

Seize the day: What to do when a 500-year flood strikes in your backyard



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Abstract

The Duluth, MN, area experienced massive flash flooding following 8-10 inches of rain in 24 hours in June 2012, causing extensive damage at Jay Cooke State Park. One affected site involved a levee breach on Forbay Lake, releasing a flood wave downslope, carving a deep valley and destroying part of Highway 210. Although devastating for the park, the event provided opportunities for student research and outreach. Students from two classes at the University of Minnesota Duluth (UMD) conducted research in October 2012 to reconstruct magnitude and timing of the flood wave, impoundment behind the road, breaching of the road, and subsequent incision. Student projects focused on delineating the flood wave's lateral extent; determining peak shear stress and its effect on sediment mobility; estimating volumes of material eroded from the levee and deposited in the temporary impoundment; and tracking knickpoint propagation. Graduate students in a fluvial geomorphology course were able to address more complex issues including paleoflood discharge, levee geotechnical stability, and detailed long profile development. Collectively, they were able to extensively document what happened during the flood event at this site. To explain this dramatic event to park visitors, science education students from the University of Wisconsin Superior are taking data collected by UMD students and developing education materials. This collaboration between UMD, UWS, and the Minnesota Department of Natural Resources has provided research and public outreach opportunities for students that will eventually help educate the general public.

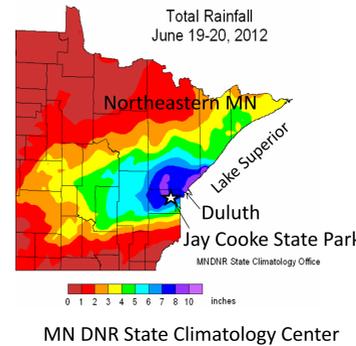
The June 2012 Flood



Duluth harbor – red with clay from flood.

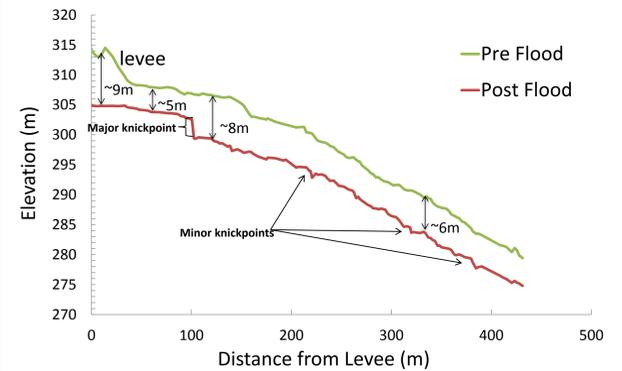


Following the flood, Lake Superior turned red with clay, remaining off-color until it over-turned in early August.



Examples of student research projects

(1) Students surveyed the long profile of the channel downstream from the levee breach with a total station and compared the long profile to a pre-flood profile using lidar data from Spring 2011.



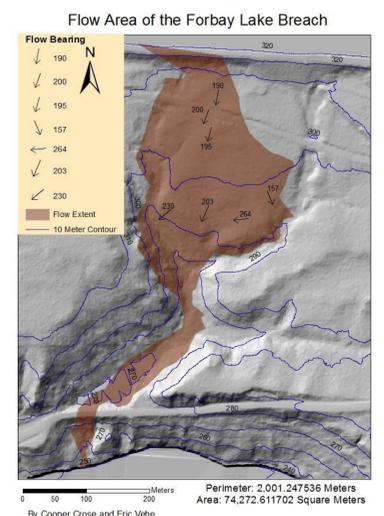
Long profile of incised channel downstream of the levee, compared with pre-flood lidar elevation data, by Grant Neitzel.

(2) Students used a GPS to mark the edges of the lake impounded behind the road, and estimated the volume of water held there temporarily. An extension of this was to determine potential discharge rates when the road failed.



Map of impoundment created behind road, by Michael Harris.

(3) Students mapped the extent of the flood wave with a handheld GPS. They used debris caught in trees as flow directional markers to capture the dynamics of the flow.



What happened?

(A) During a 500-year flood event on June 20, 2012, a levee breached on Forbay Lake, a diversion canal Minnesota Power used to send water to a hydropower plant to the east.



Levee breach as viewed from above (top) and from the ground (left). The failure occurred rapidly, sending a wave of water and sediment downslope.



(B) The levee breach caused widespread scour, scarring on trees, and deposition of levee material across a wide area.

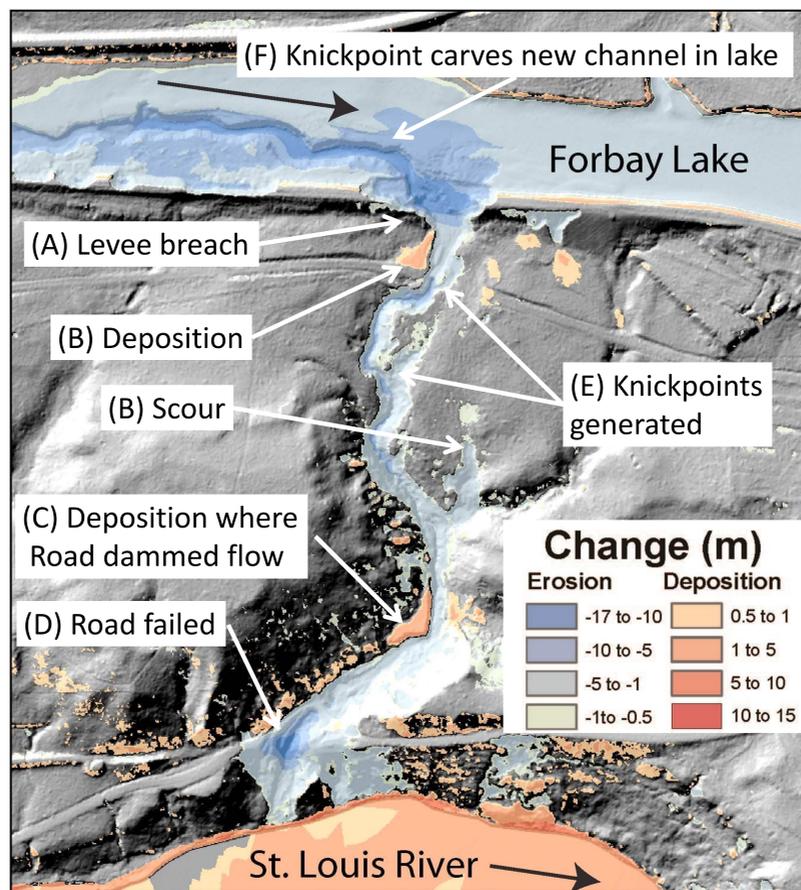


(C) Downstream, water backed up behind a road, leading to deposition of sediment.

(D) Eventually, the road failed, and the river scoured down through the deposits and into underlying glacial tills.

(E) Knickpoints initiated in the flood moved upstream, excavating a deep, narrow valley.

(F) Meanwhile, a knickpoint generated at the levee breach site itself moved upstream over 500 m, carving a new channel up to 5.5 m deep.



Hillshade of Forbay Lake breach at Jay Cooke State Park, MN. Overlain on the hillshade are data from repeat aerial lidar showing the difference pre- and post-flood. Lidar data were flown in spring 2011 and November 2012.



Multiple knickpoints migrated rapidly upstream, incising through glacial tills.



Jay Cooke State Park suffered greatly in the flood and was closed the rest of the summer. This map was created in Fall 2012, when portions of the park reopened to visitors. Our site is shown in the red box.



Photo by Derek Montgomery

Many thanks...

to Jay Cooke State Park, for allowing us access to the site many times, to the students in UMD's Geology 3210 and Geology 5260 who did an amazing job collecting, analyzing, and presenting their data, and to independent research students (Jacob Kolke, Emily Scheller) who are currently carrying this project forward.