SCIENCE BRIEFS

The Vanishing Marshes of Jamaica Bay: Sea Level Rise or Environmental Degradation?

By Ellen K. Hartig and Vivien Gornitz — December 2001

In the shadow of New York City's skyscrapers and adjacent to one of the nation's busiest airports, the salt marshes of Jamaica Bay offer prime habitat for migratory birds and other wildlife. The marshes have been protected since 1972, as part of the Gateway National Recreation Area. However, they are vanishing and no one really knows why.

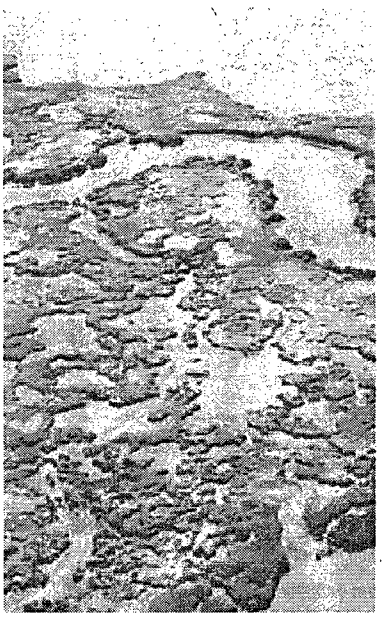

Fig. 1: Helicopter view of Yellow Bar Hassock at low tide looking southeast (July 18, 2001). Note dissection and fragmentation of Spartina alterniflora vegetation cover and replacement by barren mudflats.

An initial comparison of aerial photographs of three selected salt marsh islands in Jamaica Bay showed that land area had decreased by around 12% between 1959 and 1998, or roughly 0.3 %/yr (Hartig et al. 2001a). More comprehensive mapping of the entire Jamaica Bay by the New York State Department of Environmental Conservation revealed a 0.4%/yr shrinkage of island salt marsh area between 1924 and 1974, increasing to 1.4%/yr between 1974 and 1994, and 3.0%/yr between 1994 and 1999 (Hartig et al. 2001b). Prior to 1974, losses occurred primarily along exterior marsh boundaries, particularly on the north, northwestern, and southwestern portions of the islands. Since 1974, interior losses have become dominant. As tidal pools enlarge and coalesce, the salt marsh vegetation becomes more fragmented, the underlying peat substratum disintegrates, and the low marsh gradually transforms into mudflats (Fig. 1). Vegetation cover has decreased, even as measurements of above-ground biomass of salt marsh grass (Spartina alterniflora) indicate values comparable to those of other regional marshes.

Is this dramatic marsh deterioration an early manifestation of sea level rise in the New York metropolitan region? The rate of local (relative) sea level rise is nearly 2.8 mm/yr, as determined by tide gauge data (1856-1999) from Battery Park in lower Manhattan. But the global mean sea level rise is only around 1.5 mm/yr, related to the worldwide warming trend of 0.6° C during the last century (IPCC 2001). The higher New York sea level trend is in part caused by ongoing crustal adjustments due to the removal of the ice sheets following the last glaciation. In Chesapeake Bay to the south, local sea level trends range between 3 to 4 mm/yr — slightly higher than in the New York City area. A number of small islands in Chesapeake Bay have either disappeared entirely or have shrunk significantly within the last 150 years. Could something similar be happening in Jamaica Bay?

While the historic rise in sea level may have contributed to some island marsh loss within Jamaica Bay, it is insufficient to explain the recently accelerating trends, inasmuch as the rate of sea level rise in this area remained relatively constant throughout the 20th century. Several nearby tidal marshes on Long Island are showing only minor signs of submergence. Salt marshes form in the intertidal zone and can usually keep pace with present-day rates of sea level rise through upward growth and sediment deposition. We conducted a sensitivity study, using a plausible suite of future sea level rise scenarios (based on historic data and on climate models from the Hadley Centre, U.K., and the Canadian Centre for Climate Modelling and Analysis) as well as the published range of marsh accretion rates. The results suggest that marshes should be capable of withstanding even moderately high rates of sea level rise, if allowed to accrete upward fast enough (Fig. 2).

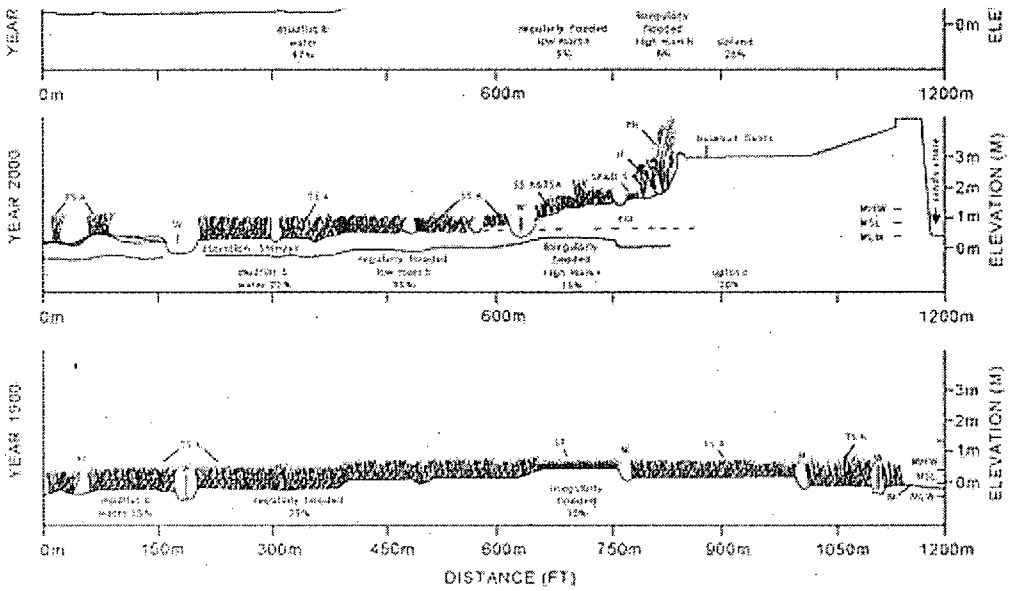

Fig. 2: Transect across Big Egg Marsh, Jamaica Bay, showing conditions in 1900, 2000, and 2100. Historic and present land cover are based on aerial photography, topographic maps, and local tidal marsh vegetation zonation. Future sea level projections are based on the Canadian Centre for Climate Modelling and Analysis GCM, assuming a 1%/yr rise in equivalent CO_2 atmospheric concentration without sulfate aerosols, and a marsh accretion rate of 5mm/yr. (Click for a larger image)

The recent marsh losses at Jamaica Bay imply an imbalance in the equilibrium between sea level rise and marsh accretion rates. A prime factor could be the lack of an adequate sediment supply. Past anthropogenic activities have probably contributed to this imbalance. Dredging of navigation channels prior to the 1970s has increased the average water depth from 1 to 3 meters, thereby strengthening tidal currents, enhancing erosion, and trapping sediments that would otherwise have been deposited on the marsh surfaces in deeper areas. Furthermore, the historic westward growth of the Rockaway spit has prevented offshore sediments from reaching the Bay. Urbanization has effectively curtailed potential upland sediment sources. Waves generated by recreational boats could also produce some marsh erosion. Other possible factors include the smothering of salt marsh grass by encroaching sea lettuce (Ulva lactuca) and unusually high populations of ribbed mussels (Geukensia demissus) attached to salt marsh grass stalks. The anomalous abundance of these two aquatic to intertidal species could be associated with excess nutrient loading in the Bay from nearby sewage treatment plants, or with gradual drowning of the marsh islands and conversion to mudflats. Further research is needed to establish the causes of the observed marsh decline.

The salt marshes of Jamaica Bay may be more vulnerable to the impacts of future sea level rise than the neighboring marshes on Long Island, due to the apparent sediment deficit and other factors mentioned above. At current rates of attrition, a number of the island salt marshes could disappear well before the full impacts of accelerated sea level rise due to global warming will occur. The fate of Jamaica Bay serves as a wake-up call to other coastal wetlands facing the intertwined effects of sea level rise and human-induced stresses.

Contact

Please address all inquiries about this research to Dr. Vivien Gornitz.

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