Research

Beyond the Instrumental:
Improving Predictions of Future Coastal Change that Inform Decision Making

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Summary

The instrumental record is too short to accurately project coastal change. Additional data is vital to improve projections and quantify uncertainty. Our proposed research theme is framed to provide researchers from a wide range of disciplines collaborative funding opportunities to:

- Develop, effectively combine, and interpret datasets from a wide variety of underutilized sources that extend beyond the short instrumental record (e.g. historical, developmental, archeological, sedimentological, stratigraphic, geomorphic, biological, ecological, geochemical).
- Utilize this data for a broad suite of model applications (e.g. hydrodynamic, statistical, meteorologic, geomorphic)
- Communicate observations, model results and uncertainties to facilitate decision support systems and operational models.

Foundation:

We suggest that CoPe emphasize as a cross-hub research theme the collection of data across temporal and spatial scales. These data can help prepare communities and decision-makers for future coastal change hazards and improve upon current projections of the coastal system. Accurate predictions of coastal change must include estimates of uncertainty; these estimates could be significantly improved by understanding regional historical and geologic context as well as by leveraging data of past changes in the coastal environments (morphology, sea level, storm activity, ect.).

Models used for community understanding can be informed by many types of data. These include forms of *Geologic Data*, leveraging both previously collected datasets and targeted new data collection activities, including:

- Sedimentologic
    - Long-term evolution
    - Event-based (tsunami and storm events, including coarse sediment, boulders, etc.)
- Stratigraphy and depositional landforms
- Paleontological and proxy datasets
- Biologic community information/changes seen in biogenomics
- Geologic context (different types of coast from rock to sandy to muddy)
- Sea-level rise history

Also, over more recent times, *Historic Data* exists, which includes data that is commonly utilized along with other datasets that have not been leveraged as frequently, including:

- Maps and remotely sensed data

- Tidal and wave gauge data
- Older documentation and historical narratives
- Records of industrial/chemical contaminants
- Historic Parcel maps and other records of community and landscape development over time

Over geologic time and across geographic locations, better understanding of coastal dynamics can be derived from analogues of coastal response to historically unprecedented changes. For example the response of barriers, marshes, and other coastal environments to rapid rates of sea-level rise may be recorded in depositional environments emplaced during rapid deglaciation thousands of years ago. Also, many coastal regions appear to have experienced periods of enhanced storminess across the previous millennia, which may help guide understanding of future potential changes to storminess.

Over historic times, there are numerous examples of “unintentional grand experiments,” typically of human origin, whereby step/rapid environmental signals propagate through natural systems, often leaving clear process traces. Additionally, anthropogenic alteration over the previous decades and centuries is rampant along many coastlines, and historical records of these alterations and concomitant coastline response can be used to better understand future coastal dynamics, particularly along anthropogenically altered coasts.

We hypothesize that increased knowledge of past behavior can improve future predictions and help constrain model uncertainty, particularly in coastal systems that are often characterized by limited data histories, non-linear feedbacks, and potential threshold behaviors.

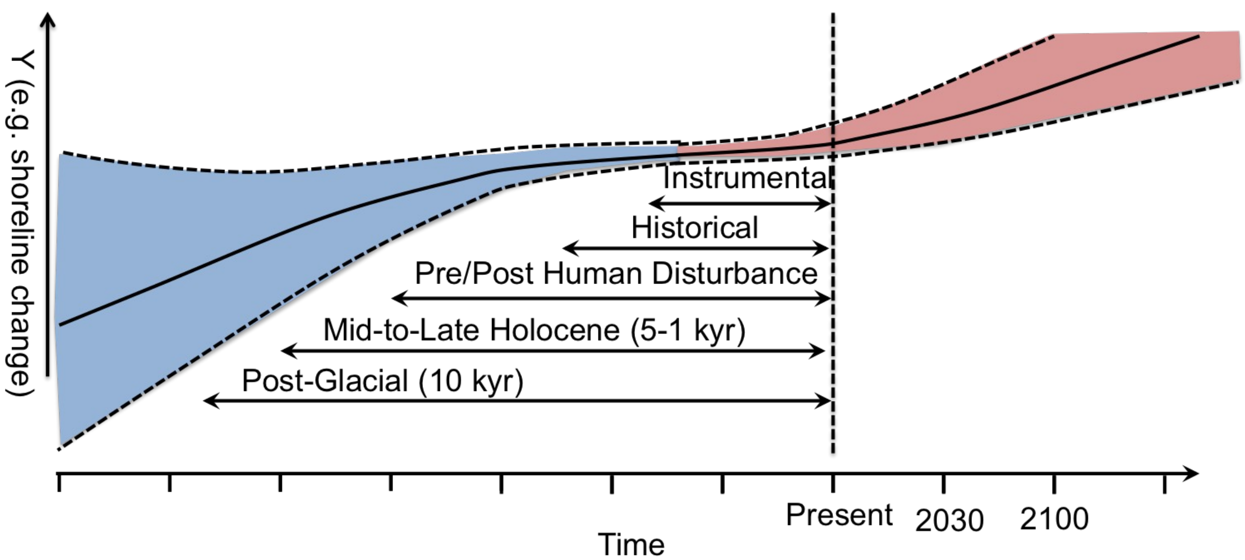

Figure 1. Conceptual sketch of the envelope of uncertainty of a hypothetical coastal metric *Y* (representing for example shoreline location) across temporal scales. We hypothesize that increased knowledge of past behavior will improve future predictions.

Proposal

Coastal systems are highly complex such that future predictions require a multi-disciplinary approach to reduce the uncertainties associated with quantitative predictions and/or forecasts of future coastal change and related hazards. The multidisciplinary expertise needed to make accurate and useful predictions spans the fields of hydrodynamic modeling, coastal and estuarine processes, coastal geomorphology, sediment transport, geology, urban planning, economics, and political and social sciences. In addition, to effectively communicate model predictions and uncertainties to decision makers and stakeholders, advances are needed in techniques of scientific visualization and development of decision support systems.

Evidence and data characterizing past coastal and environmental changes will be used to inform and constrain models that are needed to make future predictions. Other natural/human interactions, such as the construction of storm barriers or implantation of living shorelines require similar predictions of coastal change to assess their efficacy. Human alterations of the coast, both past and future, often originate from complex and developmental histories.

The use of the geological and historical data to characterize past coastal systems will be used to test and improve model hindcasts of coastal and environmental change. In addition, these inferred changes can be used to determine what coastal geomorphological change is precedented—for example can recent changes be attributed to climate change or are they part of long-term processes. Improvements on model hindcasts will reduce the uncertainty for future predictions, which will aid decision-makers by providing improved models and forecasts of coastal evolution spanning time scales from years up to a century.

The integration and involvement of inputs from diverse local, state and federal stakeholders and decision makers from the beginning and throughout the lifetime of the projects represents a key aspect of the proposed activities—this will enable a more successful and effective implementation of the recommended actions during and beyond the lifetime of projects; moreover, it will provide a mechanism to enable the sustainability of the projects past their funding timeframe.