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Geographical Study Area:
Western South America (mainly Peruvian coast)

Key Hazards:
El Niño (on land: torrential flooding with consequent effects including catastrophic erosion, landslides, destruction of fields and canals, coastline change, insect plagues, disease epidemics; offshore: lowered productivity leading to local decline or extinction of marine species, species replacement, red tides)
Earthquakes
Tsunamis
Coastal Sand Mobilization

Past Impacts:
El Niño/Earthquakes/Coastal Sand Mobilization: Rapid loss of productivity, both marine and terrestrial, on short and intermediate time scales, in part in response to synergistic effects (Moseley's Radical Environmental Alteration Cycles, or REACs) such as flooding/coastal change/sand sheet invasion of fields and sites.
Earthquakes, tsunamis: Site damage or destruction

Human Response/Mitigation:
El Niño/Earthquakes/Coastal Sand Mobilization: Decline and abandonment of monumental centers, possible shifts in population, possible change in proportional importance of different subsistence sources.
Earthquakes, tsunamis: site reconstruction or abandonment (or both in sequence); destruction of agricultural infrastructure.

Future Risks:
All the above are ongoing processes with increased risk due to increased population density. For instance, Peru constructed a very large multivalley canal to bring water from a high volume river to four other valleys—across a terrain subject to flooding, landslides, and large magnitude earthquakes.
Loss of fresh water as global warming causes the tropical glaciers to melt and disappear—the glaciers provide up to 40% of river flow to the desert coast of Peru, now inhabited by the majority of the country's ~28 million inhabitants.

Worksheet for Hazards Group Discussion

1. New Knowledge

We have been working on a Peruvian coastal REAC that seems related to end of first monument-building sedentary society on coastal Peru (2009 paper on conference website). Summery: around 3800 BP, earthquake production of landslides provided abundant loose material in a lightly vegetated landscape for movement by El Niño floods to rivers and out to shore, driving coastal progradation (with effects on littoral productivity) and providing a new source of sand that began moving inland (constant onshore winds) to swamp field systems and sites. Earthquakes also damaged sites (additional observations last summer). Response was rebuilding following earthquakes, then attenuated rebuilding following first arrival of sand sheets, then abandonment of monumental sites.

A related question regards the role of El Niño frequency changes. We and others have identified important variation in the frequency (and possibly intensity) of El Niño across the span of time humans have occupied western South America (see 2007 paper on website) but have only begun to explore the possible human consequences of the variable temporal structure of this family of related hazards.

2. Emerging Research Questions

1. Test the hypothesis that natural processes created a sediment cycle that impinged on human lifeways and organization in the Supe region at the end of the Late Preceramic Period by reconstructing the sequence and chronology of the paleoecology and paleogeography of beach, sand, and canals in the Supe Valley and adjacent drainages.
2. Hazards are also opportunities. Who might have taken advantage of the opportunities created by the processes we are identifying (both the specific REACs and the El Niño frequency variation? What are the appropriate spatial and temporal scales for these analyses?
3. How often did similar REACs occur along the Peruvian coast? Where and when?
4. How and why did responses to REACs vary? (investigate Payson's concept of scaled vulnerability in this context).
5. What is the risk of similar events today?

3. Fundamental Limits

1. Difficulties in constructing tight chronological correlation between hazard occurrences and cultural systems and events, or between related hazards.
2. Magnitude of hazards can be hard to assess.
3. We still know more about monumental sites than about domestic sites for most periods of interest, yet we need both to understand how individual hazards and REACs played out in terms of human response.
4. Difficulties in moving from collation to correlation to causation (see 2008 chapter).

4. Blockages that could be removed by collective action.

We need to develop closer links (effective communication) between paleoscientists (archaeologists, paleo scientists, etc.) working on REACs and other past hazards and policy makers in the region. This will require effective models, confidence-building, and a shared conceptual vocabulary.

5. Action Areas

Assemble appropriate team—interdisciplinary (including policy and communications specialists as well as arhaeologists and paleo scientists), multinational, student and professional to realize this program, from funding to field to models to applications (understanding the past, informing the future).

6. Deliverables/Outreach/Broader Impacts

1. Identify past REACs and their consequences for infrastructure, apply to relevant hazard predictions (El Niño, earthquakes and associated processes as above) to model risk on the Peruvian coast. Use output to advise policy makers from local to national/regional level.
2. Establish a training program to prepare individuals from appropriate communities in western South America to understand and use models and model output, possibly using a PSM model.