American Water Resources Association
2015 SUMMER SPECIALTY CONFERENCE
Climate Change Adaptation

June 15 - 17, 2015
New Orleans, LA

Monday, June 15
3:30 PM – 5:00 PM
SESSION 4: Engineering and Infrastructure 1

Scaling up Use of Natural Infrastructure as a Coastal Community Resiliency Tool: Findings of an Experts Workshop - Shannon Cunniff, Environmental Defense Fund, Washington, DC

The Environmental Defense Fund organized an emerging issues workshop in May 2015 bringing academics and researchers, practitioners, insurers, federal policymakers, and community representatives together to discuss issues associated with broadening acceptance and use of natural infrastructure as a tool for enhancing coastal community resiliency. Many on-the-ground projects have been and are being implemented by natural resource agencies and environmental NGOs. Much of the literature promoting coastal natural infrastructure focuses on improving and quantifying habitat, water quality, recreation, and tourism aspects of ecosystem services. Ecologists are clearly bought into the idea of the value of natural infrastructure but engineers are less so. EDF started from the premise that a key factor preventing widespread adoption of natural infrastructure as an element of coastal resiliency planning was the relative lack of performance data and design criteria. Such criteria would enable engineers, insurers, and funders to quantify and value natural infrastructures' risk reduction services, in addition to other ecosystem services. Therefore a goal for the workshop was to determine what scientific and engineering analyses were vital for informing and influencing policies and practices that recognize and promote the risk reduction functions of natural infrastructure. The workshop sought to define what would constitute evidence of effectiveness of natural infrastructure in the risk reduction arena. Participants were tasked to identify whether and what kinds of additional information are needed to establish the risk reduction performance and conditions affecting the reliability of natural infrastructure so as to quantify its contribution to risk reduction and allow its evaluation alongside nonstructural and structural infrastructure solutions. Key activities included: assessing the potential for various types of natural infrastructure to mitigate coastal community risks affected by climate change; determining what additional information decision-makers needed to increase their confidence in natural infrastructures' contribution to risk reduction/resilience - and which information was vital to inform policy and influence practice and how quantitative it must be; identifying where performance gaps need to be addressed to better define design criteria, performance and reliability; determining the level of effort required to obtain adequate information; and establishing research priorities. Perhaps most important the group discussed how to move this agenda forward. The participants also identified other opportunities and challenges to scaling up adoption of natural infrastructure. This presentation will summarize the findings of the workshop.

Structures of Coastal Resilience: The Amphibious Suburb – Julia Chapman, Princeton University, Princeton, NJ (co-authors: P. Lewis, M. Tsurumaki, D. J. Lewis, A. Knoell, K. Hayes)

This project develops design strategies for back bay suburban coastal resilience. It proposes an alternative model for dealing with sea level rise and storm surge than the problematic alternatives of fortification or retreat. Instead we propose designs for an amphibious suburb in which neighborhoods strategically co-exist with wetlands and water. In Atlantic City, as along the East Coast, beachside property benefits from protective measures such as continued beach nourishment and dune construction, while low-lying back bay communities remain vulnerable to storm events and sea level rise. Enhanced beach profiles designed by the USACE protected much of Atlantic City's seaside properties during Hurricane Sandy. However, storm surge entered through the inlets at both ends of Absecon Island, flooding much of the city's back bay. This paper proposes the adaptation of the Chelsea Heights neighborhood in Atlantic City's back bay into an amphibious suburb resilient to the effects of sea level rise and flooding from storm surge. Built on a former salt marsh, Chelsea Heights is an economically and racially diverse community with a particular urban fabric. It therefore offers both generic and specific conditions on which to test the amphibious suburb. Our proposal for Chelsea Heights considers the vital relationship between city and ocean, hybridizing the logic of each in order to improve the quality of life for residents. It suggests that more radically combined natural, structural, and urban features can produce neighborhoods in which residents live with water more beneficially. Scenarios are phased over 80 years and anticipate the behavior of residents. Elevated roads would function as protective edges or berms with benefits, strategically designed to allow water to penetrate them at specific points. Canals with living shorelines would replace back alleys, moving all local traffic to newly elevated roads with boardwalk access to lifted homes. The threat of flood damage and the increased cost of flood insurance already incentivize homeowners to lift their homes above the designated base flood elevation. The combination of new canals, lifted homes, and abandoned lots would encourage the migration of wetlands into Chelsea Heights. Wetlands, as opposed to hardscape or grass lawns, also slow the movement of water in storm events. This controlled permeability, in concert with a reduction of hardscape throughout Chelsea Heights, would allow for its slow transformation into a true amphibious suburb. While our proposal is designed specifically for Chelsea Heights, the resilient features within it-- elevated roads, lifted homes, canals, and wetlands-- can be applied to back bay communities elsewhere. Like Absecon Island, the barrier islands along the New Jersey Shore feature sprawling back bay suburbs as their wetlands were unprotected from development until the early 1970s. Due to changes in weather patterns and sea level rise, these aging neighborhoods are now almost entirely within the FEMA defined 100-year floodplain, and face an increasingly volatile future. The amphibious suburb offers a course of action. This paper is one of four papers submitted from the Structures of Coastal Resilience project. More information about this interdisciplinary effort can be found at www.structuresofcoastalresilience.org.

Structures of Coastal Resilience: Novel Systems of Marsh Restoration: Atoll Terraces and the Island Motor, Jamaica Bay - Catherine Seavitt Nordenson, City College of New York, New York, NY

Several experimental marsh restoration projects using novel techniques of marsh terracing have been implemented along the coastal Chenier Plain of Louisiana and Texas. Marsh terraces are discontinuous narrow strips of emergent marsh, constructed of dredged material and stabilized by emergent vegetation. Terraces reduce wave energy and dampen the erosive force of water, thus encouraging sediment deposition and increasing water clarity. This paper proposes to transfer the principal of marsh terracing to the back bays of the North Atlantic coast, and presents a specific design for Jamaica Bay, New York, embracing urban strategies of social and environmental resilience. Salt marsh loss at Jamaica Bay is a paradigmatic example of environmental vulnerability, particularly given sea level rise. The area of the marsh islands within the embayment has decreased from 2200 acres in 1924 to approximately 800 acres today, with accelerated marsh loss of 15-20 acres per year occurring since 1974. This loss is likely attributable to multiple factors acting in combination, including sea level rise, erosion, sediment deficit, nutrification, and biotic influences. Improved restoration strategies are imperative: a resilient marsh ecosystem provides coastal storm risk management services to adjacent communities through wave attenuation and wind fetch reduction. Wetland ecosystem services also include water filtration and storage, carbon sequestration, and the provision of intertidal habitat for many species. The future success of these marshes is critical to both Jamaica Bay and the region. This design proposes novel strategies of marsh island restoration at Jamaica Bay by harnessing the natural processes of current-driven sediment transfer and encouraging deposition through the strategic placement of minimal quantities of dredged material. A constructed "atoll terrace," emerging just above the high tide line, wraps the perimeter of the marsh island footprint. This double-sloped ridge, formed with strategically placed dredged material and stabilized with low and high marsh species, evokes the intermittent appearance of an atoll formation. Slopes are designed to support the upward migration of low marsh grasses (Spartina alterniflora) with sea level rise. In addition to trapping sediment, the atoll terraces reduce wave energy and turbidity, providing ideal conditions for achieving the water clarity and light penetration required for the successful establishment of submerged aquatic vegetation (Zostera marina). The atoll terrace is nourished by the "island motor," a natural system of sediment distribution that harnesses the forces of tides and current to encourage sediment deposition and accretion within the footprint of the salt marsh. This sediment source may be beneficially placed dredged material or naturally occurring sediment suspended within the water column. The island motor allows the atoll terraces to engage with natural processes and perform as "nature-based features" of coastal resiliency. As both an ecosystem restoration and storm risk management strategy, the coupled use of the atoll terrace / island motor would be beneficial at other back-bay sites along the East Coast, ensuring the future success of salt marsh islands. This paper is one of four papers submitted from the Structures of Coastal Resilience project. More information about this interdisciplinary effort can be found at www.structuresofcoastalresilience.org.

Methods for Uncertainty Analysis in Climate Predictions for a Resiliency Planning in Urban Scale - Krishna Khatri, Patel College of Global Sustainability, University of South Florida, Tampa, FL (co-author: K. Ghebremichael)

Most of the urban infrastructure systems planning and design process require climatic information in a smaller temporal scale (i.e., minutes, hours, day, and week for a season) and spatial scale (i.e., a few km ranges). For example, in case of urban water systems, analyzing the performances of a wastewater treatment plant with the changes in a temperature; allocating a peak water demand in certain hours of the day (i.e., with the changes of temperature in a day or hours); predicting the evapotranspiration rate, soil moisture changes, and impact on the runoff flow and groundwater level within a smaller pocket of urban land; estimation of flash flood event within few minutes to list a few. Despite ongoing extensive development in the climatic modelling and downscaling techniques, climate change predictions in urban scale are not sufficient and are always associated with a myriad of uncertainties. Thus, planning for a resilient system as well as developing adaptation measures with a least regret or no regret principles become challenging undertakings without addressing the associated uncertainties. The main objectives of this paper are: i) to present the major sources of uncertainties associated with climate change predications in an urban scale, and ii) propose methods for addressing the associated uncertainties for designing a resilient system and developing adaptation measures. The paper presents multiple sources of uncertainties in the climate change predictions that cascades from Global Climate Models (GCM), Regional climate Models (RCMs) to the hydrological) and finally to a system model in an urban scale. Considering the identified sources of uncertainties, it presents different methods of uncertainty analysis including frequentist probability distributions, subjective probability and belief statements of Bayesian statistics, and recommends the best methods of uncertainty modelling. Most of the analyses and discussions presented in this paper are based on the recent state-of-art review available in the areas of climate change prediction, uncertainty analysis, and designing for a resilient system as well as adaptation measures. The discussions and analyses are supported by cases of urban water systems and planning process in the USA. It is expected that the proposed methods of uncertainty analysis will be useful for scientists, planners, and decision-makers who design resilient systems and develop adaptation measures in an urban area, particularly for a water utility.