A Physical Based Approach to Simulate Streambank Erosion in the Clear Creek Watershed

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Problem Statement

Streambank erosion is widespread in the Mid-Continental United States, leading to increased sediment yields. The transported sediment can have detrimental effects to the downstream reaches of the stream in terms of water quality and affect the geomorphology of the stream. Therefore, a numerical model that can properly quantify streambank erosion contributions to the total sediment fluxes is required. But most of the available models do not account for the governing mechanisms triggering streambank erosion. The models consequently give less accurate predictions of stream bank erosion rate.

In this study, streambank erosion will be simulated using CONCEPTS (CONservational Channel Evolution and Pollutant Transport System), which is a physically based computer model capable of simulating open-channel hydraulics, sediment transport, and channel morphodynamics (Langendoen & Alonso, 2008). The model is attractive to use due to its inherent ability to account of most of the governing processes triggering bank erosion in the Midwest.

Objectives

- ❑ Simulate streambank erosion in Clear Creek at South Amana accurately using CONCEPTS (Conservational Channel Evolution and Pollutant Transport System), validate the model and point out its limitations.

Methodology

Step 1: Perform field and laboratory measurements to collect input data used for CONCEPTS model simulations.

Step 2: Simulate bank erosion using CONCEPTS numerical model

Step3: Compare the result of model simulation with the observed data to test the accuracy of numerical model in predicting bank erosion rate .

Field Work & Laboratory Tests

Case study : Clear Creek at South Amana,Iowa

Before flood event (May 28th, 2009)

Measurement after flood event (June 23rd, 2009)

Important laboratory tests are:
1.Sieve analyzes and hydrometer test.

2.All tests required to determine bed and bank soil properties viz. water content, porosity, unit weight, angle of internal friction, cohesion.

Required field works are:
1.Real time monitoring of erosion event.
2.Measurement of channel cross section before and after flood .
3.Submerged jet testing (Hanson, 1990) to determine bed and bank erodibility parameter (critical shear stress and erodibility coefficient).
4.Amoozeemeter test to measure hydraulic conductivity of bank soil.
5.Survey and measurement to determine type and density of vegetation, root diameter, and root tension strength.

Real-Time Erosion Measurement

Milivolt signal is send to data logger

Milivolt signal is directly proportional to the length of tube which expose to the light

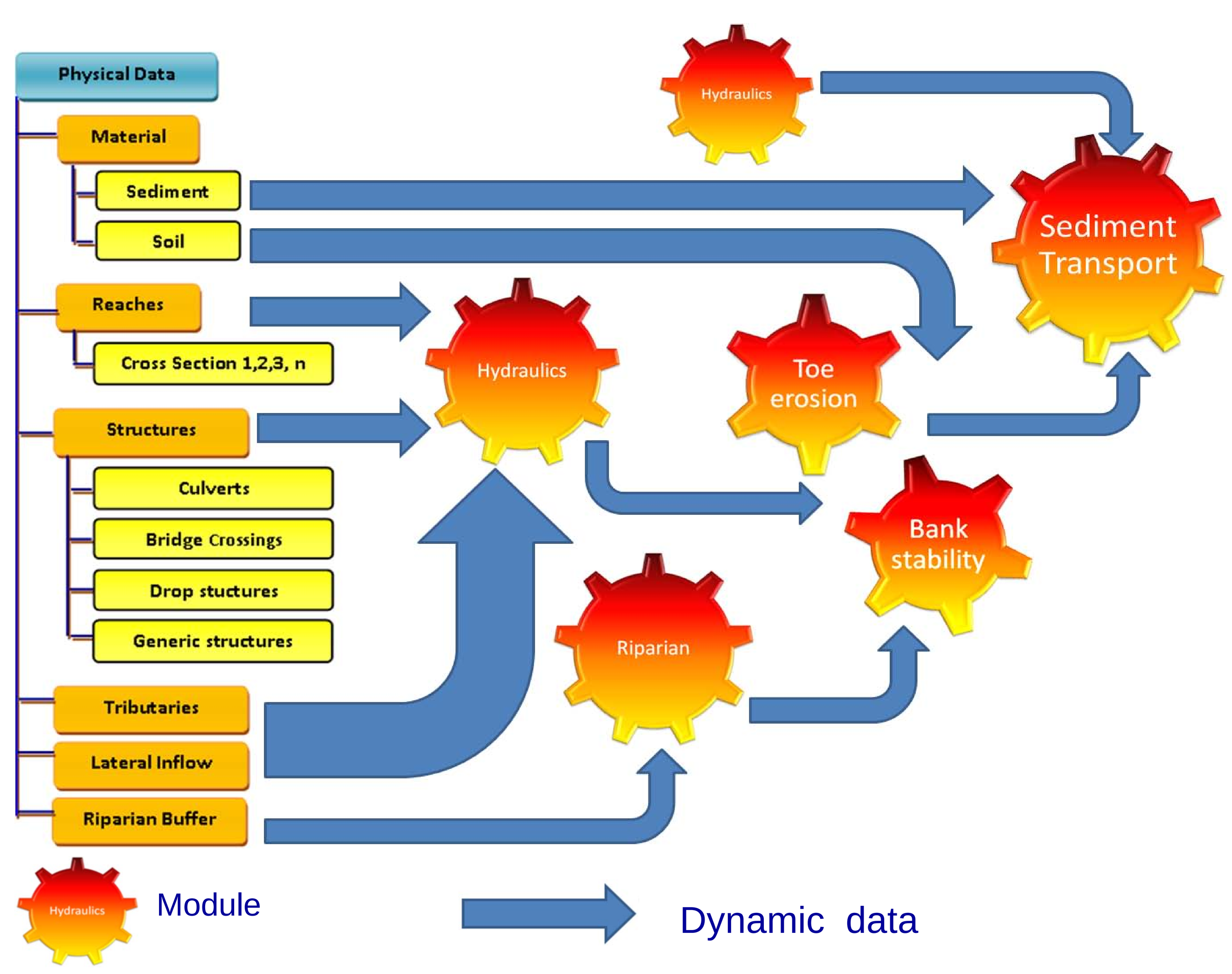
PEEPs (Photo-Electronic Erosion Pin) and conventional erosion pins are used to monitor erosion and deposition.

PEEP sensors, developed by Lawler (1991), provides more detail temporal erosional and deposisional activities at the monitored site.

CONCEPTS Numerical Modeling

CONCEPTS model was developed by Eddy J. Langendoen and Carlos V. Alonso from USDA-ARS, Oxford, Mississippi.

Structure of the CONCEPTS Model



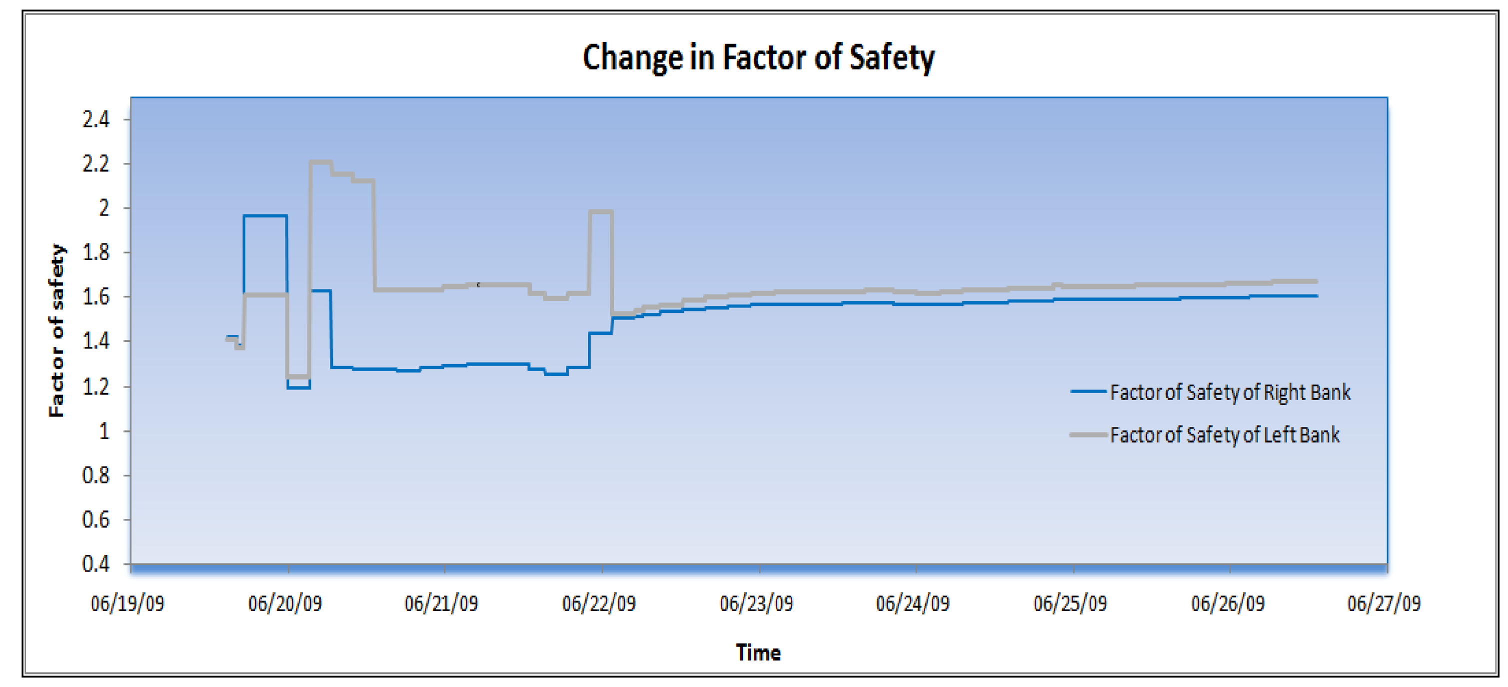
Model Set Up

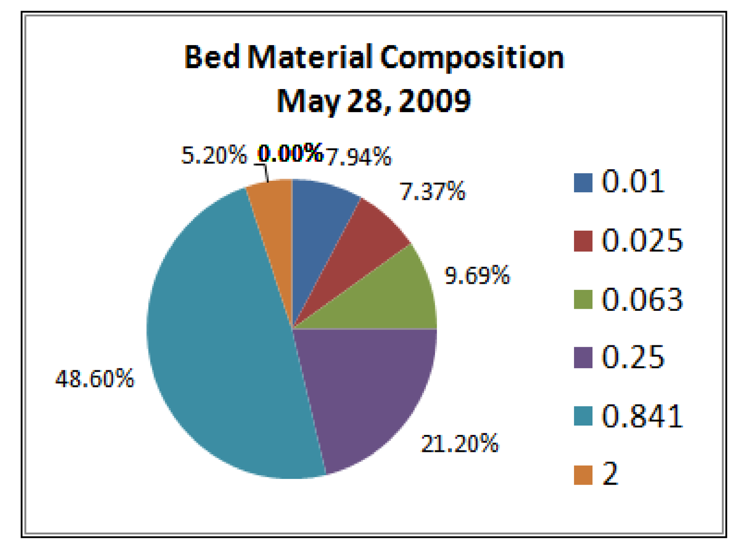
❑Time series of discharge and sediment inflow were imposed as upstream boundary condition.

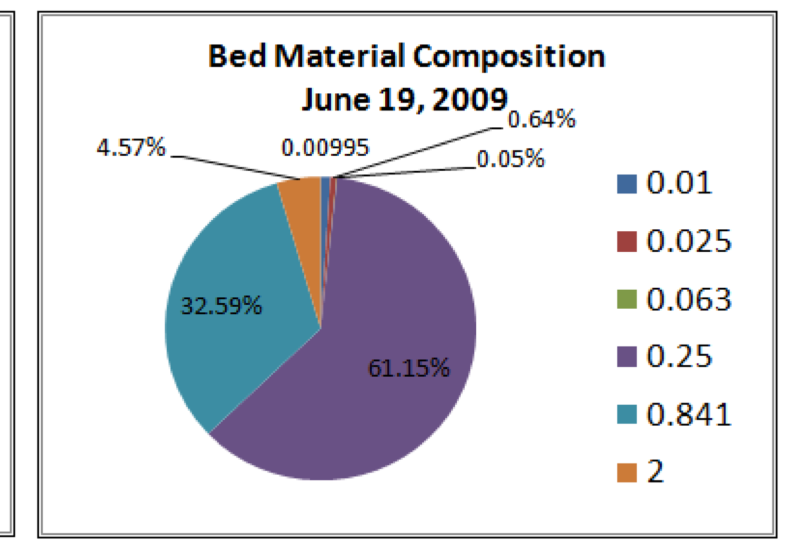
❑Discharge rating curve was employed as a downstream boundary condition

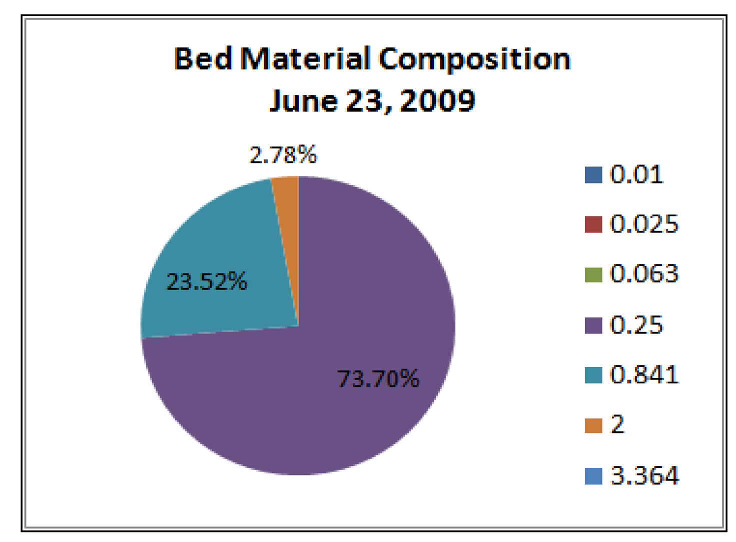
❑Initial time step: 100 seconds

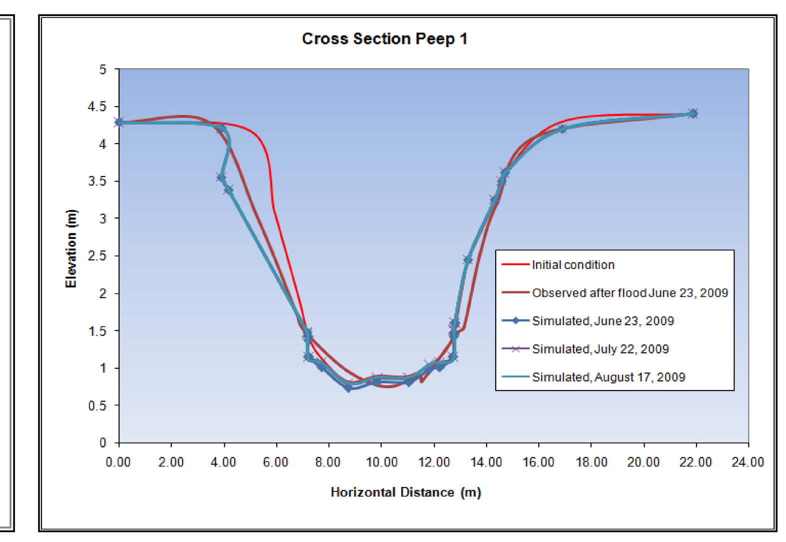
PRELIMINARY RESULT











Change of Bed Material Characteristic					
Date	D16 (MM)	D50 (MM)	D84 (MM)	D90 (MM)	DMEAN (MM)
05/28/09	0.027	0.275	0.642	0.746	0.147
06/19/09	0.087	0.187	0.549	0.687	0.201
06/23/09	0.085	0.16	0.425	0.579	0.181
07/22/09	0.079	0.126	0.202	0.22	0.126

The results displayed above are the output of CONCEPTS model without running the Riparian module. Consequently, the additional soil shear strength provided by the vegetation roots is not taken into account for computing bank stability. Anyhow, the model has simulated the bank failure after flood event successfully.

Conclusion

1. This study will simulate bank erosion in the Clear Creek using the CONCEPTS model which is based on physical process occurring in a streambank and riparian area.

2. Interaction between in-stream and riparian physical processes must be simulated properly to be able to perform a more realistic simulation of stream bank erosion.