Multiproxy Analyses of Past Vegetation, Climate, and Sediment Dynamics in Hudson River Wetlands

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The Hudson River estuary (New York, USA) is a heavily urbanized estuary with a long history of environmental impacts from anthropogenic activities for hundreds of years. The estuary is intensely utilized, serving over ten million people throughout New York, Connecticut, and New Jersey. The portion of the Hudson River from Troy, NY to New York Harbor is tidal and is considered an important estuary. Tidal marshes are especially important for their roles in carbon sequestration, water filtration, primary production, flood-zone buffering, fisheries, and recreation. However, these valuable ecosystems are threatened by increasing anthropogenic activities, such as land clearing, channel modification, contamination release, and the introduction of invasive species (Howarth et al. 1991, Swaney et al. 1996, Pederson et al. 2005, Miller et al. 2006, Wall et al. 2008, Chou and Peteet. 2010, Nguyen and Peteet 2010, Collins and Miller 2011). In addition, projected warming, drought, sea level rise, and salt intrusion will likely amplify these anthropogenic effects (Bindoff et al. 2007, Christensen et al. 2007). Vegetation and sediment composition are two major keys that determine the health of the ecosystem. Thus, a necessary key in the restoration of the estuary is the understanding of baseline ecosystem and sedimental conditions as well as their long-term responses to climatic and anthropogenic activities. Such information is limited in the Hudson estuary (NYSDEC 2006, 2009, 2012). In this dissertation, we establish the baseline conditions of the vegetation and sediments of the Hudson Estuary using sediment cores from marshes and tributaries of the Hudson Estuary and investigate how the ecosystems have changed over time in response to major environmental changes. We expand paleoecological records in the freshwater section of the estuary to understand regional ecological changes as prior studies are restricted to the lower portion of the Hudson. An estuary-wide study of wetland and delta sediments across various environmental regimes aids our understanding of regional environmental shifts. We used two approaches to investigate environmental changes of the Hudson Estuary: 1) Long-term multiproxy paleoecological reconstruction at two important freshwater National Estuarine Research Reserve marshes; and 2) pre and post industrialization sediment composition analysis across a North-South transect of the river. Knowledge about past ecosystem structure and ecosystem response to anthropogenic and climatic changes can provide insights on how future changes may impact the ecosystem. Such information may be useful in future environmental management (Jackson and Hobbs 2009). In the first two chapters, we implement multiple proxies, including pollen, spores, macrofossils, charcoal, sediment bulk chemistry, and stable carbon and nitrogen isotopes to identify ecosystem changes spanning the past 1000 years in Tivoli Bays and Stockport Flats. Paleoecological reconstruction at both of these sites reveal climatic shifts such as the warm and dry Medieval Warm Period (MWP, 800 - 1300 AD) with high fire occurrence followed by the wetter cooler Little Ice Age (LIA, 1400 - 1800 AD), along with significant anthropogenic alterations in the watershed. Wetland and upland vegetation slightly changed during that period, reflecting water availability and temperature. The most striking changes occurred after the European settlement in the 17th - 18th centuries. Throughout the last century, invasive plant species including Typha angustifolia, Phragmites australis, and Lythrum salicaria pollen percentages increased by up to 20 times the pre-European settlement values, concurrent with marked changes in sedimentation rate, sediment composition, nutrient input, and organic content. Isotopic analysis of 13C at Tivoli Bays confirms major vegetation shifts concurrent with European settlement. The increase of fertilizer and sewage water was also visible by the enrichment of 15N in the sediment at the onset of European settlement. The concurrent trend of vegetation and sediment compositional changes suggests that sediment dynamics may play an important role in shaping wetland characteristics. In Chapter 2, the paleoecological result at Stockport Flats shows similar adverse anthropogenic impacts to the wetland as the biggest vegetation changes occurred at the onset of European settlement. In contrast to Tivoli, Stockport was a mudflat prior to the European settlement. As a result, Stockport has lower organic matter content (measured as Loss-On-Ignition (LOI)), less peat accumulation, and coarser grain size than Tivoli. This raises a question about what type of habitat should be targeted for conservation. A recently colonized wetland such as Stockport Flats does not serve the same function in carbon storage as an older wetland such as Tivoli. The third chapter is the first estuary-wide study of Hudson River sediment composition and sediment change before and after significant anthropogenic impacts. We characterize sediment composition at 20 wetlands and deltas across various environmental regimes from Troy, NY to the mouth of the Hudson River in New York Harbor. We identify natural and anthropogenic control of sediment dynamics in the estuary. Prior to the industrialization, LOI in
Analysis of multiple proxies within this sediment sequence, including understanding the role of climate and humans in generating mountain slope instability is crucial because such instability influences downstream fluvial activity and is a major threat to societies. Here, we use the sedimentary archive of Lake Allos (southeastern France), a mountain lake in the European Alps, to characterize mountain flood deposits and vegetation dynamics over the past 7000 yr. This study investigates sediment cores from the Mediterranean alpine lakes located in upvalley cirques upper than 1700 metres a.s.l. using sedimentological, palynological and geomorphological studies, in order to document environmental changes following the last phase of glacier retreat. During the past 100 y, however, the wetlands south of Lake...
Okeechobee were converted to agricultural fields, and the northern and central Everglades were compartmentalized into Water Conservation Areas that regulate flow southward to Everglades National Park (Fig. 1) (1–4). Stratigraphic studies provide an alternative means to reconstruct the past dynamics of the Everglades with respect to climate, sea level, and geology (9–12). We, therefore, conducted a multiproxy analysis of a sediment core from the Northeast Shark River Slough (NESRS) after finding initial evidence for paleodust indicators in cores from the central Everglades (Fig. 2012) Carbon and sediment accumulation in the Everglades (USA) during the past 4000 years: Rates, drivers, and sources of error.

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