INTEGRATED MODELLING TO PREDICT LANDSCAPE EVOLUTION, FLOODING, AND WATER QUALITY IN JAMAICA BAY, NY

Heather D. Smith, ARCADIS, heather.smith@arcadis.com
Philp Orton, Stevens Institute of Technology, philip.orton@stevens.edu
Eric W. Sanderson, Wildlife Conservation Society, esanderson@wcs.org
Jordan Fischbach, RAND Corporation, jordanf@rand.org

INTRODUCTION

It is well-known that rising sea levels will increase pressure along shorelines, yet how society and natural systems will respond is uncertain. Natural systems such as wetlands can respond dynamically to changing conditions, and recent sea level rise has been matched in many places with a rising marsh substrate. The societal response to increasing flooding by necessity is adaptation, particularly in areas with a higher population. However, the subsequent influences on flooding, habitat, and water quality have rarely been evaluated.

Jamaica Bay, NY is a coastal embayment bounded on the south by the Rockaway Peninsula and the Atlantic Ocean, on the north by Brooklyn, Queens, and Nassau counties, on the east by the John F. Kennedy Airport, and to the lower bay of New York Harbor on the west through the Rockaway Inlet (Sanderson et al. 2016). The Bay perimeter is home to a large human population, as well as a variety of wildlife that live within the Bay's salt marsh and adjacent upland ecosystems. The Bay has been identified as an area where ecosystem restoration will potentially have a major impact for protection of the Bay's population, as well as enhancing the recreational, commercial, and ecological services the Bay provides.

INTEGRATED MODELING

Several approaches to restoring the Bay have been suggested. However, the long-term impact and efficacy of these approaches has been difficult to estimate given the complexity of feedback between the hydrodynamic forcing of the Bay, the ecosystem response, and changes in water level due to climate change. In order to predict the evolution of the Bay over a 50-year time horizon, the landscape response to the changing forcing from climate change must be estimated. However, the landscape evolution inherently changes the prediction of the water levels and hydrodynamic forcing within the Bay. The model developed here seeks to couple these two processes. This modeling framework utilizes two existing models: the hydrodynamic model, sECOM, and the landscape evolution model, visionmaker marsh (VMM).

RESTORATION SENSITIVITY TESTS

The newly developed integrated model is then extended to test the changes in the Bay with selected restoration approaches. Through outreach to various Jamaica Bay stakeholders, 11 different restoration approaches or levers were identified. Of these, five were developed further for the integrated model based on model suitability. To best examine each lever's impact on the Bay, each newly developed sensitivity test took the lever to its maximum feasible extent and were then compared with Future Without Action (FW) simulations. These restoration approaches include: Grassy Bay Shallowing (GS), Whole Bay Shallowing (JS), Rockaway Inlet Narrowing (IN), Wetland Restoration (WR), and Perimeter Restoration (PR). The impact of each approach is assessed through three metrics: the change in the landscape distribution; the change in the nuisance tidal flooding; and the change to the water quality within the Bay. Within the landscape model, 6 ecosystem types are defined: deep lagoon waters, shallow lagoon water, intertidal mudflat, salt marsh, salt scrub, and upland areas.

RESULTS

Figure 1 presents the distribution of landscapes for the Future without Action and 5 sensitivity tests. Salt marsh areas are lost in a consistent net 12-15% range over the timeframe for all tests except for the Wetland Restoration test, which sees a net gain of 14% of the initial area. Salt scrub losses are a consistent 9-15% of their initial areas, and upland losses are approximately 10%. All the sensitivity tests showed a decrease in nuisance tidal flooding, with the largest reduction due to Whole Bay Shallowing or Inlet Narrowing with an approximate 30% reduction in built areas inundating. Residence time in the Bay dramatically reduced for both shallowing sensitivity tests. The largest increase in residence time was observed with the Wetland Restoration test, which is largely due to the increased resistance from the larger vegetated areas.

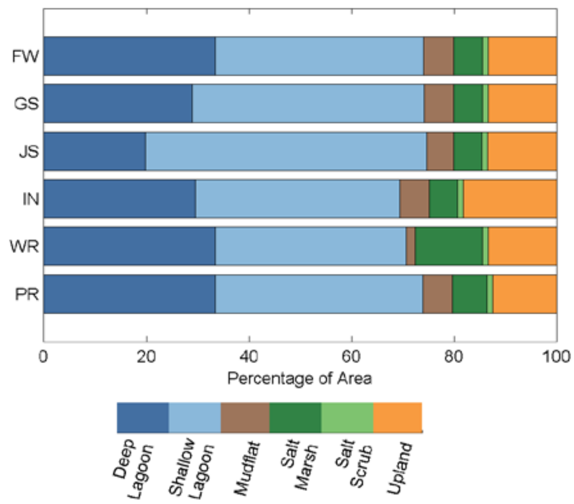

Figure 1 – The predicted ecosystem distributions at Yr 50.

CONCLUSIONS

No one restoration approach tested here met the goals for all three metrics. Wetland Restoration provided the most retained salt marsh habitat, but resulted in the largest residence times. Whole Bay Shallowing, while providing the largest reduction in nuisance tidal flooding and residence time, retained less land than the no action case. Insights gained for individual levers were utilized to develop 2 concepts that were tested in a later phase.

REFERENCES

Sanderson, Solecki, Waldman, and Parris (Eds.). (2016). Prospects for Resilience: Insights from New York City's Jamaica Bay. Island Press, Washington D.C.