WATER RESOURCES

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COASTAL ZONE MANAGEMENT

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COASTAL ZONE MANAGEMENT

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If one thing is clear from reports and studies on sea level rise and climate change, it is that we need to simultaneously understand, respond, and adapt to sea level rise. In the United States and worldwide, large population concentrations are in growing cities in coastal areas that are generally ill adapted to a changing, dynamic sea. This issue of *Water Resources IMPACT* contains articles on what the federal government and two state goverments, Oregon and Hawaii, are doing to address these problems, and what we are doing for/with a partner nation, the Marshall Islands, to prepare for imminent changes.

FEATURE ARTICLES

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THE COASTAL ZONE MANAGEMENT ACT AT 40

Joelle Gore

INTRODUCTION

Recognizing the national importance of coasts and Great Lake shorelines, in 1972, leaders in Congress created the Coastal Zone Management Act (CZMA) to balance economic development and natural resource protection so that we can continue to enjoy the benefits the coasts provide. To meet the goals of the Act, the National Coastal Zone Management Program (CZM Program) takes a comprehensive approach to coastal resource management, focused on national objectives to protect natural resources; manage development in areas most prone to coastal hazards; ensure priority is given to activities that depend on the water, such as ports, fishing, and the revitalization of waterfront areas; and provide public access for recreation. The CZMA also seeks to preserve and protect estuaries for long-term research and education by encouraging the states to designate National Estuarine Research Reserves, and since 2002, conserves sensitive coastal and estuarine lands, or "green infrastructure," under the Coastal and Estuarine Land Conservation Program (CELCP pronounced "kelp").

The year 2012 marked the 40th anniversary of the CZMA, and the challenges for the nation's coasts and shorelines are ever more complicated. The Act was a result of growing concerns for the degradation of coastal and ocean resources, and the increasing demand on those resources as more and more people in a growing post-WWII economy, along with a growing interstate highway system, sought out time along our shores for recreation and work (Bailey and Fletcher, 2013). Population in coastal areas continues to grow, resulting in a 43% increase between 1970 and 2010; the number of housing units has increased by 77% (National Ocean Economics Project, 2009). The coastal area is home to over 160 million people, supports 66 million jobs, and contributes $8.3 trillion to the United States (U.S.) economy, accounting for 58 percent of the nation's economic output. (NOAA State of the Coast, 2013).

Compounding the impacts to coastal resources from population growth and development is the increase in the number and intensity of coastal storms and projected changes in sea and lake levels. Weather and climate-related disasters are increasing and the damages from these disasters cost a great deal. NOAA's National Climatic Data Center noted 14 weather and climate-related disasters in 2011 with over $1 billion in damages each; and in 2012, AON Benfield (insurance broker) noted 11 disasters with over $1 billion in damages. The latest large storm, 2012's Super Storm Sandy, affected states from the Mid to North Atlantic region as well as Great Lakes states and resulted in an estimated $70 billion in damages in New York and New Jersey alone.

Another compounding factor for our coastal areas over the last decade is driven by energy scarcity that has spawned national and state interest in renewable energy technologies such as wind, waves, thermal conversion, and tides. Overlaid on these pressures in our coastal communities – population, impacts from changing climate, and energy demand – is the public's demand for all levels of government to work more efficiently to both protect and balance the use of coastal and ocean resources. This coordination and partnership across levels of government is at the center of the National Coastal Zone Management Program's mission.

NATIONAL COASTAL ZONE MANAGEMENT PROGRAM

The CZMA's National Coastal Zone Management Program serves as the nation's backbone to address these and other critical issues. The CZM Program provides for the conservation of the nation's coastal resources, sound management of coastal development, and the reduction of government red tape by encouraging states to exercise their full authority over land and water uses. This is accomplished through the development of state comprehensive programs, in cooperation with federal and local governments and other vitally affected interests. These comprehensive programs include state and local policies, criteria, standards, methods, and processes for managing resources and resolving conflicts among important and competing land and water uses in the coastal zone.

As the Coastal Zone Management Act moves just past its 40th year and into the nation's complicated future of increasing storms, and demands on coastal and ocean natural resources to meet our needs for energy, food, and our recreational interests, the call to ensure our coastal communities are safe and resilient is louder than ever.

An important role these state comprehensive programs have played over the last 40 years is to help reduce risks to storms and inundation and increase the "resilience" of coastal communities, in part, by redirecting development away from the most hazard prone areas along ocean and Great Lake shorefronts. The term "resilience" refers to the ability to effectively plan for, respond to, and recover from the social, ecological, and economic impacts of disasters. Resilient coastal communities plan for and take deliberate action to reduce risks from coastal hazards, accelerate recovery from disaster events, and adapt to changing conditions. By being resilient, communities tend to lessen the severity or extent of damage and to limit "down time" for area businesses and residents post-disaster.

Roughly 80% of the states that participate in the CZM Program employ shorefront no-build areas to prevent unsustainable development and protect public interest, but associated laws and regulations vary considerably because of differences in geographic and geologic situations, regulatory frameworks, shorefront property ownership, and levels of existing development. States change their laws and regulations over time to improve effectiveness and reflect better information and new challenges. Given the extent and cost of damages in recent years from coastal storms, climate change and the increasing impact from storms is one of the challenges that already has states reevaluating how best to protect their shorefronts. (Rabenold, 2013).

Coastal and Great Lake states are also on the front lines of the rush to develop renewable energy facilities. The interest in wind, wave, and tidal energy is placing unprecedented pressures on coastal states to plan for these new uses and to balance them with existing economic and environmental uses and values. To help identify suitable areas for these technologies and to streamline decision making, many states have developed ocean management plans and have incorporated these plans into their state coastal management programs. Likewise, many coastal state governors have established Regional Ocean Partnerships to address and fund this work under the Regional Ocean Partnership Funding Program. This grant program was developed to advance effective coastal and ocean management through regional ocean governance, including the goals for national ocean policy and comprehensive ocean planning set out in the President's Final Recommendations of Interagency Ocean Policy Task Force, July 19, 2010.

Coastal state participation in the CZM Program is entirely voluntary, and currently 34 of 35 coastal and Great Lakes states are participating. In 2012, Illinois became the most recent state to develop and receive approval of its state coastal program by NOAA. In 2011, Alaska became the first and only state to leave the CZM Program when its program authority sunset in the state legislature. With its departure, Alaska no longer qualifies for funding under the CZM Program or the Coastal and Estuarine Land Conservation Program. The state is, however, eligible to receive funding and NOAA support for the implementation of the Kachemak Bay National Estuarine Research Reserve.

NATIONAL ESTUARINE RESEARCH RESERVES

The CZMA established the National Estuarine Research Reserve System, which sets out to preserve lands representing different biogeographic regions of the U.S. Currently, there are 28 reserves that provide a network of living laboratories around the nation. The Lake Superior Reserve in Wisconsin, which encompasses 16,697 acres representing four distinct land areas, was the latest designation in 2010. In 2012, The Governor of Hawaii expressed interest in establishing a research reserve and the state has recently launched a site proposal process to engage citizens in the reserve designation. The designation of a reserve in Hawaii will fill an unrepresented biogeographic region in the reserve system. It will also facilitate new partnerships, initiate new research on estuarine, and will serve to improve coastal management and create new opportunities for citizen and visitor engagement.

Like the National CZM Program, the National Estuarine Research Reserve System, is implemented through a state-federal partnership, protecting more than 1.3 million acres of estuarine land and water. Over the last 20 years, NOAA and the states that comprise the reserve system have worked to develop system-wide programs that provide consistency in focus, while allowing the flexibility for each reserve to address its most critical research, education, and training needs for their community. These system-wide components include the System Wide Monitoring Program, established in 1995 to track short-term vulnerability and long-term changes in estuaries and coastal areas to understand how human activities and natural events can affect ecosystems. A K-12 Estuarine Education Program, or "KEEP," is another program focused on the increase of ocean literacy of students, teachers, and the general public. Lastly, the Coastal Training Program helps address coastal management issues by providing up-to-date scientific information, and access to technologies and skill-building opportunities for decision makers and other resource management professionals.

Over the last three years, the reserve system has increased its focus on stressors from climate change, storms and changes in sea and lake levels. Super Storm Sandy provided an opportunity to have an enhanced focus on resilience, and the reserves in both New Jersey and New York are helping to understand the important role of healthy wetlands in helping reduce the impacts from these stressors. These natural systems protect communities from storm surges, filter runoff before it enters rivers and estuaries, provide habitat for fish, and increase the value of homes because of their scenic beauty. In this way, these natural systems can provide immediate physical resiliency, and also contribute to the longer-term economic resilience of a region.

In the report, *The Climate Sensitivity of the National Estuarine Research Reserve System*, released by NOAA in July 2013, a collaborative and interdisciplinary team of scientists found that the reserves are experiencing the negative effects of human and climate-related stressors. The report points to Sapelo Island NERR in Georgia, ACE Basin NERR in South Carolina, Waquoit Bay NERR in Massachusetts, and the Tijuana River NERR on the California Mexico border as the reserves most sensitive to climate change. This information is important to helping coastal managers and local community leaders make informed decisions for their coastal communities.

The report includes three key findingst. First, all reserves around the country are sensitive to climate change to some degree. Second, socio-demographic factors are important to look at in managing impacts from climate. The study found that estuarine areas where people were most likely to be affected by climate change were dependent on fishing, tourism and shipping industries. Low incomes, high percentages of minority populations,

and undereducated populations make communities highly sensitivity to climate change. Finally, temperature change and sea level rise exposure are key factors in determining a reserve's sensitivity to climate change.

COASTAL AND ESTUARINE LAND CONSERVATION PROGRAM

To further advance the CZMA objectives to protect sensitive coastal and estuarine lands, in 2002, Congress established the CELCP. Since then, CELCP program funding has been used to protect through acquisition, nearly 100,000 acres of critical coastal and estuarine lands in partnership with federal, state, territorial, and local government agencies and private organizations. These lands have been identified by states as important for their ecological, conservation, recreational, historical, or aesthetic values and are under threat of conversion. Like estuarine research reserves, these lands also serve as "green infrastructure," naturally protecting coastal and Great Lake communities from hazards with their ability to soak up and store water and enabling tidal wetlands to migrate landward with sea level rise.

In order to receive funding, applicants must be in a state with a federally approved coastal zone management or research reserve, and must have developed a CELCP Plan for NOAA approval. Applicants must also be a public entity, such as a state agency, local government, or other authority, such as a park district, and be able to provide for public ownership of the proposed lands in perpetuity. Lastly, applicants must provide nonfederal funds equal to the amount requested.

CONCLUSION

As the CZMA moves just past its 40th year and into the nation's complicated future of increasing storms, and demands on coastal and ocean natural resources to meet our needs for energy, food and our recreational interests, the call to ensure that our coastal communities are safe and resilient is louder than ever. The National Coastal Zone Management Program, National Estuarine Research Reserve System, and the CELCP provide a critical foundation for managing coastal uses, conducting long-term research and education and training opportunities, and protection for some of our most sensitive and threatened coastal lands.

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WATER RESOURCES
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KEEPING PACE WITH FUTURE ENVIRONMENTAL CONDITIONS IN COASTAL OREGON, USA

Rebecca Flitcroft and Guillermo Giannico

INTRODUCTION

Coastal managers face a particularly serious challenge. Increasing scientific evidence indicates that the climate of the planet is changing, but they lack comprehensive local predictions that enable community planning and disaster preparedness. Predicted effects of climate change in coastal areas worldwide are diverse, and include alterations in sea level, tidal heights and action, ocean current circulation, severe storm frequency, and freshwater inputs (from both rivers and glaciers). In Oregon, land-use planning that proactively considers an altered future land- and sea-scape is beginning in some coastal communities. Although this planning would be facilitated by comprehensive studies of detailed local-scale effects of climate change, such information is rarely available. However, the absence of precise local information should not forestall active consideration of future environmental conditions for coastal management and planning.

Human infrastructure is generally conceived and built assuming stable environmental conditions. In Oregon, as in other parts of the world, settlement and community development has often been dependent on water availability and accessibility. Estuaries and rivers have been particularly important as transportation corridors for people and products, or as sources of energy and food. Estuarine marshes and coastal wetlands were easy to drain and develop. Located where rivers meet the sea, most estuaries have attracted urban development, and those with adequate natural depth have become important ports. As a result, no large estuary in Oregon is without urban and transportation infrastructure. However, coastal Oregon experiences dynamic environmental conditions, as evidenced by its historic record of floods, fires, earthquakes, landslides, tsunamis, and changes in sea level.

In their natural state, estuaries and coastal wetlands have the capacity to absorb changes in sea level by distributing water in both vertical and horizontal directions. Vertical movement results in shallower or deeper tidal channels, while horizontal movement is associated with incoming rivers and the depth of salt water inundation upstream. Over time, the configurations of estuarine habitats change to reflect dominant tidal patterns. The ongoing interaction between fresh and salt water results in a highly productive environment that supports diverse ecosystems. Healthy estuarine ecosystems provide habitats for a variety of species, many of which have significant economic and cultural value, including Dungeness crab (*Metacarcinus magister*), Pacific oyster (*Crassostrea gigas*), and Pacific salmon (*Oncorhynchus* spp.). However, development in Oregon has reduced estuarine wetland area by 68% (Good, 2000) resulting in a coastal landscape that has limited potential to respond to altered sea level.

Approximately 363 miles of shoreline and 22 estuaries are present along the Oregon coast. The north coast (from the Columbia River to Nestucca Bay) (Figure 1) is characterized by a complex mix of sedimentary and volcanic rocks. Except for the broad Tillamook Bay, estuaries here are generally small. The mid-coast (between Salmon River and the Coquille River) (Figure 1) is characterized by ancient mountains and the estuaries were typically created by rising sea level that filled river valleys. South of the Coquille River, the geology is characterized by hard Klamath Mountain rock, resulting in steep rivers and small estuaries. Important coastal communities include the towns and outskirts of Astoria, Tillamook, Newport, Florence, Coos Bay/North Bend,

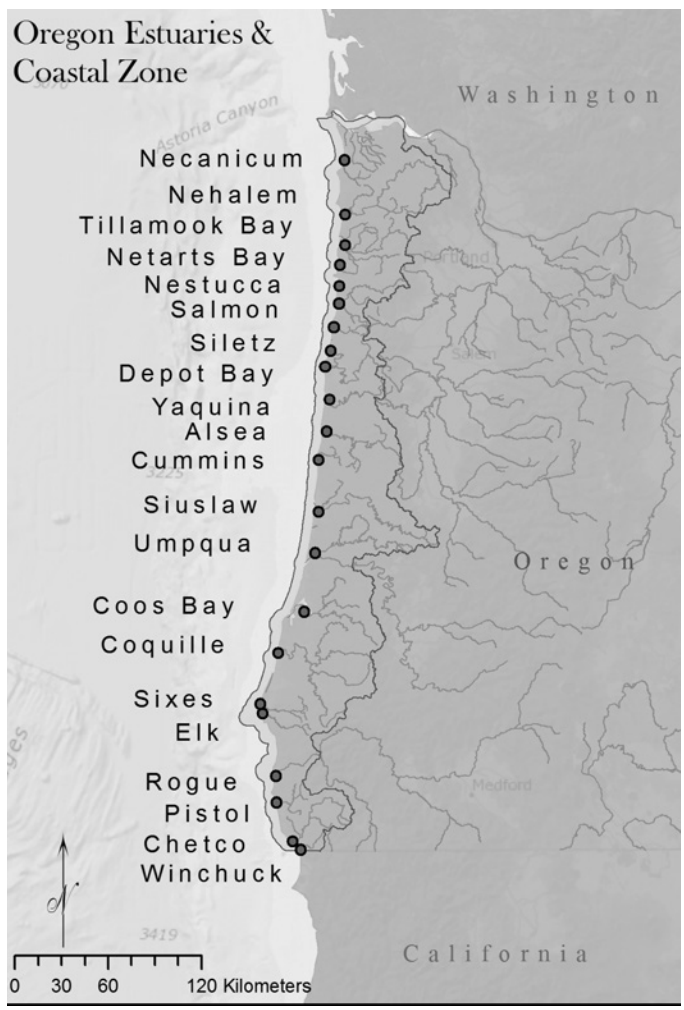

Figure 1. Estuaries on the Oregon Coast.

Bandon, and Gold Beach. All of these communities depend, to varying degrees, on tourism, resource extraction (including timber and/or seafood harvest), and agriculture. (Oregon Estuary Plan Book, 1987).

Ongoing cooperative work is already under way that recognizes the inherently diverse future that we can expect on the Oregon coast ... we can be certain of one thing, change is coming and we need to take proactive measures to minimize anynegative effects it may have on our coastal communities.

WHAT ARE SOME PREDICTED FUTURE ENVIRONMENTAL CONDITIONS ON THE OREGON COAST?

Hydrogeomorphic effects of climate change are predicted to vary along the latitudinal gradient of the Oregon coast. Offshore, the active Cascadia subduction zone effectively causes much of the Oregon coastline to rise by between 1.3 and 3.0 mm/year (NRC, 2012). This uplift is thought to reflect instability in the subduction zone that could result in a major earthquake with the potential to drop the coastline by as much as 1 meter (earthquakes of this magnitude occur in the region every 100-1,000 years; the most recent occurred in 1700 C.E.) (NRC, 2012). Different models predict the "tipping" point for tectonic uplift to be located somewhere between the mid-coast of Oregon and Cape Mendocino, in California. Tectonic processes have the potential to exacerbate the effects of climate change in some places while lessening them in others. Even with tectonic uplift, recent projections of sea-level rise for the entire Oregon coast range between 10 and 143 cm by 2100 (NRC, 2012).

Additional anticipated effects of climate change in coastal Oregon include alterations in storm surges, tidal heights, and littoral cells. The impacts of these changes continue to be a topic of research, but there are concerns about jetty and sand bar viability as well as beach erosion. It is unclear how jetties will be able to withstand changed tidal heights, or how beach location and size are likely to be affected by altered littoral cells. Beach tourism is important to many coastal communities in Oregon, and in many locations, home values are linked to beach views or access. Offshore sand bars may also be affected by a combination of wave action, sand movement, and rising sea level. Some of these sand bars are stable, vegetated, and form a protective barrier between the ocean and coastal estuaries, and in several locations, homes have been constructed on them.

Changes in ocean current circulation are another projected effect of climate change that may affect the Oregon coast. For marine food systems, ocean currents affect off-shore upwelling and are complicated by broad climate patterns such as the El Niño-Southern Oscillation and the Pacific Decadal Oscillation. Upwelling occurs as a result of thermal differences in water between the surface and bottom of the ocean along the shoreline. Cold and nutrient-rich bottom water is forced upwards at different times of the year, facilitating plankton growth, which stimulates the coastal food web. Off the Oregon coast, species such as salmon depend on the predictability of ocean upwelling to deliver food. Salmon population size is connected with ocean productivity and upwelling. In years with strong upwelling conditions, there is high survivorship and populations flourish. The opposite is observed in years of poor upwelling conditions. How upwelling and ocean current circulation will be affected by changes in ocean conditions is not fully understood at this time, and remains a topic that requires additional research.

Due to the location of coastal areas at the margin of land and sea, some inland effects of climate change are also relevant to coastal communities. For the Oregon Coast Range, the quantity of precipitation in the future is predicted to remain fairly constant, but the timing of the precipitation may change. Greater storm frequency and intensity, and alteration in the onset of the winter wet season, are some effects of climate change being considered by scientists. Because the Oregon coast is a rain-dominated region, there is little water storage capacity, and rivers in this area are flashy and immediately responsive to storm events. This also means that estuaries that assimilate freshwater have seasonal changes in salinity levels in response to the quantity of freshwater input. These salinity levels may change as a result of altered precipitation regimes. The effect of these changes in salinity on existing salt marshes is unclear.

WHO WILL BE AFFECTED ON THE OREGON COAST?

The aforementioned lack of precision in local predictions has been a stumbling block to identifying who and what will be affected. However, some predictions of the effect of climate change are understood well enough to forecast potential impacts, such as those of sea-level rise on estuaries, and more frequent and extreme storm events on coastal infrastructure.

Sea-level rise is expected to alter the availability and distribution of estuarine habitats (Figures 2a and 2b). Coastal marsh plants have specific salinity and inundation tolerances. If sedimentation rates and tectonic uplift cannot keep up with rising sea levels, there is potential for coastal wetland areas to become mudflats (intertidal areas), and current mudflats to be permanently submerged (tidal areas). The transition between habitat types is a topic that requires further research, but some scientists are currently working to predict simple relationships between sea-level rise and habitat of culturally and commercially important species. What is clear from this work is that each estuary has a unique setting and will have a different response to sea-level rise.

Evidence recorded since the 1940s along the Oregon coast indicates that winter storms have increased both in frequency and severity (OCCRI. 2010). This trend is associated with stronger winds and higher waves that not only intensify beach erosion but also threaten coastal infrastructure and the communities that depend on it. Hardscaped infrastructure may require greater mainte-

nance or adaptation in order to avoid high tides and winter flooding. Likewise, landowners in areas of drained floodplains in lower portions of river networks may see additional flooding in the future. Landowners upstream who currently own property adjacent to freshwater may see the water become more saline as salt water intrudes upstream.

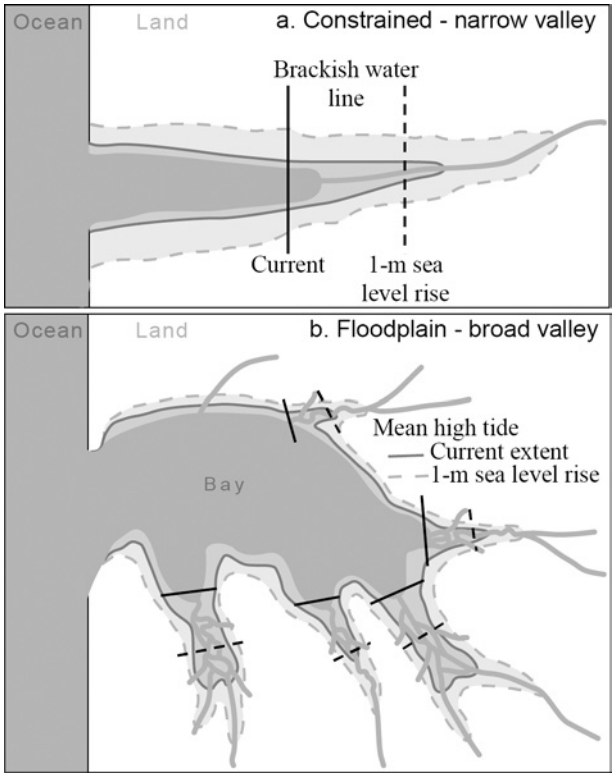

Figure 2. The Response of Estuaries to Sea-Level Rise May Vary With Different Geomorphic Settings Such as (a) Narrow, Constrained Systems or (b) Broad Unconstrained Systems.

HOW CAN COMMUNITIES RESPOND?

The need for more information regarding local environmental conditions, and the geophysical setting of local communities is critical to detailed and refined predictions of the future environmental conditions. However, most communities on the Oregon coast do not have access to such information. Coast-wide LiDAR datasets are available and offer a start for even small communities to access detailed topographic information. This can allow for an adaptive management approach that is poised to respond to actual conditions without needing to know in advance precisely what the land- and sea-scape will look like. Approaches that provide for multiple scenarios based on the best available science can guide the development of management plans with the capacity to respond to changing environmental conditions. Such adaptive management can be implemented through staged restoration or mitigation plans tailored to a variety of future environmental conditions.

Throughout the coast of Oregon, several initiatives are currently underway to assess the vulnerability of estuaries and infrastructure to the predicted rise in sea level and increased storm severity. Communities on the northern coast are paying closer attention to changing storm intensity and direction than to sea-level rise because, despite some differences in the conclusions of the OCCRI (2010) and NRC (2012) reports, it is expected that tectonic uplift on the northern portion of the Oregon coast will cancel or minimize the effects of rising sea level. Therefore, for communities in northern Oregon, increasing severity of storms (especially during El Niño years) and a change in their predominant direction top the list of concerns regarding future environmental conditions. Perhaps the most complete assessment to date for that part of the coast is the Neskowin Coastal Erosion Adaptation Plan (2013), which aims at identifying all possible impacts and analyzing what options local governments and the communities have in dealing with them. This plan emphasizes structural solutions (i.e., rip-rap and dune stabilization), but other hazard alleviation techniques are being considered, such as relocation or modification of structures and changes in planning and zoning codes.

The southern Oregon coast is expected to benefit less from tectonic uplift and, as a result, the anticipated negative effects of sea-level rise receive greater consideration than in the northern coastal counties. Several collaborations are underway to evaluate climate change impacts and possible responses, involving NGOs, research institutions, and various levels of government. In Coos County, for example, both the Coos Bay Watershed Association and the South Slough National Estuarine Research Reserve are leading the work of the Partnership for Coastal Watersheds (http://www.partnershipforcoastalwatersheds.org/) in figuring out how the local community can plan ahead to address the effects of climate change. The Coquille River Estuary Climate Change Vulnerability Project (co-led by Ecoadapt, The Nature Conservancy, Oregon Department of Land Conservation and Development, and the U.S. Fish and Wildlife Service) represents a collaborative effort to identify problems in estuarine habitats and animal species of interest and to find possible solutions that minimize negative impacts of changing climatic conditions.

CONCLUSION

Science assures us that the dynamic conditions that has characterized the Oregon coast in the past will continue into the future. Changes due to a variety of environmental factors including climate and tectonic processes are predicted. Even with the limited data available to decision makers today, plans can be developed that begin a conversation about information needs and potential future conditions. Ongoing cooperative work is already under way that recognizes the inherently diverse future that we can expect on the Oregon coast. We can be certain of one thing, change is coming and we need to take proactive measures to minimize any negative effects it may have on our coastal communities.

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Solution to Puzzle (pg. 28)

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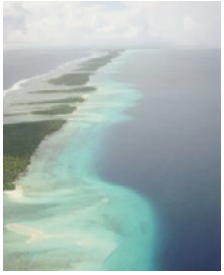
WATER RESOURCES
IMPACT

SHORELINE PROTECTION ON A CORAL ATOLL: MITIGATING HAZARDS AND PLANNING FOR AN UNCERTAIN FUTURE

Karl Fellenius



INTRODUCTION

The Republic of the Marshall Islands (RMI) is a low-lying nation of 29 atolls and four islands that span 2 million square km of an Exclusive Economic Zone in the central Pacific. It represents one of the most at-risk island nations in relation to coastal hazards and is particularly vulnerable to the impacts of climate change. These include projected sea level rise and increased frequency and intensity of extreme weather events. Marshall Islanders live on narrow, reef-parallel islands entirely composed of detrital sediment produced on adjacent coral reefs. Such protective barriers shelter its coastline from offshore wave energy, and are the first line of defense in a range of coastal adaptation options that strive to mitigate erosion and subsequent damage to physical, economic, and social infrastructure. The RMI has demonstrated a collective increase in capacity and willingness to address difficult issues, improve governance, and commit resources towards a collaborative effort. This work continues and expands 20 plus years of partnership between Sea Grant and partners in the United States (U.S.)-affiliated Territories and Freely Associated States, and especially furthers the partnership since 2009 between the University of Hawaii Sea Grant and the College of the Marshall Islands.

Effective coastal management on atolls raises many challenges when faced with the prospect of at least a 30 cm rise in seal level by 2050 and a projected 1 m rise by the end of the 21st Century. At what point do affected nations change their approach from one of coastal protection to planning for evacuation and relocation? Aggregate resources for armoring the shoreline against coastal inundation are already at a premium in the RMI, and the process of prioritizing some islands over others is only just beginning. Is it realistic to expect a sovereign country to select which populated areas are more deserving for survival over others? Fortunately, there is research that suggests that some islands are accreting rather than eroding, and this combined with targeted information on historical shoreline changes and local coastal processes can help facilitate this process (Ford, 2012; Ford, 2013a).

The 44th Annual Pacific Islands Forum was just held in the capital city of Majuro in the RMI. It comes on the heels of a severe drought in the northern atolls, which led the government to declare a state of national emergency. The theme of the forum is "Marshalling the Pacific Response to the Climate Challenge." A "Declaration for Climate Leadership" was adopted, which calls on the nations of the world to phase out the use of fossil fuels and reduce greenhouse gas emissions to levels that would give ongoing and future adaptation measures some possibility of success. Adaptation should allow Pacific Islanders to continue a meaningful existence, but how habitable will these low-lying islands be under even reduced emissions scenarios given the current momentum for sea level rise and extreme weather events? These are questions that are very difficult to answer for scientists and resource managers tasked with coming up with tangible and practical adaptation solutions to the crisis facing atoll nations. Australia and New Zealand have already endorsed the week-old declaration, and pledges of adaptation support are already coming in for Pacific Islands Nations. How should the funds best be spent, and more importantly, who decides? Unless the world succeeds in establishing a binding agreement on emissions by 2015, no amount of adaptation money will make a difference for atoll nations in the long run. Despite these overarching issues, resource management in the Marshalls continues to move forward under the assumption that practical and progressive steps on the ground make a difference. There are several initiatives underway that exemplify best practices in community-based planning and management. To understand their context a brief description of institutional arrangements for coastal management in the RMI is first summarized below.

An inspiring poet and lecturer in contemporary Marshallese studies, Kathy Jetnil-Kijiner says that if the Marshallese lose their land, they will lose their culture and their identity along with it ... for this reason, she explains, the country does not have an evacuation plan to leave the islands in the event that sea level rise eventually claims their home.

COASTAL INSTITUTIONS

The Coastal Management Advisory Council (CMAC) was formed in 2005 to facilitate cooperation between agencies and organizations involved in both marine and terrestrial resource management. It has worked on many different projects including the creation and monitoring of protected areas, education and awareness campaigns, training for resource management personnel, and scientific surveys. For any given project it is often difficult for one agency or NGO to muster all the resources needed, and CMAC provides a mechanism for collaboration and integration of strategies across multiple sectors. A community-based process called Reimaanlok was initiated in 2007 that led to the establishment of a national conservation area planning framework (Reimaan National Planning Team, 2008) and a facilitator's guide (Ishoda *et al.,* 2012). Reimaanlok means "looking ahead" in Marshallese, and is now the central institutional arrangement for land use planning in the RMI.

The precursor to CMAC was a working group called MEIC, aptly named for MIMRA (Marshall Islands Marine Resources Authority), EPA (RMI Environmental Protection Authority), IA (Internal Affairs), and CMI (College of the Marshall Islands). In partnership with the NRAS (National Resource Assessment Survey) Team, MEIC facilitated outer island marine biodiversity assessments and household fishing pressure surveys as early as 2001. This led to the establishment of marine protected areas via local government ordinances in hotspots of biodiversity and spawning aggregation sites. While invaluable in its content, its approach contained gaps in consultation with landowners and traditional leaders and subsequently was not as effective as it could have been. This has been rectified under CMAC.

Three additional planning frameworks underlie efforts on coastal management and sustainable development in the context of climate change. First there is the National Action Plan on Disaster Risk Management (RMI Government, 2007) that focuses on key vulnerability and risk issues, and on priority gaps. Second there is the National Coastal Management Framework (RMI Government, 2008), a living document that reviews coastal conditions and recommends policy in the coastal zone. Third there is the overarching National Climate Change Policy Framework (RMI Government, 2011), which sets out the Government's commitments and responsibilities to address climate change.

The National Coastal Management Framework fulfills the requirement under the Coast Conservation Act (1988) to create a national coastal management plan. It has recently resulted in new sustainable development regulations that are meant to "more actively manage the range of coastal activities, bolster monitoring of both land-based and marine activities, minimize environmental impacts, maintain a sustainable shoreline, and prevent future erosion and marine pollution." The framework goes further and calls for phasing out shallow water lagoonside sand mining and dredging, and emphasizes environmental impact assessments for major development projects. As with any national development plan, there is a significant gap between planning and implementation. The reality in the RMI today is that virtually all coastal infrastructure in the built environment needs to be upgraded. Resources are spread so thin that few projects get the attention they deserve. Piecemeal there is some progress through adaptation. There are plans for a new landfill, and an expectation that serious consideration will be given this time to mitigating toxic leachate from hazardous materials. There is some hope that the government will cease allowing the mining of live coral for fill as a result of the controversy surrounding the ongoing airport expansion project. The notion of resilient communities however, is difficult to imagine when much of the shoreline in urban areas continues to be armored with old vehicles and scrap metal waste. These are but a few of the challenges facing effective implementation of the coastal management framework. Toxic leachate, mining live coral, and turning shorelines into junkyards should have straightforward solutions by any definition of integrated coastal management in any jurisdiction. The RMI still struggles with managing these fundamental issues. It has historically been both a testing ground for nuclear bombs "for the good of mankind" and a dumping ground for heavy machinery and industrial waste in the form of "international aid." It is the Marshall Islanders themselves that are resilient, if not their environment.

Another coastal institution in the making is the RMI Protected Areas Network (PAN). The driver for this initiative is the Micronesian Challenge, which led to commitments by Micronesian nations to set aside 20% of terrestrial and 30% of marine areas for conservation by 2020. CMAC is facilitating the establishment of national protected areas legislation, grounded in the spirit and approach of Reimaanlok. There have been marine protected areas designated in the Marshalls for over a decade under the auspices of community-based fisheries management plans and other atoll-specific conservation plans relating to sustainable livelihoods. These will be encapsulated by the national legislation, with the continued explicit purpose that resource management must be community-driven and supported with resources and expertise from national agencies.

BEST PRACTICES

Notwithstanding the Reimaanlok approach, proactive planning frameworks, and the PAN described above, there are several other CMAC initiatives underway that demonstrate innovative practices across a range of resource management sectors in the coastal zone. An amendment to the RMI Fisheries Act passed by the RMI Nitijela (Parliament) in 2011 bans all commercial shark fishing within the Marshall Islands EEZ. At the time this became the largest shark sanctuary in the world. Enforcement of this law is an ongoing effort and to date five vessels have been fined for possession of shark fins. The College of the Marshall Islands and MIMRA recently conducted their 4th consecutive year of the Marine Conservation Certificate Program, a course aimed at improving the skills of outer island practitioners in marine protected areas compliance and management. They are planning a similar certificate program for climate change, focusing on curriculum development and training for outer

island K-12 teachers. Since a decade, the College Marine Science Program also carries out coral disease and bleaching monitoring across several atolls, and indications are that both are on the rise. Coral disease on the urban atoll of Majuro has been ongoing for many years, while bleaching related to localized warming is more recent. The University of the South Pacific as part of the EU-Global Climate Change Alliance Project is facilitating and equipping at least 40 communities within 15 Pacific island countries with capacity to adapt to climate change. In the RMI the project is engaged on food security, water quality and supply, re-vegetation, energy, and revitalizing the use of traditional canoes across six atolls. The Pacific Adaptation to Climate Change (PACC) Program under the Secretariat of the Pacific Community Regional Environment Program (SPREP) focuses on water supply issues on Majuro. It is expected that this project will upscale into wider coastal management efforts related to coastal protection in the RMI, and as such will become more integrated with CMAC initiatives.

LANDOWNER'S GUIDE TO COASTAL PROTECTION

USAID, UH Hawaii Sea Grant, and NOAA Coastal Storms funded a recent publication called the Landowner's Guide to Coastal Protection (Ford, 2013b). It is atoll-specific, and outlines different hard and soft methods that can be combined for protection against shoreline erosion. It is being used in community discussions by CMAC in Majuro, and has been embraced by government agencies as a set of guiding principles to aid decision-making in the coastal zone. It underscores the importance of healthy coral reefs as the first line of defense in dispersing incoming wave energy, and then moves on to highlight the positive benefits and negative impacts of seawalls, revetments, and other fortification measures. The figure below encapsulates some adaptation strategies that are being discussed.

Ocean and lagoon side ridges in Majuro have largely been replaced via coastal development and reclaimed land fronted by smail seawalls or other adhoc infrastructure. In between the fortified sections the shoreline is highly modified and exposed to coastal inundation because of the loss of these ridges. Among other options, Sea Grant extension activities in the RMI include efforts at building back these ridges using local materials and re-vegetation in high risk areas.

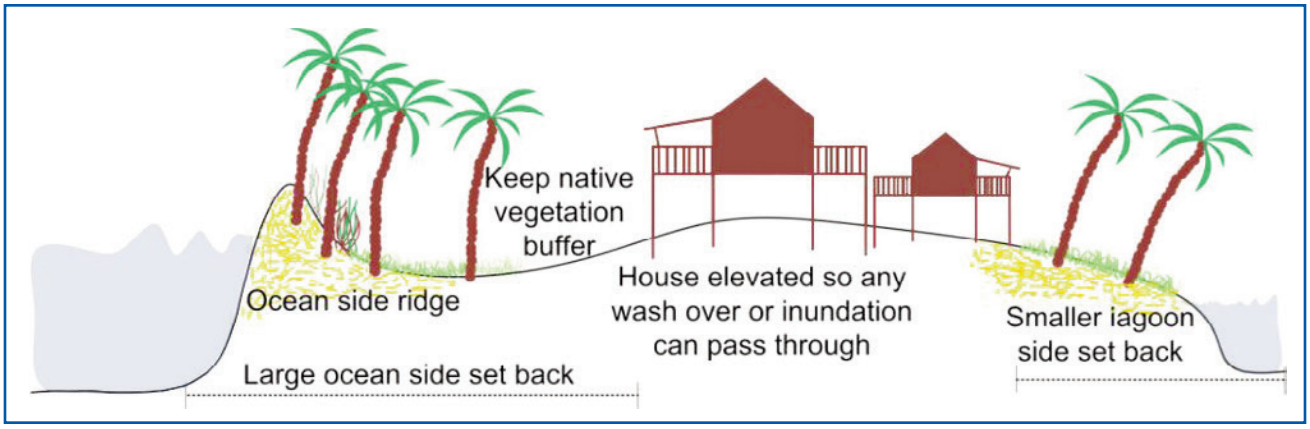
HOMEOWNER'S HANDBOOK FOR NATURAL HAZARDS

Currently there are plans for a Homeowner's Handbook to Prepare for Natural Hazards to be developed for Majuro. It will build upon the National Action Plan on Disaster Risk Management, and be guided by recent gap analysis work and a similar handbook produced for Hawaii (Hwang, 2013; Hwang and Okimoto, 2011). The hazards that are most locally relevant are coastal inundation and drought, but hurricanes and tsunamis will also be included. One of the key gaps identified so far is the lack of comprehensive coastal inundation maps for the capital. This data is necessary for effective local evacuation planning in emergencies. The RMI has a National Disaster Management Committee with broad representation from almost every branch of government. Work on the handbook will proceed in close collaboration with this committee to ensure that it becomes locally relevant and communicated in a format consistent with Marshallese culture.

CONCLUSION

An inspiring poet and lecturer in contemporary Marshallese studies, Kathy Jetnil-Kijiner says that if the Marshallese lose their land, they will lose their culture and their identity along with it. For this reason, she explains, the country does not have an evacuation plan to leave the islands in the event that sea level rise eventually claims their home. "We are nothing without our islands." While this is representative of how Marshall Islanders feel and should provide a strong impetus for adaptation action, it also underscores the need for some sort of strategy of prioritization. Unless sea level stabilizes and erosion returns to levels that are mitigated by natural processes, it is very unlikely that adaptation alone can protect the shorelines on all of the 1200 plus islands of the RMI.

(Note: The views expressed herein are those of the author and do not necessarily reflect the views of University of Hawaii Sea Grant College Program and NOAA or any of its subagencies.)



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▲ HIGHLIGHTS OF JAWRA TECHNICAL PAPERS • OCTOBER 2013 • VOL. 49 • NO. 5

We are pleased to present one of our most ambitious Featured Collections to date: Chesapeake Bay Total Maximum Daily Loads (TMDLs). The Chesapeake Bay Program, a state-federal partnership founded in 1983, has coordinated a huge scientific effort to learn more about this irreplaceable natural resource touching parts of seven States. Guest Editors Lewis Linker, Richard Batiuk, and Carl Cerco put together this Featured Collection to document the enormous effort to establish nutrient and sediment TMDLs for the Bay and its surrounding watershed. Topics covered include:

- History of pollutant load targets and allocations;
- Deriving water quality standards;
- Atmospheric nutrient loads;
- Development and application of the TMDL model;
- Extent of impervious surfaces and turf grass;
- Evaluation of a three-dimensional hydrodynamic model;
- Shallow-water component of the model package;
- Sediment and nutrients;
- Eutrophication; and
- TMDL assessment using monitoring and modeling data.

Other Technical Papers Highlights:

Ahiablame *et al.* explore a method for calculating base flow quantity and quality for different land uses.

Gene J-Y You discusses a hedging policy for managing Lake Okeechobee.

Dudley and Hodgkins look at historical groundwater trends in New England.

Thomas Myers looks at problems in estimating loss rates for Lake Powell.

A full Table of Contents may be viewed at http://www.blackwell-synergy.com/toc/jawr/49/5

JAWRA ~ Journal of the American Water Resources Association

WATER RESOURCES IMPACT

HUMAN DIMENSIONS PERSPECTIVES ON THE IMPACTS OF COASTAL ZONE MARINE RENEWABLE ENERGY

Caroline Pomeroy, Flaxen Conway, and Madeleine Hall-Arber

INTRODUCTION

Climate change and soaring energy costs have fueled attention to renewable energy. In coastal areas, the potential to harness the clean power of offshore wind, wave, and tide is irresistible. Our extensive coasts and oceans offer what appears at first glance to be virgin territory for development of energy producing facilities. A closer look, however, reveals that these areas are teeming with productive activity, activity that cannot be ignored in planning and implementing marine renewable energy (MRE) development and production.

Historically, marine management decisions have focused on the ecological dimensions, that is, marine life and associated habitat. Humans traditionally have been viewed primarily as stressors on, rather than as functional components of, the ecosystem. While human activities in marine areas have been managed, they have been considered individually (within sectors) rather than holistically, with little attention paid to conflicts and cumulative impacts (Ehler, 2008).

However, a focus on human dimensions – the economic, social, cultural, and political ways people affect or are affected by the ocean and coastal environment (NCCOS, 2007) – is gaining traction. Ecosystem-based management (EBM), a key principle of United States (U.S.) ocean and coastal management, "is an integrated approach that considers the entire ecosystem, including humans" (Leslie and McLeod, 2007). Marine EBM considers "interactions among ecosystem components and the cumulative impact of multiple activities" (Leslie and McLeod, 2007). Both ideally and legally (the latter according to the National Environmental Policy Act), projects in the marine and coastal zones must minimize negative impacts on the ecosystem. To attain the goal of well being of our coastal and ocean ecosystems, coastal management policy must consider these coupled natural-human systems in decision making.

THE COASTAL OCEAN AS A SOURCE OF ENERGY

Growing interest in generating a significant percentage of our energy from renewable sources has led many states, regions, and countries to consider their marine waters as developable space. Policies are beginning to reinforce this interest. Oregon, for example, has a "Renewable Portfolio Standard" that includes the goal of a power supply comprised of 25% renewable energy (for all large utilities, and 10% and 5% for smaller utilities, depending on their size) by 2025. The MRE industry is nascent, with technology undergoing frequent change. Underwater turbines, stationary and floating wind devices, and over 100 wave energy conversion devices have been conceptualized or initially developed; however, few have been built as full-scale prototypes or tested. Production potential is currently limited by the challenges of generating energy in a harsh ocean environment, a lack of knowledge about environmental impacts, regulatory and permitting hurdles, and the slow pace of efforts to determine which areas might be most suitable for ocean energy projects.

One step toward identifying areas suitable for ocean energy projects was taken in 2009 when the United States (U.S.) Bureau of Ocean Energy Management (BOEM, then the Minerals Management Service) funded a bicoastal study to (1) investigate potential space-use conflicts between offshore renewable energy and existing uses on the Outer Continental Shelf; and (2) in cases of unavoidable conflict, to identify mitigation measures for the loss of use of that space by existing users. Here, we briefly present lessons learned from this research regarding understanding, avoiding, and mitigating negative – and often unintended – impacts of MRE development and generation (Industrial Economics, Inc., 2012).

It is incombent upon coastal policy makers, managers, existing users, and the public to keep in mind potential differential impacts and vulnerabilities, and to commit to working together in an effective, responsible, and swift manner to maintain or enhance the well-being of coastal space and place.

THE COASTAL OCEAN IS A PEOPLED PLACE AND SPACE

To understand, avoid, and/or mitigate impacts of MRE development, it is essential to consider the context, that is, the place and space. Some have called the ocean a "peopled seascape" (Shackeroff *et al.*, 2009), characterized by diverse and extensive uses and users, with a range of values, preferences, and needs. Among the myriad existing uses of the marine and coastal zones that we documented are:

- commercial harvest and processing of fish/seafood
- consumptive and nonconsumptive recreation (e.g., fishing, boating, diving)
- transportation and shipping
- military operations
- sand and gravel excavation
- oil and gas generation
- scientific research

Using existing data along with new data collected through interviews and group meetings, we documented space use by those engaged in these activities. Impor-

tantly, we also documented the spatial and temporal variability in and nuances of these uses, the importance of place as well as space, and the sociocultural and socioeconomic impacts that could occur if these activities had to change due to MRE development and production. For example, we found that the focus of commercial shipping and transportation was on space (the ability to move from point a to point b as directly and safely as possible). In contrast, recreational fishing, boating, and scientific exploration activities were focused on place since their activities were often associated with particular geographies, temporal limits and/or long-term studies. Commercial seafood producers (fishermen, aquaculturists, processors) were focused on both space and place. They value having enough space to access moving resources, but also often rely on particular places, identified through the development and sharing of local knowledge, to succeed. An important key to cooperative sharing of space and/or place in the past has been the ability to move and use the place/space at a variety of times, sometimes with agreed-upon spatial limitations (e.g., towboat lanes) so that other users can access the space at the same time.

LESSONS LEARNED ABOUT UNDERSTANDING, AVOIDING, AND MITIGATING UNINTENDED IMPACTS

Indeed, the coastal ocean is a place of cooperation and conflict. Current ocean users talked about compatibility and on-going efforts to coexist. This cooperation exists within industries or groups, such as fishermen cooperating with fishermen to avoid gear conflict, or scientists cooperating with scientists to coordinate at-sea data collection. There also are examples of cooperation and conflict avoidance between industries or groups. Scientists and fishermen cooperate, both to avoid potentially detrimental conflicts between research equipment and fishing gear in areas they use in common, and in "cooperative fisheries research." Another example, the West Coast Crabber – Towboat Lane Agreement, established in the late 1970s to reduce dangerous and costly conflict and coordinate use of space valued by each group, persists to this day. The Oregon Fishermen's Cable Committee is a cooperative effort involving the cable and commercial fishing industries working to prevent and mitigate the costs of unintended interactions between fishing gear and seafloor cables. Participants in our study pointed to this last example, especially, as a model structure and process that enable these parties to co-exist and thrive.

Yet conflicts among existing uses still occur, especially when one or more users want exclusive access to an area. Federal, state, and regional agencies or organizations must then work to manage the space equitably. New uses such as aquaculture and marine renewable energy, with their demand for extensive, exclusive space, may engender additional serious conflicts.

Despite the diversity of uses and potential for conflict on both the Atlantic and Pacific Coasts, our study developed a number of common recommendations as marine renewable energy development efforts proceed:

- **Planning and siting of marine renewable energy facilities must be done with stakeholders involved throughout the process.** Marine renewable energy development is a multistage process that includes conceptualization, planning, and implementation. Transparency, communication, and incorporation of local knowledge of current ocean space users is critically important to the effective design and deployment of such efforts and to the avoidance or minimization of conflict.

- **Maps and images with easily understood descriptions are necessary but not sufficient for the planning process.** Maps provide particular snapshots in time and space and therefore have inherent limitations in conveying the highly dynamic nature of space and place use. Local knowledge of historical use is invaluable for understanding the dynamics and other nuances of use and for tracking changes in use, local conditions and context. Insights can be gained by looking back; problems can be avoided by looking forward.

- **Information on how some industries use the ocean is lacking, and this data gap should be addressed.** In addition to general use patterns and values, safety considerations are particularly important in the context of multiple ocean uses including marine renewable energy production. Indeed, as our data demonstrate, the coastal zone is a busy place. Crowding and other space constraints, on the waterfront as well as at sea, have implications for existing and prospective uses, especially as they interact with one another.

- **Sociocultural differences within and among regional user groups should be considered and included in the development and implementation of plans.** In addition to the practical considerations discussed here, several other values are central to the well-being of existing ocean and coastal space uses and users. Study participants highlighted a range of such values as aesthetics and "traditional use," and food and employment security. They also expressed concern about the distributional and cumulative impacts of MRE development, particularly on small-scale users who may not be well represented in decision-making processes.

- **Mitigation is not universally applauded.** Most study participants strongly preferred negotiation for allocating the use of commonly desired or needed space rather than mitigation for its loss. Within and among ports and user groups, however, ideas about whether and how to mitigate for loss of access and other impacts of marine renewable energy development and production varied. This evidence suggests that effort must be made to avoid the need for mitigation and, where that cannot or will not be done, to identify site-specific mitigation strategies.

It is incumbent upon coastal policy makers, managers, existing users, and the public to keep in mind potential differential impacts and vulnerabilities, and to commit to working together in an effective, responsible,

and swift manner to maintain or enhance the well-being of coastal space and place. Considering the human dimension is paramount to understanding, avoiding, and mitigating negative – and often unintended - impacts of coastal zone marine renewable energy generation.

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HAVE SOME COMMENTS ABOUT THIS ISSUE OF IMPACT? SEND US YOUR FEEDBACK

Water Resources IMPACT is in its 15th year of publication and we have explored a lot of ideas. We hope we have raised some questions for you to contemplate. "Feedback" is your opportunity to reflect and respond. We want to give you an opportunity to let your colleagues know your opinions ... we want to moderate a debate ... we want to know how we are doing. For this issue send your letters by e-mail to **fitche@marietta.edu.** Please share your opinions and ideas. Please limit your comments to approximately 350 to 400 words. If published, your comments may be edited for length or space requirements.

▲ IN MEMORIAM ... KENNETH L. BOWDEN (AWRA PRESIDENT, 1974)

AWRA Past President Kenneth L. Bowden, 78, died Friday, July 12, 2013 in DeKalb, Illinois. A native of Chicago, Ken attended Wheaton Academy, received his B. S. degree from Northern Illinois University, and his M.S. from the University of Michigan. He was a professor in the Northern Illinois University Geography Department for 30 years. He also served on the Presidential Advisory Committee for Water Resources in Washington, D.C. In retirement, he taught at Waubonsee College and at Elderhostels. Ken is survived by his wife of 49 years, Audrey Sue Pearson Bowden, his son Eric D. Bowden of Chicago, one sister and one nephew.

Ken was one of several dedicated individuals that saw the need for a multidisciplinary water resources organization and was a giant in the early history of AWRA. Ken was a charter member of AWRA when it was founded in 1964. In 1965, he was elected to the AWRA Board of Directors and served with distinction during the years that AWRA was experiencing fast growth. Also in 1965, he was chair of the Program Committee for the Second Annual Conference held at the University of Chicago. He served as Vice President in 1972, President-elect in 1973, and President of AWRA in 1974. His forethought and influence helped shape AWRA into the organization it is today. He was responsible for the creation of AWRA Student Chapters – today's student chapters owe their existence to him.

Ken will be greatly missed by the AWRA community.

WATER RESOURCES
IMPACT

MULTIHAZARD COASTAL INUNDATION RISE AND VULNERABILITY ASSESSMENT: A NEW GENERATION OF INUNDATION INFORMATION FOR COMMUNITY RESILIENCE PLANNING IN HONOLULU, HAWAII

Dolan Eversole

PROJECT SUMMARY

This project modeled sea-level rise (SLR) inundation to assess the increased coastal inundation risk and vulnerability from tsunami and hurricane of selected low elevation coastal lands in Hawaii. The project includes the primary urban corridor of Honolulu, Diamond Head to Pearl Harbor and includes urban Honolulu with high-density development, large population, major infrastructure and transportation assets representing the majority of the state's commercial and industrial sectors (Figure 1). Recent global projections for SLR suggest elevations by the end of the century will be significantly higher, possibly on the order of one meter or higher than current mean sea level. Therefore, coastal communities and ecosystems within low-elevation regions, are vulnerable to increased exposure to coastal inundation hazards related to SLR in addition to direct impacts resulting from SLR. Identifying and mapping the infrastructure located there, and assessing the socio-economic sectors that are likely to be impacted by SLR are critical components of coastal hazard and climate adaptation risk and vulnerability assessment. Potential flooding and coastal inundation occurring at the confluence of high tides (and/or high waves) and rainfall, and modeled storm surge inundation under SLR conditions are assessed as part of this mapping effort. The results of the study are being communicated to local emergency and resource managers, decision makers and affected communities in coordination with the project partners and will enhance local community resilience to coastal hazards.

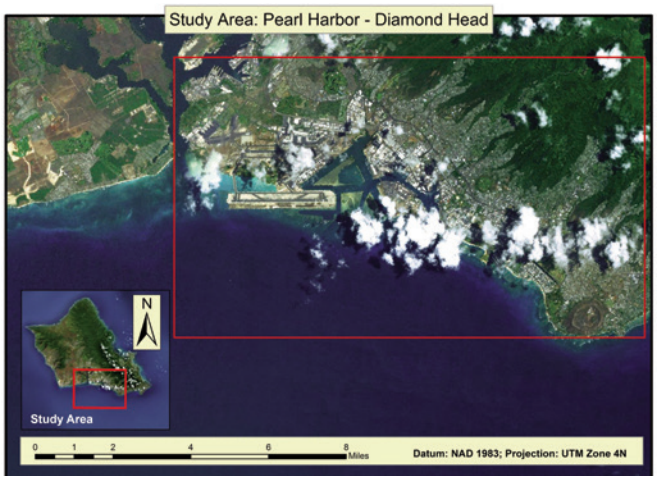

Figure 1. Project Study Area, Honolulu, Hawaii.

SUMMARY FINDINGS

- About 42% of the study area grid is flooded under the worst-case independent inundation scenarios due to hurricane storm surge, tsunami run-up and riverine flooding with one meter SLR.
- The largest independent cumulative area of flooding depth category is 1 to 3 feet (19.4%). Less than 5% grid cells are flooded beyond 8 feet.
- As a whole, $34.8 billion or 80% of the study area economy is exposed to the modeled combined hazard, the worst-case inundation scenario due to hurricane storm surge, tsunami run-up and riverine flooding with one meter SLR.
- The total economic value of tourism sector in the study area is $3.207 billion out of which $2.802 billion may be subjected to flooding (87%). The tourism economic exposure to the modeled flooding is therefore 87%.
- Building value exposed to flood hazards: $27.24 billion, 65% of the total building value in the study area.
- Land value exposed to flood hazards: $29.11 billion, 55% of the land building value in the study area.
- As a whole, 212,746 or 76% of the total study area jobs are exposed to the combined modeled hazard.
- As a percentage, except for the people with disability, the vulnerable population of Honolulu is proportionately more exposed. The total population percentage exposed to inundation is 45%, whereas exposure for the population under poverty, household without vehicle and, housing units occupied by renters are 52%, 63% and 57%, respectively (IPCC, 2007).

The results of this study are being used to guide local hazard and land use planning efforts ... these efforts will facilitate the development of actionable outcomes that constructively advance decision making on environmental disasters and will result in effective hazard planning, preparation and response, and support community resilience.

INTRODUCTION

This article provides an overview of a powerful new suite of sea-level rise (SLR) coastal inundation mapping products that serve as important risk assessment and planning tools. The study investigated the effects of SLR on the current tsunami and hurricane inundation zones in the urban core Honolulu, Hawaii. Based on a large body of international research of sea-level rise, the predicted global mean sea level could rise 32 cm and reach 75 to 190 cm over the next century, but most projections

for the year 2100 approximate one meter (Verneer and Rahmstorf, 2009; Rignot *et. al.*, 2011; Slangen *et al.*, 2012). The United States (U.S.) government has also identified four scenarios of global mean SLR ranging from 0.2 meters (8 inches) to 2.0 meters (6.6 feet) by the year 2100 (NOAA, 2013). These scenarios provide a set of plausible trajectories of global mean SLR for use in assessing vulnerability, impacts, and adaptation strategies. With regard to planning for sea-level change, a "one-size-fits-all" approach is not appropriate. There are simply too many environmental variables and political implications unique to each location to consider. For this reason a scenario approach is recommended that considers a range of hazard scenario possibilities and lets stakeholders incorporate the most appropriate values and variables to reflect the priorities of the community when conducting a risk and vulnerability assessment. The first step in considering a hazard scenario is to assess the frequency, magnitude, extent of the hazards (FEMA, 2010). This project incorporates the first step principle of hazard assessment in order to better understand the predominant hazards and vulnerabilities for Hawai'i's primary urban center and capitol.

As part of this effort, two inundation computer models were rerun with an elevated mean higher high water of +1 meter to produce a futuristic look at the existing storm surge and tsunami inundations zones. The storm surge model simulated a Category 4 hurricane, similar to Hurricane Iniki, which devastated the Island of Kauai in 1992, with a central pressure ranging from 910 to 970 millibar and maximum sustained winds ranging from 90 to 150 miles per hour. The model results show storm surge flow depth, flow speed and inundation extent. The second inundation model simulated maximum coastal inundation based on five major historical tsunamis that impacted Hawaii: (1) the 1946 Aleutian earthquake (8.2 M_w), (2) the 1952 Kamchatka earthquake (9.0 M_w), (3) the 1957 Aleutian earthquake (8.6 M_w), (4) the 1960 Chile earthquake (9.5 M_w), and (5) the 1964 Alaska earthquake (9.2 M_w). A 500-year return period inland flood was also incorporated into both the hurricane and tsunami coastal inundation models. The inland flooding flood depth grid was generated by using Hazus-MH flood model (FEMA, 2013). The hazard data, sea level rise estimates, storm surge and tsunami inundation areas were provided as part of a NOAA Coastal Storms Program (CSP) project in partnership with the University of Hawaii Sea Grant College. The three modeled products: (1) hurricane storm surge with one meter SLR, (2) inundation due to tsunami with one meter SLR, and (3) inland inundation due to 500-year flood event.

MAPPING SEA-LEVEL RISE HAZARDS

The base SLR mapping was conducted as part of a national mapping effort lead by The National Oceanographic and Atmospheric Administration (NOAA) Coastal Services Center (CSC) Digital Coast Sea Level Rise and Coastal Flooding Impacts Viewer (SLR Viewer). The Viewer brings risk and hazard mapping capability to coastal communities around the nation via an online web mapping service (Figure 2). The NOAA CSC has recently expanded the coverage of the SLR Viewer to include coastal counties in California, Oregon, and Washington. The viewer now covers nine states, with coverage eventually for all the nation's coasts. The tool features coastal flooding scenarios with visualizations of local landmarks, uncertainty maps, flood frequency information, and social and economic vulnerability information. The purpose of this data viewer is to provide coastal managers and scientists with a preliminary look at sea level rise and coastal flooding impacts. The viewer is a screening-level tool that uses nationally consistent data sets and analyses. Data and maps provided can be used at several scales to help gauge trends and prioritize actions for different scenarios. To compliment this mapping effort, NOAA has also produced a companion guidance SLR document in the form of a NOAA technical publication, which outlines eight steps a community can take to develop site-appropriate scenarios. Due diligence is required for this process, but the result is a reasonable and realistic approach to coastal community planning.

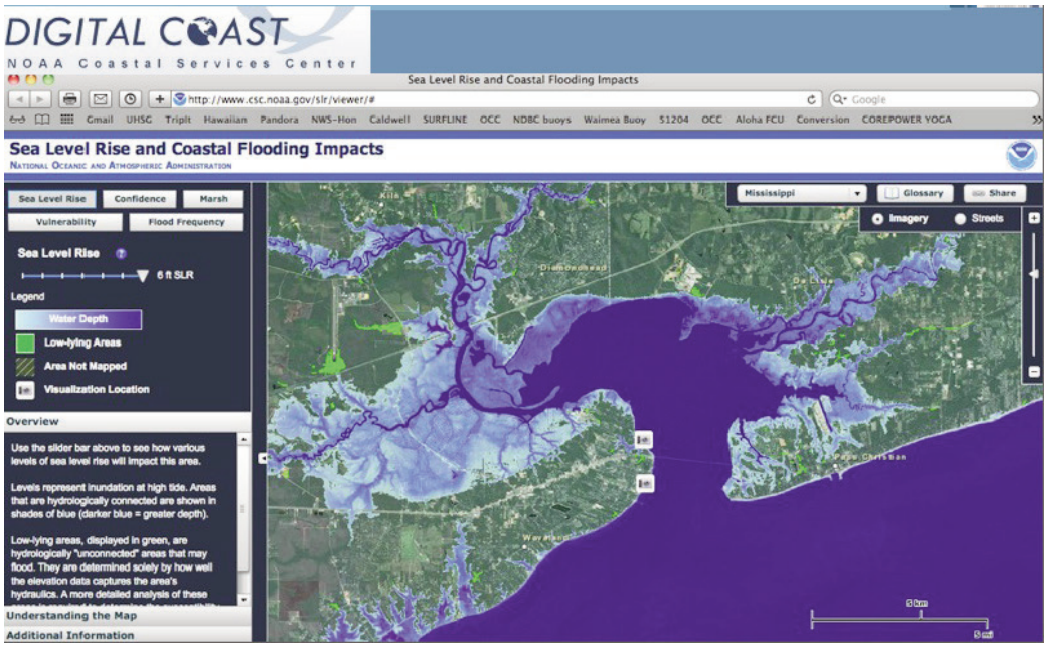

Figure 2. Example of the NOAA Sea-Level Rise Online Map Viewer (http://www.csc.noaa.gov/digitalcoast/tools/slrviewer).

CASE STUDY: HONOLULU COASTAL RISK AND VULNERABILITY STUDY

This project assesses the Risk and Vulnerability (R&V) of high-density urban coastal lands in Honolulu to coastal inundation hazards due sea-level rise (SLR). The project identifies low elevation regions of Honolulu that display vulnerability to coastal inundation from multiple sources. The results of this study are being used guide local hazard and land use planning efforts. These efforts will facilitate the development of actionable outcomes that constructively advance decision-making on environmental disasters and will result in effective hazard planning, preparation and response, and support community resilience. The project scope includes:

1. Mapping coastal inundation hazards including: tsunami, hurricane inundation and sea-level rise 1 meter above MHHW (Figure 3).
2. Compute model hurricane storm surge and tsunami inundation under one meter sea level projections (future hazard zones).
3. Develop a digital overlay of multiple coastal hazards for the region as a decision-support tool for planners.
4. Development of a critical infrastructure inventory and economic impact assessment based on the map products.

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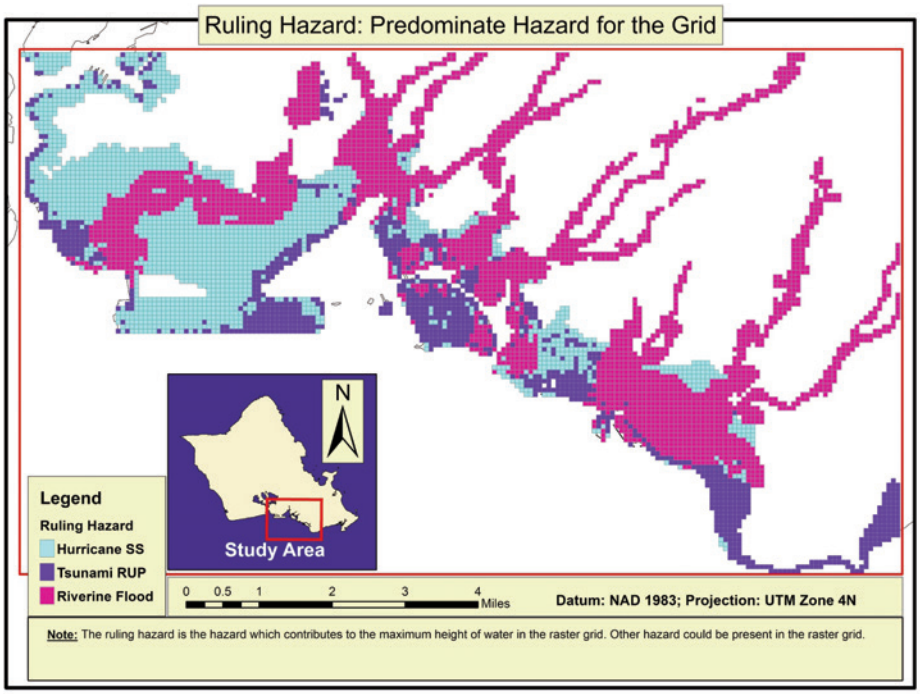

Figure 3. Predominant Hazard for the Project Area (this figure identifies the dominant hazard for the study area that affects the most grids in each area).

ASSESSING THE CURRENT AND PROJECTED IMPACTS OF CLIMATE CHANGE ON COASTAL AND OCEAN RESOURCES

Ralph Cantral

BACKGROUND

The National Climate Assessment is undertaken once every four years by the United States Global Change Research Program (USGCRP), a consortium of 13 Federal agencies. The goal is to understand changes in the climate and the impacts of these changes on a number of sectors of society. The Assessment is a requirement of the Global Change Research Act of 1990.

To undertake the Third National Assessment, the White House Office of Science and Technology Policy, working with the National Oceanic and Atmospheric Administration (NOAA), created an advisory committee composed of citizens with a variety of backgrounds as well as representatives of each of the 15 pertinent Federal agencies. Over the course of more than a year, the 60 member National Climate Assessment Development and Advisory Committee (NCADAC) worked with groups of experts from each of the sectors and from all regions of the country as they prepared technical input documents.

SECTORS ANALYZED IN THE THIRD NATIONAL CLIMATE ASSESSMENT

Water Resources
Energy Supply and Use
Transportation
Agriculture
Forestry
Ecosystems and Biodiversity
Human Health

CROSS-SECTORAL ANALYSIS

Water, Energy, and Land Use
Urban Systems, Infrastructure, and Vulnerability
Tribal, Indigenous, and Native Lands and Resources
Land Use and Land Cover Change
Rural Communities
Biogeochemical Cycles
Oceans and Marine Resources
Coastal Zone Development and Ecosystems

After receiving the technical inputs from the external teams, the NCADAC then appointed a set of lead authors for each of the chapters of the Assessment. These lead authors were charged with examining all available information on their topic, including identifying additional contributing authors as needed. In addition to a chapter on each of the sectors, the NCADAC appointed authors to look at each of the regions of the country as well as such topics as mitigation and adaptation, and decision support.

The NCADAC received all of the draft chapters in mid-2012 and released a draft of the report in January 2013. The draft report was open for public comment until April 12, 2013. The draft report is still available for inspection at http://ncadac.globalchange.gov/. The NCADAC is reviewing all of the public comments and will work with the lead authors to consider the public input and make amendments as warranted.

The purpose of this article is to identify existing and projected climate impacts to the people, the natural resources, and the economy of the coastal areas of the United States.

IMPACTS OF CLIMATE CHANGE ON COASTAL AND MARINE RESOURCES

In the two prior National Climate Assessments (2000 and 2009), coastal and marine resources were examined together. Due to numerous observations of changes in the ocean that could possibly be attributed to climate change, the continuing impacts of coastal storms and sea level rise, the NCADAC determined that separate chapters on the two regions should be prepared for the Third Assessment. In addition, coastal and marine impacts were identified in chapters related to such sectors as Transportation; Tribal, Indigenous and Native Lands and Resources, and Peoples; and Urban Systems, Infrastructure, and Vulnerability.

Coordination among public and private resource managers may reduce the impacts to the people of the coastal areas, yet management efforts needs high quality, up-to-date information ... the U.S. Global Change Research Program hopes to provide this information through a continuing assessment that can provide information as it becomes available as opposed to waiting for a formal report every four years.

IMPACTS TO COASTAL RESOURCES

The convening lead authors for the *Coastal Zone Development and Ecosystems* chapter were Margaret Davidson of NOAA and Susanne Moser of Moser Research and Consulting and Stanford University (Burkett and Davidson, 2012). The convening lead authors worked with six other lead authors from around the country to identify the key impacts. These impacts included:

1. Water supply and energy infrastructure and evacuation routes are increasingly vulnerable to higher sea levels and storm surges, inland flooding, and other climate-related changes.

2. Economic activity related to nationally important assets, such as ports, tourism and fishing sites will be disrupted by climate change and significant costs for protecting or moving them will be incurred.
3. Socioeconomic disparities will result in the displacement of the most vulnerable from coastal areas.
4. Coastal ecosystem services are particularly vulnerable to climate change because many resources have already been dramatically altered by human stresses.
5. Growing awareness of the high vulnerability of coasts to climate change will lead coastal regions to plan for potential impacts on their citizens, businesses, and environmental assets, but significant institutional, political, social, and economic obstacles to implementing adaptation actions remain. (NCA, 2013, p. 867).

In addition, the authors of the *Transportation* chapter identified the following key messages related to coastal areas :

1. The impacts from sea level rise and storm surge, extreme weather events, higher temperatures and heat waves, precipitation changes, Arctic warming, and other climatic conditions are reducing the reliability and capacity of the U.S. transportation system in many ways.
2. Sea level rise, coupled with storm surge, will continue to increase the risk of major coastal impacts, including both temporary and permanent flooding of airports, ports and harbors, roads, rail lines, tunnels, and bridges.
3. Extreme weather events currently disrupt transportation networks in all areas of the country; projections indicate that such disruptions will increase. (NCA 2013, p. 195).

The authors of the *Impacts of Climate Change on Tribal, Indigenous, and Native Lands and Resources* chapter also identified significant impacts on coastal communities.

> Accelerated sea level rise, erosion, permafrost thaw, and/or increased intensity of weather events are forcing relocation of entire tribal and indigenous communities in Alaska, Louisiana, the Pacific Islands, and other coastal locations. These relocations and the lack of governance mechanisms or funding to support them are causing loss of community and culture, health impacts, and economic decline, further exacerbating tribal impoverishment. (NCA 2013, p. 441).

The impact of climate change on the balance between freshwater and brackish water in coastal areas was identified by the authors of the *Water Resources* chapter.

> Sea level rise, storms and storm surges, and changes in surface and groundwater use patterns are expected to challenge the sustainability of coastal freshwater aquifers and wetlands. (NCA 2013, p. 107).

The impact of sea level rise on the regional economy was identified by more than one region, as the *Southeast and Caribbean* chapter found that:

> Sea level rise poses widespread and continuing threats to both natural and built environments, as well as the regional economy. (NCA 2013, p. 583)

The Southeast and Caribbean authors also found that the impacts of climate change would affect freshwater resources as well as brackish.

> Sea level rise increases pressure on utilities, water, and energy, for example, by contaminating potential freshwater supplies with salt water, and such problems are amplified during extreme dry events with little runoff. Although uncertainties in the scale, timing, and location of climate change impacts can make decision-making difficult, response strategies can be effective with early planning. Some utilities in the region are already taking sea level rise into account in the construction of new facilities and are seeking to diversify their water sources (NCA 2013 p. 592).

In the Northwest, the chapter authors found numerous impacts from climate change:

> In the coastal zone, the effects of erosion, inundation, threats to infrastructure and habitat, and increasing ocean acidity collectively pose a major threat to the region. (NCA 2013, p. 721)

OCEANS AND MARINE RESOURCES

Scott Doney of the Woods Hole Oceanographic Institution and Andrew Rosenberg of the Union of Concerned Scientists led the efforts to develop the *Ocean and Marine Resources* chapter of the Assessment (Griffis and Howard, 2012), The key messages that they and the six other authors identified included:

1. Ocean temperatures will continue to rise in the future and will have major impacts on climate, ocean circulation, chemistry, and ecosystems.
2. Continued ocean acidification will alter marine ecosystems in dramatic yet uncertain ways.
3. Habitat changes due to climate change, and especially for Arctic and coral reef ecosystems, will alter the distribution, abundance, and productivity of many marine species.
4. Rising sea surface temperatures have been linked with increasing levels and ranges of diseases of humans and marine life, such as corals, abalones, oysters, fishes, and marine mammals.
5. Altered environmental conditions due to climate change will affect, in both positive and negative ways, human uses of the ocean, including transportation, resource use and extraction, leisure and tourism activities and industries. (NCA, 2013, p. 835),

SUSTAINING THE ASSESSMENT PROCESS

The NCADAC also has placed a high priority on making the National Climate Assessment a continuous process as opposed to a series of individual reports. To that end, the final chapter in the Third Assessment is *The NCA Long-Term Process*. The USGCRP held a workshop in April 2013 to start the design of a long term process for the Coastal and Marine chapters.

The Sustaining National Climate Assessments of Oceans and Coasts Workshop was attended by approximately 60 representatives of a number of sectors, Federal agencies, and organizations. The participants examined the coastal and marine chapters of the draft 2014 National Climate Assessment, reviewed advances in science since the chapters were written, and made recommendations as to how to maintain the engagement of current participating agencies and organizations for the 2018 Assessment and beyond.

Both the *Long Term Process* chapter and the Oceans and Coasts workshop identified the development of a system of indicators as a high priority. As a system of indicators is developed, it is recommended that it focus on key aspects of change, ranging from direct impacts to vulnerabilities and states of readiness for impacts. These indicators would include resource status, rates of change, and trends related to physical, societal, and ecological variables. The need to have indicators that can be understood and used by the public as well as public officials who make decisions related to communities and land use was stressed in both the National Assessment and the workshop report.

One of the key recommendations of the draft report is that there needs to be a standing network of organizations from outside the government (corporations, foundations, professional societies, and advocacy groups) to provide a variety of functions in support of the National Assessment. The "NCAnet" (http://ncanet.usgcrp.gov/) was created in the fall of 2011 to bring these groups together for this purpose. It encourages groups to participate in a variety of capacities to support efforts ranging from communication to climate data collection.

CONCLUSION

The coastal areas of our country face serious impacts from climate change. Sea level rise, ocean acidification, changes in freshwater flows to estuaries, and drinking water shortages have all been identified in the Third National Climate Assessment. Coordination among public and private resource managers may reduce the impacts to the people of the coastal areas, yet management efforts needs high quality, up to date information. The U.S. Global Change Research Program hopes to provide this information through a continuing assessment that can provide information as it becomes available as opposed to waiting for a formal report every four years. NGOs and corporations are being sought to help with collecting and disseminating information.

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OF DROUGHTS AND TUNNELS: CALIFORNIA'S MEGA WATER PROJECT

Brian Bourquard and Clay Landry

Struggling under several years of drought, California's central and southern residents are seeking ways to shore up water supplies and provide relief to agricultural irrigators. In a state known for big plans and competing interests it should be no surprise that the proposed Sacramento-San Joaquin Delta Tunnel Project is a source of controversy.

It is not easy to determine economic damages to the state for water supply shortages, but anecdotally it is destroying livelihoods and depressing local economies. The *Wall Street Journal* reported on June 26, 2013, that cash crops are declining rapidly as irrigators in the Central Valley are being provided, "as little as 20% of their contracted supplies of water from the mountains of Northern California." The cotton harvest declined to 280,000 acres from 367,000 acres in 2012 and both honey and rangelands are experiencing dramatic productive declines. Shasta Lake, a key reservoir for the Central Valley Project, was at only 45 percent of its normal capacity on September 9. This year, 57 out of 58 California counties were declared disasters due to drought and farmers are expecting to increase fallowing next year, some by as much as 300 percent, leaving many farm workers out of jobs. To compound this, local businesses say they are also laying off staff to compensate for declining sales.

The solution from Sacramento: California Governor Jerry Brown backed a controversial infrastructure plan to construct tunnels to carry water from the Sacramento-San Joaquin River Delta to "farmland and cities." The 37-mile twin tunnels are to be 30 to 40 feet in diameter and will transport water from the Sacramento River to the head of the California Aqueduct, near Tracy. Construction costs for the tunnel generally fall around $15 billion with an additional $10 billion set aside for habitat restoration. The construction costs will be funded by water companies, and will therefore be passed onto the 25 million water users projected to benefit from the project. Despite the enormous cost, a recent study written by David Sunding of The Brattle Group and cited by the *Los Angeles Times* indicates that the project passes a cost-benefit test by a $5 billion margin. The report also notes that the tunnel would create or sustain $83.4 billion in business activity through its 50-year lifespan by averting further water supply cuts and creating various jobs. Alternatively, Jeffrey Michael, of the Business Forecasting Center at the University of the Pacific in Stockton claims that for every $1 in benefits, the project would cost $2.50. The disagreement between the reports comes predominately from a huge disparity in the valuations of water supply: UP Stockton values "Export Water Supply" at $3.9 billion while Sunding values "Water Supply Reliability" at $15.7 billion (both using a 3% discount rate).

The disparity may derive from inclusions by Sunding of employment impacts based on increased economic activity, particularly to agricultural producers. This would be welcome news to California's dry farmers and ranchers, who will unfortunately see no benefits, regardless of their size, for at least ten years. The project is not slated to open before 2025, if it ever makes it past the opposition.

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▲ AWRA FUTURE MEETINGS (2014)

May 12-14, 2014 ~ Cliff Lodge ~ Snowbird, Utah
AWRA'S 2014 SPRING SPECIALTY CONFERENCE
GIS AND WATER RESOURCES-VIII: DATA TO DECISIONS

June 30-July 2, 2014
John Ascuaga's Nugget Casino Resort ~ Reno, Nevada
AWRA'S 2014 SUMMER SPECIALTY CONFERENCE
INTEGRATED WATER RESOURCES MANAGEMENT:
FROM THEORY TO APPLICATION

AWRA's 2014 ANNUAL WATER RESOURCES CONFERENCE
November 3-6, 2014
Sheraton Premiere Hotel ~ Tysons Corner, Virginia

CHECK OUT AWRA'S WEBSITE FOR ADDITIONAL
INFORMATION ON ANY AWRA MEETING
www.awra.org

DOWN BY THE SEA

Eric J. Fitch

The first panacea for a mismanaged nation is inflation of the currency; the second is war. Both bring a temporary prosperity; both bring a permanent ruin. But both are the refuge of political and economic opportunists. ~ Ernest Hemingway

Prime Minster Count Rupert Mountjoy: *My idea was sound. Only an idiot could have won this war, and he did.*

Grand Duchess Gloriana: *How did the war go?*
Tulley Bascombe: *Well, this is a bit of a surprise. A pleasant one, I hope. I think we've won.*
Prime Minster Count Rupert Mountjoy: *You think you've *what*?* from *The Mouse that Roared*

Once upon a time (well, if you insist it was 1959), Peter Sellers, the late, great actor, starred in and played multiple roles in a hilarious little comedy called *The Mouse that Roared*. The basic premise was that a small European country (The Grand Duchy of Fenwick) was flat broke and its Prime Minister hatched an idea: declare war on the United States (U.S.), lose and have the U.S. rebuild the country and its economy. It was a great idea except by a series of misadventures the U.S. surrendered to the Grand Duchy. They of course had no idea what to do with us ... much like Congress or at least the Tea Party wing. [Please switch to heavy sarcasm reading mode. Thank you!] The other day, I read another marvelous idea: now that we are out of Iraq and soon to be out of Afghanistan (or is it vice versa), why don't we invade ourselves. We won't put up a fight, and then we can vote to rebuild ourselves putting millions of people to work on everything from infrastructure to art. We can call it the New New Deal or maybe the Truman Show Plan (we'll turn the whole thing into a giant reality show). [Heavy sarcasm mode off! Thank you for your cooperation!]

Now I know that the whole previous premise may sound exceeding silly, but my travels this summer have convinced me that it is no sillier than what we are doing. The waters of Honolulu harbor have been spoiled by 1,400 tons of molasses spilling into it from a broken, old commercial pipeline used to load the product onto ships. Last weekend, I left from Marietta, Ohio (where I live now) to Monroeville, Ohio (where my mother still lives on the family farm) to Toledo, Ohio (where I went to high school) for the ordination of a old friend. When I returned to Marietta Monday, my mom informed me that an intersection in Toledo that I had driven over at least three times during my visit had collapsed into a sinkhole swallowing whole a sedan down into the sewer system (thankfully no serious injuries or deaths). Everywhere I drove or traveled I saw urban and rural infrastructure decay. Most of this damage is from deferred maintenance, neglect, and decay. Now add to that the increasing damage that has been caused by natural disasters through a combination of sprawl/development and climate change. Fires in the southwest and west, floods in the mountains and plains, and the refuse of hurricanes from the previous season were all active matters for government action. None have received fully adequate support.

Fracturing in the infrastructure of democracy is making the situation almost unworkable (e.g. members of the House of Representatives voting for relief for disasters in their regions but against it anywhere else). It all reminds me of two periods in our history: the late 1850s/early 1860s and 1878 to 1898. We know that the first period was characterized by political and regional factionalism that led to the Civil War and the second the Gilded Age where the vast majority of Americans lived below the poverty line while a few plutocrats made fabulous fortunes. This led to a series of economic downturns culminating in the Great Depression. The crises that are confronting us and will be confronting us into the future was reinforced this week when the IPCC (Intergovernmental Panel on Climate Change) brought out its Fifth Major Report. We are more certain than ever that human-caused climate change is real, is happening now, and will be accelerating into the future. There will be more dislocation of water resource availability, there will be more droughts, more desertification, more sea level rise, more coastal land and water loss, loss of glaciers and ice caps, and destruction of habitability of islands and archipelagoes. More than ever, we need governments that listen to their scientists and work together to address current infrastructure problems and future needs.

If one looks at Congress today, it doesn't look like a source of such hope. But one should not just look to the past for fear as many do, but for hope as well. The Civil War led to (at least temporally) the elimination of the concept of autonomous separate states and a reaffirmation of the Union; the U.S. as a singular body. The conditions of the Gilded Age: the extreme concentration of wealth in the hands of the rich, the vast number of poor, awful working conditions for adults and children, junk medicines, unsafe food and wholly owned elected officials led to the Progressive Revolution of the first four decades of the 20th Century. Despite the conditions leading into them, both these experiences led to a stronger nation. Despite the current unpleasantness, let us hope the traumas of governance of today will lead us to a time where a stronger democracy will arise and our real problems becomes addressed ... or maybe we can just invade ourselves!

E-Mail Connection

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DO YOU EVER ASK YOURSELF ... *WHAT HAVE WE DONE???*

Laurel E. Phoenix

I feel like I am watching from a great distance, seeing a confluence of the tyranny of small decisions, past and future wastelands created by energy spills (spill-lands?), landscapes irrevocably damaged, and Black Swan events more frequently highlighting our idiocy. Most recently I have been viewing photos of Front Range flooding; particularly scenes of indundated fracking sites where soils and storage equipment has shifted, failed and spilled toxics into the floodwaters (see below).

Flooding is distributing fracking contaminants in even more mediums (e.g., residential yards, agricultural fields, riverbeds) than was previously envisioned and Colorado will have years of assessments ahead of them to measure the severity of soil and water contamination. (Food contamination will probably be overlooked, as it is usually.)

This flooding comes on the heels of the maps I've been perusing for the last month of various conventional oil and tar sands pipelines – present and future routes – tar sands railroad routes, fracking sites nationwide, and all of the rivers, lakes, and aquifers they intersect. By the time all this data is combined, you have a map where few places in the country are not at risk. I find this as horrifying as the massive contamination of the Gulf of Mexico by the 2010 BP oil spill and other ongoing spills in that region. One would think that, as a culture, we are suicidal. And considering that so much damage is risked, and inevitably, experienced, for a paltry amount of additional fossil fuels only temporarily delaying our experience of energy descent, one can only surmise that we are fools. Wake up, folks, and smell your future!

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Flooding of Colorado Frack Sites (photos courtesy of Robert Winkler).

WATER RESOURCES PRIORITIES FOR THE NEAR TERM FUTURE

Carol R. Collier

Lately I have been thinking a lot about water resource priorities for the near term future. This is driven by three events in my life. I have decided to retire from DRBC in March 2014. Fifteen years in the Executive Director position is enough for the person and the position! Wanting to stay involved in water resources, I have been developing a list of the greatest water resource needs in my area.

The second event was my attendance at the AWRA co-hosted conference on Water for Mega Cities, held in Beijing, which included some staggering facts on the numbers of persons who will be living in cities and the dire situation of water supply and infrastructure in many of them.

Lastly, the President's Hurricane Sandy Rebuilding Task Force recently released their report on recommendations on how to rebuild the Mid-Atlantic area that was devastated by the storm. Their basic recommendation was to plan for future storms in an age of climate change and rising sea levels.

The emphasis needs to be placed on the word PLAN. For the most part, we have not done a good job lately in planning for our future and that of our water resources. Whether the lack of planning is due to the recession, politics, or just being overwhelmed by the problems, the nation as a whole needs to step up our planning for sustainable water resources. Integrated plans that view groundwater and surface water conjunctively and address water quantity and quality should be prepared on a watershed basis at a fine enough scale (HUC 12?) to consider localized impacts. These plans should include assessment of needs (water supply for humans and the environment as well as virtual water needs), (raw and consumptive) over a number of time frames – 2025, 2040, 2060. An assessment of potential water supplies and conservation measures should be completed.

Planners have a pretty good handle on population growth projections (*albeit*, less defined the further out one goes), but the tricky part is to include other less well defined drivers of change. How much water should be left in the streams and rivers for aquatic communities, and, of course, the big elephant in the room - climate change. I am a true believer that climate change is and will continue to be a driving force in our management of water resources and glad to see the results of the newest IPCC report. We know that the drought and flood of record for a particular area are likely less severe than we will see in the future. How do we decide what bar to set for our planning process? We need to look at a range of potential scenarios and make changes to develop more resilient systems. What can be accomplished in the short term? What should be done for a "no regrets" policy? Climate change affects both water quantity and quality so potential solutions need to address both aspects.

Lessons learned from Superstorm Sandy also addressed the need for resilient electric power grids. Water and wastewater plants cannot function when the power is out. The report also cited the need for multiple communication channels and clarifying up front which agency does what. Rebuilding communities after disasters provides opportunity to test long standing hypotheses and make changes to planning assumptions. To increase resiliency, we will be forced to ask difficult questions. Is the existing infrastructure in optimal locations? What is the right mix of green and grey infrastructure projects in an uncertain world? Is there a better way – small wastewater facilities instead of massive regional treatment plants that can dewater watersheds? Are there new manufacturing or power generation technologies that will tax our water resources? Do agricultural crop selection or irrigation practices need to change in drought or flood prone areas?

There is a lot of work to do in order to be better prepared for an uncertain future. It takes time to change land use policies or build a new reservoir. The time is now to get started. My hope is that there will be a national push for water planning and action and AWRA will be there to help you find your way.

In closing, I want to say thank you to Earl Spangenberg for his years of service to AWRA and *IMPACT*. Job well done! This is my last President's column. The year went by incredibly fast, and my admiration for the staff and members of AWRA has grown exponentially. The organization is needed now more than ever!

E-Mail Connection

Carol R. Collier ~ president@awra.org

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DON'T MISS ANY OF AWRA'S FUTURE MEETINGS

SEE A COMPLETE LISTING FOR 2014 ON PG. 23

JOIN US AT OUR ANNUAL SPRING SPECIALTY CONFERENCE ON "GIS AND WATER RESOURCES-VIII"

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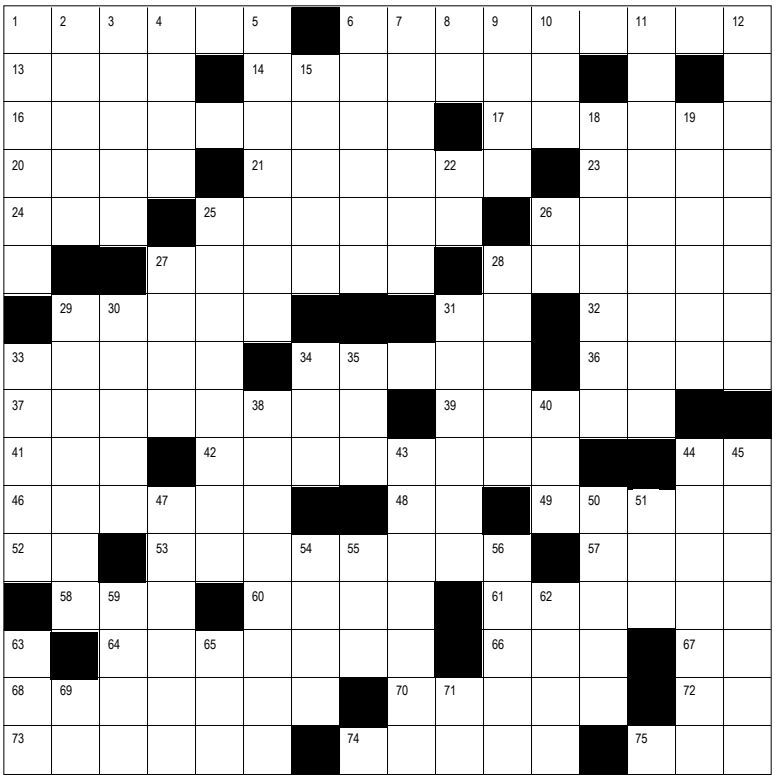
▲ WATER RESOURCES PUZZLER (answers on pg. 9)



ACROSS

1 Solstice
6 engulf
13 jungle sound
14 resistance to motion
16 downtown
17 a vast number
20 an odd man
21 indicates other
23 "At Last" singer
24 start of loft or stack
25 an alcove
26 followed by band or wool
27 sandy expanse
28 a hospital (obs.)
29 a strong gust
31 loc. of Quinnipiac. R.
32 an attorney's client
33 inner strength
34 forbidden
36 failed to be truthful
37 trapped
39 the interior of anything
41 allow
42 delicately
44 Plato's 12th letter
46 a light tint
48 loc. of James R.
49 an acrylic fiber
52 cousin of ave.
53 a visionary
57 congers
58 a witch
60 an inland sea
61 reflect
64 a graduated tape
66 a listening device
67 prof's assistant
68 a sweet water ice
70 parts of a decade
72 followed by art or ed
73 threw
74 books
75 HD flat screens

DOWN

1 Orville or Wilbur
2 ancient region of Asia Minor
3 type of nurse
4 a journey
5 wealthiest
6 a dog breed
7 most crooked
8 at. no. 85
9 prom transport
10 to sit down
11 a North American deer
12 biked
15 sibling's offspring
18 eyepiece grid
19 sergeant's command
22 host's plea: _____ VP
25 described again
26 editor's abbreviation
27 potty mouth's exclamation
28 followed by pigeon
29 under
30 endures
31 venemous snakes
33 assists
34 gallons in a hat?
35 sum up
38 let go
40 neighbor of Colo.
43 superstitious look
44 type of cocktail?
45 loosens
47 feline mammals
50 raises
51 _____ Brown of renown
54 "I'm in – – – –!"
55 ancient Roman diety
56 to give medical aid to
59 the singing _____ Brothers
62 hearing aids?
63 fast flier
65 honest prez.
69 fat man's pronouncement
71 former spouse

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AWRA 2014-2015 RICHARD A. HERBERT MEMORIAL SCHOLARSHIP OPPORTUNITIES

Background – In 1980, AWRA established the Endowment-Memorial Fund to be used for the enhancement of education in water resources. The fund has since been renamed the Richard A. Herbert Memorial Educational Fund to honor Richard A. Herbert -- a champion for water resources education -- who passed away in 1994. In order to carry out his vision, AWRA is proud to announce the availability of scholarships derived from the proceeds of this fund.

Eligibility and Awards Available – **Each applicant must be a national AWRA member.** At least one $2,000 scholarship will be awarded to a **full-time undergraduate student** working toward his/her first undergraduate degree and who is enrolled in a program related to water resources for the 2014-2015 academic year. At least one $2,000 scholarship will also be awarded to a **full-time graduate student** enrolled in a program relating to water resources for the 2014-2015 academic year. (The AWRA Board of Directors may, at its sole discretion, approve additional scholarship awards, based upon the performance of the Memorial Fund.)

Selection Criteria – The **undergraduate scholarship** will be awarded to the student most qualified by academic performance. Measures of academic performance include the cumulative grade point average, relevance of the student's curriculum to water resources, and leadership in extracurricular activities related to water resources. The **graduate scholarship** will be awarded to the student most qualified by academic and/or research performance. The measures of academic performance are identical to those of the undergraduate scholarship with the addition of the quality of the student's research and its relevance to water resources. Recipients will be selected by the AWRA Student Activities Committee and announced during summer 2014.

Application Process – A complete application packet contains:

- Title page that includes the applicant's full name, permanent mailing address, email address, phone number where he or she may be easily reached, and the type of scholarship (undergraduate or graduate).
- Two-page summary (approx. 500 words) of his/her academic interests and achievements, extracurricular interests, and career goals as they relate to the above selection criteria.
- Resume or curriculum vitae.
- Three signed letters of reference from professors and/or advisors. Letters of reference MUST include the signatures of the referee – PDFs of the signed letters work best.
- Transcripts of all college courses (undergraduate and graduate). **Legible** copies of "Issued to Student" transcripts are acceptable to save on fees but unofficial grade reports (such as those students can access from their online student accounts at the university) are unacceptable. ***Application packets that include unofficial grade reports will not be considered.***

Application packets should be submitted electronically to info@awra.org and limited to 5mb in size to ensure delivery. ***All applications must be submitted in their entirety.*** AWRA will provide an acknowledgement of receipt of your application but will not provide updates to your application status or request missing information. Please make sure your application is complete when it is submitted. We look forward to hearing from you.

Deadline
All applications and supporting materials must be received electronically by **APRIL 22, 2014**

Questions?
Call AWRA at (540) 687-8390 or send an e-mail to **info@awra.org**

AWRA
Community, Conversation, Connections
American Water Resources Association

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ENVIRONMENTAL ENGINEERING FACULTY POSITION

University of Maryland, Department of Civil and Environmental Engineering seeks applicants for a tenure-track position in environmental engineering, preferably at the assistant professor level, but appointment at other ranks will be considered.

We are especially seeking candidates with an academic background in water sustainability and biological processes, possibly including biological energy conversion processes.

Candidates should demonstrate the ability to: teach effectively at the undergraduate and graduate levels, guide an active scholarly research program, and obtain funding from competitive external funding agencies. Of specific interest is expertise that would complement existing research programs. UMD has a strong Engineers Without Borders program and EWB experience is a plus. All applicants must hold a PhD in Civil or Environmental Engineering or a related field by September 2014 for appointment in fall 2014.

For best consideration applications should be received by December 20, 2013, but later applications may be reviewed. Applications should include a cover letter, curriculum vitae, statement of research and teaching interests, and four names of references with contact information. Applicants should apply electronically at https://jobs.umd.edu/applicants/jsp/shared/Welcome_css.jsp, position number 116995.

Questions should be referred to:
Ms. Janet Alessandrini
Tel: +1 301-405-1974
Email: jalessan@umd.edu

The University of Maryland is an equal opportunity and affirmative action employer. Women and under-represented minority candidates are particularly encouraged to apply.

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COMMENTS FROM THE EDITOR-IN-CHIEF ... A FINAL EDITORIAL

N. Earl Spangenberg
Editor-in-Chief
Water Resources IMPACT
1999-2013

This is the last issue which will bear my name on the masthead. For personal reasons, I am resigning as Editor-in-Chief as of January 2014.

I was told long ago that I should write regular editorials and get my picture in the magazine. As you know by now, that recommendation fell on deaf ears. I didn't follow the suggestion because *IMPACT* isn't me, and I didn't think it appropriate to assume credit for the hard work of a lot of people,

Water Resources IMPACT is the product of Associate Editors, Guest Editors, and authors working together. Our aim has been to produce an assembly of articles to highlight the variety of problems, and the plethora of opportunities facing the water resources professional. Every other month since 1999, we have brought thought-provoking, interesting information to you that we hoped would expand your horizons, and give you insight into happenings outside of your own area of practice and expertise. As someone in some planning conference once said " to show us something besides our own silos."

I think we've succeeded.

While I can't know what the future holds, I believe that we've provided a template that will help *IMPACT* to grow and develop further in interest and importance.

This has been a great ride folks! I have enjoyed working with all the Associate and Guest Editors and authors who have made *IMPACT* what it is. Thank you all for the time and energy you have devoted to writng, rewriting, editing, and re-editing to bring each issue to press. Finally, a special thank-you to Charlene Young, our long-time publications director, without whose composition and publishing skills we would be nothing.

Earl