Impacts on Geostructures of the Michigan Dam Failures of May 19, 2020: Preliminary Observations

A preliminary report of the NSF-Sponsored Geotechnical Extreme Event Reconnaissance Association

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Event background

On the afternoon of Tuesday May 19, 2020 following two days of heavy rainfall, two embankment dams on the Tittabawassee River in Midland County, Michigan failed. The fifty four foot high Edenville dam was breached and the downstream thirty six foot high Sanford dam was subsequently overtopped. The water level in the river at the Midland monitoring location reached a record high of thirty five feet, compared to a 'Major Flood' threshold of twenty eight feet[1]. In response to the dam failures approximately 10,000 people were evacuated, and the resulting flooding (Figure 1) caused significant damage to infrastructure and property including the destruction of bridges and buildings. The Village of Sanford, immediately downstream of the Sanford dam, was particularly affected.

GEER Mission

GEER conducted an initial review of the impact of the flooding on geostructures. This has been informed by publicly available reporting and through a field reconnaissance trip conducted by a two-person GEER team on June 2, 2020. The field reconnaissance included capturing geo-referenced images and recording field observations. The route taken by the reconnaissance team is shown on Figure 2. Observation or review of the Edenville and Sanford dam performance and failures was beyond the scope of the GEER mission. This document provides an preliminary summary of observed impacts ahead of the production of a detailed report.

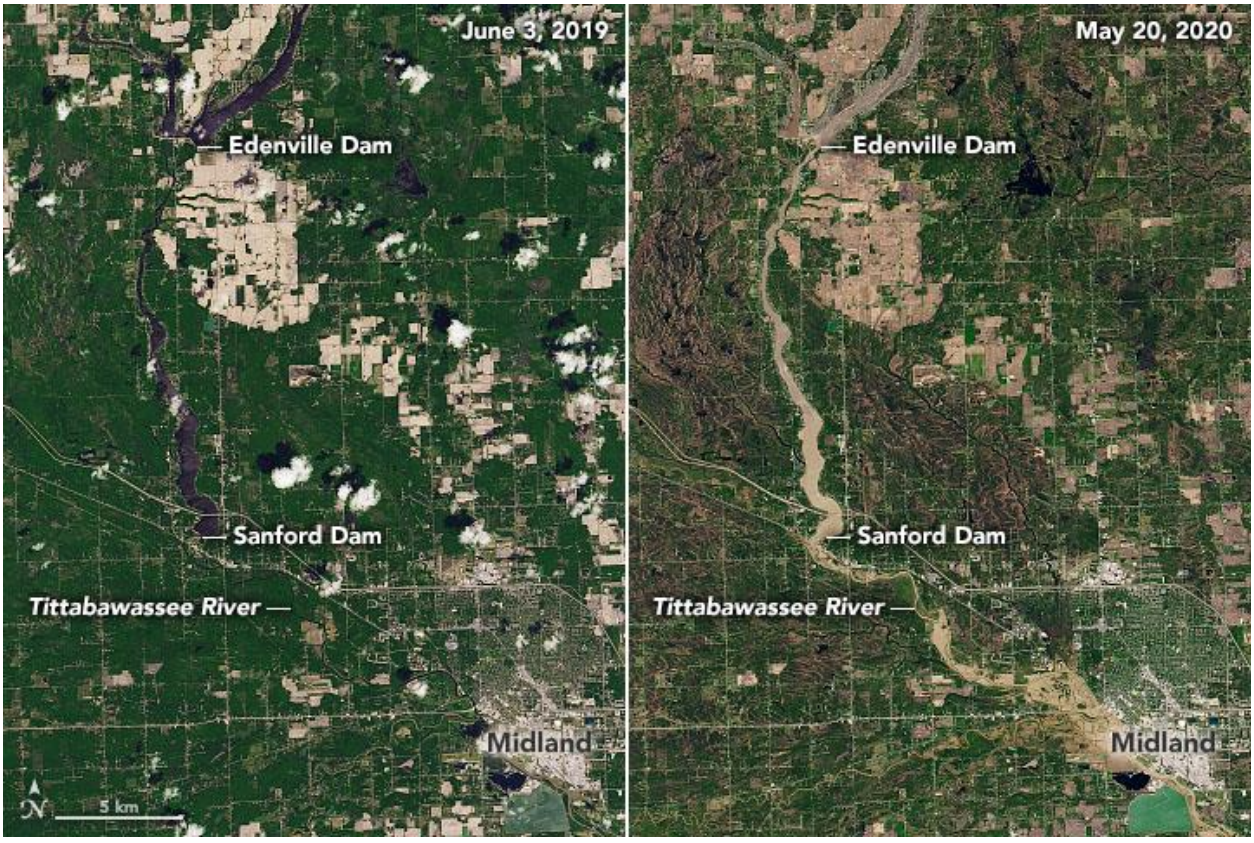

Figure 1. Satellite images showing the Titabawassee River before and after the May 19, 2020 dam failures (Source: earthobservatory.nasa.gov)

[1] https://waterdata.usgs.gov/monitoring-location/04156000/

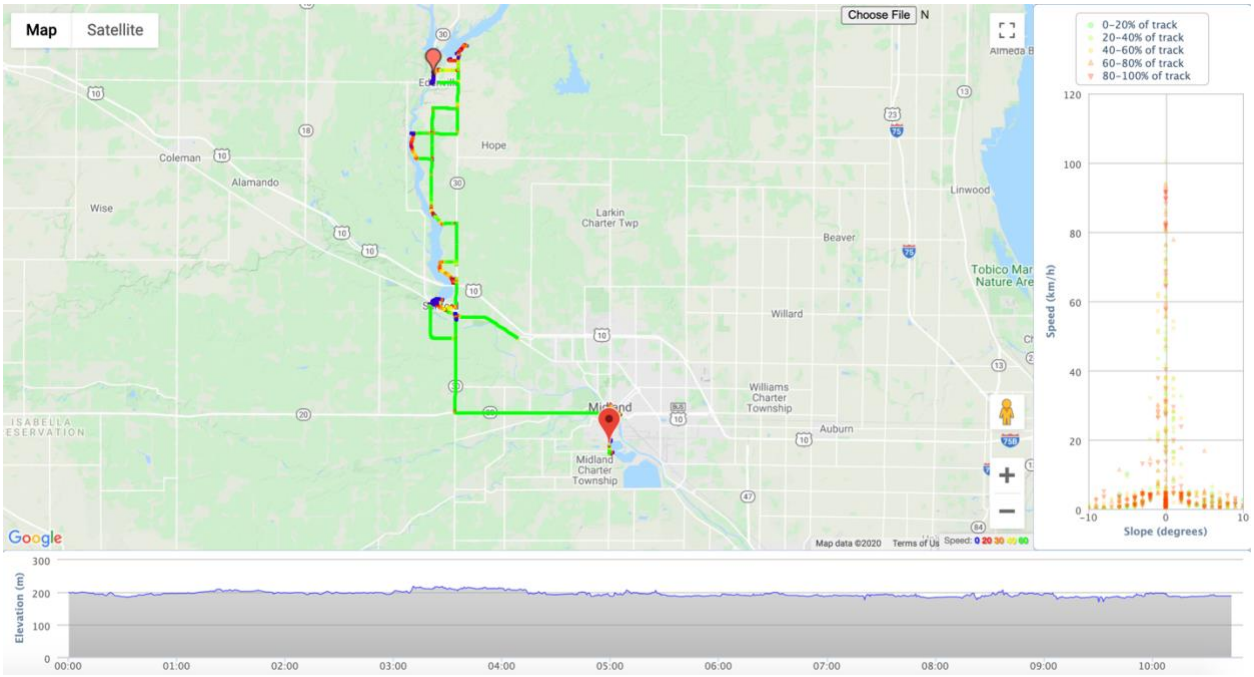

Figure 2. Route taken by the GEER Reconnaissance team on June 2, 2020. Colors are correlated with speed of travel (Source: Route Tracker Lite mobile app)

Preliminary summary of observed impacts on geostructures

- Observations were made at a total of 12 locations. This included 11 bridges, of which 7 exhibited damage significant enough to take them out of service. In addition, 16 other structures were observed that had been damaged beyond repair. These included single-family homes, commercial buildings and bridge approach embankments.
- The observed damage to structures was primarily due to scour and inundation and limited to a zone relatively close to the river channel and near the dam failures, at or upstream of the Village of Sanford. Several bridges were severely affected, as was property in Sanford.
- In the City of Midland, downstream of Sanford, the peak flood water level was not high enough to cause flooding at or beyond Main Street which represents the south-west boundary of the most densely developed areas. Impacts to property were therefore limited, and the bridges in the river at this location did not appear to have suffered any significant damage. However, the lower-lying industrial area south-west of the City that includes the DOW Chemical plant experienced flooding.
- Where floodwater did reach structures, there was a significant range in their observed performance. In some cases, this appeared to be correlated with distance relative to the dam failures and therefore floodwater height and energy, but it was also clear that age, design and construction played a part in how structures performed.
- The impacts on structures were in some cases severe (Figures 3 and 4) due to scour and erosion. These included the complete loss of multiple properties in Sanford, and severe damage to bridges, approach embankments and utilities.
- Where building damage was observed, some instances of partial foundation failure were apparent. However, the primary damage pattern appeared to be failure of timber-framed and masonry superstructures, with limited impact on substructures.
- For bridges, abutments were a common point of failure. There was some evidence that buried utilities through earthen structures had acted as initiation points for failures.

- Significant impacts on utilities were observed, particularly displacement of overhead power lines and telecommunications poles.
- No failures of retaining structures were observed other than at bridge abutments.

a. West Saginaw Road and West Center Street, Sanford (43.67334, -84.38350, NE)

b. Telecom pole directly upstream of West Saginaw Road Bridge (43.67629, -84.38509)

c. M-30 Road Bridge South Abutment, Edenville (43.80547, -84.38611)

d. West Saginaw Road Bridge Approach Embankment, Sanford (43.67462, -84.38653)

Figure 3. Images from GEER reconnaissance conducted June 2, 2020

a. US 10 Bridges, Sanford (43.684041, -84.373967)

b. M-30 Causeway Bridge, Wixom Lake (43.818118, -84.386174)

Figure 4. Images from Michigan DoT(Source: mdot.maps.arcgis.com)

A more detailed report documenting the observations of the GEER team is in preparation. The GEER response was limited by travel restrictions resulting from the Covid-19 event.