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The shore is wider than the beach: Ecological planning solutions to sea level rise for the Jersey Shore, USA

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HIGHLIGHTS

- Coastal landscape planning can accommodate the uncertain pace of climate change.
- Ecologically, the shore is functionally deeper than the narrow sandy beach.
- Ecological and social functions can be relocated locally to reflect climate change.

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ABSTRACT

Coastal communities worldwide are faced with climate change effects that include sea level rise and increases in the severity and frequency of storms. We present a framework for coastal adaptation to these impacts in planning efforts, using the landscape of the Toms River-Barnegat Bay ecosystem in New Jersey (eastern coast of United States, 90 km south of New York City) as a case study. This plan is a proof-of-concept, showing that collaborative design can improve the ability of shore regions in many regions to recover from storms and sea level rise if it uses a broad concept of the shore's ecological and geomorphological structures. Ecological connections are maintained or restored from the sand beach through the tidal bay to the mainland Pine Barrens, allowing species to migrate inland as their ecosystems change over time. This plan also re-envisions shore tourism by attracting visitors to the larger and wider shore area, an approach that can maintain or even increase social and economic activity as sea level changes. Transportation routes connecting the changing shoreline area to inland sites help to integrate social activities throughout the region. Watershed based projects to handle stormwater runoff from severe inland storms are also required. These principles can be applied in any coastal landscape where sea level rise is expected. This approach was fostered and supported by a USHUD program – Rebuild by Design – to incorporate unique, collaborative, architectural and ecological approaches to changing climate and sea level rise in Hurricane Sandy-affected states. These ecological concepts can be adapted for use to maintain biotic and economic processes in threatened coastal communities.

1. Introduction

Sea levels are rising along nearly all coasts, worldwide. Coastal communities need plans that will sustain ecology, economies, and social activities, which together drive community persistence. We present a framework for adaptation that enhances existing ecological, economic, and social connections across a heavily populated coastal region, from inland areas to the beach. This conservative and safe approach to sea level rise allows these functions to shift locations over time, as needed, so that shore areas do not have to be abandoned in haste as climate change progresses.

We use a case study to assess the potential for ecologically based adaptive regional design that could be used in many settled coastal areas. This plan for the Toms River-Barnegat Bay ecosystem (eastern coast of United States, 90 km south of New York City) was created under an international competition for innovative coastal

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design after Hurricane Sandy (rebuildbydesign.org). Sea level rise here is relatively fast for North America (NPCC2, 2013). The Toms River plan addresses the most vulnerable coastal typology, barrier islands, back bays, and the mainland areas they protect, a typology that exists in most parts of the world. This is the type of study that Wu (2006) recognized as increasingly important in landscape studies, multidisciplinary "place-based and solution-driven investigations." In the United States and elsewhere around the world, many barrier islands and nearby coastal areas are threatened by climate change impacts (e.g. Rodriguez & Brebbia, 2015). These sea-land interfaces are under intense development pressure, attracting residents and tourists even as climate change makes these islands more hazardous (Stutz & Pilkey, 2011). If sea levels rise along coastlines with bulkheads, roads, and other structures in place, ecosystems may not be able move inland without interventions such as this plan. A plan for climate adaptation that can enhance ecological transitions at highly vulnerable barrier island regions can be a model for other coastal regions that are less immediately threatened.

This study contributes to landscape architecture and planning theory by identifying principles for regional-level ecological design in the face of climate change. We contribute to coastal landscape practice by presenting solutions for highly vulnerable coastal areas. A design case study would ideally assess the entire life cycle of a project, through to its implementation and use (Francis, 2001). Yet communities that are already losing land to rising seas need to learn of designs that are at all stages of development, including designs at the plan stage, presented here. The Rebuild by Design competition recognized this need by sponsoring not only designs for implementation but also designs that software engineers call proof-of-concept, test runs providing evidence that a design and set of processes are feasible (Gendall, 2015). The plan presented here is a proof-of-concept for coastal design.

This plan was developed iteratively over seven months through active collaboration with federal, state, and local officials. We also consulted with local experts and interest groups (e.g., insurance firms and environmental activists), and participatory exercises and meetings with residents (including an online game created by the team). Studies of public perceptions, population trends, the tourism economy, land economics, participatory planning, and planning tools that were done to inform this plan are presented elsewhere (see Sasaki Associates et al., 2014). Throughout our description of the plan, we include potential objections to elements of our proposals that emerged in the course of our consultations. The analyses we made, the consultations that informed this design, and the design itself show that with resources, technical support, and political will, planning participants of all kinds can collaborate to create designs that foster adaptation and promote regional connectivity by following ecological principles.

Our Toms River plan aims to retain economic, social, and environmental functions within the nearby region and to strengthen the ecological base of community needs. The plan does not begin as others do, by attempting to move populations away from vulnerable coastlines, variously called managed, strategic, or tactical retreat. These terms imply defeat, and residents have often resisted them (Palmer, 2013; Wilby & Keenan, 2012). We suggest plans that instead attract attentions to sites that are relatively safer and that offer benefits in the near term by reducing current hazards and expanding social and ecological options. These features are more likely to win social and political support.

The benefits of a regional approach and a long-term perspective are relevant to all coastal areas but are especially apparent for barrier islands. In the study area of Monmouth and Ocean counties, New Jersey, under the expected 1 m sea level rise scenario, barrier islands are projected to lose half of their land area (USGS, 2013). In a 2 m sea rise scenario, popular beachside tourist destinations nearly disappear (NPCC2, 2013). The solutions most evident to residents, because they are already in use, are artificial beach replenishment, artificial dunes, seawalls, and levees. Our landscape approach differs by allowing the economic, social, and ecological health of the region to be supported even as the environment of the shore changes, rather than attempting to permanently fight sea level rise. Building connections across a region improves the ability of communities to cooperate by sharing resources, before or after a disaster or other disruption (Comfort, Boin, & Demchak, 2010). Sociologist Harvey Molotch (personal communication) characterizes our design as presenting options for "rearranging" social uses across a region in order to reduce communities' exposure to emerging hazards.

The study starts with the following questions about process and design. How can a new ecological reality inform successful landscape architecture and planning practices on our coasts?

What interventions are needed to secure social and ecological assets? How can the existing distribution of ecological, economic, and social processes across a transect of the coastal region be used as a basis for adaptive design?

2. New ecologically based design principles for our coastal communities

Our plan is based on a set of ecologically informed principles for highly vulnerable coastal areas. Some similar principles are being discussed in landscape architecture (e.g. Brash, Hand, & Orff, 2011; FARROC, 2015), and we created other principles suited to coastal areas facing climate change. Planning for climate adaptation routinely addresses infrastructure needs (e.g., Rosenzweig et al., 2011). We hold that for coastal areas undergoing sea level rise, attention to the ecological foundations of the economy and the character of the shore must take equal footing. Our thesis is that the following five perspectives must underlie modern planning practice at the coast.

- Design and planning must be consistent with ecological and geomorphological structures and processes to be sustainable (Childers, Pickett, Grove, Ogden, & Whitmer, 2014; McHarg, 1971 [1969]; Riggs, 2011; Rottle & Yocum, 2010).
- Coastal planning must integrate watershed processes, rather than focusing solely on the very local, narrow thread of beach sand. In our conception, the "shore" is deeper than the beach. Assessing the transect from the beach to inland landscapes allows the design to incorporate ecological heterogeneity (Pickett, Cadenasso, & Grove, 2004), fluxes, and connections (e.g., Durand, 1998).
- Underlying ecological processes include successional change, fluctuating estuary and beach morphology and hydrology, and loss of salt marsh islands (Bertness, 1999; Nordstrom, 2004; Pennings & Bertness, 2001). They must be accommodated.
- Ecologically informed design must incorporate climate change impacts and its associated disasters (Steiner, 2014).

With altered climatic conditions, the designed landscape must also be able to change (Walker, Haasnoot, & Kwakkel, 2013). We do not yet know the speed and intensity of this climatic change (IPCC, 2007; Mastrandrea & Mach, 2011), although change is coming. Design must recognize that the tempo of change is uncertain.

- Human activities may need to be rearranged across the newly defined coastal zone to accommodate the shifting ecological foundations.