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SEA STATE CHARACTERIZATION FOR ENVIRONMENTAL RISK ASSESSMENT USING HYDRODYNAMIC MODELING

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Silent Springs Session: How best to perform environmental assessments

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integral consulting inc.

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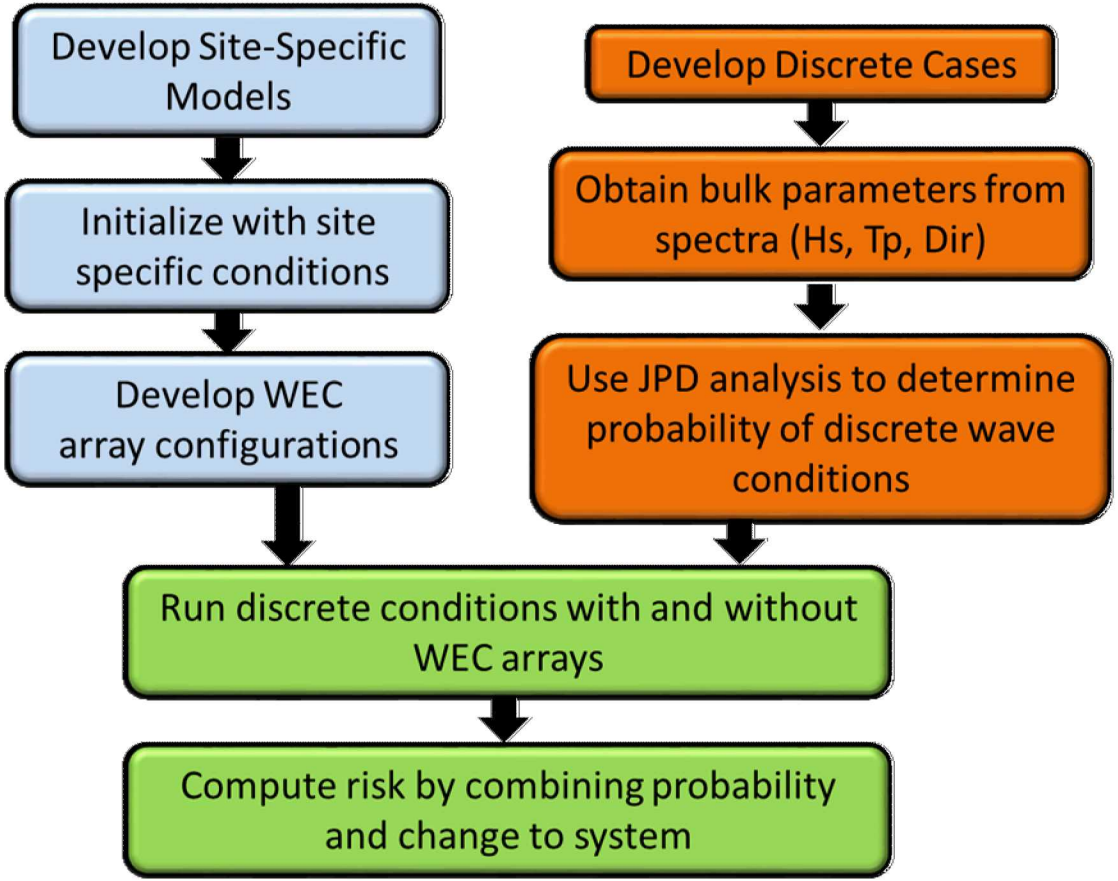
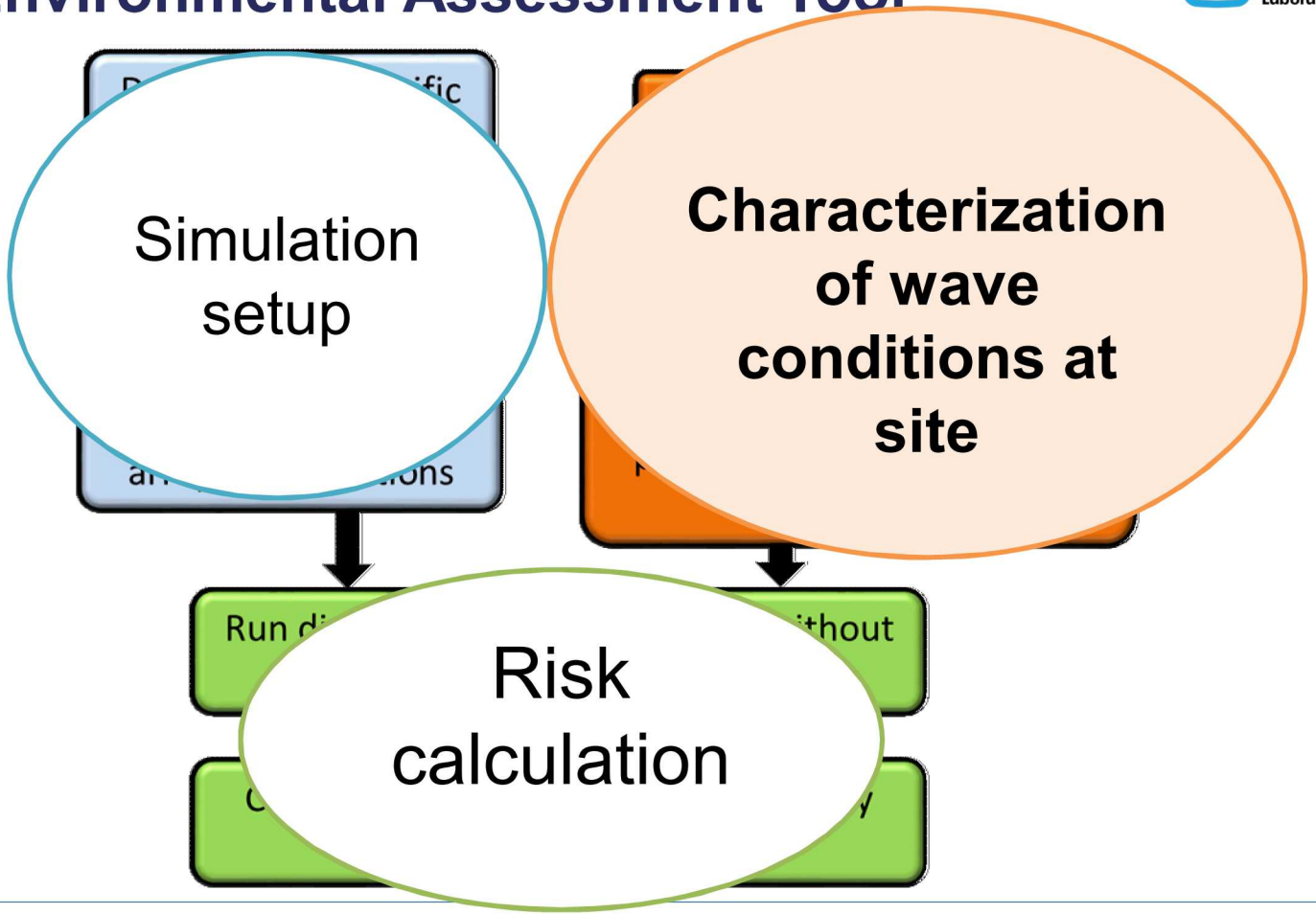
Introduction

- **Robust tools** are needed to evaluate site characteristics and the potential environmental effects of MHK devices.
- Sandia National Laboratories and Integral Consulting have developed:
  - SNL-SWAN, a modified version of the open-source model SWAN,
  - SNL-SWAN coupled with Delft3D-Flow to allow for the investigation of WEC array effects on the physical environment,
  - associated methodologies to assess impacts of WEC arrays.
- Environmental impact analysis of a WEC farm requires ***characterization of the environmental conditions*** at the site of interest to ***determine the 'risk'*** associated with specific wave conditions.

Spatial Environmental Assessment Tool

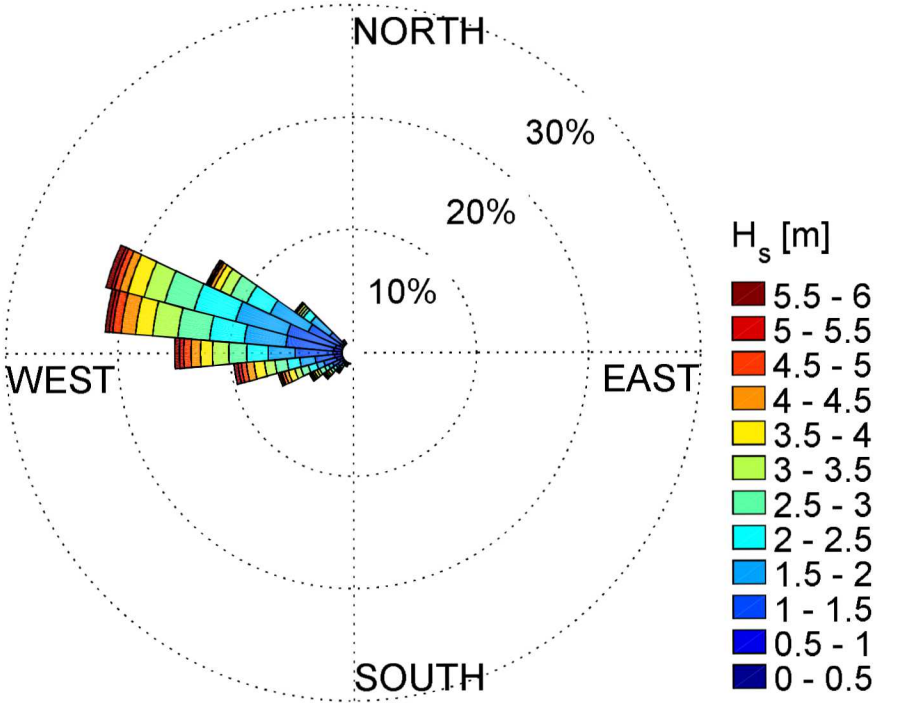


Spatial Environmental Assessment Tool



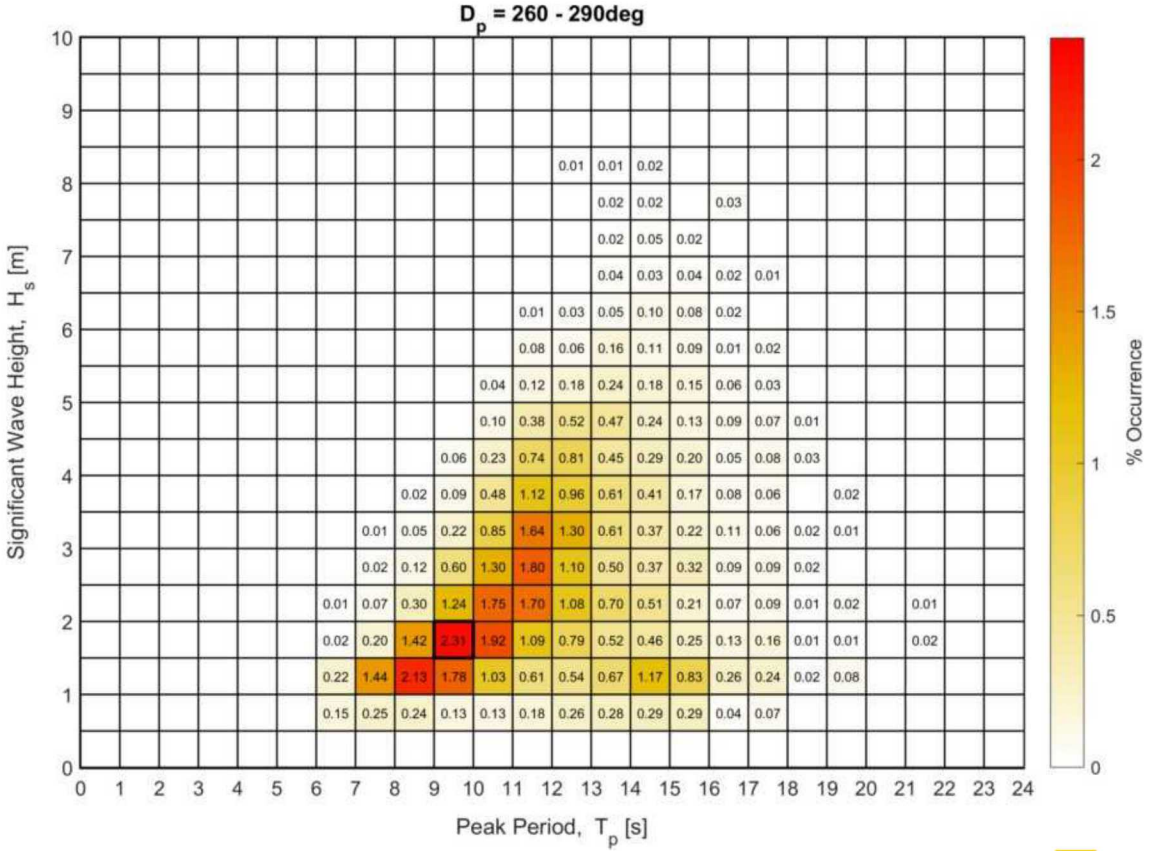
Sea State Characterization

- A seven-year wave record [1] analyzed to yield a multi-dimensional wave occurrence distribution.
- Data is first binned by direction; bins selected by considering the distribution of wave direction at the site
- 4 bins selected for this analysis



Sea State Characterization

- Individual JPDs of significant wave height and peak period calculated in each directional bin.



Sea State Characterization

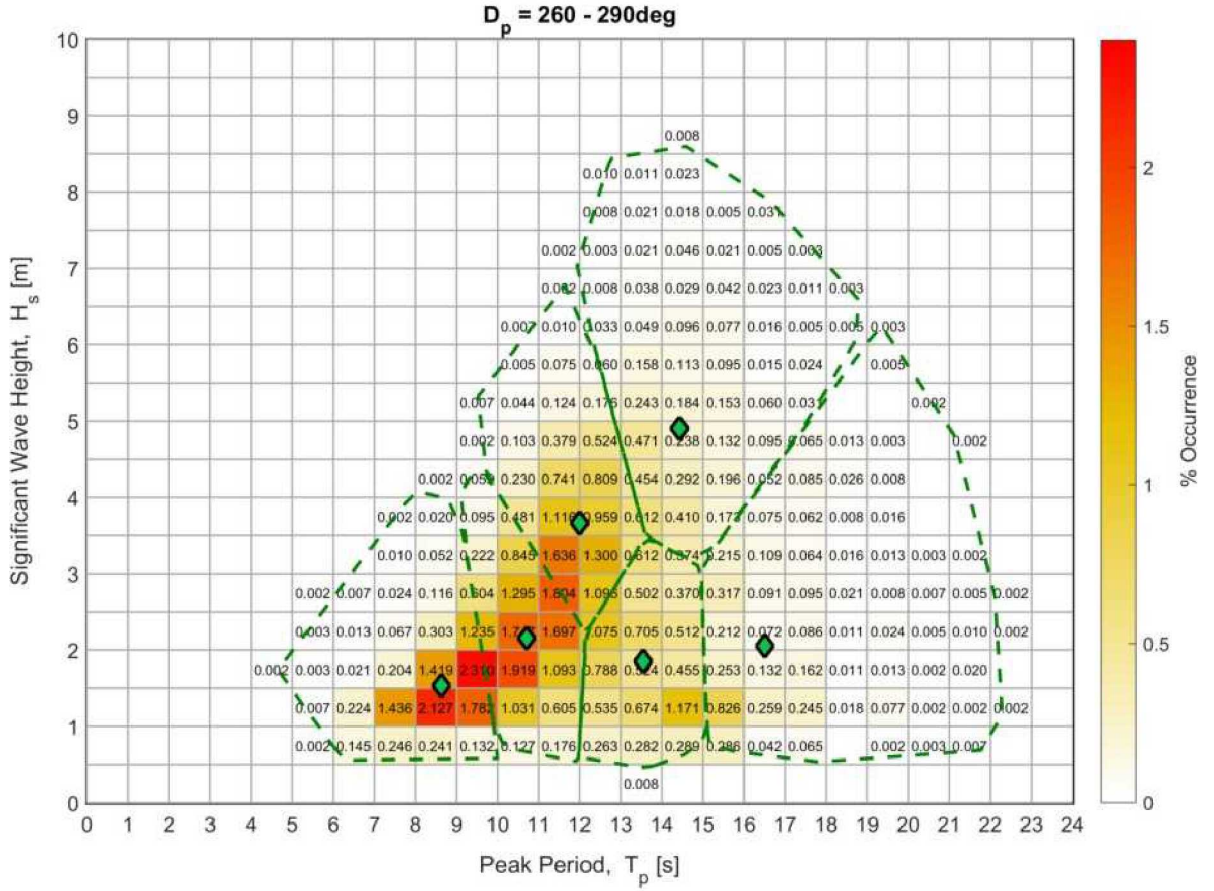
- Often testing or simulating every sea state within a joint probability distribution (JPD) is not feasible, therefore a subset of conditions need to be selected.
- Discrete wave events are chosen using k-means cluster analysis [2]; see example in Figure 3.
- These set of conditions (cluster centroids), along with the probability of occurrence of each cluster, represent a comprehensive set of conditions over the record in a probabilistic sense.

Sea States Selected

- The representative occurrence of the cluster centroid:

$$\frac{\#\ points\ in\ cluster}{\#\ points\ in\ JPD}$$

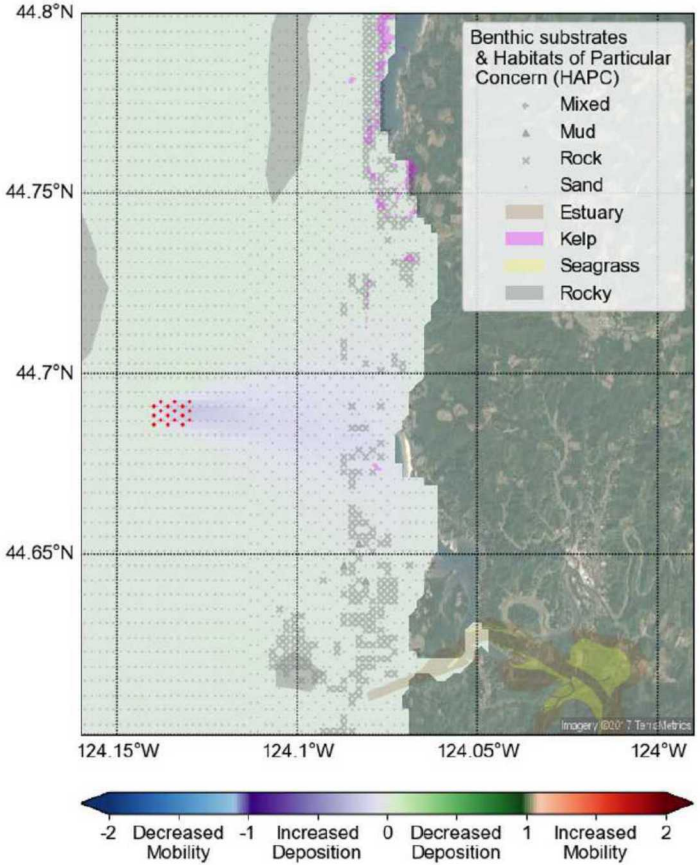
- The probability of occurrence within a direction bin, season, and full record can be considered for the risk assessment.

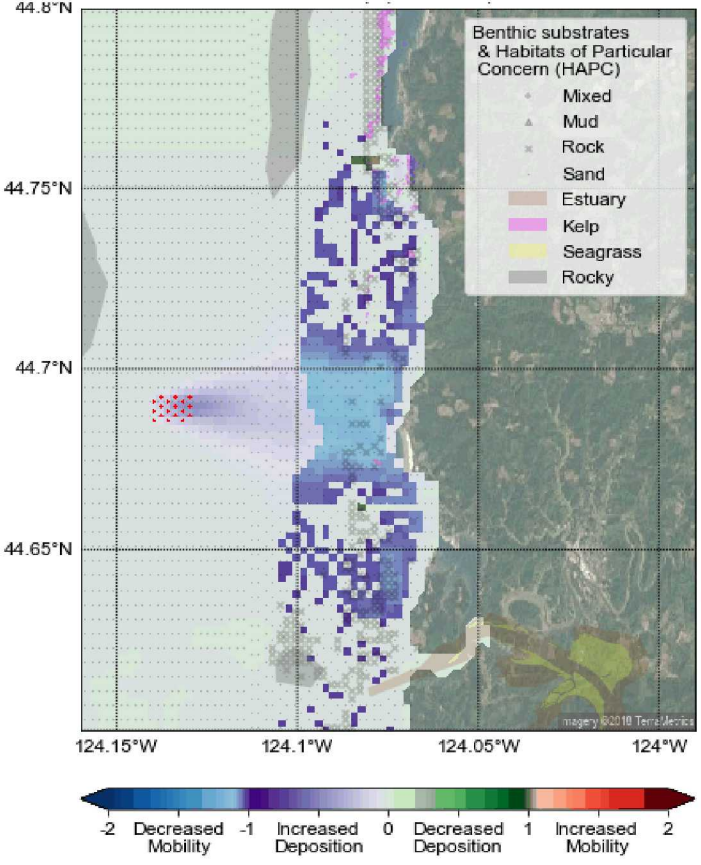


Risk Assessment

- WEC array can change the shear stress in lee of array
- Potential of changing the sediment erosion (or accretion)
- Risk is function of probability & change in conditions
- Example risk metrics being considered [3]:
  - Sediment transport
  - Bottom elevation changes
  - Larval & fish motility
- Risk can be mapped and compared to habitat areas of interest

Seasonality





Summary

- This describes a methodology for **characterizing the wave environment** in a **condensed manner** and **selecting sea states** for representative cases to model
- Factors such as the number of sea states to select and directional bins depend on the individual site and WEC array being studied
- Seasonal characteristics are also being considered in the full assessment
- Full application of a Spatial Environmental Assessment Tool (SEAT) assessment (details can be found in [3])

References

[1] García-Medina, Gabriel, Özkan-Haller, H. Tuba, Ruggiero, Peter. "Wave resource assessment in Oregon and southwest Washington, USA," Renewable Energy Vol. 64 (2014): pp. 203-214.

[2] Bull, D., and A. Dallman. 2017. Wave Energy Prize experimental sea state selection. ASME 2017 36th International conference on ocean, offshore and arctic engineering, Vol. 10: Ocean Renewable Energy.

[3] Jones, Craig, Kaustubha Raghukumar, Samuel McWilliams, Dallman, Ann, Roberts, Jesse. "A SPATIAL ENVIRONMENTAL ASSESSMENT FRAMEWORK FOR WAVE ENERGY INSTALLATIONS," METS2018.

Acknowledgements

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