Candidate Recommendation

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ORIGINAL BIG IDEA
8: Linkages and interactions among multiple high impact weather events across different spatial and temporal scales are not well understood, nor are the strategies and interactions among various stakeholder groups and communities who deal with multiple hazards mitigation, communication and response. This research would include co-produced interdisciplinary science of predicting, preparing for, communicating, responding to and recovering from co-occurring or sequential extreme events affecting coastal communities. Work with stakeholders will focus on key issues of concerns regarding multiple hazards (hurricanes, sea level rise, extreme heat, air pollution and water contamination). Intellectual merit will be in better understanding of interactions among atmospheric, hydrologic, land use and social processes that lead to co-occurring or cascading extreme events in the coastal regions. Broader impacts will focus on addressing community needs in reducing current and future vulnerabilities and community engagement in co-production of knowledge. Connected with the linkages among events is the need to develop scenarios that illustrate levels of interaction of the events by types of events, community characteristics, and temporal relationships among the the events.

Expected linkages/overlap: 12,14,20, and 26

What is your specific* recommendation?

(* Don't be abstract, general, or try to do too much in your recommendations. Try to be specific, actionable, stand alone)

One recommendation is to articulate alternative ways the events can impact, alternative locations, and alternative social characteristics of those impacted.

- Addressing observational needs, including new observational methods, that enable comprehensive evaluation of event impacts across the impacted landscapes and w.r.t. Human (human health, social disruption, economic health, impacts on built environment and infrastructure), geomorphic, ecological consequences - during the event and appropriately to capture longer-term change. [To inform immediate response efforts and long-term recovery and assessment of hazard/risk within the altered landscape; to improve models underlying forecasts and hazard assessments]
- Development of multi-hazard/multi-dimensional hazard assessments; ideally communicated as "risk" in ways that are accessible and actionable. Risk assessments should go beyond "life and property" and include human and environmental health, economic health etc. etc. and include immediate and persistent consequences of events.
- Physical science point of view: how to quantify the linkages (both spatial and temporal) between hazards - what kinds of extreme/high impact events may be spatially and/or temporally linked together? How to couple land/ocean/atmospheric models with economic / infrastructure/health models to build capability in impact

forecasting? How to model critical infrastructure interdependencies?

- Research on human/social behavior (e.g., use of information, compounding vulnerabilities, risk perception, protective decision-making) to ensure physical science products result in effective actions (by the general public, emergency responders, and local/state planners/managers) to reduce losses. Focus on suite of products: technical, experiential (scenarios), and educational.
- Provide tools to evaluate alternative strategies to reduce risk (and maintain ecosystem services/economic values) to future events - in the near-term and the long-term (within a changing climate/landscape). Engage community so that risk is framed with respect to those things they value most and that will be most motivating.
- Start with some case studies - past cases of cascading/multiple hazards - provide data (wind, precipitation, storm surge, flooding) data in a central data depository for downstream modeling/research, at the same time investigating and understanding the potentials of different types of multi-hazards
- Shared access to data, observations and model-outputs to provide diverse researchers access to both forecast and observed storm processes, extent, and immediate impacts [helps target post-impact research and allocation of resources]
- How to improve the situation awareness? Environmental monitoring system is needed.
- Understand linkages among different systems: environment, infrastructure, social/behavioral. Where is a weak link w.r.t. preparing, responding, and recovering from extreme events? What elements of the system affect exposure and vulnerability to present and future hazards?
- Investigate effective risk communication strategies. Use of social media (e.g. Twitter) in disaster communication. Use of immersive visualization technologies in awareness and education. What types of messaging and communication work for different segments of population?
- Health is important to this issue (determinants of health could provide basis in a more basic research sense)
- Integrate social and behavioral science with engineering research. How does urban infrastructure affect risk perception and decision-making? What is the role of infrastructure in the population exposure to multiple and/or cascading hazards (e.g., the “levee effect”)?
- How does vulnerability of community evolve with increased frequency of tropical storms / flooding / health outcomes?
- What institutional capacity exist to address multiple hazards or cascading events? How do stakeholders coordinate efforts to prepare, respond and recover? How does local governance structure support public engagement?
- Risk communication of multiple threats both short-term and long-term is critical to the process
- Co-production of knowledge involving community members. Need local knowledge on what types of cascading events are important to the community, economy, infrastructure, health. Where are the gaps in preparedness, response and risk communication.
- Engage (local) stakeholders to find out what types of cascading events could be highly impactful - part of an iterative process but should start at initial stage

Why is it valuable?

Who does it impact? How? How will the world be better? Who are the stakeholders and who

will you partner with to make it stronger?

- Multiple/consecutive hazards stretch the capability of hazard response and could be much more impactful than single hazard events
- Begin to develop information and observations, and evaluation of models/predictions across multiple events - increase “n” through systematic approach to multiple events.
- Focus on developing methods to quantify and effectively communicate multi-hazard, multi-timescale, multi-dimensional RISK. (including exercises/scenarios that engage the community)
- Common needs for data/models that characterize pre-event conditions, within-event processes, and post-event response/recovery - more effectively served with a coordinated observational and data sharing framework. (Ties to 12?)
- Better understanding of multi-hazard risk will increase community resilience, more targeted interventions and coordinated effort in response and recovery
- Stakeholders will represent community members and decision / policy makers involved in emergency management, public health officials, urban and regional planners, resilience officers, media
- How can knowledge from difference emergency responders be collected, represented, and transferred promptly under time stress in disaster management? Fast knowledge transformation and representation will increase the community resilience in a disaster event.
- These events and the compounding effects are likely to increase with changing coastal demographics, land use, and climate change.

What’s the reasoning or supporting evidence behind it?

Evidence based, fact based, Takes into context current research (hasn’t already been tried and failed). How will you validate success? How is it grounded in existing scholarship? Why do this now, above all the other things we could do?

- Harvey, Maria, Irma, Florence - cascading consequences are real, responses to warnings/alerts are not as effective as they should be, long-term development practices have contributed to cascading risk (Ash piles/animal waste)
- Storms have persistent as well as immediate impacts - including population displacement, human health impacts.
- Post-event investments are probably amongst our best opportunities to build resilience to climate (and other long-term) change - recovery/rebuilding decisions should integrate resilience to future events with adaptation/resilience goals.
- Post-storm assessments have shown that the impacts deemed to be of greatest consequence (school/daycare closures) are not those that are regularly of primary concern in preparation/education efforts.
- Evidence: Recent research has indicated that frequency of severe extratropical cyclones are not random in time but are “serially clustered”; another example is in 2004 4 hurricanes affected Florida in the same season. Research is still needed to understand and examine the spatial/temporal clustering of high impact or extreme events
- Human -centered interactive computing environment: big data computing environment based on advanced cyberinfrastructure. Computational research is need to be done to handle the geospatial big data that comes from different Hubs.

Your specific, differentiated recommendation

1. **The Converging Science of Interactions and linkages**

- *Interactions among hazards*
  - Develop multi-hazard/multidimensional risk assessments to evaluate the nature of interactions among coinciding and sequential hazards
  - Quantify the spatiotemporal linkages between disasters, environment, infrastructure, social/behavioral.
  - Develop tools to evaluate alternative strategies to reduce risk (and maintain ecosystem services/economic values) to future events - in the near-term and the long-term (within a changing climate/landscape).
  - Investigate spatial interactions between disasters and health
- *Interactions among timescales*
  - Develop real-time (or near real-time) environmental monitoring system
  - Quantify linkages (spatial and temporal) between hazards
  - Identify and evaluate the evolution of community vulnerability and resilience with cascading (and repeated) disasters
- *Interactions among different systems*
  - Investigate effective risk communication and knowledge sharing strategies (e.g. Twitter and visualization technologies in awareness and education)
  - Develop new observational methods enabling comprehensive evaluation of event impacts across landscapes, human systems, and consequences (e.g., health, community, geomorphic, ecological).
  - Research on human/social behavior to ensure physical science products result in effective actions.

•2. Co-production of knowledge

•Engage community and stakeholders in defining research needs

•Engage community so that risk is framed with respect to those things they value most and that will be most motivating

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3. Data and Technology Challenges

•Big data computing environment

•Shared access to data, observations and model-outputs to provide diverse researchers access to both forecast and observed extreme event/coastal hazard processes, extent, and immediate, sustained, and interacting impacts

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CHALLENGE: Topical focus on extreme events argues that the focus of the Hub can not be local/regional - but rather defined by the range of the hazards of interest.

NOTES FOR DISCUSSION
Immediate vs. Persistent and/or cascading events
Interactions of storms with long-term coastal change (Sea Level, Development)
Risk Science and Communication - how to we quantify/characterize risk (multi-hazard risk) and make it “actionable” and accessible to multiple public groups and decision makers
Development of science-based tools for entire life-cycle of storms - preparation, immediate response, long-term recovery and efforts to build resilience/reduce risk to future events.