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National Regional Sediment Management Program
Omaha District (NWO):
Developing BSTEM Functionality and Visualizations in HEC-RAS for Large River Sediment Impacts Modeling

Description

The BSTEM (Bank Stability and Toe Erosion Model) is often used in HEC-RAS to calibrate and predict bank erosion, which in some cases, can constitute up to 25% of the sediment supplied to a river channel. The current BSTEM interface in HEC-RAS needs additional development for the calibration and testing of moveable bed and bank models on large rivers. This project will significantly increase the functionality and visualizations associated with BSTEM, test the new capabilities on a large river system calibration, and use that model to examine the sensitivity of a navigation channel to increased sediment loads from an upstream dam.

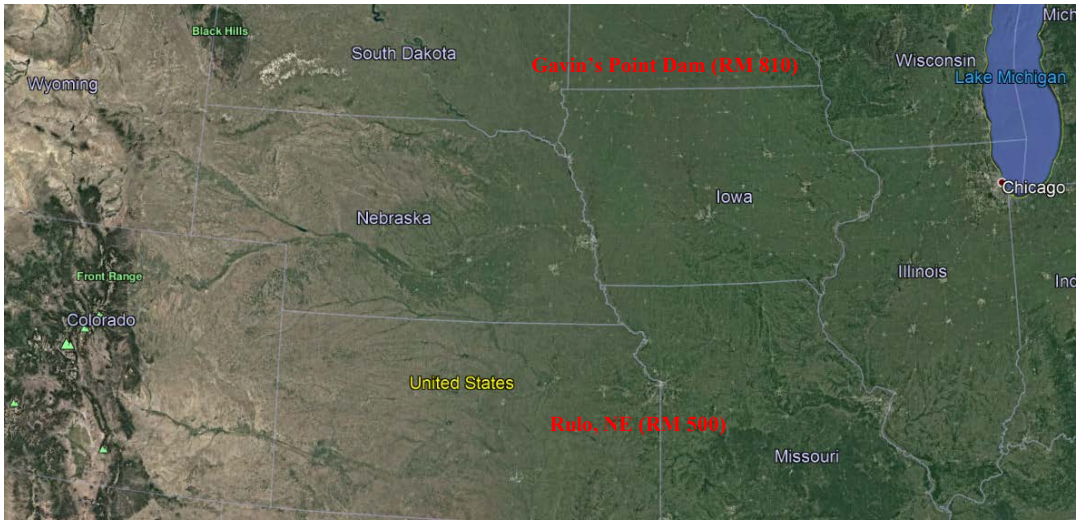

Figure 1. Missouri River, Rulo NE to Gavins Point Dam

Issue/Challenge To Address

When BSTEM functionality was added to HEC-RAS with version 5.0, Omaha District was one of the first to incorporate it into a model. At the time, Omaha planned to use a BSTEM model to meet the goals of the FY16 RSM project. Much of the funding for that project was expended in testing HEC-RAS BSTEM functionality. In the end, the model code was not yet robust enough to meet the goals of that project, and the project was not completed. Multiple improvements to BSTEM occurred as a result.

Multiple models have been developed since using BSTEM to erode banks, and recently Omaha developed an extensive model below Gavin's Point Dam for a reservoir flushing study. The model uses BSTEM, but was not accurately calibrating the split of sediment transported between the bed and banks. This lead to the discovery with the HEC-RAS team that BSTEM is calculating the values correctly, but not tracking the new bank toe location when reporting the volume split between bed and bank. That discovery led to the collection of functionality and visualization additions to be made as part of this project.

To confirm that the new additions are working properly, a calibration of a larger Missouri River model will be completed.

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Successes

BSTEM has been developed extensively with District model testing over the past two years. This effort will address issues that have been an obstacle to accurate reporting of bank volume change in modeling.

Projected Benefits

All users of HEC-RAS who may run the BSTEM algorithm to model bank erosion

Cost Savings

Efficiencies in the model calibration process may be realized by correct reporting of the split between bed and bank erosion.

Expected Products

- Four functions will be added to the BSTEM model within HEC-RAS:

1. $Improved accounting of bank vs bed change volume and mass: BSTEM currently tracks the change in the toe of bank location throughout a simulation, but when reporting the split between bed and bank at the end of the simulation, still uses the original toe location for reporting. This modification will update that function to report the split using the methods shown in Figure 2.

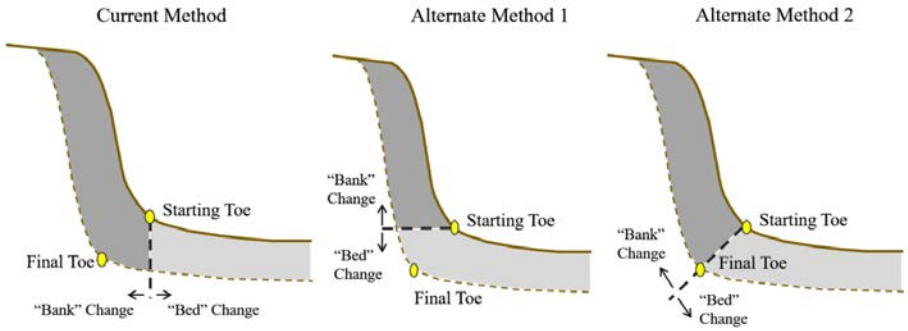

Figure 2. Current and Alternative Methods for Reporting Bank Toe Location at End of Simulation

2. $Toe Scour (or bank failure) only modes: In some cases using only one of the failure modes may better reflect actual river conditions. This will allow the modeler to selected a single mode or both (current condition)
3. $Develop mid-simulation bank protection further: The ability to turn on or off BSTEM in a long duration model will assist in conditions where bank protection was either added or removed.
4. $User selected BSTEM variables: If users have bank scour data available, they will be able to use local data to adjust BSTEM variables.

- Two visualizations will be added to HEC-RAS.

1. $Input visualization of toe location: Users will be able to select the bank toe location on the interface just as they can with the bank location, instead of having to input the station into the table. Figure 3 shows the proposed location for the interactive toe selection editor.

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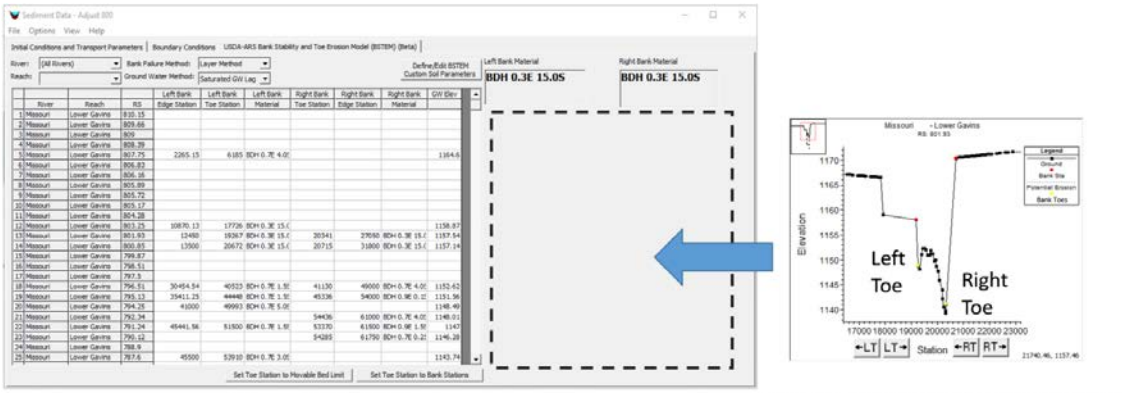

Current BSTEM Interface — Proposed Interactive Toe Selection Tool

Figure 3. Location of Interactive Toe Selection Tool

2. $Bank Migration Profile: For sediment modeling output, the user will now be able to see a graphical representation of bank recession for both banks at the same time, along the entire length of the model.

- Two technical papers at the SEDHYD 2019 conference on a) developing BSTEM testing algorithms (Gibson et al.), and b) calibration methodology for large rivers using BSTEM (Pridal et al.) will be presented.
- SEDHYD Conference Special Session on RSM - Papers that are submitted for the track, and other that match the principles of RSM will be organized into a RSM-centric session.
- RSM In-Progress Review meeting presentation in project progress.
- ERDC Tech Note on Using BSTEM in Large River Models.

Stakeholders/Users

HEC-RAS is commonly used for sediment transport modeling in rivers and reservoirs. An update on the new BSTEM tools in HEC-RAS will be included in future HEC-RAS classes. Omaha district representatives will attend the annual Missouri River Sedimentation Action Coalition (MSAC) annual meeting and present the results of the modeling analysis as it related to their interest in removing sediment from Lewis and Clark Lake behind Gavin's Point Dam. The Special session at the SEDHYD conference will introduce RSM principles to a wide cross-section of river and reservoir practitioners.

Leveraging Opportunities

The lower Missouri River modeling that will be used as a calibration tool has been initially developed as a fixed bed model in support of a Management Plan effort for the Missouri River Recovery Program (MRRP). This will allow that previous model to be update to a movable bed model which significantly reduces the burden to develop geometry and flow data for a model from scratch.

Points of Contact

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