Sediment accumulation and flooding of Otter Creek in Cortland

Dr. David Barclay, Scott Causer, Elizabeth Hensel, Bobby Taylor, Matt Vitale and Fall 2007 Geomorphology (GLY 367) undergraduate students

Geology Department, SUNY Cortland

INTRODUCTION

Fig. 1. On July 28th, 2006, flooding from Otter Creek at the Townley Avenue bridge in the City of Cortland inundated basements and properties near Groton and Townley avenues. It has been suggested by some residents that sediment accumulation in the Otter Creek channel near Broadway and Townley Avenue was the cause of this flooding.

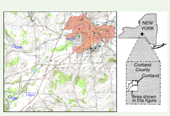
RESEARCH QUESTION

- Is the flooding of Otter Creek at Broadway due to sediment accumulation in the channel?

To explore this question, the Fall 2007 Geomorphology class completed a study of channel morphology and sediment transport dynamics in two sections (reaches) of Otter Creek. This involved:

1. Collecting survey data of the channel dimensions and gradient,
2. Assessing possible sources of sediment to the Broadway reach,
3. Determining the theoretical water depth need to entrain sediment in the channel.

STUDY AREA



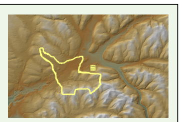


Fig. 2. The Otter Creek drainage basin is located in central New York State. The majority of this basin is within the Town of Cortlandville and City of Cortland in Cortland County. Otter Creek drains the area to the west and southwest of the city. The main stem of Otter Creek begins at Stupke Pond (~2.5 miles southeast of Cortland) and flows northeast. It is joined by two intermittent tributaries before eventually draining into the West Branch Tioughnioga River. Valleys in this area are broad and are bounded by steep hillsides that rise nearly 700 feet above the valley floors.

GLACIAL HISTORY

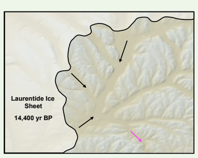


Fig. 3. Glacial and glacifluvial processes during the Quaternary period shaped the landscape currently observed throughout central New York. The Laurentide Ice Sheet was at its most recent maximum extent in northern Pennsylvania and Long Island about 20,000 years ago. Ice retreat dominated for the next ~5000 years prior to the Valley Heads re-advance, when moraines and outwash were deposited around the Cortland area. The Laurentide ice margin then withdrew northwards from the area, leaving the Valley Heads deposits as the dominant landforms and features of our local landscape.

REGIONAL GEOLOGY

Bedrock Geology

- Bedrock in the region is predominantly Devonian in age, nearly flat laying beds of shale with minor siltstone and fine-grained sandstones.
- Much of the bedrock is buried under glacial deposits, which are thickest in the valleys.

Surficial Geology – Fig. 4.

Till: Till, an unsorted mixture of silt, clay, sand, gravel, and rock fragments, covers most of the hills in this region. Lodgement till on College Hill represents the "plastering" of material into place beneath the Laurentide Ice Sheet.

Outwash Deposits: Valleys in this area are in-filled by a mixture of grain-sizes ranging from layers of silt and sand to rounded cobbles and boulders. These were carried into place and deposited by braided meltwater rivers in front of the Laurentide Ice Sheet margin.

DATA COLLECTION

Waterworks Reach Survey

Fig. 5. Teams of students surveyed channel cross-sections along the Waterworks reach of Otter Creek. Each team used a Lietz Automatic Level with tripod and survey pole to take elevation measurements. With a tape measure stretched across the channel, each team recorded rod points (elevations and distances from the right bank) to record significant changes in the channel profile. Differential leveling was used to determine each cross-sections' elevation relative to a benchmark (NAVD 88 datum). At the farthest upstream and downstream cross sections, teams determined the median grain size of sediment in the bed of the channel.

Broadway Reach Survey

Fig. 6. Observations of bank condition, bed material type, and relevant infrastructure (e.g. storm drains) were carried out at the Broadway reach of Otter Creek on October 22, 2007. Bed material thickness was measured using a tile probe and bed material samples sieved to determine the grain size distribution.

WATERWORKS REACH RESULTS

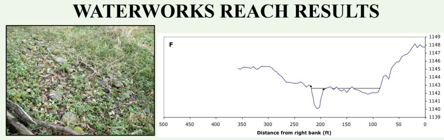


Fig. 7. For the upstream site F, the median grain size of sediment on the channel bed was 5.88 cm and the maximum bankfull channel depth was 2.39 feet. From the critical shear stress equation (not shown) it was found that 8.94 feet of water would be needed to move this sediment downstream.

Fig. 8. Visual estimation of bankfull conditions and required water depth to entrain (suspend and move downstream) sediment at site F in the Waterworks reach. Pink lines represent bankfull conditions while green dots on trees mark the approximate water height necessary to entrain the bed material at this location.

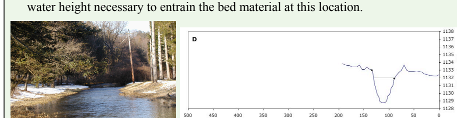


Fig 9. At site D, the median sediment size on the bed was 3.18 cm and the maximum bankfull depth was 3.13 feet. It was calculated that 4.84 feet of water would be necessary to move this sediment. Together with the data from site F, this shows that the sediment in the bottom of the channel in the Waterworks reach cannot be entrained under modern bankfull conditions.

BROADWAY REACH RESULTS

Fig. 10. The visual survey found signs of bank degradation such as "J-trees" indicating slope movement. In the channel, larger clasts lying on top of gravel-sized sediments are another indicator that sediment is being removed from the banks.

Fig. 11. In other parts of this reach there is vegetation growth in between the large clasts, indicating that the area is stable with no significant degradation or aggradation. The only indication of aggradation is fine sediment bars building up in eddies created by stormwater runoff from culverts.

Analysis of channel cross-sectional surveys from 1998 (by the Cortland County Soil and Water Conservation District) revealed that bankfull depths in the reach range from 3.5 to 5.6 ft. It was determined that the median grain size in the bed was 0.7 cm. Calculations showed that this sediment could be mobilized by a water depth of 1.63 ft, which is well below bankfull flow.

INTERPRETATION

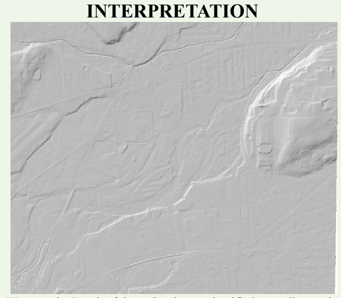


Fig. 12. The Waterworks Reach of Otter Creek was classified according to the Rosgen system as having the morphology (appearance) of a braided stream. This is supported by this hillshade LIDAR image that shows braid features in the Waterworks reach that contrast with the channelized reaches of Otter Creek elsewhere. However, Otter Creek today is not an active braided stream. Rather, it is a relic of the Valley Heads re-advance, and it has remained virtually unchanged by water flow for ~14,000 years.

The preservation of the braided appearance of Otter Creek suggests that no sediment is being eroded and transported downstream from the Waterworks reach. This is supported by the visual appearance of Otter Creek in the Waterworks, where there are no cutbanks or significant exposed areas of sediment to suggest either sediment originating or passing through this area. These observations are at odds with the suggestion that the Broadway reach is gaining sediment and aggrading.

CONCLUSIONS

- No significant sediment is entering the Broadway reach from the Waterworks reach.
- The sediment in the channel bed in the Broadway reach will be readily entrained and moved downstream under significant flow.
- Sediment accumulation is not the cause of the flooding of Otter Creek along Broadway and at the Townley Avenue bridge.