Understanding temporal and spatial dynamics of hazards and interactions with coastal human-natural-built systems' resiliency

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ORIGINAL BIG IDEA

14: Develop an integrated model and data-driven framework for human-natural-built systems in coastal areas to analyze the temporal and spatial evolution of coastal hazards, assess impacts on human-natural-built systems, predict decision making and migration patterns, and devise effective risk management solutions.

What is your specific* recommendation?

We recommend that the new hub should be more than a response to the communities' needs and beyond scientists' goals with measurable outcomes. Coastal hazard could be location specific and vary in terms of temporal and geographic scale. Examples of hazards include sea level rise, earthquakes, extreme weather events such as hurricanes, flooding, fire, volcanic eruption, tsunami, mudslides, coastal erosion, and so on. In this proposal a hazard would be introduced to the integrated framework as a module. This will allow to investigate different hazards individually or as cascading effects.

A main objective of the hub would be to develop module based integrated modeling framework that can lead to a better understanding of the temporal and spatial evolution of coastal hazards, allow an assessment of impacts on human-natural-built systems, predict decision making and migration patterns, and to devise effective risk management solutions. This would be accomplished by: citizen science observations, rapid response sampling teams, encouraging data sharing between agencies to facilitate model development, laboratory based solutions, easily deployable sensor networks, satellite imagery, and dynamic coupling of existing and newly developed models for natural, built, and human systems in a modulated simulation environment with the ability to function on different spatial and temporal scales. This module-based integrated model would provide an understanding of the signals of impending hazard, impacts of the hazard, and longer-term impacts and alterations to ecosystem and communities, informed by surveys of people's decision making in coastal areas, building regulations and codes data, policies, and community-level information such as health and hazard exposures, and potential solutions. This would require a convergent approach that engages expertise in engineering, chemistry, economics, psychology, decision science, sociology, geography, computer science, biology, climate and atmospheric science, law, public policy, public health, and statistics. Engagement with stakeholders is necessary to provide input on needs and priorities, and to understand how stakeholder participation will be encouraged and facilitated. The hub should integrate ongoing efforts of other agencies to ensure that activities are greater than the sum of the parts. Joint support for postdocs and graduate students is one way to accomplish this.

Why is it valuable?

Who does it impact?
Communities, policymakers and relevant decision makers, other researchers, ecosystem, and businesses and industries. Use new knowledge development, training of scientists, under-represented groups, REUs (recruiting from local areas) and community ambassadors (engagement, buy-in, long-term sustainability of the HUB after funding ends, develop and maintain relationships).

How will the world be better?
Society
Create a Hub environment that would facilitate bring people together to discuss the evidence developed through the research done by students and researchers in order to make informed decisions that impact resilience in coastal areas. This process may improve relationships between scientists, researchers, policymakers, and stakeholders by engaging more honest conversations about how plan for the challenges we face today and in the future. The decisions that result from this process may yield outcomes that result in better infrastructure and investment decisions that result in improved human and ecosystem health, and longevity.

Research
Having a modulated integrated framework that contain modeling, data collection, and solution development that will help communities (applied) and scientists (fundamental) to have a better understanding of resiliency. It will allow tackling challenges at the intersection of knowledge domains and develop multi-faceted solutions that cut across multiple domains. Meets the needs of policymakers, such as informing decision making on how to allocate resources, plan for disasters and gradual changes, anticipate what resources and infrastructure are needed to accommodate shifting population dynamics in areas impacted by coastal change and those that will likely receive SLR (or other changes) migrants.

Who are the stakeholders and who will you partner with to make it stronger?
Communities, policymakers and relevant decision makers, other researchers, ecosystem, and businesses and industries. To make it stronger, industry, insurance companies, FEMA, Sea Grants, USGS, NOAA, boundary organizations, local community groups, local and state policymakers, etc. The mechanism for making the relationships stronger could be funding (e.g. industry and insurance companies), actively collaborating together on research projects, industrial and public advisory boards, individuals from these various groups who are on staff in leadership roles, and data/tools are open source with appropriate tutorials so that everyone can access the information and use it. For example, all collected and modeled data can be stored in existing NSF infrastructures such as NHERI.

What's the reasoning or supporting evidence behind it?

How to evaluate?
The Hub will involve a protocol to evaluate both process and outcome. Examples of what we mean follows:

Process evaluation: (1) amount of additional funds secured by researchers funded through seed monies from the HUB, (2) number of minority and underrepresented students

participating in the HUB, (3) depth and breadth of participants (industry, insurance, other stakeholders), (4) qualitative assessment of participants' satisfaction

Outcome evaluation: (1) number of visits to the websites, (2) number of publications, (3) number of students graduating, (4) tools that are used, (5) scorecards assessing the networks of plans, (6) number of engagement activities

How is it grounded in existing scholarship?
The literature on Integrated modeling, assessments of hazards and impacts on the human-built-natural environment, uncertainty quantification, system dynamics, outbreak models (agent based models), decision support systems, heuristics and biases, risk communications, risk perceptions, behavioral psychology, environmental economics, modulated modeling, learning, demography, social psychology, public health, disease outbreak, among others is very rich. The HUB will also draw on the scholarship being developed at other NSF funded centers and HUBs for cross-pollination of ideas and research.

Why do this now, above all the other things we could do?
The need for an integrated simulation environment is supported by the response and impacts observed in recent severe storm events (*Katrina, Ike, Sandy, Harvey*) as well gradual changes such as sea level rise. Research generated from these events demonstrated the need for an integrated approach that would inform community resilience efforts across a number of scales. For example, are people going to stay and adapt-in-place and how will that affect future infrastructure decisions? What are the health consequences of exposure to contaminants from these events? How are people likely to respond in the long term, will they migrate to a new community and what are the impacts to those receiving these migrants? Simulation models in each of areas (i.e., hydrologic, human behavior, pollutant transport, the performance of the built environment, exposure risks) must be based on observations and are becoming more mature and advances in computational science allow for greater resolution of the hazards and associated impacts. However, the integration of these simulations is lacking and would be a major focus of this hub along with finding solutions. Simulations could be scenario-based for better understanding and planning but also have a real-time component that could inform communities more directly.