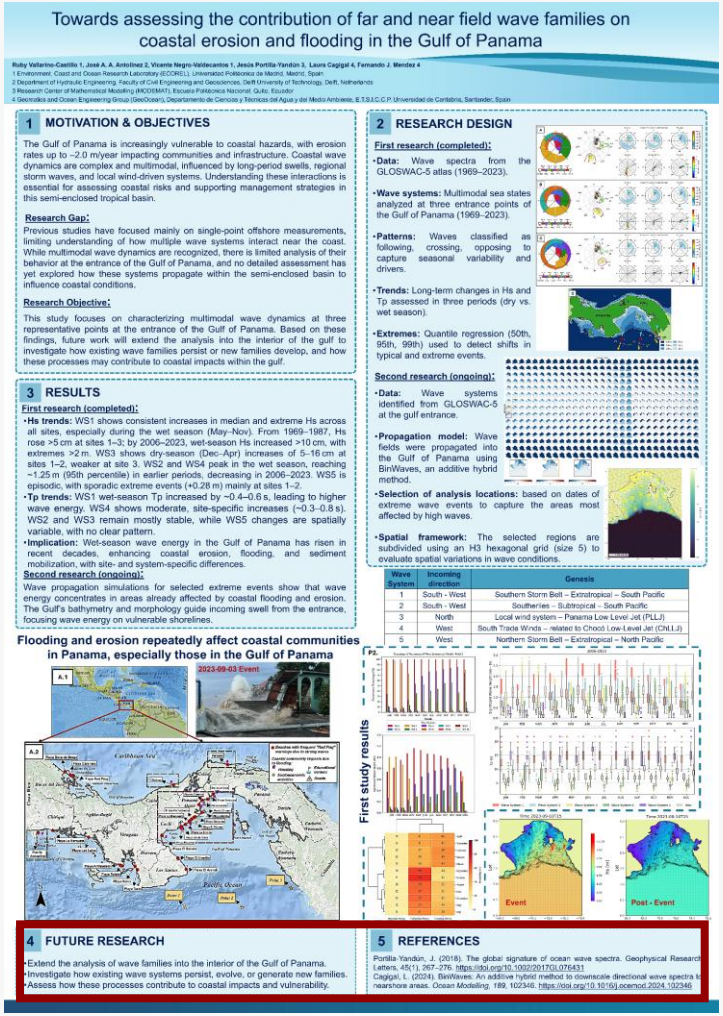


Wave energy concentrates in areas already affected by coastal flooding and erosion



FUTURE RESEARCH

- Reconstruct a detailed spectral hindcast for the interior of the Gulf of Panama, providing data not yet available at this scale.
- Explore wave systems in the interior of the Gulf of Panama.
- Investigate how wave dynamics influence vulnerable beaches within the Gulf.



REFERENCES

GLOSWAC-5 atlas:

Portilla-Yandún, J. (2018). The global signature of ocean wave spectra. Geophysical Research Letters, 45(1), 267–276. https://doi.org/10.1002/2017GL076431

BinWaves model:

Cagigal, L. (2024). BinWaves: An additive hybrid method to downscale directional wave spectra to nearshore areas. Ocean Modelling, 189, 102346. https://doi.org/10.1016/j.ocemod.2024.102346