Resistance to Resilience: Coastal Hazard Policy, Science & Planning in New Jersey[1]

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I. Introduction

Although New Jersey is the fourth smallest state in the United States, its high population density and physiographic diversity make it a unique landscape through which to view coastal hazard policy. More than eight and a half million people presently reside in New Jersey's coastal counties, a 21% increase since 1980.[3] Roughly bounded by New York City to the north and Delaware Bay to the south, the state's coastal area is largely comprised of low-lying barrier islands and tidal marshes, interrupted by geologic headlands in northeastern Monmouth County and southern Cape May County, totaling 1,792 linear miles altogether.[4] In the past fifty years, New Jersey has been impacted by an array of nor'easters, tropical storms, and intense rain events that have caused extensive damage throughout the shore area, in some instances washing away sections of communities and reshaping barrier island systems within single tidal

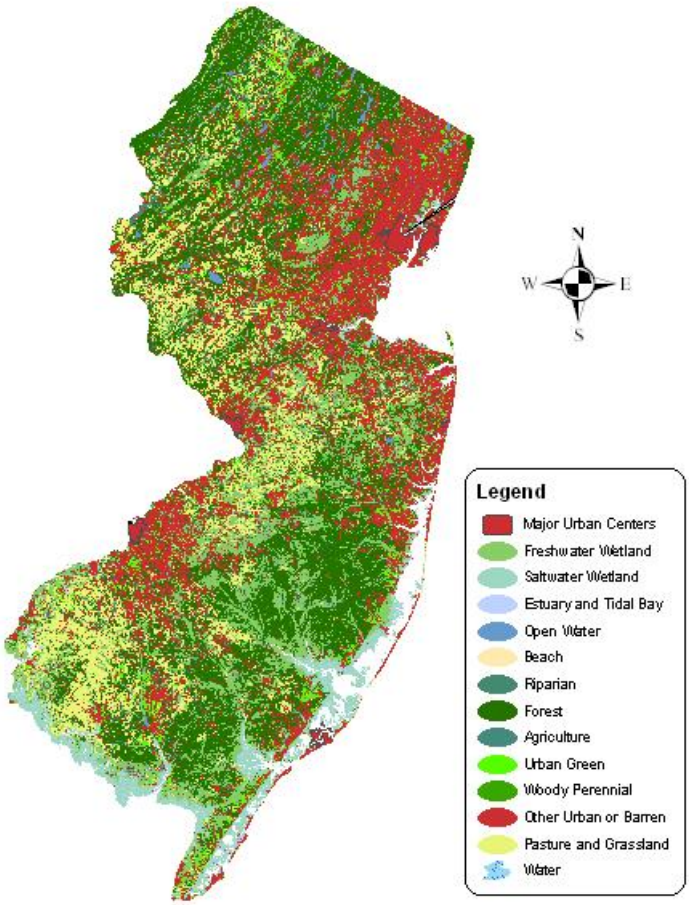
[1] This paper was presented during the Sea Grant Law and Policy Journal's inaugural symposium on Coastal Resiliency held on March 25–26, 2008 at the University of Mississippi in Oxford, Mississippi. Coastal resiliency refers to the ability of coastal cities, towns, and communities to adapt to and recover from natural hazards, including hurricanes, tsunamis, floods, and disease epidemics. Seven authors were selected to present papers on a wide range of topics related to coastal resiliency. Powerpoint presentations and additional information about the symposium are available at http://www.olemiss.edu/orgs/SGLC/National/SGLPJ/SGLPJ.htm .

[2] N.J. Coastal Planning Office.

[3] NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), POPULATION TRENDS ALONG THE COASTAL UNITED STATES: 1980-2008 (2004).

[4] B.R. COLLINS AND K.H. ANDERSON, PLANT COMMUNITIES OF NEW JERSEY: A STUDY IN LANDSCAPE DIVERSITY (1994).

cycles.[5] While much of New Jersey's coastal landscape remains highly susceptible to tidal flooding during strong storm events, the region's population has continued to swell, expanding the interface between natural and human systems. In many areas, where extensive natural areas once existed, residential and commercial development has taken over. More recently, large portions of the coastal landscape have been transformed from small, year-round residential neighborhoods to high-end vacation communities for second-home owners, exacerbating the exposure of people, property, and infrastructure to potential loss.



New Jersey Statewide Land Cover (1995)

New Jersey's approach to statewide resilience policy has been a multi-layered regulatory and planning effort that seeks to support a variety of hazard mitigation efforts across a diverse coastal zone. The complex interplay of New Jersey's physiographic regions and population patterns over many decades has yielded a densely populated, near-sea level metropolitan population to the north, more moderate urban and suburban development along the Atlantic barrier island and back bay central regions, and a more sparsely populated, extensive wetlands area along the state's southern Atlantic and Delaware Bay coasts. A myriad of regulatory tools and authorities have been developed to manage these diverse coastal areas, requiring extensive coordination of state mitigation efforts with respect to coastal hazards.

[5] N.P. PSUTY AND D.D. OFIARA, COASTAL HAZARD MANAGEMENT, LESSONS AND FUTURE DIRECTIONS FROM NEW JERSEY (2002).

II. New Jersey Coastal Management

To develop an integrated framework of coastal management, New Jersey's Coastal Management Program was established as the regulatory and planning arm of the federal Coastal Zone Management Program in 1978, integrating the overarching policies of the state's Coastal Area Facilities Review Act of 1973 (CAFRA),[6] the Waterfront Development Law,[7] the Wetlands Act of 1970,[8] and the Tidelands Act.[9]

The overarching goal of the Coastal Management Program is to address:

> the complex coastal ecosystem as a whole, integrating goals and standards for protection/enhancement of natural resources, for appropriate land use and development and for public access to and use of coastal resources.[10]

Passed prior to the establishment of New Jersey's Coastal Management Program, the Wetlands Act of 1970 requires the New Jersey Department of Environmental Protection (NJDEP) to regulate all development on lands near tidal water, due to the likely presence of coastal wetlands either on-site or nearby. At present, 15% of New Jersey's landscape, approximately 700,000 acres, exists as freshwater wetlands.[11] Although much of the state's coastal region is characterized by tidal and freshwater ecosystems, NJDEP estimates that 39% of its original wetland area was lost from 1870 to 1970, and despite the State's targets to increase net wetland acreage in the state, estimates continue to indicate a wetland loss rate of 1020 acres per year (although this represents a 52% decrease in wetland loss from prior assessments).[12]

The coastal area in northern New Jersey, notably Hudson and Essex counties, consists largely of urbanized impervious surface and shoreline bulkheading, past zoning policies having encouraged dense settlement patterns in close proximity to the large mosaic of fluvial wetlands known as the Meadowlands. South of the Meadowlands along the Arthur Kill tidal strait separating New Jersey and Staten Island, the coastal area remains highly developed, albeit more sparsely, down to the southern edge of Staten Island where the Raritan River enters lower New York Bay, with the region dominated by the Port Elizabeth and Port Newark shipping terminals.

In the region south of the Cheesequake Creek – Raritan River confluence, coastal management jurisdiction is accomplished through the enforcement of the Wetlands Act and CAFRA. The landward distance of New Jersey's CAFRA delineation ranges throughout the southern half of the state from a few thousand feet to approximately twenty-four miles, providing jurisdiction over more than fifty communities and approximately 963 square miles of the state's Atlantic Ocean and Delaware Bay coasts. The landward extent of the CAFRA zone follows an irregular line determined by public roads, railroad tracks, and natural landscape features incorporating much of the wetlands and tidelands regions throughout the outer coastal plain. Within this area, proposed development is regulated with increasing degrees of scrutiny, contingent upon the construction's proximity to tidal water bodies. More specifically, coastal zone types classified as "high hazard," "erosion hazard," and "flood hazard" are

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[6] N.J. STAT. ANN. § 13:19-1 *et seq.*
[7] Id. § 12:5-1 *et seq*..
[8] *Id.* § 13:9A
[9] *Id.* § 12:3-1 *et seq.*.
[10] N.J. ADMIN. CODE § 7:7E.
[11] R.G., LATHROP, MEASURING LAND USE CHANGE IN NEW JERSEY: LAND USE UPDATE TO YEAR 2000. A REPORT ON RECENT DEVELOPMENT PATTERNS 1995 TO 2000 (2004).
[12] *Id*.; NEW JERSEY SUSTAINABLE STATE INSTITUTE, LIVING WITH THE FUTURE IN MIND (3d ed. 2004).

subject to unique regulations based on an understanding of those regions' hazard vulnerability from past episodes of coastal flooding and storm surge.

New Jersey Coastal Area Facilities Review Act Region

Overall, CAFRA prohibits development in coastal high hazard areas with the exception of single family and duplex infill developments that must meet two specific standards. In the first standard, proposed developments must be sited at a distance greater than 500 feet from the mean high water mark of the affecting water body. In the second, an exception may be granted if the cross-sectional volume of the primary frontal dune between the proposed development site and affecting water body exceeds 1100 square feet, the area most recently deemed by the Federal Emergency Management Agency (FEMA) as necessary to provide an effective barrier to 100-year flood events and associated wave action.[13]

[13] 44 C.F.R. § 65.11; N.J. ADMIN. CODE § 7:7e – 7.2 et seq.

Erosion hazard areas are defined as those regions anticipated to erode over a certain period of time based on best available erosion rates. Present Coastal Zone Management Rules proscribe time horizons of thirty years for one to four unit dwelling structures and sixty years for all other structures in both developed and undeveloped regions. The erosion hazard areas extend inland from either the most landward stabilized upland area, the crests of coastal bluffs or unvegetated dunes, or the first vegetation line from the water for vegetated dune areas. If the area in question does not have dunes, the erosion hazard areas are measured from the eight foot contour line (as defined relative to National American Datum 1983).[14]

While erosion hazard areas are New Jersey's version of rolling setbacks, two scale issues emerge. First, erosion rates used to estimate the extent of future erosion is based on one-mile sampling intervals, valuable for regional assessments, but often less so for municipal officials addressing localized erosion at the block group or parcel level. Secondly, the rules are based on past erosion trends that may not reflect potentially accelerated erosion rates due to sea level rise due to human climate forcing. In light of recent scientific assessments addressing the potential for such complex interactions,[15] the Coastal Management Office is well served in continuing to monitor and address policy concerns regarding the impact of coastal sensitivity in erosion hazard zones.

In New Jersey, hazard mitigation efforts must be perceived through the lens of municipal "home rule" authority, which extends to municipal governments "the fullest and most complete powers possible over the internal affairs of such municipalities for local self-government."[16] This authority extends such that while extensive resources have been allocated towards past hazard mitigation efforts, success in effecting consistent hazard mitigation is strongly predicated on the willingness of local governments to consider state goals in their land use considerations. Planning and regulation within different coastal zone areas is therefore reflective of both past development trends and the potential impact of anticipated future hazards.

In order to promote and support resilient coastal development, planners must have a comprehensive understanding of both current risks and anticipated future scenarios based on present biophysical and socio-economic landscape trends. As Honeycutt & Mauriello note, "sustainable, hazard-resistant coastal development (and redevelopment), must be carried out with . . . knowledge of the interrelationships and consequences of the development practices employed."[17] Accordingly, resilience is a multi-faceted and constantly evolving process in coastal regions, a pursuit that demands redundancy, diversity, efficiency, autonomy, strength, interdependence, adaptability, and collaboration.[18]

III. New Jersey Coastal Resiliency Planning

A. State Land Acquisition

Within the framework of coastal regulation, state and local governments are charged with different responsibilities in addressing coastal resilience planning. At the state level, the State Planning Commission was established in 1985 and is charged with preparing, revising, and readopting New

[14] N.J. ADMIN. CODE § 7:7e – 3.19.
[15] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FOURTH ASSESSMENT REPORT (AR4). (2007).
[16] N.J. STAT. ANN. § 40:42 *et. seq* .
[17] M.G. Honeycutt and M.N. Mauriello, *Multi-Hazard Mitigation in the Coastal Zone: When Meeting the Minimum Regulatory Requirements Isn't Enough*, in Conference Proceedings of Solutions to Coastal Disasters 2005 176, 71 (2005).
[18] D.R. Godschalk, *Urban Hazard Mitigation: Creating Resilient Cities.* NATURAL HAZARDS REVIEW 4(3): 136–143 (2003).

Jersey's State Plan every three years utilizing "cross-acceptance" to incorporate the needs and interests of impacted, nearby communities in regional decision-making.[19]

The State's open space acquisition program, Green Acres, was created in 1961 to support the state goals of providing public conservation and recreation. The Program was supported from 1961 to 1995 through a series of voter-approved bond measures. In 1998, voters approved a referendum to provide stable funding, which resulted in the legislative establishment of the Garden State Preservation Trust in 1999.[20] For coastal areas, the State originally set aside $15 million for the Coastal Blue Acres program established exclusively to acquire properties for improved flood mitigation.[21] Of that $15 million, $6 million was dedicated to pre-storm acquisition of unimproved storm damage-prone and buffer areas and $9 million for post-storm property acquisitions in areas suffering at least a 50% reduction in value due to storm damages. Prospective properties must be located either on coastal barrier islands, within 150 feet of mean high water of a tidal waterway, or 150 feet of the landward limit of a beach or dune. Funding for this program was extended in 2007, when Governor Jon Corzine signed the *Green Acres, Farmland, Blue Acres, and Historic Preservation Bond Act of 2007* dedicating $12 million to acquire floodway areas of the Delaware, Passaic and Raritan Rivers, and their tributaries.[22]

B. Shore Protection

While state Blue Acres funding is significant, its funds are appropriated for projects throughout the state. The funding burden for coastal hazard mitigation falls more significantly on New Jersey's Shore Protection Fund established by the Shore Protection Bond Act of 1983.[23] The Fund has had a dedicated revenue stream since 1992 when the New Jersey Legislature decided to allocate a portion of the state-dedicated realty transfer fee, capped at $25 million per year, to the Fund.[24] The revenue stream supports the Bureau of Coastal Engineering by providing state-federal and state-local cost shares to fund protection projects associated with the protection, stabilization, restoration, or maintenance of the shore, including monitoring studies and land acquisition.[25]

In the period between fiscal years 2003 and 2008, 57 coastal projects have been funded through the state's Shore Protection Program in 53 different CAFRA municipalities. 32 of these projects have been "hard" engineering constructs, consisting of installations or restorations of coastal bulkheads, revetments, groins, and sea walls in highly eroded or unstable areas. Remaining projects have been soft engineering projects, such as dune creation and maintenance in less critically vulnerable areas and geotubes and breakwaters in high-wave energy zones.

C. State Hazard Mitigation Task Force

In 1994, Governor James Florio signed Executive Order No. 115, establishing the State Hazard Mitigation Task Force to coordinate state emergency management, environmental protection, and planning agencies in overseeing statewide mitigation projects and planning.[26] The group was charged

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[19] N.J. STAT. ANN. § 52:18A-196 *et seq*.
[20] NEW JERSEY OFFICE OF EMERGENCY MANAGEMENT, NATURAL HAZARD MITIGATION PLAN (2008); N.J. STAT. ANN. § 13:8C-1 *et seq*.
[21] Green Acres, Farmland, Historic Preservation and Blue Acres Bond Act of 1995, Pub. L. No. 204 (1995).
[22] Green Acres, Farmland, Blue Acres, and Historic Preservation Bond Act of 2007, Pub. L. No. 119 (2007).
[23] Shore Protection Bond Act of 1983, Pub. L. No. 356 (1983).
[24] The fee varies from $2.00 to $6.05 per $500 assessed value based on the type and total value of the property being transferred. RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY, AN ECONOMIC ANALYSIS OF NEW JERSEY'S REALTY TRANSFER FEE (Feb. 2006).
[25] N.J. STAT. ANN. § 13:19 – 16.
[26] Exec. Order No. 115, Establishment of Interagency State Mitigation Team, Governor Florio, Jan. 14, 1994.

with developing and maintaining comprehensive hazard reduction plans, increasing public awareness of hazard risks and promoting preparedness, and developing a systematic program to identify hazards, monitor changes in vulnerability and implement measures to reduce potential damage.

The Task Force, headed by the State Police Office of Emergency Management, administers and operates FEMA grant programs in the state, including the Flood Mitigation Assistance, Pre-Disaster Mitigation, Repetitive Flood Claims, Severe Repetitive Loss, and Hazard Mitigation Grant Programs. Of these, the first four are pre-disaster programs aimed at funding plans or projects that identify or mitigate developments or programs that increase community vulnerability to flooding hazards. Conversely, the Hazard Mitigation Grant Program, authorized by the 1988 Stafford Act, administers post-disaster recovery funds to communities with FEMA-approved All-Hazard Mitigation Plans to further encourage community preparedness.

In 2000, Congress passed the Disaster Mitigation Act in order "to provide an orderly and continuing means of assistance by the Federal Government to State and local governments" in mitigating hazard potential and increasing community preparedness.[27] The Act mandated that State and local governments wishing to remain eligible for federal emergency management relief funding and pre-disaster mitigation grants, establish FEMA-approved hazard mitigation plans. In 2005, New Jersey adopted its first official Statewide Hazard Mitigation Plan to facilitate hazard mitigation planning and projects at the county and local levels through the coordination of state resources in emergency management, environmental protection, transportation, community affairs, and banking and insurance.[28] Using this plan as a template, hazard planning has become increasingly integrated in New Jersey's statewide master plans, most notably in the 2001 State Planning Act, that provided both the State Planning Commission and State Hazard Mitigation Task Force the opportunity for coordinated plan review through the State's tradition of "cross-acceptance."[29] Representation by the Department of Community Affairs' Office of Smart Growth on both the Task Force and State Planning Commission serves to advise both entities when proposed changes to the state's Development and Redevelopment Plan may encourage hazard-prone developments, increase hazard to adjacent areas, or detrimentally impact floodplain regions.

IV. Flood Insurance and the Coast

A. National Flood Insurance and Community Rating

The State Hazard Mitigation Plan's 2008 update indicates that all but twenty-two of New Jersey's 567 municipalities were participating in the National Flood Insurance Program (NFIP). Forty-four of the state's municipalities participate in the National Flood Insurance Program's Community Rating System to leverage municipal resources into community premium reductions, thirty-six of which are located in the state's CAFRA zone.[30] Of these, twelve municipalities have earned advanced classifications of 7 or higher (on a scale of 1-9, with 1 being the highest). Avalon, in northern Cape May County, has the highest classification with a Class 6. By fall 2007, all of the state's counties (either independently or in conjunction with one another) had received funding to commence development of all-hazard mitigation plans, if those plans had not already been earlier initiated without funding.

B. Policies and Claims in Perspective

[27] Disaster Mitigation Act of 2000, Pub. L. No. 106-390 (codified at 44 U.S.C. § 5121).
[28] NEW JERSEY OFFICE OF EMERGENCY MANAGEMENT, NATURAL HAZARD MITIGATION PLAN (2008).
[29] N.J. STAT. ANN. § 52:18A-196 *et seq*.
[30] Natural Hazard Mitigation Plan, *supra* note 27.

Given state and national investment in hazard mitigation, planners must consider the relative impact on flood insurance coverage and claims in New Jersey against a national backdrop. In 2007, New Jersey had 221,879 active flood insurance policies, ranking fifth nationally behind Florida, Louisiana, Texas, and California, all of which dwarf New Jersey's total land area.[31] New Jersey far exceeded second-ranked Texas, a state thirty times its size, in total claims by more than 20%. Since 1978, New Jersey has ranked fifth nationally in policies in force and seventh in total flood claims, but first categories in terms of claims per unit area.

While the actual number and total loss value of flood claims in any given year varies with climactic trends and storm patterns, these statistics illustrate the effect of past development on the state's floodplain. Even more significant is the number of the State's coastal repetitive and severe repetitive loss properties. Along the Atlantic coast alone, more than 9800 repetitive and severe repetitive loss properties have totalled more than $556 million dollars in losses since the program's inception.[32] It is anticipated, however, that the 2004 Flood Insurance Reform Act, which instituted a pilot program to wean severe repetitive loss properties from the NFIP's rolls will, over time, address this lingering problem.[33]

C. Flood Mitigation Trends

Although New Jersey has developed a variety of mechanisms to address coastal hazard regulation and planning in the state's coastal regions, demographic trends continue to illustrate residential migration to coastal areas throughout the Atlantic seaboard.[34] Due to the state's large coastal area relative to its total land area and increasing population migration, New Jersey consistently ranks among the top states in annual flood claims and total loss value.

In striving to address and mitigate the vulnerability of the state's most vulnerable areas, the State Hazard Mitigation Task Force has been active in facilitating FEMA's hazard grant funds toward specific plans and projects throughout the state. In the past three years alone, through FEMA's Pre-Disaster Mitigation, Flood Mitigation Assistance, and Hazard Mitigation Grant Program, the state has leveraged over $5 million toward the development of mitigation plans for all of the state's counties. The Task Force has obtained an additional $15 million in federal funds to elevate or acquire a number of the state's high-risk and repetitive loss properties. With the exception of a pumping station in Brigantine City, however, hazard mitigation funds have been overwhelmingly directed toward inland at-risk properties. Given that the extent and intensity of major flood damage has largely impacted more central and western portions of the state, or has affected coastal areas during periods of low tide, the dearth of coastal area mitigation projects is understandable. While the State Office of Emergency Management and Land Use Regulation Program at NJDEP coordinates communication and outreach with interested local officials, the absence of compulsory incentives for proactive mitigation means that engaged communities reap the benefit of federal hazard mitigation support, while others miss continued funding opportunities for proactive coastal hazard planning.

Flood mitigation projects in coastal areas, however, deal more directly with the impacts of regional shoreline erosion, garnering much of their support through Federal beach nourishment and State Shore Protection Funding. It is unknown, however, how the financial burden of beach nourishment in New Jersey will shift in coming years, given the significant amount of federal investment in past beach

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[31] National Flood Insurance Program, Policy & Claim Statistics 2007. *available at* (http://www.fema.gov/business/nfip/statistics/pcstat.shtm)
[32] Natural Hazard Mitigation Plan, *supra* note 27.
[33] Bunning-Bereuter-Blumenaurer Flood Insurance Reform Act of 2004, Pub. L. No. 108-264 (codified at 42 U.S.C. § 4001 Sec. 102).
[34] NOAA, *supra* note 3.

nourishment and the increasing cost of identifying and transporting potential sediment beds from New Jersey coastal waters. If national legislators and executives choose to begin divesting themselves of the federal cost-share of New Jersey's and others' beach nourishment programs, the burden of coastal hazard defense would fall more squarely on the shoulders of the state's shore protection and state hazard mitigation programs, significantly affecting the state's traditional operating framework.

Consequently, despite past efforts, coastal flooding remains of major concern for citizens and government officials. To that effect, the state's foremost challenge to integrating resilience into its policy framework is to have a broad understanding of the impacts of coastal sensitivity to sea level rise.[35] For if resilience is a matter of bouncing back from the damaging impacts of future, unknown, exogenous shocks, it is imperative that state and local officials have a strong scientific understanding of the state's vulnerabilities in order to institute prudent hazard policies.

V. Science and Research

As noted earlier, New Jersey supports a diversity of coastal landscape "types" and population patterns, different aspects of which are of major interest to state planners and the region's academic institutions. Throughout the state, university research centers have developed vulnerability and resilience assessments addressing complementary components of the coastal environment. Researchers from Princeton University's Woodrow Wilson School have provided a geophysical template of sea level rise on which a number of regional impact assessments have been based. The Coastal Studies Program at Rutgers University, in conjunction with the Jacques Cousteau National Estuarine Research Reserve, the American Littoral Society, and the NJDEP has produced valuable state-wide land use/land cover and coastal wetland assessments that have been valuable in monitoring annual trends and changes in the state's biophysical composition. Richard Stockton College's Coastal Research Center has worked closely with the NJDEP's Coastal Engineering bureau to assess dune vulnerability and coastal erosion rates throughout the state to prioritize Shore Protection resources and development actions. Monmouth University's Urban Coast Institute focuses on academic coordination and public policy development to promote coastal economies, ecosystem-based management, resilience outreach, and sustainable coastal communities and is invaluable in providing concurrent outreach and engagement with researchers and public officials. Additional academic research and outreach on coastal processes and ocean engineering is also provided by the Stevens Institute of Technology and in conjunction with the New Jersey Marine Science Consortium.

A. Sea Level Rise and Future Flooding

Based on New Jersey's present 3-4 mm/yr rate of sea level rise, Cooper, Beevers and Oppenheimer of Princeton University assessed the potential extent of anticipated sea level rise and flooding on the state's landscape.[36] Applying a generally accepted annual rate of rise of 3-4 mm/yr, the study yields a median .71 m rise in sea level by the year 2100. To assess changes in landscape inundation, the researchers employed .61 m (2 ft) and 1.22 m (4ft) contour intervals to proxy for the median and high end (1%) rates of anticipated rise. It was found that, assuming the median sea level rise scenario, 171 square miles (approximately 1% of the state's land area), concentrated in back bay wetlands regions in Middlesex, Ocean, Atlantic, Cape May, and Cumberland Counties, would be permanently inundated at the end of this century. In the 1% scenario, 442 square kilometers (3% of the state's area) is expected to be inundated. The effect of increased permanent inundation also subsequently impacts the frequency and extent of

[35] B.T. GUTIERREZ, S.J. WILLIAMS, AND E.R. THIELER, U.S. GEOLOGICAL SURVEY, POTENTIAL FOR SHORELINE CHANGES DUE TO SEA-LEVEL RISE ALONG THE U.S. MID-ATLANTIC REGION (2007).

[36] M.J.P. COOPER, M.D. BEEVERS, AND M. OPPENHEIMER, FUTURE SEA LEVEL RISE AND THE NEW JERSEY COAST: ASSESSING POTENTIAL IMPACTS AND OPPORTUNITIES (Nov. 2005).

episodic storm surge and flooding. Presently, FEMA designates the 100-year flood level in New Jersey as 2.90 meters above National Geodetic Vertical Datum. In the median sea level rise scenario, the 100-year base flood elevation will instead correspond to that of a 30-year flood. Should the high end of anticipated sea level rise occur, the study anticipates the 100-year flood level to be reached a frequency greater than once every five years.

B. Landscape Change and Wetland Migration Potential

Changes in sea level are also anticipated to have associated impacts on coastal ecosystems and the ability of saltwater wetlands to migrate inland over time. Building on previous work, the Center for Remote Sensing and Spatial Analysis at Rutgers University (funded by the American Littoral Society) produced an assessment both of the capacity for New Jersey's wetland areas to migrate apace with anticipated sea level rise, and of their horizontal proximity to infrastructure such as roads, buildings, and bulkheads that would likely impede such inland migration.[37] The assessment used recent satellite imagery and the Remote Sensing Center's land cover characterization typology to characterize the upland landscape within 500 meters of the state's shoreline area. Given these parameters, researchers Lathrop and Love found 42% of coastal upland buffer areas to be human-altered, comprised of residential, commercial, or industrial development or transportation infrastructure that would prevent the natural movement of saltwater wetlands. An additional 44% was classified as "natural," consisting of forests, scrub/shrub, beaches, streams and lakes, and freshwater wetlands, areas subject to composition changes due to shifts in environmental conditions. Given earlier mention of New Jersey's development patterns, much of this "natural" landscape is found in the southern portion of the state, most notably along the southern Atlantic coast and Delaware Bay.

Employing FEMA's present 100-year flood level (2.90m, in this study, rounded to 3m), the study used Cooper, Beevers and Oppenheimer's median and high-end 21st century sea level rise projections (.61 and 1.22m, respectively) to assess the 100-year flood impact on the state's coastal buffer area. The researchers determined that approximately 240 km^2 (16%) of the impacted area is presently developed, most notably the entirety of the New Jersey's barrier islands and significant portions of Barnegat, Delaware, and Raritan Bays. 79% (1,200 km^2) of this area was classified as natural, the largest percentage (42%) of which is comprised of tidal salt marshes and freshwater wetlands. Although there is significant overlap between the extent of coastal buffer and tidal surge areas, sharper elevation gradients in the Monmouth County and Navesink River headlands regions minimize the relative area of impact in comparison with the remainder of the state.

Finally, the study examined the capacity for wetland ecosystems to horizontally migrate by a process of vertical accretion, to keep pace with expected rise. Presently, 29% of potential tidal marsh retreat zones (up to 500m) are limited by developed features and transportation corridors, with notable contrast in distribution and extent between the more upland northern coast and the wetland-dominated southern landscape. While it is noted that New Jersey's salt marshes have traditionally been able to keep pace with historic 3-4 mm/yr rates of rise, the capacity under duress of rates equaling or exceeding more recent estimates of 6 mm/yr or more are unknown.[38]

C. Dune Vulnerability

In 2001, DEP began funding Richard Stockton College's Coastal Research Center to perform concept work on dune vulnerability to storm damage in the borough of Holgate on Long Beach Island with an

[37] R.G. LATHROP, JR. AND A. LOVE, VULNERABILITY OF NEW JERSEY'S COASTAL HABITATS TO SEA LEVEL RISE (Jan. 2007).
[38] COOPER, *supra* note 36; PSUTY, *supra* note 5.

ensuing demonstration project applied to and paid for by the Borough of Mantoloking in northern Ocean County. In the study, the linear shoreline extent of northern Ocean County was divided into 250-foot "bins" whose average volume, crest height, 2d area, etc. were determined and then relatively ranked versus the range across the entire northern Ocean County dune region.[39] The vertical and horizontal extent of each dune bin was then assessed relative to increasing storm surge inundation levels, and whether those dunes met FEMA's 540 (standard at the time) and 1,100 (updated standard) square foot primary frontal dune area.[40] Although the analysis omitted bins in which no dunes were located (35 total), of those remaining bins (455), approximately 33% meet the 540-rule, with 33% of those (25) located in Island Beach State Park. Along developed shoreline reaches, approximately 8% of the surveyed bins, concentrated on the borders of Bay Head and Point Pleasant Beach, Mantoloking and Brick Township, Toms River and Lavallette Borough, central Seaside Park, and northern Berkeley Township, meet the FEMA 540 criterion.

Only 6% of the bins analyzed meet FEMA's updated primary frontal dune area 1100-rule, recently incorporated by NJDEP in its coastal engineering assessments. All but one of the areas meeting the 1100-rule are located in Island Beach State Park, the exception an extent near 8th Street in northern Berkeley Township. NJDEP funded the continuation of this work to all of Northern Ocean County using the Mantoloking work as a basis. This work was extended to Long Beach Island with anticipated completion in the fall of 2008. Subsequent work is being extended to all of the State's ocean-facing shoreline with Congressional funding for the period from August 2006 through the end of 2013.

D. Socio-Environmental Resilience

Resilience, it must be remembered, is comprised of more than a coastal area's physical characteristics. It must include social, economic, hazard planning and environmental frameworks that mitigate potential hazards and support a strong response network by diverse groups within and between affected communities. In a recent white paper for the Urban Coast Institute, Dr. Susan Cutter from the University of South Carolina's Hazards Research Lab has developed an initial framework to address demographic and economic contributors to resilience both within New Jersey and in comparison to other states.[41] The framework is one of many attempts to capture community demographic information such as resident age average and distribution to proxy for citizens' ability to response in hazard circumstances, preparedness information and mock-drills to foster public awareness, and identification of landscape characteristics to identify local hazard mitigation capacity. It is anticipated that the continuation of this and similar indicator development will be valuable in providing a consistent metric of community resilience throughout the state for prioritization of future hazard planning.

E. Natural Capital

In 2004, New Jersey received a grant from the Geraldine R. Dodge Foundation to perform an economic assessment of the state's ecosystem services and natural capital. This valuation was conducted by researchers at the NJDEP and the University of Vermont using value transfer and hedonic analysis methodologies of land cover and available real estate and census data within complex economic models. In the former method, service values for various types of ecosystems, published in scientific literature, was aggregated into an Eco-Value database, from which median, mean, high, low and variance of service values were derived for each New Jersey land cover type (in this assessment, 14 categories were used),

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[39] MIHALASKY ET AL., N.J. DEPARTMENT OF ENV. PROTECTION, BEACH-DUNE SUSCEPTIBILITY ASSESSMENT: NORTHERN OCEAN COUNTY, NJ (Ver. 1.0 May 2007).

[40] 44 C.F.R. § 65.11.

[41] S.L. CUTTER, A FRAMEWORK FOR MEASURING COASTAL HAZARD RESILIENCE IN NEW JERSEY COMMUNITIES: WHITE PAPER FOR THE URBAN COAST INSTITUTE (2008).

based on 1995 satellite-interpreted land cover/land use data. The per-unit area value was then multiplied by each ecosystem's total land area to provide an aggregate value of the state's ecosystem services and natural capital. In the second methodology, a database of 30,000 plus real estate transactions between January 2001 and August 2004 was statistically disaggregated to interpret the marginal price effect of environmental assets on home values throughout the central portion of the state. These marginal values were then integrated based on location to determine the net value of public amenities such as beaches, forests, and wetland areas. The results of this study indicated that New Jersey's ecosystems provides an annual public benefit of between $11.6 and $19.4 billion per year, with a present future value ranging from $387 to $648 billion.[42] By far, the largest per unit land cover contributor to these values are coastal wetlands and marine ecosystems. The largest ecosystem service value of these land covers is derived from water filtration, nutrient cycling, and, most importantly, disturbance (hazard) mitigation.

F. Coastal Telemetry

Considering the more short-term mechanisms of developing resilience, the New Jersey Geological Survey, in cooperation with New Jersey Department of Transportation, designed and installed the New Jersey Tide Telemetry System with assistance from the National Ocean Service.[43] The system provides comprehensive, real-time tide-level and meteorological data for flood-prone areas along shore and back bay areas. Information is gathered from twenty tide gauges, five tide/weather stations, and thirty-one tidal crest-stage gauges in thirteen counties, tides being measured at six-minute intervals and sent to National Weather Service, New Jersey State Police, state Department of Transportation, and county emergency management agencies. Rainfall, wind speed and direction, air and water temp, relative humidity, and barometric pressure are also gathered and transmitted by the National Oceanic and Atmospheric Administration's geostationary operational environmental satellite (GOES). At a more local scale, five additional flood warnings are presently operating throughout the state in Burlington, Passaic and Somerset Counties, and along Pascack Brook and the Rahway River. Although each system is invaluable in providing real-time tide and flood data, in many areas subject to combined fluvial and coastal flood events, benefit could be gained from incorporation of additional hydrologic information to better inform future planning and emergency management decision-making.

Automated real-time coastal hazard monitoring is also supported by the Stevens Institute of Technology through the Coastal Monitoring Network. The Institute's system is comprised of automated stations at three locations along the New Jersey oceanfront that collect and disseminate real time oceanographic and meteorological information including wave height and period, mean water level, water temperature, wind speed and direction, barometric pressure, air temperature, and digital imagery of the beach.

VI. Promoting Resilience

A. New Flood Hazard Area Rules

In November 2007, New Jersey adopted new Flood Hazard Area rules and associated changes to the Coastal Permit Program rules and Coastal Zone Management rules that established more stringent standards for riparian corridors.[44] The goal of the new rules was improvement of surface water quality through increased buffering capacity and increased flood mitigation potential throughout the state. The new rules expand the preservation of near-stream vegetation by implementing new riparian buffer requirements that are 50, 150, or 300 feet wide, depending on the resources being protected. The most protective riparian zone, 300-ft, is reserved for Class 1 waterways and certain upstream tributaries. Waters supporting trout, threatened or endangered species habitat, or flowing through areas containing

[42] R. COSTANZA ET AL., THE VALUE OF NEW JERSEY'S ECOSYSTEM SERVICES AND NATURAL CAPITAL (Apr. 2007).
[43] H. Hoppe, U.S. Geological Survey, *New Jersey Tide Telemetry System***,** Fact Sheet 2007- 3064 (Aug. 2007).
[44] NJDEP, Flood Hazard Area Program, http://www.state.nj.us/dep/landuse/se.html .

acidic soils require a 150-foot buffer. 50-foot buffers are required along all other watercourse. The impact of development on flooding is further addressed through the state-wide adoption of a 0% net-fill requirement for all non-tidal flood hazards, previously confined to the central Passaic Basin and Highlands Regions. The new rules also increase minimum heights for homes and roadways to one foot above FEMA-determined base flood elevation to provide vertical buffering against flooding levels.

B. No Adverse Impact

In September 2005, the New Jersey Association for Floodplain Management (NJAFM) was established as a state chapter of the Association of State Floodplain Managers (ASFPM) to encourage greater awareness and engagement in state flood issues by New Jersey's planners, engineers, regulators, and emergency management officials so as to reduce loss of life and property damage resulting from floods and promote sound floodplain management.[45] As part of its advocacy and outreach, ASFPM has developed a set of planning principles that promote such sound management under the title of No Adverse Impact (NAI). NAI seeks to encourage the application of V-zone building standards to coastal A zone buildings, limit the use of fill when elevating coastal A residences to reduce adjacent flooding and support the active maintenance and vegetation of dunes exceeding minimum hazard mitigation requirements set forth by the NFIP. As part of a coordinated effort to encourage more widespread adoption of NAI, NJAFM has promoted its use at a variety of annual conferences and symposia such as at Monmouth University's Urban Coast Institute in May 2008.

C. New Jersey Department of Environmental Protection

In December 2007, the New Jersey Coastal Planning Office contacted state, academic, and non-profit partners to examine how scientific assessments of sea level rise and associated flooding have been or are being incorporated into local hazard planning. From that outreach, it is evident that resources have been strongly leveraged toward either hazard workshops or symposiums given by academic and non-profit centers to address the science and sociology of sea level rise impacts and direct engagement by the New Jersey State Police and Division of Dam Safety and Flood Regulation with local emergency management and public officials to inform and support FEMA/NFIP and NJDEP programs and regulations. Missing from this equation has been the integration of measures that reflect an appreciation of social, economic, environmental, *and* physical factors that constitute proactive community preparedness, a paradigm that represents a shift from hazard resistance to resilience.

However, to achieve consistency throughout New Jersey's coastal zone in coming years, it is important for state planners to integrate comprehensive scientific assessments of future sea level rise to assist community planning and preparedness. As such, the Coastal Planning Office has coordinated with NJDEP's Geographic Information Systems office, the New Jersey Office of Geographic Information System, the New Jersey State Police, United States Geological Survey, the Philadelphia District of the U.S. Army Corps of Engineers, and the Natural Resource Conservation Service to procure LiDAR mapping of New Jersey's Delaware Bay-adjacent counties. From this procurement, two-foot contour intervals will be generated on which more high-resolution hydrologic models of sea level rise and increased coastal flooding will be produced. The Coastal Planning Office will then have far greater spatial precision by which to assess the current and future vulnerability of coastal areas and the landward migration of coastal wetlands, the establishment of coastal wetlands along open water areas, and transformation of freshwater wetlands to tidal wetlands.

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[45] *See*, Constitution of the New Jersey Association for Floodplain Management (2005) *available at* http://www.njafm.org/Archives/NJAFMconstitution.PDF .

The Coastal Planning Office has begun to coordinate with the NJDEP's Division of Dam Safety and Flood Regulation to engage Delaware Bay communities about the need for comprehensive planning to anticipate sea level rise and associated impacts. Ensuing engagement will utilize the obtained LiDAR topographic data as a template to generate more precise spatial data of aforementioned sea level rise, flooding, wetland migration, and socio-economic assessments for municipal planning officials.

VII. Looking Forward

Coastal hazard policy, planning, and science have recently begun to emerge from a hierarchical regulatory structure to a more integrated management paradigm of resilience. The difference between resistance and resilience, it seems, is one between an either/or operator (i.e. resistant or not) to one that addresses the need for a complex and dynamic understanding of vulnerable coastal landscapes. While municipal planning has not moved so far as to have become mandated as part of the state planning process, it is evident that there is significant opportunity to more effectively integrate local planning and response with state and federal resources to address local hazard needs. To this effect, a more thorough understanding of local erosion and coastal sensitivity, wetland dieback and migration potential, flood hydrology, and socio-economic vulnerabilities are critical considerations for state and local planners to comprehensively and effectively manage the diversity of New Jersey's shore region in the face of anticipated coastal landscape change. It is expected that as the concept of coastal resilience continues to evolve in coming years, the experience of New Jersey's policy, planning and science communities will offer valuable perspective towards a more sustainable coastal environment.