Florence Hulbert
Hughes Center for Public Policy
January 10, 2020

The Effects of Climate Change in New Jersey

As climate change is one of the most pressing issues affecting society today, it is important to consider the changes to our ecosystem that it has caused in order to best prepare for its future effects. New Jersey, being one of the states most disproportionately affected by climate change as measured through increases in temperature, the extent of extreme weather, and impacted homeowners, will see the effects of climate change occur at a more rapid pace than most other states (Gil-Alana & Sauci, 2019; Solecki et al, 2005). The effects of climate change in New Jersey may be observed through evaluating the changes in rising sea levels and extreme weather as well as what current actions are taken to mitigate those effects and how to plan for the future.

Rising Sea Levels

Rising sea levels occur as a result of the thermal expansion of ocean water, mass loss from glaciers and ice caps, changes in land water storage, and the increased use of fossil fuels (Kopp et al, 2016). Increased usage of fossil fuels results in the release of additional carbon dioxide into the atmosphere which traps heat by preventing the escape of solar radiation into the atmosphere (Kopp et al, 2016). In New Jersey, according to a Rutgers University study, sea levels along the coast have risen 1.5 feet from 1911 to 2019, which is over double the global average of 0.6 feet (Gralish, 2019). Further, the same study predicts rises of up to 2.1 feet by 2050, 3.5 feet by 2070, and 6.3 feet by 2100 (Kopp et al, 2016). Various studies have shown that rises of even the current 1.5 feet can have large impacts on vulnerable communities along the coast, including Atlantic City (Kopp et al, 2016). Thus, climate change and the forecasted sea level rise will put New Jersey businesses, homes, and entire cities at risk of flooding and

Browning, & Kemp, 2013). The underestimation of rising sea levels has continued to influence predictions today in New Jersey, which continue to be higher than anticipated.

Rising sea levels contribute to higher levels of coastal flooding in New Jersey. Since 1980, sea levels in New Jersey have risen by nearly six inches, increasing the risk of tidal flooding by at risk homes by 110% and the frequency of storm surges (Johnson, 2019). For example, a projected 1-foot increase in sea level would result in portions of Toms River, NJ being submerged and portions of Ocean Gate, NJ and Point Pleasant Beach, NJ being underwater (Kopp et al, 2016). This flooding also puts New Jersey's wetlands at risk. In a case study of Cape May, New Jersey, findings showed that rises in sea-level will result in increased vulnerability and exposed areas to flooding hazards (Wu, Yarnal, Fisher, 2002). Five to seven feet rises in sea levels may result in about 80% losses in the state (Titus et al, 1988). As sea levels are projected to rise up to 6.3 feet by 2100, this loss in wetlands is feasible in the near future. Further, these risks are projected to grow in New Jersey and extend beyond just the predominantly affected coastlines (Johnson, 2019). This increased risk of flooding is due to sinking land along the coast, resulting in increased flooding due to precipitation and high tides (Kopp et al, 2016).

Rising sea levels may cause additional issues such as economic issues that disproportionately affect at risk areas along the coast (Kopp et al, 2016). For example, economic impacts stemming from rising sea levels may be observed through higher costs of production, elevation, and abandonment of properties (Hudgens, Herter, & Martinich, 2010). Additionally, national studies have found that large-scale climate events have posed health-related costs that total $10.0 billion and mortality costs exceeding the combined cost of illness and lost wages (Limaye, Max, Constible, & Knowlton, 2019). These findings result from a 2012 analysis that covered cases of observed climate change from 11 U.S. states ranging from wildfires in Colorado

of rainfall, meaning the state experienced levels of precipitation 18.43 inches above the statewide normal without the presence of a major tropical storm (Byers, 2019).

Shore erosion has become an increasingly common effect of climate change in the state of New Jersey as a result of both rising sea levels and intense storms (Lorenz, Shadel, & Glick, 2017). Current trends have suggested that a sea level rise of 1 foot may contribute to a shoreline erosion of up to 120 feet (Lorenz, Shadel, & Glick, 2017). While erosion in New Jersey has experienced high rates of variability, complex differential resistance patterns and irregular shoreline configurations affecting shoreline exposure to wave energy impact levels of shore erosion the most, as shown by a case study of Delaware Bay, New Jersey (Phillips, 1986). In an attempt to best combat this issue in the short-term, sand dunes in New Jersey have historically faced large levels of human modification. This involves modifying the size and shape of dunes in relation to the level of perceived threat from coastal winds and the level of defense needed (Nordstrom & Arens, 1998). Further, coastal New Jersey has been found to be the most vulnerable to shoreline erosion out of states in the Northeast (Karmeshu, 2012). This is due to increasing trends in precipitation which result in higher levels of coastal flooding (Karmeshu, 2012).

Extreme temperatures have also become increasingly prevalent in New Jersey due to an increase in paved surface in the state (Lorenz, Shadel, & Glick, 2017). Among other Northeastern states, New Jersey has experienced an increasing trend in warmer temperatures since 1901 (Karmeshu, 2012). New Jersey recorded one of the highest temperature increases in the country between 1895 and 2017, with temperatures rising about 2.9°C over the past 100 years (Gil-Alana & Sauci, 2019). Additionally, temperatures in New Jersey are projected to increase by between three- and ten-degrees Fahrenheit by 2100 (Byers, 2019). Accordingly, since 1985, New Jersey has had nine out of the state's 10 warmest summers in the past 20 years (Byers, 2019). Within the trend of rising temperatures within the state, an additional sub-trend of the Urban Heat Index and "Heat Island Effect" may also be observed. This effect is observed in metropolitan areas within the state such as Newark and Camden where high temperature, low cloud cover, and low wind speeds intensify that heat within the area (Rosenzweig, Solecki, Parshall, Chopping, Pope, & Goldberg, 2005). Temperatures have already been shown to be higher in Newark and Camden in comparison to nonurban communities in New Jersey by 1.5-3°C with a projected continuation in the future (Rosenzweig, Solecki, Parshall, Chopping, Pope, & Goldberg, 2005). With higher temperatures in Newark and Camden, heatwaves are projected to become increasingly likely and result in higher levels of mortality than other areas in the state (Rosenzweig, Solecki, Parshall, Chopping, Pope, & Goldberg, 2005). Suggestions to mitigate this effect have included increased vegetative cover and higher-albedo surface materials that reduce the impacts of biohazards in urban areas, in order to reduce elevated temperatures, air pollution, and public health effects (Solecki et al, 2005).

Responses to Climate Change

As a result of the l, Pope

New Jersey have led to buyouts that have contributed to inland migration. Specifically, in Woodbridge Township, New Jersey after superstorm Sandy, 142 homeowners accepted buyout offers, making it one of the largest buyout projects and proving the programs popularity (Schwartz, 2019). However, this program tends to be costly as it has already cost $172 million for the accepted buyout offers of 713 homeowners (Schwartz, 2019). Moreover, the most common response to rising sea-levels by barrier-islands involved pumping sand into the beaches and building lots in order to raise the islands and a possible retreat inland (Titus, 1988).

Additional responses to climate change along the coastline include measures such as adaptation in the state (“NJ Coastal Resiliency Plan,” n.d.). The Department of Environmental Protection leads these initiatives through their evaluation of policies and regulations at the state levels to reduce risk and increase coordination at a state-level (“NJ Coastal Resiliency Plan,” n.d.). Further, the Bureau of Climate Resilience Planning provides support to communities audiences understand data such as rising sea levels, exposure to coastal inundation, and the vulnerability of different parts of given communities in order to help them best make decisions in relation to coastal preparedness (Lathrop, Auermuller, Trimble, & Bognar, 2014).

The effects of climate change in New Jersey may be observed through evaluating the changes in rising sea levels and extreme weather as well as what current actions are being taken to mitigate those effects and how to plan for the future. Further, as

concerns, and ecological ratings. *Journal of Toxicology and Environmental Health. Part A*, *80*(6), 315–325. doi: 10.1080/15287394.2017.1297275.

Burger, J., & Gochfeld, M. (2019). Involving community members in preparedness and resiliency involves bi-directional and iterative communication and actions: a case study of vulnerable populations in New Jersey following superstorm Sandy. *Journal of Risk Research*. doi: 10.1080/13669877.2019.1593221.

Byers, M. S. (2019, February 14). How will climate change impact New Jersey? Retrieved December 19, 2019, from https://www.njconservation.org/how-will-climate-change-impact-new-jersey/.

Dundas, S. J. (2017). Benefits and ancillary costs of natural infrastructure: Evidence from the New Jersey coast. *Journal of Environmental Economics & Management*, *85*, 62–80. doi: 10.1016/j.jeem.2017.04.008.

Flavelle, C. (2017, May 8). New Jersey Builds Walls Against a Rising Tide. *Bloomberg Businessweek*, (4521), 25–28. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=bsh&AN=122839659&site=ehost-live.

Gao, Y., Fu, J. S., Drake, J. B., & Lamarque, J.-F. (2012). Projected changes of extreme weather events in the eastern United States based on a high resolution climate modeling system. *Environmental Research Letters*, *7*(4). doi: 10.1088/1748-9326/7/4/044025.

Gil-Alana, L. A., & Sauci, L. (2019). US temperatures: Time trends and persistence. *International Journal of Climatology*, *39*(13), 5091–5103. doi: 10.1002/joc.6128.

Hall, T. M., & Sobel, A. H. (2013). On the impact angle of Hurricane Sandy's New Jersey landfall. *Geophysical Research Letters*, *40*, 2312–2315. doi: 10.1002/grl.50395.

Hayhoe, K., Wake, C., Anderson, B., Liang, X.-Z., Maurer, E., Zhu, J., … Wuebbles, D. (2008). Regional climate change projections for the Northeast USA. *Mitigation and Adaptation Strategies for Global Change*, *13*(5-6), 425–436. doi: 10.1007/s11027-007-9133-2.

Hess, H., Delgado, M., Hamidi, A., Houser, T., Kopp, R., Bolliger, I., … Greenstone, M. (2019, October 29). New Jersey's Rising Coastal Risk. Retrieved December 19, 2019, from https://rhg.com/research/new-jersey-flooding-hurricanes-costs-climatechange/.

Horton, B. P., Engelhart, S. E., Hill, D. F., Kemp, A. C., Nikitina, D., Miller, K. G., &
3HOWLHU : 5 ,QIOX
+RORFHQH UHODWLYH VHD(OH,YHO
28(4). doi: 10.1002/jqs.2634.

Johnson, T. (2019, October 29). What's Ahead for NJ — More Tidal Flooding, More Battering from Hurricanes? *NJ Spotlight*. Retrieved from https://www.njspotlight.com/2019/10/whats-ahead-for-nj-more-tidal-flooding-more-battering-from-hurricanes/?ct=t(EMAIL_CAMPAIGN_10_29_2019_COPY_01)&mc_cid=96e4fee0f3&mc_eid=4bbd5b394b.

Jordi, A., Georgas, N., Blumberg, A., Yin, L., Chen, Z., Wang, Y., … Saleh, F. (2019). A Next-Generation Coastal Ocean Operational System: Probabilistic Flood Forecasting at Street Scale. *Bulletin of the American Meteorological Society*. doi: 10.1175/BAMS-D-17-

https://www.inquirer.com/science/climate/climate-change-sea-level-rise-new-jersey-rutgers-20191212.html.

Lam, N. S.-N., Arenas, H., Li, Z., & Liu, K.-B. (2009). An Estimate of Population Impacted by Climate Change Along the U.S. Coast. *Journal of Coastal Research*, *2*, 1522–1526. Retrieved from https://www.jstor.org/stable/25738044.

Lathrop, R., Auermuller, L., Trimble, J., & Bognar, J. (2014). The Application of WebGIS Tools for Visualizing Coastal Flooding Vulnerability and Planning for Resiliency: The New Jersey Experience. *International Journal of Geo-Information*, *3*(2), 408–429. doi: 10.3390/ijgi3020408.

Lathrop, R. G., Irving, W., Seneca, J. J., Trimble, J., & Sacatelli, R. M. (2019). The limited role salt marshes may have in buffering extreme storm surge events: Case study on the New Jersey shore. *Ocean & Coastal Management*, *178*. doi: 10.1016/j.ocecoaman.2019.05.005.

/ L P D \ H 9 6 0 D [: & R Q V W
5 H O D W H G & R V W V R I ,&(9). doi: P D W H (
10.1029/2019GH000202.

Lucash, M. S., Scheller, R. M., Kretchun, A. M., Clark, K. L., & Hom, J. (2014). Impacts of fire and climate change on long-term nitrogen availability and forest productivity in

Miller, K. G., Kopp, R. E., Horton, B. P., Browning, J. V., & Kemp, A. C. (2013). A

Rise Impttas: A GIS -Based Framework and Application to Coastal New Jersey. *Coastal*

[redacted]

New Jersey Coastal Resilience Plan. (n.d.). Retrieved December 19, 2019, from https://www.nj.gov/dep/coastalresilience/.

Earth's Future, *1*(1). doi: 10.1002/2013EF000135.

Schwartz, J. (2018). Surrendering to Rising Seas. *Scientific American*, *319*(2), 44–55. doi: 10.1038/scientificamerican0818-44.

Small-