Title: Assessing Short and Long Term Stressors on Coastal Ecosystem and Human Responses

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Idea in a nutshell (Introduction/Motivation)

Coastal systems face unique stressors -- forcings, responses, and management actions -- occurring at multiple time scales. Mechanisms of ecosystem and socioeconomic responses may be sensitive to the time scale at which such stressors occur. To understand and address the consequences of these stressors over varying time scales, focused efforts are required that consider various facets of research enterprise ranging from data collection, modeling, process understanding, and human dynamics. The meeting of urban and marine environments, the transport of freshwaters from headwaters through the built environment to the ocean, and the dependence of coastal societies on marine resources create challenges that are unlike those faced in other systems. We seek to address coastal issues with an explicit focus on complexities arising from the ***spectrum of temporal scales of forcings and responses***. We envision an approach that has three broad components: 1) evaluate the frequency, magnitude, and intensity of extreme weather or climate events; 2) assess and/or model the responses of ecological and socioeconomic systems; 3) explore the capacities of societies to perceive and adapt to stressors. Investigation of the dependendence of these components on the time scale of forcing will improve understanding of the complexities of coastal systems, advise changes to coastal management strategies, and inform education and outreach efforts. Such understanding will also help to identify the degree to which human society has the capacity to adapt to stressors occurring at differing time scales.

Specific, differentiated recommendation

The recommendations included here all focus on elucidating impacts over **different temporal scales**:

Evaluate, model, and forecast how the frequency and magnitude of episodic events (storms, etc.) will be accentuated by local development strategies and long-term global change stressors. In addition to long-term, chronic stressors (e.g., temperature change, sea-level rise), the frequency, magnitude, and intensity of episodic events may be influenced or exacerbated by local management plans and long-term climate change.

Evaluate the responses of ecosystem characteristics (water quality, nutrient loadings, algal blooms, etc.), fisheries (finfish and shellfisheries, habitat), and hydrological processes (water quantity) to short- and long-term coastal stressors.

- *Discern trophic interactions within and among functional groups.* The diversity of life history strategies in the marine environment (e.g., from microbes with life spans on the scale of days to marine mammals that reach maturity after several years) generate sensitivities to environmental forcings at differing time scales. These differing sensitivities affect trophic interactions that can further influence ecosystem structure, stability, and resilience.
- *Evaluate how coastal development modifies ecosystem responses.* Prudent development decisions require understanding of potential ecosystem consequences at both short and long time scales.
- *Evaluate the influence of global change stressors on the distribution and occurrences of pathogens in coastal environments and their interactions with humans.* Virulence and pathogenicity are functions of variability and modality of geophysical processes and therefore needs qualification under changing climatic conditions. The goal is to understand how interactions between pathogens and humans differ at short and long time scales and affect public health outcomes.

Assess how human perceptions of long- and short-term coastal stressors influence decision making (for example, development, land use, relocation, business investments, resource management). In many instances, individuals and groups make decisions based on beliefs and perceptions derived from or informed by their own experiences. Slow onset and chronic stressors, such as sea level rise, may be more difficult to incorporate into decision making than are acute and dramatic stressors, such as extreme storms. Additional research is needed to understand these decision dynamics (and their feedbacks) in detail.

Examine how the vulnerabilities and adaptive capacities of human communities differ for short- and long-term stressors. It is possible that the various human attributes that contribute to relative vulnerability to coastal stressors may operate differently over different time scales. Similarly, attributes that may make individuals or communities more resilient, or serve as a source of adaptive capacity, in the short term may actually prove maladaptive over the longer term.

Increase education and awareness of coastal stressors at the public and K-12 level; increase capacity for educators to better inform public outreach. There is great opportunity to leverage lessons from the learning sciences to translate science on coastal stressors for educational settings.

Impact or value to be delivered

The goal is to create a shock (time variant geophysical process) resilient coastal system which include time-dependent understanding of ecosystem responses, management capacities, and building infrastructure under changing climate and development regimes. In other words, we envision a harmony between humans and coastal environments based on the platform of

scientific understanding of coastal processes, human actions, and their interactions and feedback. This holistic understanding of science and engineering with sustainable action plans is expected to enhance human and ecosystem well-being.

Reasoning or supporting evidence (if any)

Previous research results have shown that coastal systems are vulnerable to variability and changing in climate, development, nutrient enrichment, and pollution from numerous other contaminant sources. More than 50% of global human population lives within 50 miles of the coasts. Climate change and intensification of severe weather events is likely to increase sea level, and is expected to make flooding or drought uncertain along the coastal regions. It is estimated that a 40 cm rise in sea level is expected to increase the average annual numbers of people affected by coastal storm surges from less than 50 million at present to nearly 250 million by 2080. The changing climate is likely to have wide-ranging effects on human health. Most of these effects are likely to occur where hydrologic, climatic, and ecological extremes converge with population vulnerability, particularly in the developing world and pose a severe threat to national security for developed countries. These issues are compounded by impacts of development on coastal ecosystems, such as but not limited to land use modification, nutrient enrichment, and habitat loss. There is an urgent need to understand how the time scales of coastal stressors and ecosystem responses influence the adaptive capacities of human societies.