DAMS AND SEDIMENT IN THE HUDSON RIVER (DASH)

Project Overview

This document is part of a series that captures the outcomes of Dams and Sediment on the Hudson (DaSH), a research project to assess how sediment released by dam removals in the Lower Hudson River watershed would affect the estuary. For more information, visit www.hrnerr.org/hrnerr-research/dams-and-sediment-in-the-hudson.

PROJECT PURPOSE

The removal of relic dams on the tributaries of the Hudson River Estuary has been a New York State priority due to concerns about dam safety and for habitat connectivity for key fish species. The fate of the sediment trapped behind a dam and potentially adverse impacts on habitat downstream often encumbers the permitting process for dam removal. Sediment can also be a beneficial resource for downstream habitats, because a supply of sediment is necessary for tidal wetlands to grow vertically and keep up with sea level rise. To understand the potential impacts of sediment released by dam removals, the Hudson River National Estuarine Research Reserve (HRNERR) in Staatsburg, NY organized a collaborative research project to investigate the following questions:

- When dams on tributaries to the Hudson are removed, will the sediment adversely impact conditions in the estuary?
- Will sediment released by dam removals on tributaries beneficially supply marshes of the Hudson and increase resilience to sea level rise?

To conduct research on this topic, the project considered the following framing questions:

1. To what extent are dams currently trapping sediment?
2. How does the mass of sediment trapped behind dams compare to the average sediment supply coming from the watershed?
3. How does the sediment released by dam removals compare with the sediment input during extreme discharge events?
4. Once sediment is released from behind a dam, how does it affect turbidity in the estuary and where does it deposit?
5. Could dam removals serve as an important additional source of sediment for Hudson wetlands?
6. How have dams impacted wetlands in the past? How could they impact wetlands in the future?

The project was designed to provide scientific research and practical tools that would be of use to regulators and practitioners who evaluate and permit dam removals. A collaborative process was used to engage stakeholders throughout the project, informing all steps of the research and analysis to maximize the utility of the end products.

TECHNICAL TEAM

The technical team conducting the project consisted of staff from Woods Hole Oceanographic Institution, the University of Massachusetts Amherst, the Hudson River National Estuarine Research Reserve and the Consensus Building Institute. This team worked for three years to scope research questions, carry out modeling and fieldwork, facilitate the process with a collaborative advisory committee, and ensure that lessons were shared across areas of expertise.

ADVISORY COMMITTEE

A group of advisors with regional expertise in estuary management, dams, sediment, ecology, engineering, environmental conservation, and state policy oversaw the project. Through day-long in-person meetings as well as virtual meetings, they helped to shape the questions the researchers addressed, optimized the locations for field work, and guide the technical team in developing final products would be most useful. They discussed many elements of the project, and these discussions influenced the research done by the technical team. Advisory committee input led the technical team to, among other things, evaluate not just dams that are effective sediment traps but other types of dams as well, and to develop a methodology for categorizing trapping efficiency that could be used by practitioners on individual dams.

MODELING AND FIELD WORK

The research methodology was multidisciplinary to address the diverse, but related research questions posed by the project. Field observations were used to sample sediment in impoundments and wetlands along the Hudson to quantify the amount of sediment trapped behind dams and to assess sediment accumulation rates along the estuary. Water monitoring data were used to quantify the amount of sediment typically supplied from the watershed and to assess how conditions in the estuary respond to increased sediment inputs during storm events. A numerical model of circulation and sediment transport in the estuary was used to assess how sediment inputs from dam removals would change turbidity and where the newly input sediment would deposit.

PROJECT PRODUCTS

Project results were captured in

1. three academic papers (submitted to peer-reviewed journals)
    a. Watershed sediment supply and potential impacts of dam removals for an estuary (preprint at https://doi.org/10.1002/essoar.10502519.1)
    b. Rapid Tidal Marsh Development in Anthropogenic Backwaters (preprint at https://eartharxiv.org/ga5pm/)
    c. Turbidity hysteresis in an estuary and tidal river following an extreme discharge event (preprint at https://doi.org/10.1002/essoar.10502535.1)

2. a decision-tree tool to aid practitioners in classifying dams into the impoundment types that characterize a dam's tendency to alter downstream sediment supply
3. data archives stored at UMass ScholarWorks detailing impoundment sediment inventories (https://doi.org/10.7275/xktv-8m12) and tidal marsh sediment cores (https://doi.org/10.7275/dh3v-0x33)
4. model simulations of sediment transport and deposition in the estuary for dam removal scenarios, archived at Woods Hole Oceanographic Institution
5. summary documents highlighting key results for dam removal policy makers and practitioners, found along with other project resources at https://www.hrnerr.org/hrnerr-research/dams-and-sediment-in-the-hudson

MAIN PROJECT FINDINGS

- The total mass of sediment trapped in tributary impoundments is minimal relative to the estuarine sediment budget, representing about two years of average sediment supply to the Hudson River estuary.
- Impoundments can be classified by their sediment trapping potential to predict release associated with dam removal: (1) effective sediment traps, (2) run of river dams (most sediment is bypassing the impoundment because it is full), and (3) non-source impoundments (small dams on springs or natural lakes that don't affect downstream sediment transport).
- The mass of sediment trapped behind each dam can be calculated. For most dams in the lower Hudson River watershed, the sediment that would be released by dam removal would be similar to or less than one year of average sediment input from the local watershed of the dam.
- Most dams on Hudson River tributaries do not presently trap sediment (run of river or non-source).
- Regional context is important. The Hudson River watershed has smaller dams and lower sediment yields than other regions of the US.
- In the Hudson River estuary, the turbidity adjusts relatively quickly (a few months to a couple of years) to increased sediment inputs from large storm events, and these sediment inputs from storm events are larger than would be associated with large (or many) dam removals.

- The Hudson estuary is relatively turbid, and the additional sediment input from large (or many) dam removal in the watershed would not significantly increase turbidity compared to the natural variability.
- The distance dam sediment travels in the estuary before depositing depends on grain size, which controls settling velocity, so coarse silt deposits within a few miles of the source tributary and fine silt is distributed more widely, spreading many 10s of miles downstream.
- The marshes on the Hudson River are not sediment starved, and in fact they are rapidly accreting. The marshes studied have high accumulation rates, outpacing even the highest projections for sea level rise over the next century. Any reductions in watershed sediment supply from dams has not limited wetland development, and any increase in sediment supply from dam removals would not significantly alter the marsh accretion rates.
- At least half of the area of tidal wetlands in the Hudson River were formed as a result of human actions like placement of dredging spoils or construction of a railroad track along the river.

WHAT NEXT?

The Advisory Committee and technical team spent some time thinking about what future research would be useful related to Hudson River wetlands, dams, and sediments, and identified topics including:

- When dams that trap contaminated sediment are removed, can the fate of that contamination and potential downstream impacts be predicted?
- How does the timing of dam removal influence the effects of sediment released by the removal?
- What can be applied from this project to questions about sediment movement and potential impacts of dam removal up in the tributaries, in addition to the main stem of the Hudson?
- Can we characterize the spatial and temporal variability in sediment load from the watershed and turbidity in the estuary with the current extent of monitoring, which is decreasing due to budgetary constraints?
- How do sediment accumulation rates in the freshwater tidal marshes of the Hudson compare to those farther down in the saline estuary such as at Piermont Marsh, in Haverstraw Bay, and in Jamaica Bay?
- How do landscapes transition from cove to marsh, and how might this inform marsh restoration efforts?