Dams and Sediment in the Hudson (DaSH)

Overview

Hundreds of dams built on tributaries of the Hudson River estuary have outlived their usefulness. Removing these relic dams is a priority for the state of New York in order to improve aquatic habitat connectivity, restore fish spawning grounds, and reduce the risk of dam failure. For those who regulate and permit dam removal, questions about the fate of sediment trapped behind these dams and its potential impact on downstream habitat has encumbered the permitting process. To better understand how sediment released by dam removal in the lower Hudson River watershed will affect the estuary, including the potential for dam-derived sediments to help offset sea level rise in tidal wetlands, the Dams and Sediment in the Hudson (DaSH) project brought together a collaborative team of scientists and stakeholders to research key questions and provide practical tools to regulators and practitioners.

The project used a multidisciplinary approach that combined field observations with an analysis of sediment transport using a proven hydrodynamic model. A broad coalition of stakeholders from state agencies, engineering firms, and environmental restoration organizations guided research and project products to maximize their utility. Dams and Sediment in the Hudson answered key questions about how dam removal will affect conditions in the estuary, and offered surprising new findings about tidal marshes in the Hudson River Valley. The project developed watershed assessment tools to support dam removal permitting and established an improved scientific basis to consider potential downstream benefits in regulatory decision-making.

Project Approach

The project convened a multidisciplinary team of researchers from the Woods Hole Oceanographic Institution, University of Massachusetts-Amherst, and Hudson River National Estuarine Research Reserve who scoped research questions, carried out modeling and fieldwork, engaged with a collaborative advisory committee, and ensured that lessons were shared across areas of expertise. A collaborative process was used throughout the project to engage stakeholders with regional expertise in estuary management, dams, sediment, ecology, engineering, environmental conservation, and state policy. Input from the advisory committee shaped research questions, optimized field work locations, and was central to the development of practical tools for practitioners.

Project Location
Hudson River estuary and watershed

Project Duration
November 2016 to April 2020

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Project Type
Collaborative research – Generating science that informs decisions

Products
- Dam sediment estimation tool to support dam removal planning
- Summary fact sheets describing DaSH project findings, dams and sediment supply, and tidal marshes
- Peer-reviewed scientific publications on dams and sediment supply, tidal marsh development, and estuary response following storm-related flooding
- Sediment core data from tributaries and marshes

Project Partners
- Consensus Building Institute
- Hudson River National Estuarine Research Reserve
- University of Massachusetts-Amherst
- Woods Hole Oceanographic Institution

Project Webpage
nerrssciencecollaborative.org/project/Ralston16

Field observations quantified sediments impounded behind dams and assessed sediment accumulation rates in wetlands along the Hudson. The team surveyed 17 representative dams in the lower Hudson River watershed with a range of conditions and characteristics and collected sediment cores from six representative tidal wetlands and coves. Sediment inventories at study sites were used to estimate the amount of sediment trapped in all 1,700 registered dams in the lower Hudson River watershed. To complement these observations, researchers analyzed sediment discharge data from existing monitoring stations to assess the amount of sediment entering the estuary and how estuary conditions responded to storm events. Historical aerial photos were used to characterize Hudson marsh development over time. The team then modeled estuarine circulation and sediment transport to evaluate how sediment inputs from dam removals would affect turbidity, and how these sediments would ultimately be deposited throughout the estuary.

Results

This project produced detailed information about sediment, dam, and tidal marsh dynamics in the Hudson River estuary and watershed. A few highlights of the findings are summarized here.

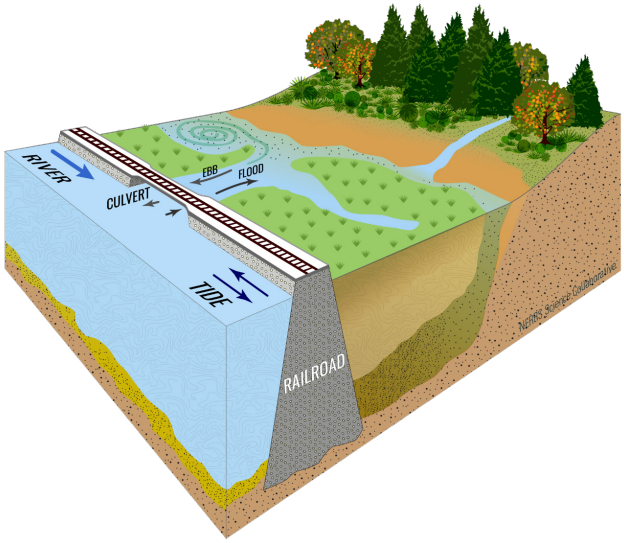
When dams on tributaries to the Hudson are removed, will the sediment adversely affect conditions in the estuary?

The Hudson River watershed has smaller dams with less trapped sediment than other regions in the United States. The mass of sediment that could be released by removing these dams is minimal compared to overall background sediment inputs from the watershed, representing less than two years of the watershed's annual sediment supply. The Hudson is naturally muddy, with relatively turbid water. When researchers looked at the effects of sediment inputs from major storms in recent years, they found that turbidity adjusted relatively quickly (a few months to a couple of years). In many cases, the amount of sediment washed into the river during storms was larger than would result from dam removals. Collectively, these findings suggest that changes in sediment load and related conditions in the estuary should not be a major concern when considering dam removal.

This information was used to develop a tool to support dam removal planning for the lower Hudson River Valley. The new tool provides a decision tree to classify dams into impoundment types and guides dam owners and decision-makers through the steps to estimate the amount of sediment trapped behind a dam, compare that to sediment inputs from the watershed, and consider the potential downstream impacts of dam removal.

Will sediment released by dam removals on tributaries beneficially supply marshes of the Hudson and increase resilience to sea level rise?

Tidal wetlands are a defining and highly valued feature of the Hudson River estuary. Although often assumed to be naturally occurring, at least half the area of tidal wetlands in the Hudson River were formed as a result of human actions, like the placement of dredging spoils or construction of railroad track along the river. Using sediment cores, the research team determined when sampled wetlands began to form and how rapidly they accumulated sediment. Surprisingly, the results show that most wetlands are remarkably young, having developed only within the last 150 years, and some only within the last few decades. On average, these anthropogenic tidal marshes and mudflats have accretion rates two to three times the rate of relative sea level rise. These human-influenced marshes are accumulating sediment at greater rates than naturally developed marshes in the region that generally gain sediment and elevation at a rate similar to sea level rise.



An estimated 50 percent of Hudson River marshes were developed as an unintended consequence of human activities, such as the constructions of railroad causeways along the shoreline.

The high sediment accumulation rate for Hudson River tidal wetlands means that wetlands will outpace even the highest projections for sea level rise over the next century. Wetlands already have the sediment they need to rapidly grow, and any modest influx of sediment from dam removal is unlikely to affect them significantly.

Benefits

- Improved collaboration – The project deepened a robust community of researchers, regulators, and practitioners already engaged with the Hudson River National Estuarine Research Reserve. The advisory committee provided a forum for exchange across diverse interests related to dam removal that did not previously exist. This created opportunities for regulators and practitioners to identify and begin to address impediments to dam removal.
- Development of tools to aid regulatory process – The project made it easier for regulators, landowners, and consultants to evaluate downstream impacts of dam removal in the permitting process by developing tools that addressed specific regulatory needs and making available peer-reviewed scientific publications to support assessments of downstream sediment impacts. Research findings will inform dam removal regulatory guidance for the Hudson. More broadly, the project's peer-reviewed studies add to a body of literature on dam removal that provides a more solid basis for future state and federal policy decisions.
- Greater understanding of the Hudson River estuary – The research addressed gaps in knowledge related to dam removal impacts and tidal marshes in the estuary, with some significant new findings related to wetland resilience and the robust growth of anthropogenic wetlands. This research also has broader applications, and results have been disseminated to a range of regional and national audiences.

What's Next

The advisory committee and technical team identified several areas for future research related to Hudson River wetlands, dams, and sediments. These include questions around contaminated sediments, the timing of dam removal, differences between freshwater tidal marshes and saline estuary marshes, the applicability of findings to the Hudson River's upper tributaries, the ability of existing monitoring to characterize spatial and temporal variability in sediment loads and turbidity, and appropriate metrics for resilience in natural versus human-fostered wetlands.

About the Science Collaborative

The National Estuarine Research Reserve System's Science Collaborative supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is managed by the University of Michigan's Water Center through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Funding for the research reserves and this program comes from NOAA. Learn more at nerrssciencecollaborative.org or coast.noaa.gov/nerrs.