Sediment Surge: Predicting the Downstream Effects of Water Injection Dredging at Tuttle Creek on the Big Blue River

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Introduction

Tuttle Creek Lake in Manhattan, KS has been steadily decreasing in water capacity due to the settling of sediment at the bottom of the as seen in Figure 1 [1]. Water injection dredging (WID), a technique used to remove sediment from a waterway by pumping water into the sediments at a low pressure and high volume to create a sediment plume that gets flushed downstream, has been proposed [2]. WID has never been done in a freshwater reservoir, making the results relatively unknown. Using historic and current conditions of water quality, sediment quality, fish communities, and geomorphic channel shifts we predicted how WID will influence the Big Blue River downstream.

Research Questions

- How does water injection dredging affect the water quality for fish?
- How will water injection dredging affect the channel morphology downstream of Tuttle Creek Reservoir?
- What environmental impacts could harmful contaminants attached to sediment introduce downstream?
- What effect will the dredging have on the various ecosystem services the river provides?

Objectives

- Establish a dataset of baseline conditions on the Big Blue River prior to the dredging project upstream at Tuttle Creek Reservoir.
- Predict the future hydrologic, environmental, ecosystem service, and, community health implications of the dredging project.

Methods

- Analyze existing research articles regarding water injection dredging, channel morphology, wildlife populations, and ecosystem services.
- Collect on-site data below the Rocky Ford dam and under the Dyer Rd. bridge.
  - Lab analysis of data including the total suspended solids, ammonia nitrogen, phosphate, and nitrate levels (As seen in figures 2 and 3).

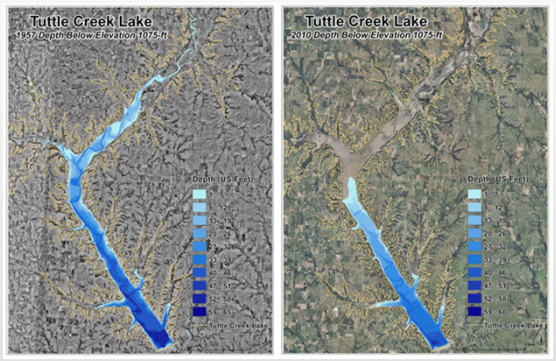
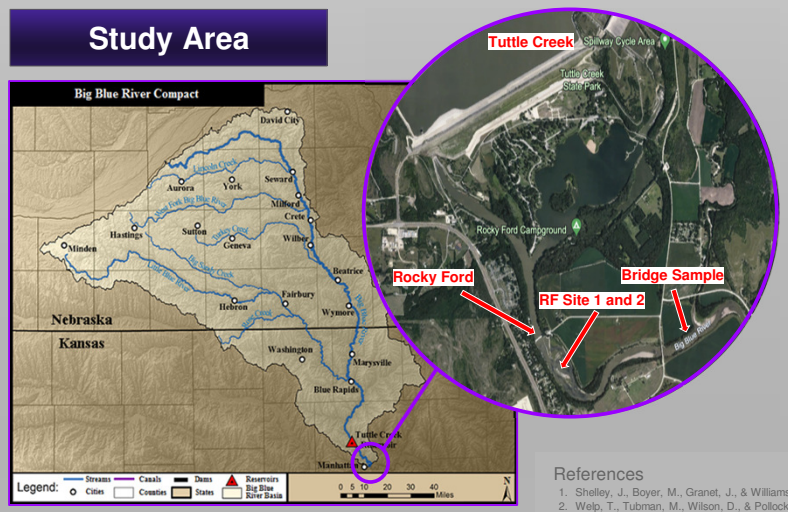


Figure 1: Depth of Tuttle Creek Lake in 1957 vs. 2010

Figure 2: Collecting water and sediment samples at the Rocky Ford site

Figure 3: Collecting water samples at the Rocky Ford site and examining them with the YSI sonde

Study Area



Results

Water Sample Analysis

Site	Total Suspended Solids (mg/L)	Ammonia Nitrogen (mg/L NH3-N)	Phosphate (mg/L P)	Nitrate (mg/L N)
Rocky Ford Site 1	62.5	0.1	0.125	0.675
Rocky Ford Site 2	26.5	0.9	0.185	0.655
Rocky Ford Site 3	23	0.2	0.26	0.75
Bridge Site	112	0.4	0.24	0.75

Objective	Hypothesized Result
Water Quality	The water will begin to degrade causing fish populations to diminish over time.
Channel Morphology	The channel will begin to aggrade, filling with sediment.
Sediment Quality	Harmful contaminants, like metals and pesticides, that are attached to sediment particles could cause adverse effects on downstream aquatic life and water quality
Cultural Services	As the hydraulic water dredging increases, then the beneficial ecosystem services will diminish. Fish populations will decrease in number, increased sedimentation will make recreational activities such as kayaking and hunting more difficult, and water quality will degrade.

Discussion

- Our data were inconclusive
- Total Suspended Sediments (TSS) were consistent, but below the normal range (155-300 mg/l). Our Turbidity (water clarity) levels that we collected from site 1 and site 3 were high (normal levels being between 1 NTU and 5 NTU). The Chlorophyll a - RFU (Relative Fluorescence Units) were within the normal ranges (0-10 microgram/liter)
- Low TSS is not a bad thing as long as it does not exceed the normal limit (300 mg/l). The same goes for Turbidity, as long as the turbidity does not exceed 5 NTU then the water quality is fine. If turbidity and TSS are high then it could become a health risk for aquatic life. RFU in chlorophyll a does not become a health risk as long as it stays below the normal range (0-10 microgram/liter).
- This study could be improved by measuring more variables, including temperature, dissolved oxygen, conductivity, turbidity, chlorophyll, etc. at every site chosen and collecting the samples over a longer period of time off of the shoreline.

Future Research

The U.S. Army Corps of Engineers (USACE) is addressing sediment build-up in lakes and reservoirs caused by dams, which reduces water capacity. They are exploring water injection dredging, a method that injects water into sediment to create density currents, aiming to move sediment away from dams. The first pilot project at Tuttle Creek Lake in Kansas will assess the effectiveness and potential downstream environmental impacts, with hopes of developing sustainable sediment management strategies applicable to other USACE lakes and reservoirs.[3]

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