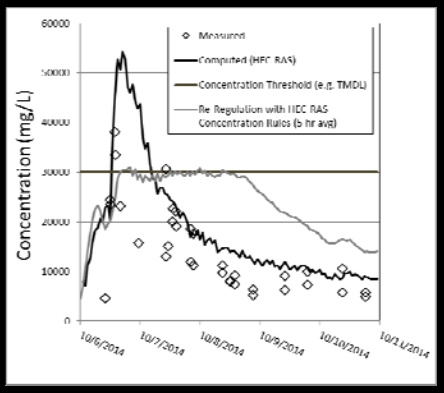
Monitoring and Modeling a Reservoir Flush:

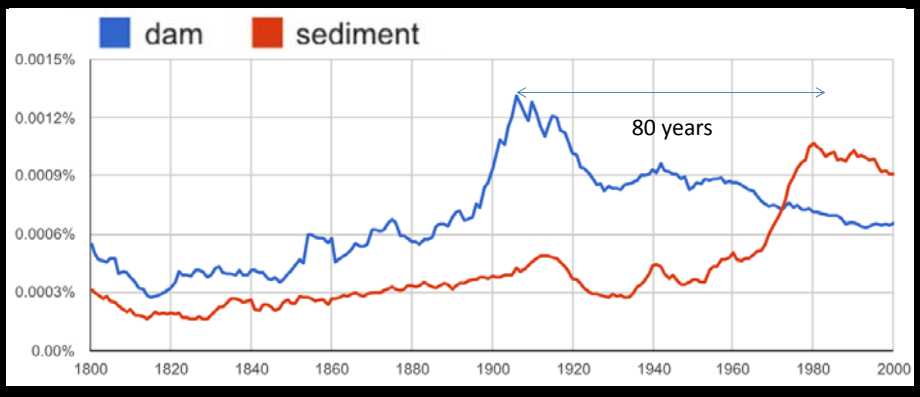
Simulating Sustainable Reservoir Management at Spencer Dam with an HEC-RAS Unsteady Sediment Model and New Sediment Operational Rules



Stanford Gibson, PhD (HEC)
Paul Boyd, PhD, PE (NWO)
Thursday January 7, 2015: Noon (PST)

Google n-gram

Measures the relative occurrence of words in books over the last 200 years.



Lewis and Clark, Missouri River

Flushing

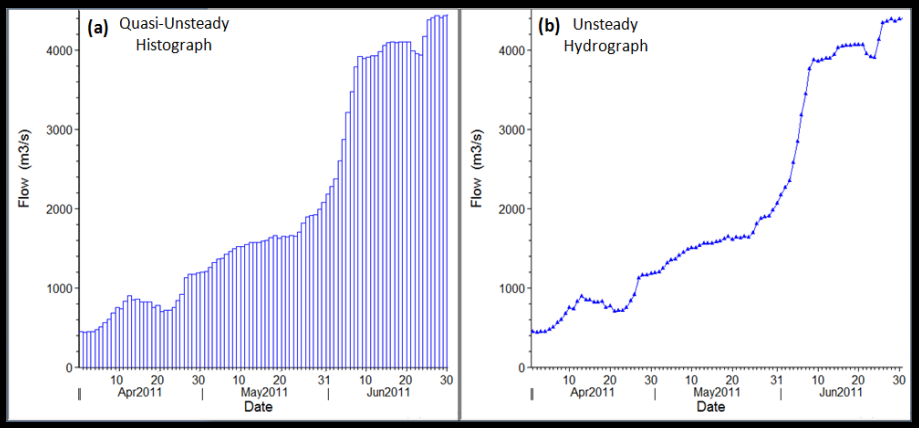
Tuttle Reservoir, Kansas

Routing

New Sediment Features in HEC-RAS 5.0

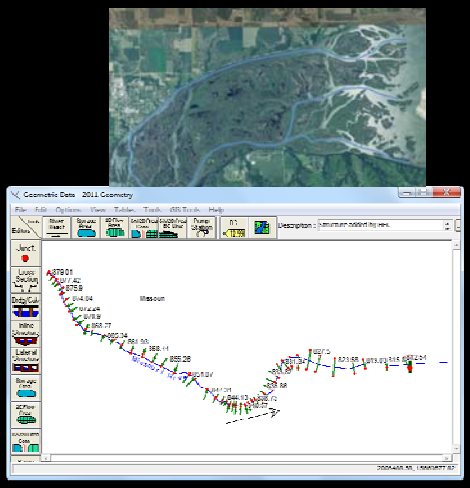
Unsteady Sediment Transport and Reservoir Sediment Management Features

Quasi-Unsteady →Unsteady Sediment



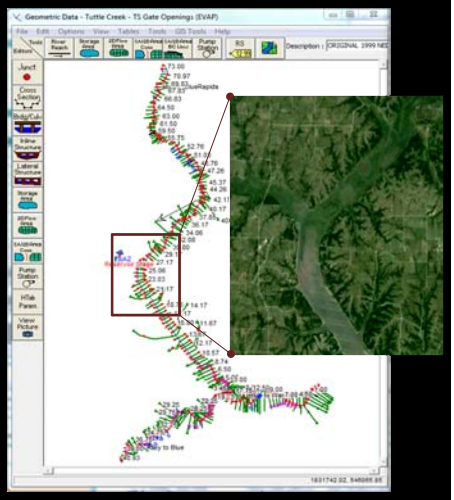
Funded by the Corps of Engineers Flood and Coastal Storm Damage Reduction R&D Program

Lewis and Clark *Flushing* Model



Gibson, S. and Boyd, P. (2014) "Modeling Long Term Alternatives for Sustainable Sediment Management Using Operational Sediment Transport Rules," *Reservoir Sedimentation* –Scheiss et al. (eds), 229-236.

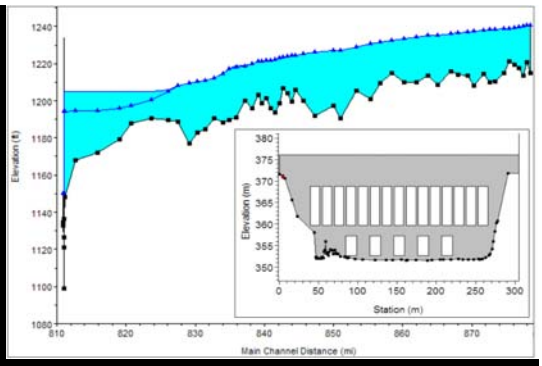
Tuttle Creek Sediment *Routing* Model

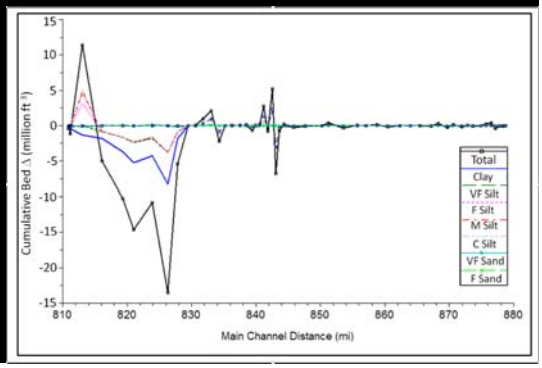


Shelley, J., Gibson, S., and Williams, A. (2015) "Unsteady Flow and Sediment Modeling in a Large Reservoir using HEC-RAS 5.0," Federal Interagency Sediment Conference, SedHyd Proceedings.

"Often the available field data are not sufficient to permit a formal calibration, but computational modeling is still the best method for analyzing the problem… The resulting studies are called computational analysis studies."

-Thomas and Chang
ASCE Manual of Practice 110

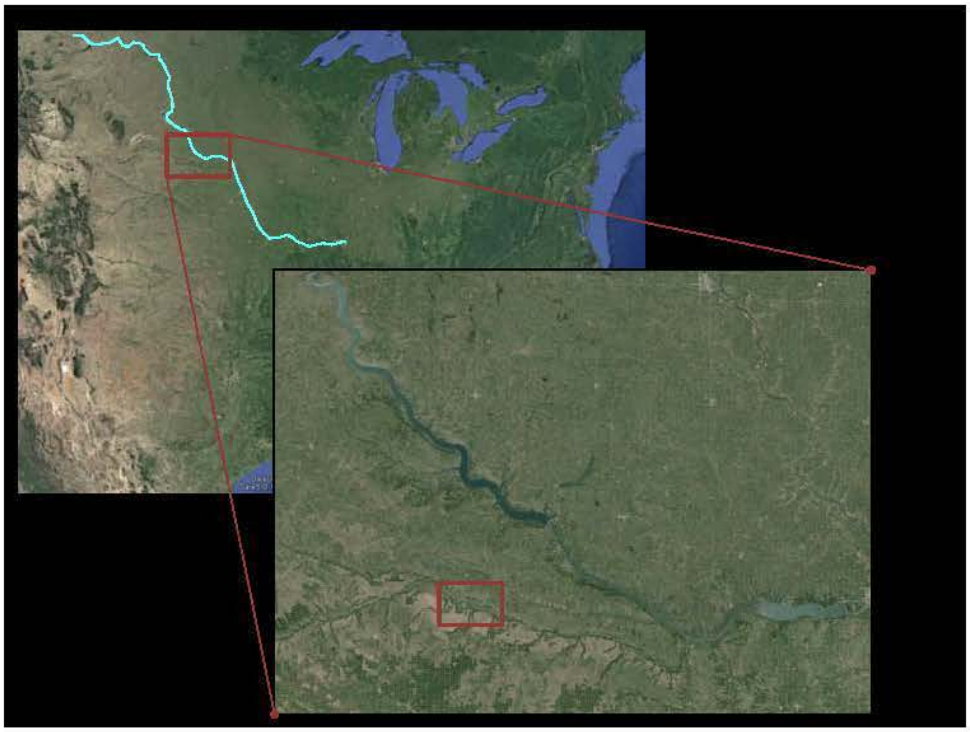


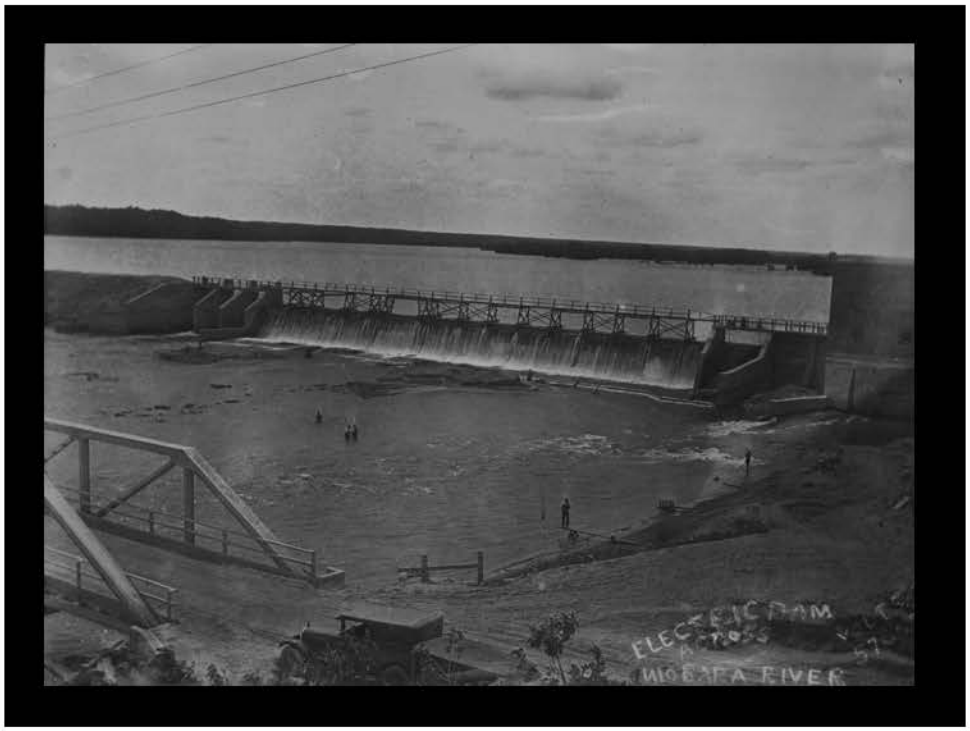


Spencer Dam Flushing Model

Funded by the Regional Sediment Management R&D Program (RSM)

Spencer Dam on the Niobrara River




ELECTRIC DAM
MISSAFA RIVER

The November 2015 Flush

vid

Reservoir Stratigraphy

Coarse Sand and Gravel Cross Bedding

Clay Seams

Organic Flood Debris Layers

Mud Flats

Qualitative Observations: Novel Bed Forms

Clay Rollers

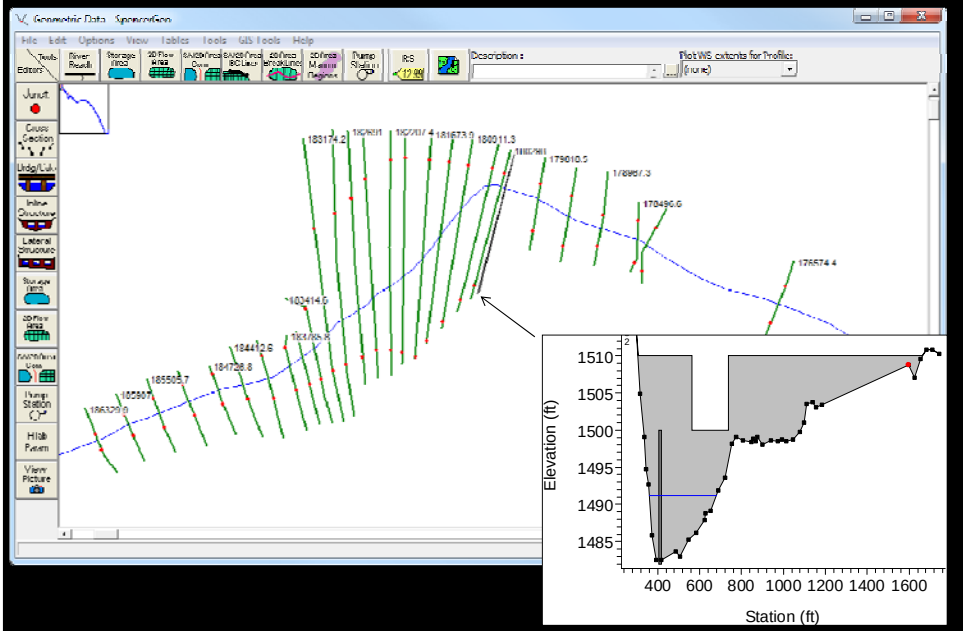
"Topographic" Bed Forms

Periodic Antidunes - 90 s cycle

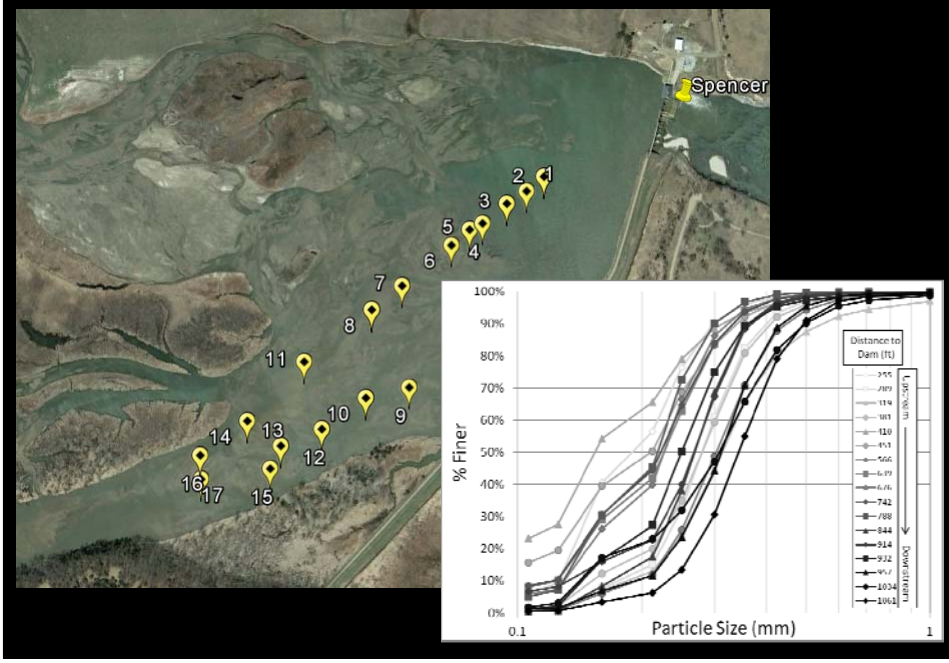
HEC-RAS Model and Calibration

Survey and HEC-geoRAS Model

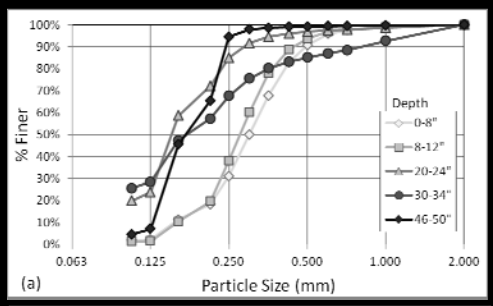
Spencer HEC-RAS Model

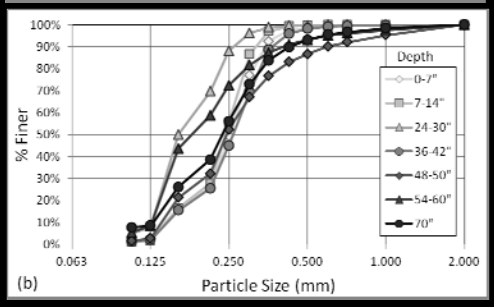


Pre-Flush Sediment Samples

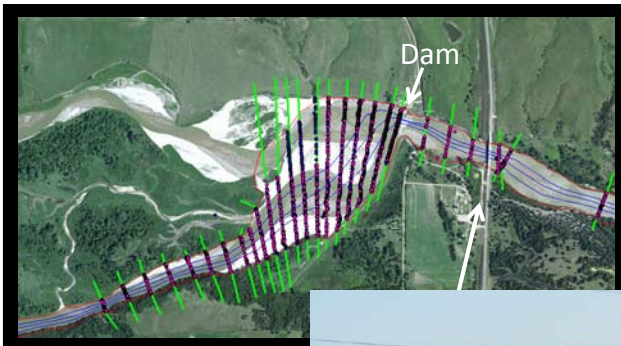


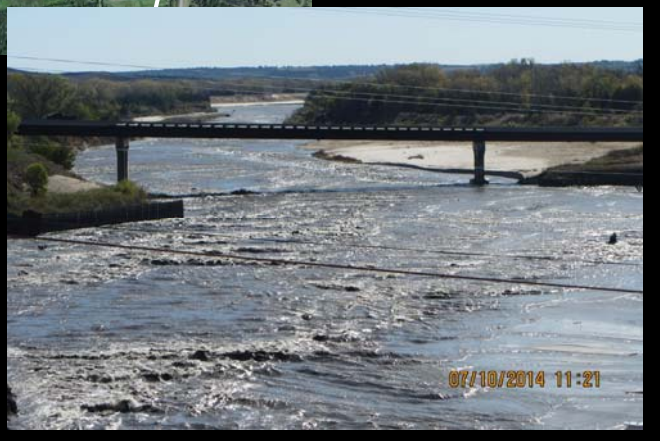
Post-Flush Core Samples



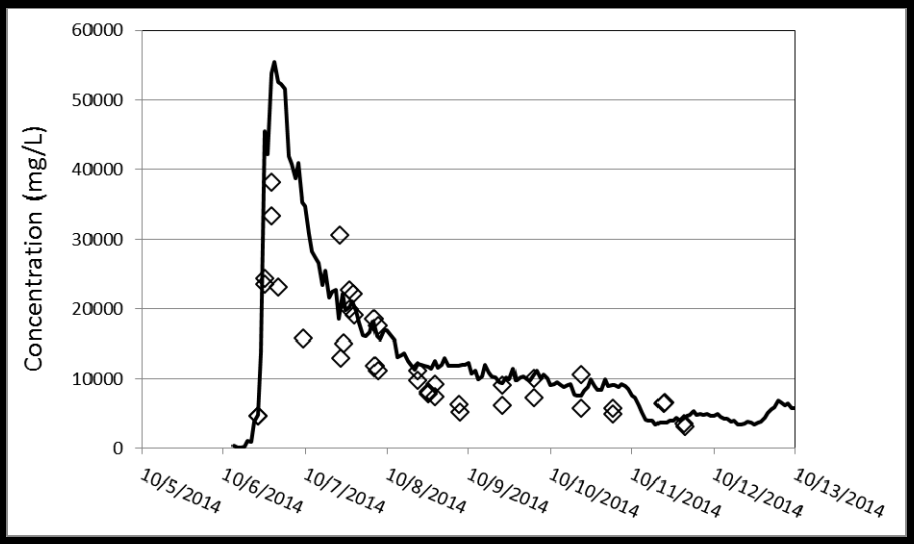


USGS Concentration Measurements

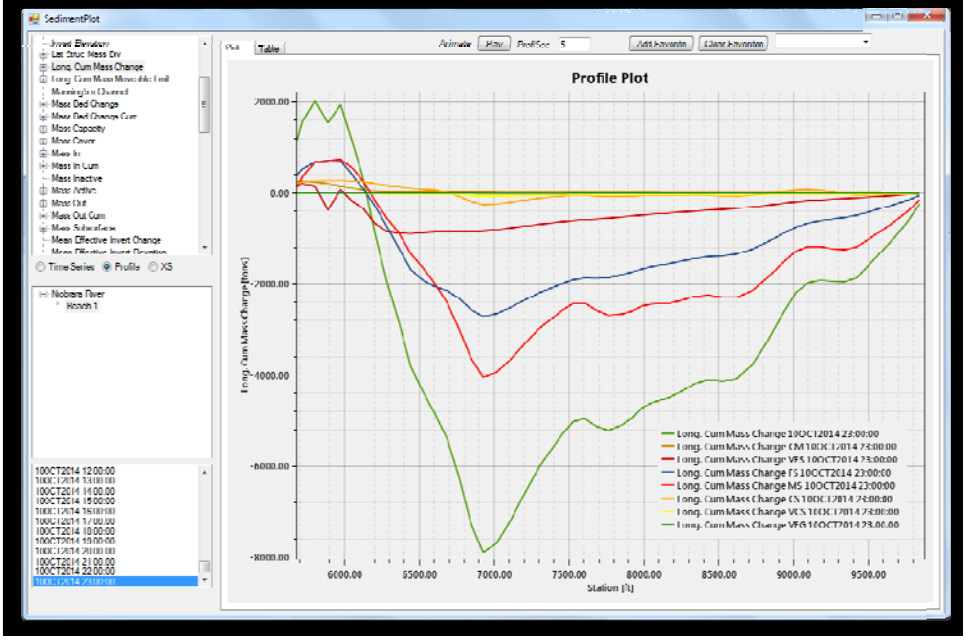




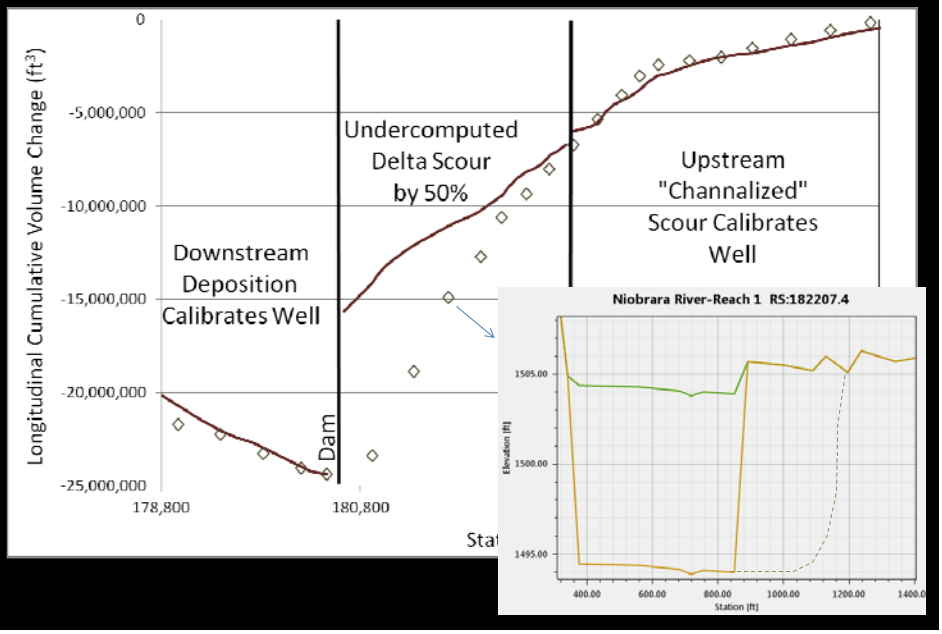
Downstream Concentration Calibration



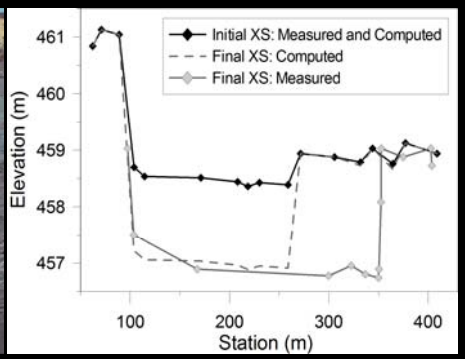
Cumulative Volume Change (4 week run)



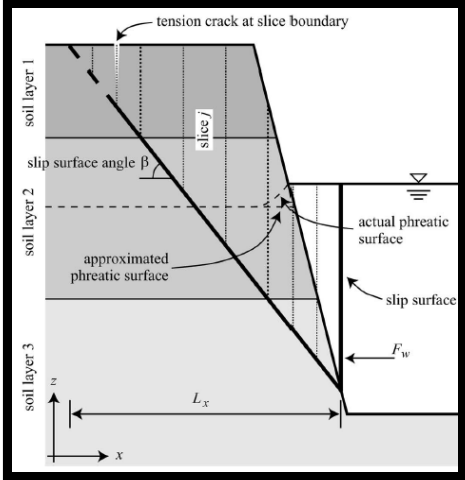
Spencer HEC-RAS Model



Lateral Processes Observed

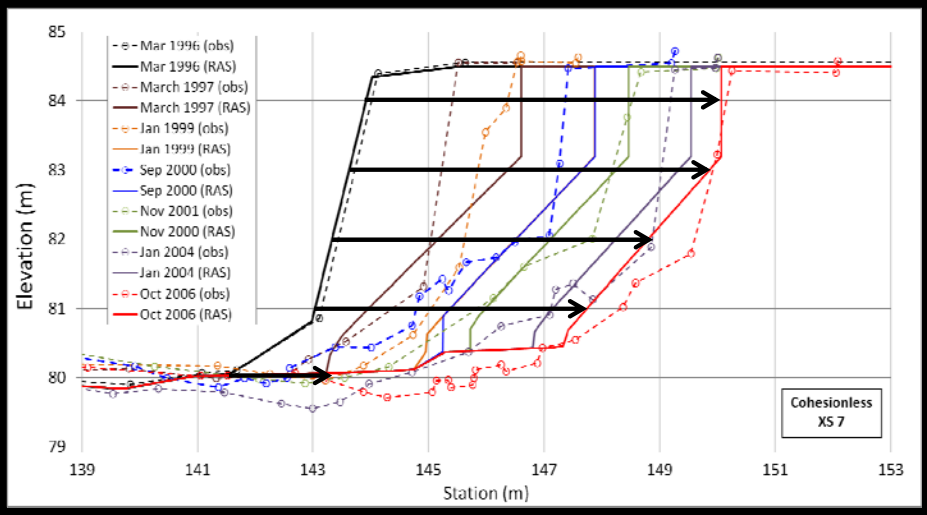


USDA-ARS Bank Failure and Toe Scour Model (BSTEM) in HEC-RAS



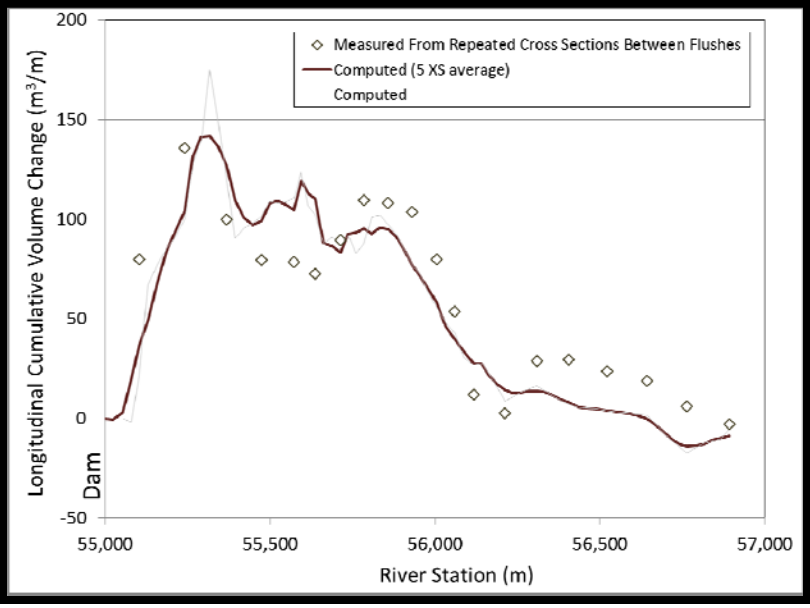
http://www.eng.buffalo.edu/glp/events/summer2008/week1/full/8-GoodwinCreekDesign.pdf

Goodwin Creek Validation



Deposition Model:

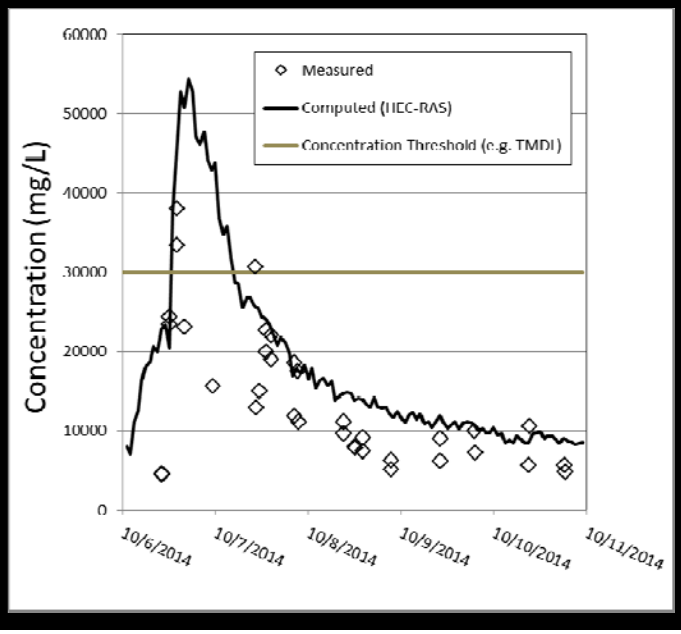
Measured and Computed Bed Change Between Fall and Spring Flushes

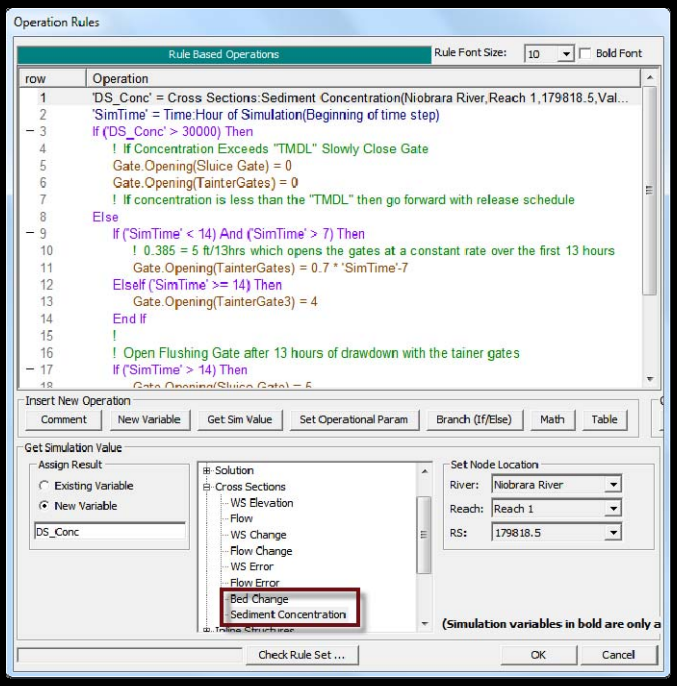


HEC-RAS Modeling Alternatives:

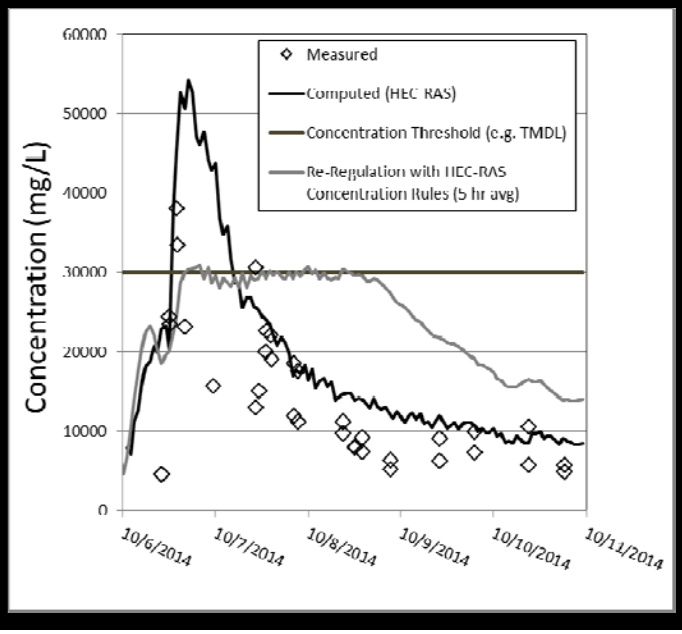
Concentration Controlled Flushing

Downstream Concentration Threshold



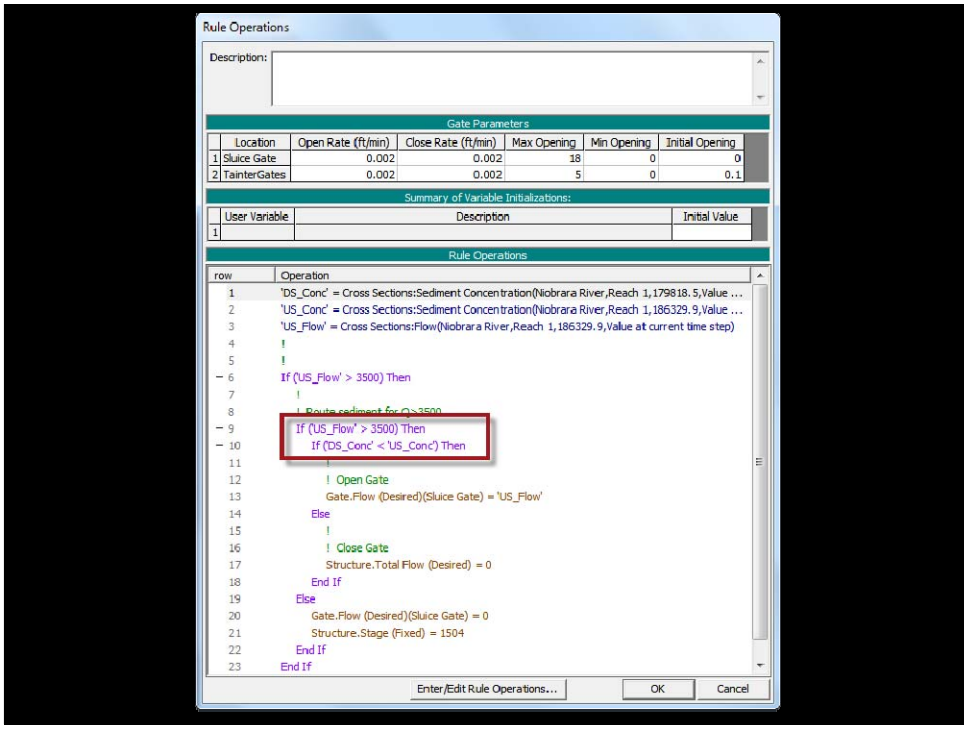


HEC-RAS Concentration Threshold Model



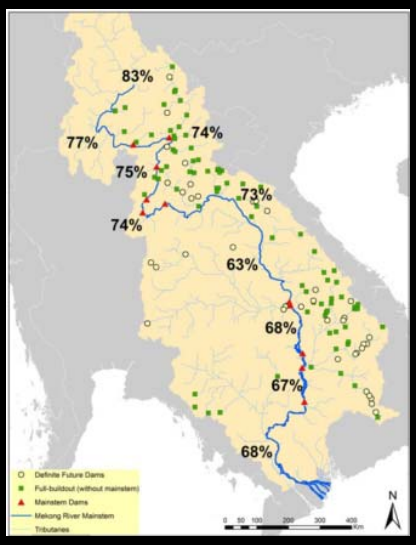
HEC-RAS Modeling Alternatives:

Routing $Q_{sed\text{-}in}=Q_{sed\text{-}out}$



International Sustainable Reservoir Management Initiatives

Lower Mekong Basin



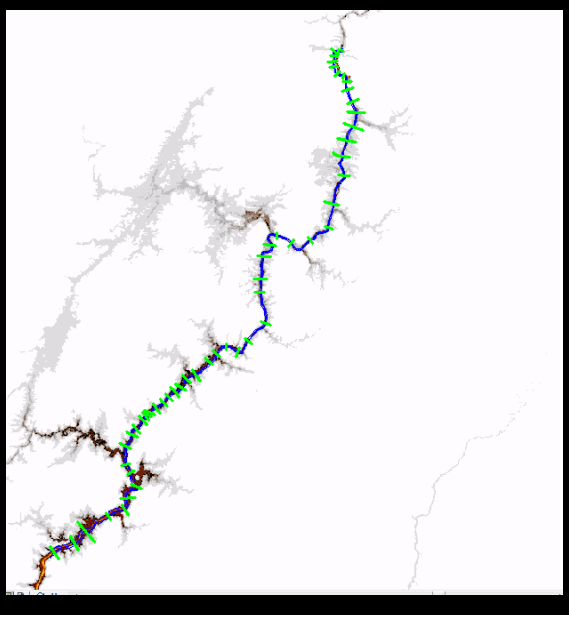
Kondolf, G.M., Rubin, Z.K, and Minear, J.T., (2014) "Dams on the Mekong: Cumulative sediment starvationWater Resources Research" Volume 50, Issue 6, pages 5158-5169, 27 JUN 2014 DOI: 10.1002/2013WR014651

Laos Reservoir Sediment Workshops

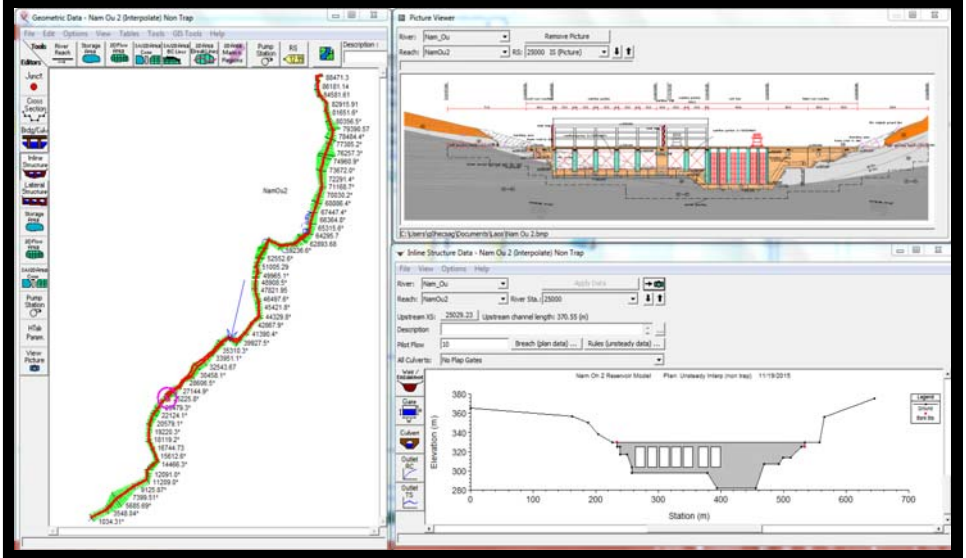
Pictures From Paul Boyd (NWO)

Laos Reservoir Sediment Workshops

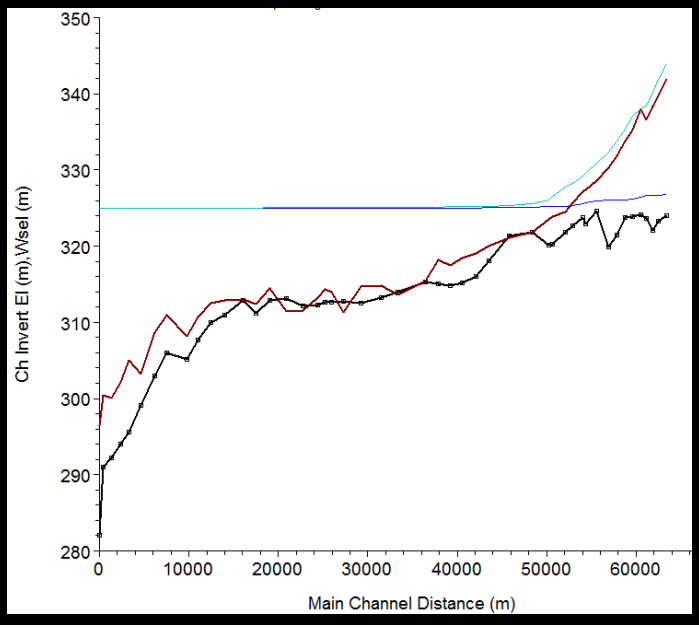
Nam Ou 2 Model



Nam Ou 2 Model



Nam Ou 2 Model



Ongoing HEC-RAS Sediment Activities

Select Projects:

-Islamabad Class and Tarbela Model
  -with Bill Doan and Mamie Brouwer - USACE/USAID
-Lower Missouri Sediment Model (500 miles)
  with John Shelley NWK
-Lower Mississippi Unsteady Sediment Model (DS of Old River)
  with ERDC CHL: Ronnie Heath, Travis Dahl, Jim Lewis, Chris Nygaard
-Muskegon River Coupled Ice-Sediment Model
  -For Detroit District - LRE
-Falls Creek Sediment Flushing Model
  -with Chris Nygaard – NWP – For RSM

Features:

2D Sediment – With Alex Sanchez
1D Unsteady Finite Volume Method – RMA and RAS Team

Partners

Funding Partners:

Regional Sediment Management R&D Program (RSM)
Flood and Coastal Storm Damage Reduction R&D Program
Omaha District
USGS

HEC-RAS Team:

Gary Brunner, Mark Jensen, Steve Piper, Cam Ackerman, Alex Kennedy

District Partners:

Paul Boyd, PhD, PE – NWO
John Shelley, PhD – NWK

Niobrara River