Modeling the Evolution of Catskill Stream Channels - Preliminary Results

Rajith Mukundan[1], Elliot Schneiderman[2], Danny Davis[3] and Eddy Langendoen[4]

[1]CUNY, Institute for Sustainable Cities

[2]NYCDEP, Water Quality Modeling

[3]NYCDEP, Stream Management program

[4]USDA-ARS National Sedimentation Laboratory

Outline

- Introduction
- CONCEPTS - model
- Model setup for Stony Clove
- Preliminary results
- Conclusions and future work

Erosion – a global challenge

NYC Environmental Protection

- In North America, damage due to soil erosion and fluvial sediment ($20-$50 billion/year)

  (Pimental et al., 1995;Osterkamp, 2004;Larsen et al., 2012)
- Damage – physical, chemical, biological
- Limited understanding – sources and fluxes
- Regionally consistent approach needed

(Larsen et al., 2012)

Erosion – in the U.S.

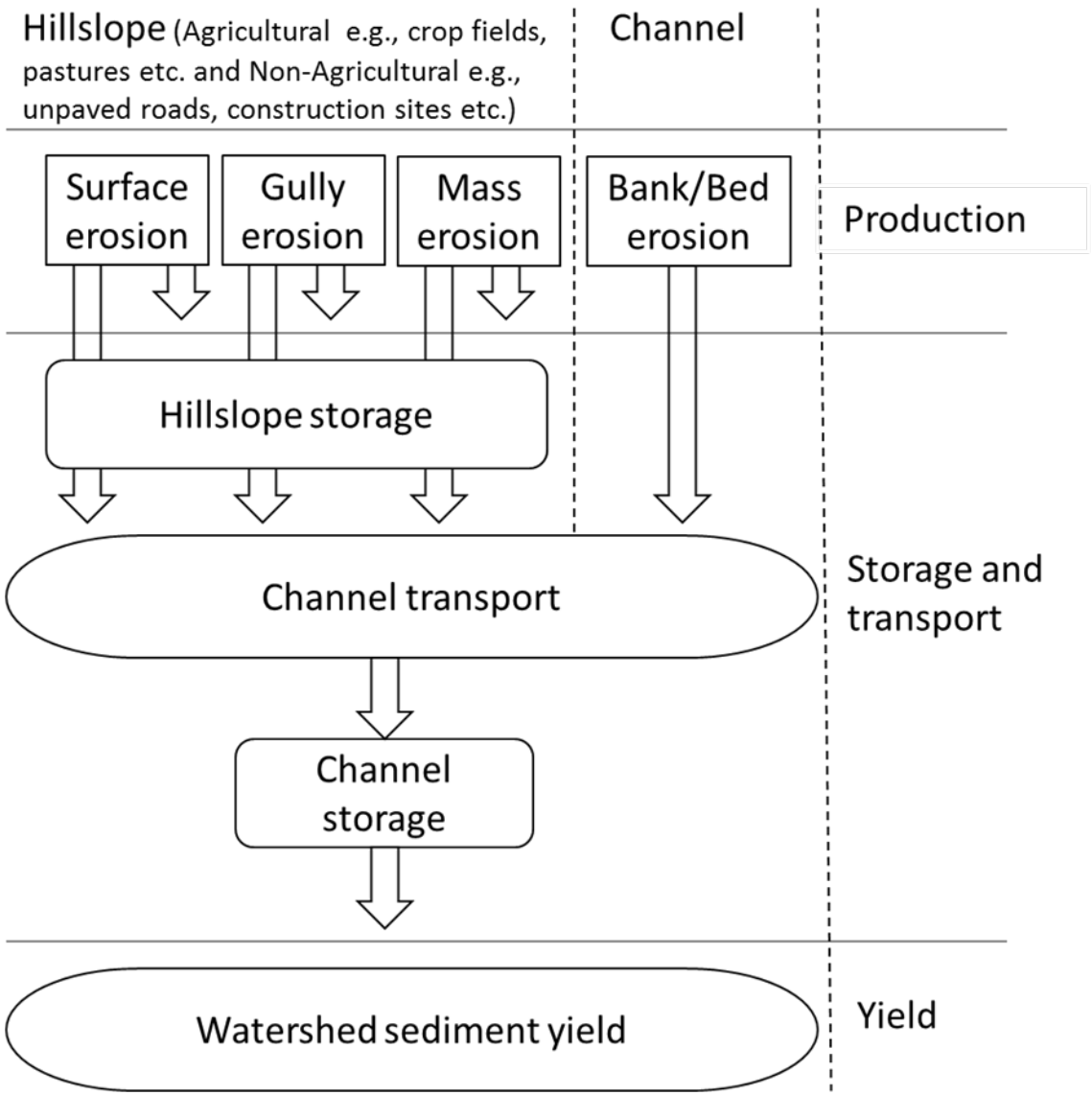
- Significant success with reducing erosion on the farmers' fields (USDA-NRCS,2010)
- Elevated sediment concentration remains a problem in many streams in the U.S.
- Whole system approach required – land and stream components (CAST, 2012)

Sediment and Water Quality

Ashokan Reservoir of NYC water supply; September 1, 2011 following Tropical Storm Irene flooding

Stony Clove Creek near Phoenicia, Oct 1, 2010

Sedimentation Process



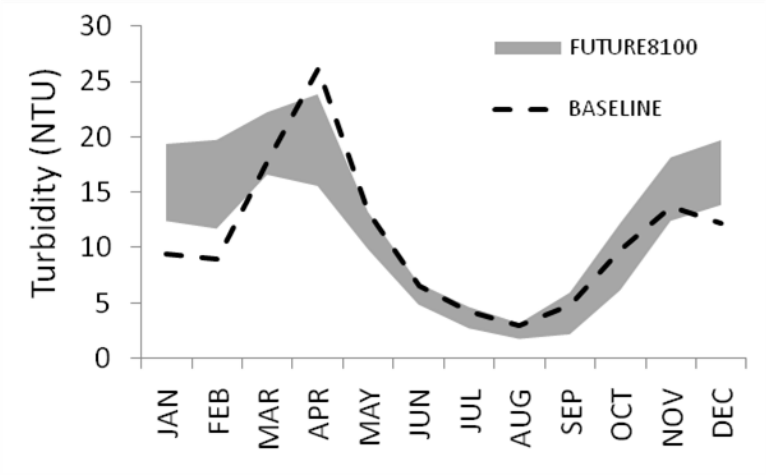
(Modified from USEPA, 1999)

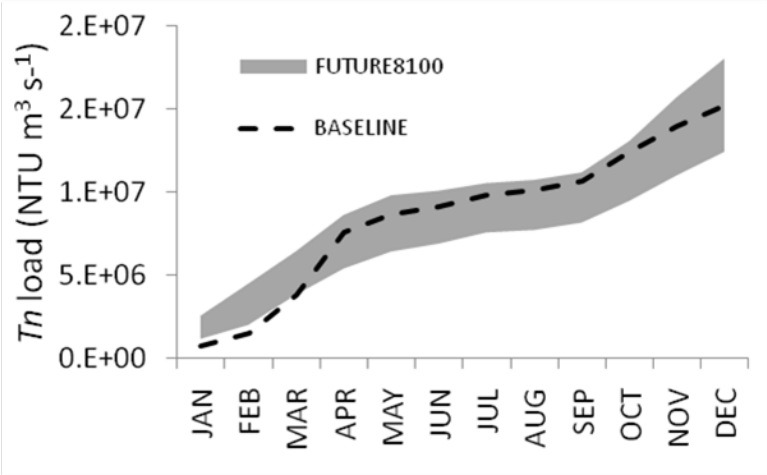
NYC Water Supply Watersheds

Catskill system	Delaware system
Less Agriculture More glacial clay	More Agriculture Less glacial clay
Dominant source of stream sediment- glacial clay from stream channels (NYCDEP,2008)	Dominant source of stream sediment- upland/agricultural source (Nagle et al., 2007)

Climate Change and Stream Turbidity

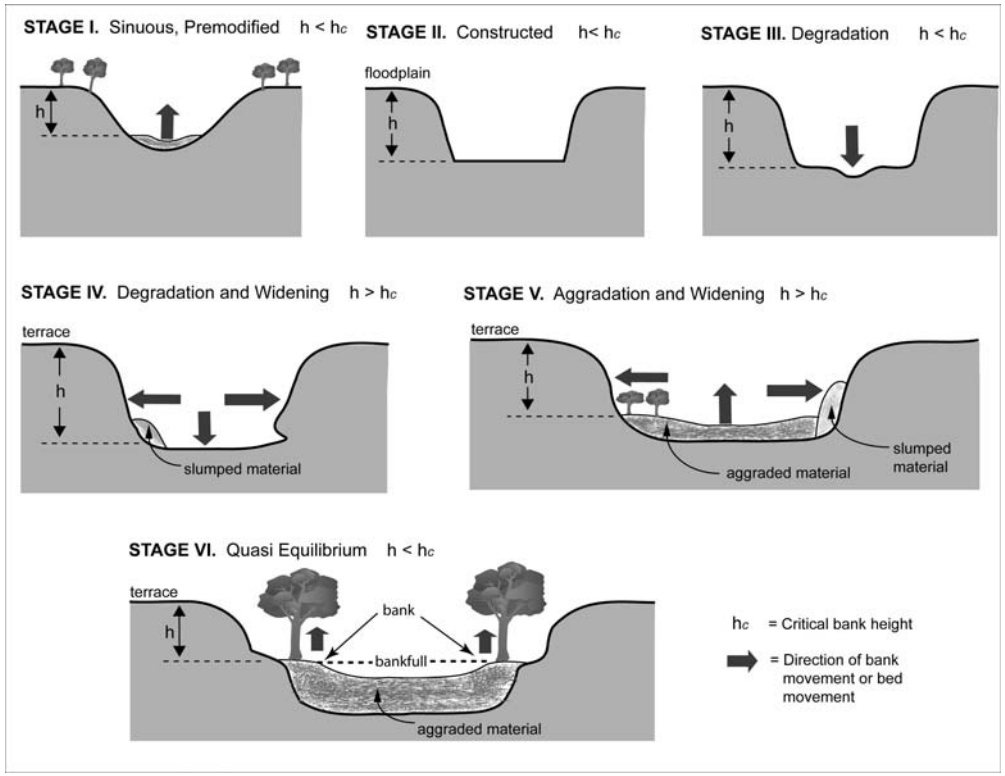
- Regional climate change (Burns et.al, 2007)
  - increase @ 0.5-2.0°C/50 years
  - increase @ 8-26 cm/50 years
  - shift in spring runoff - 1-2 weeks earlier in the year
- Impact on stream turbidity ?
  - Current assessment use flow based turbidity rating curves
  - Need for physically based models





Mukundan et al. (In review)

Channel Evolution Model



Modified from Simon and Hupp (1989)

CONCEPTS - Model

USDA United States Department of Agriculture

Agricultural Research Service

CONservational

Channel

Evolution and

Pollutant

Transport

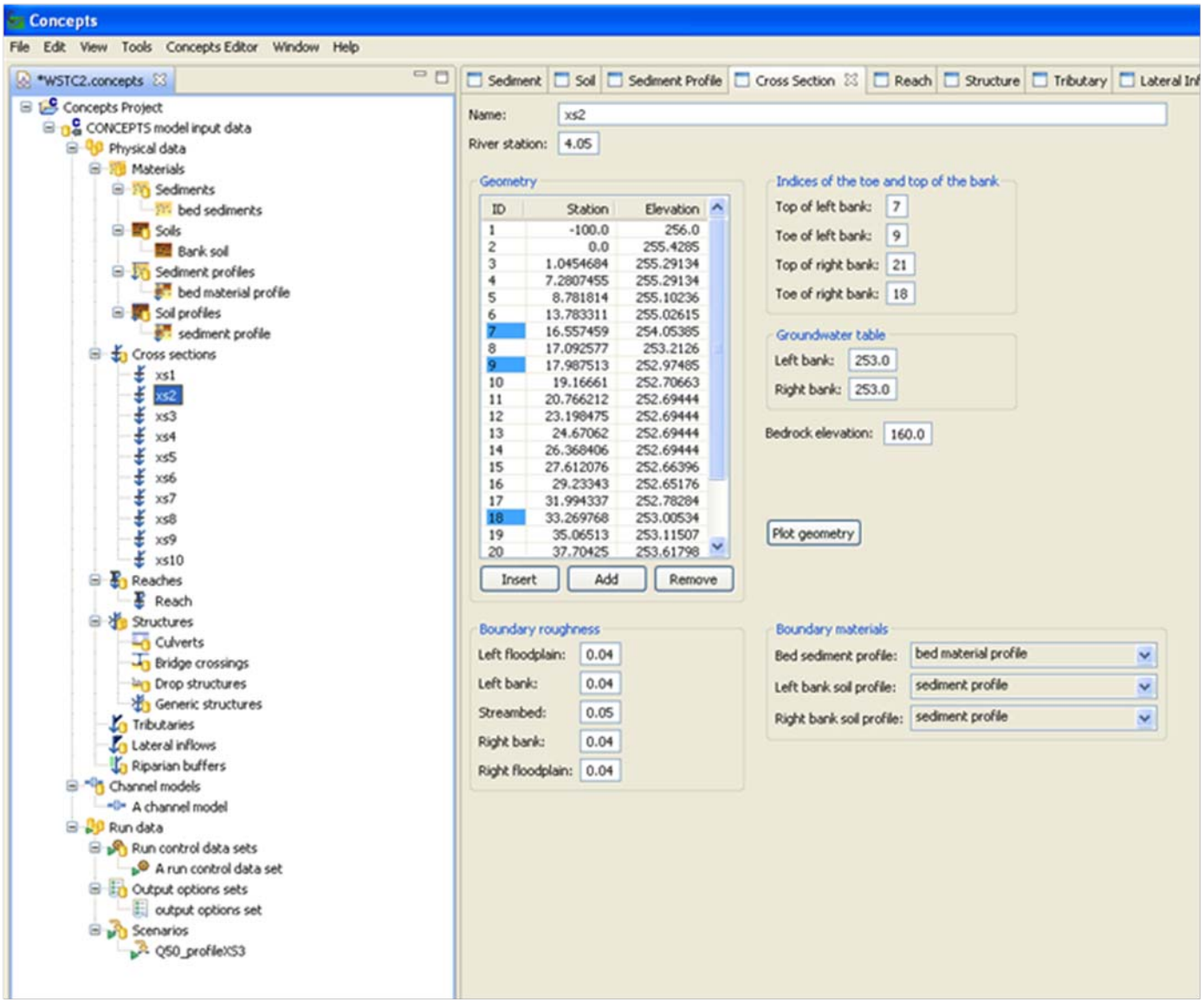
System

- Part of USEPA's "toolbox'' of approved models
- Developed at the USDA- National Sedimentation Lab Oxford, Mississippi (Langendoen, 2000)
- 1-dimensional numerical model
- Simulates
  - Sediment transport by size classes
  - Channel erosion processes
- Successfully used in incised stream systems

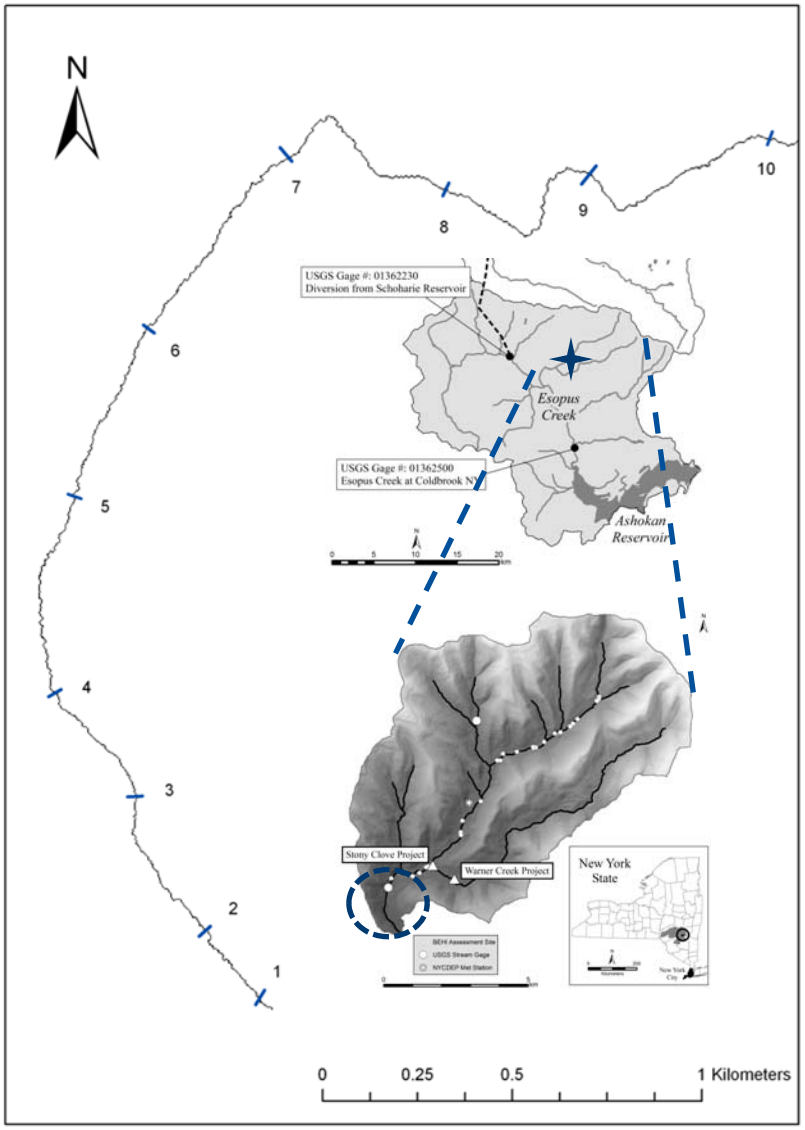
CONCEPTS - Model

- Model inputs
  - Channel dimensions
  - Hydraulic resistance
    - (particle size, erodibility, critical shear stress etc.)
  - Shear strength
    - (bulk density, pore-water pressure, root biomass etc.)
  - Inflows
    - (water and fine sediment from upstream)

CONCEPTS - Interface



Model Setup – Stony Clove

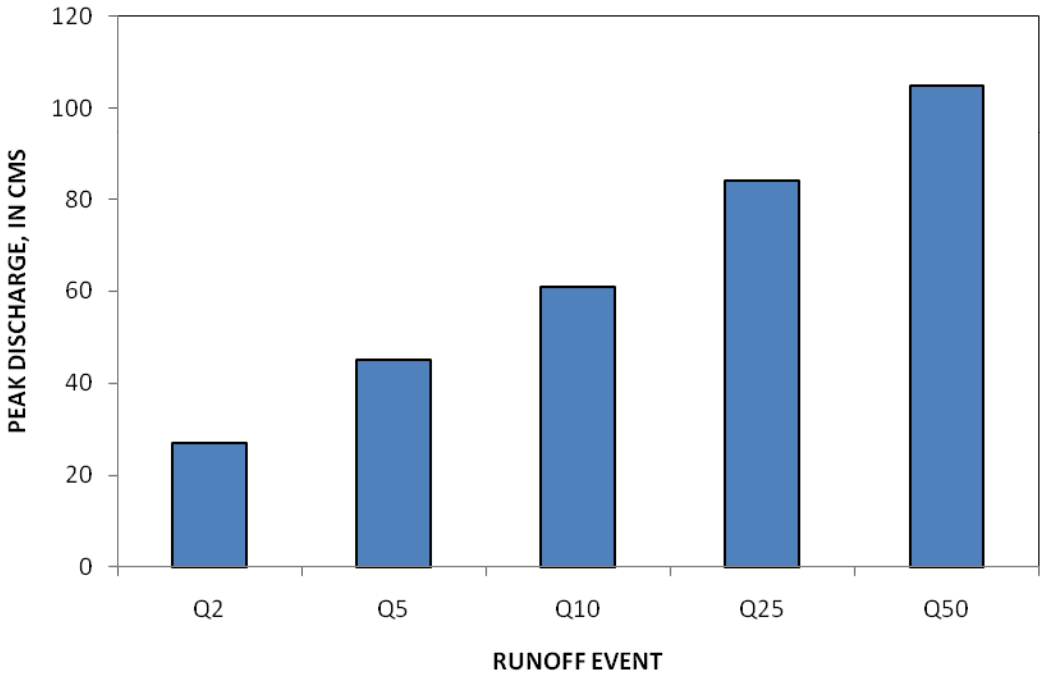


- Tributary of Esopus Creek
- 4.28 Km reach
- 10 cross-sections (01-19-2012)
- Distance between cross sections (231-592 m)

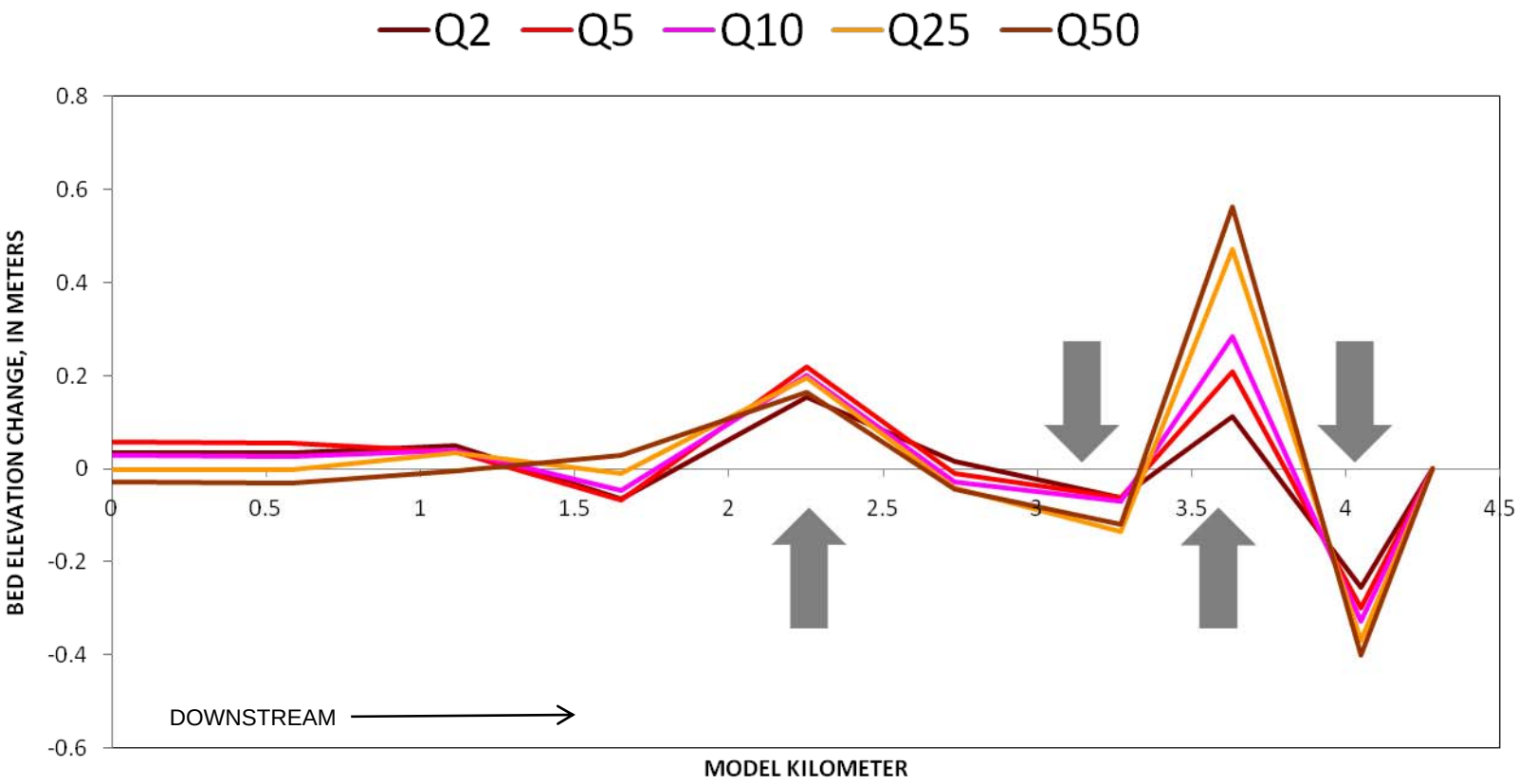
Stony Clove at Phoenicia, Oct 1, 2010

Model Setup – Stony Clove

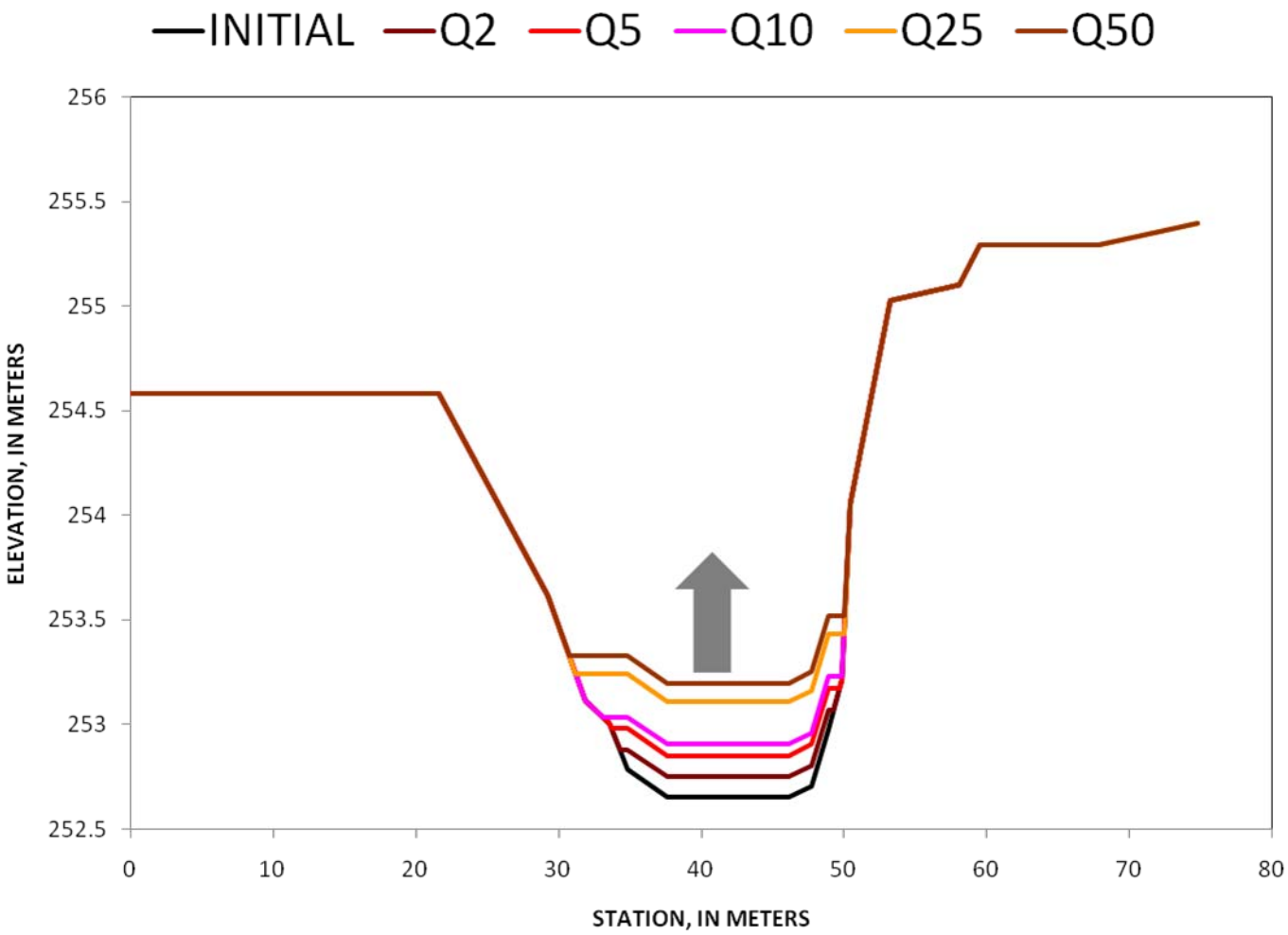
- **SCENARIOS**
  - Runoff events of different return periods
  - Discharge (Q) estimated from regional curves based on drainage area (USGS, 2006)
  - Q2
  - Q5
  - Q10
  - Q25
  - Q50



Results – change in bed elevation



Results - XS3 geometry



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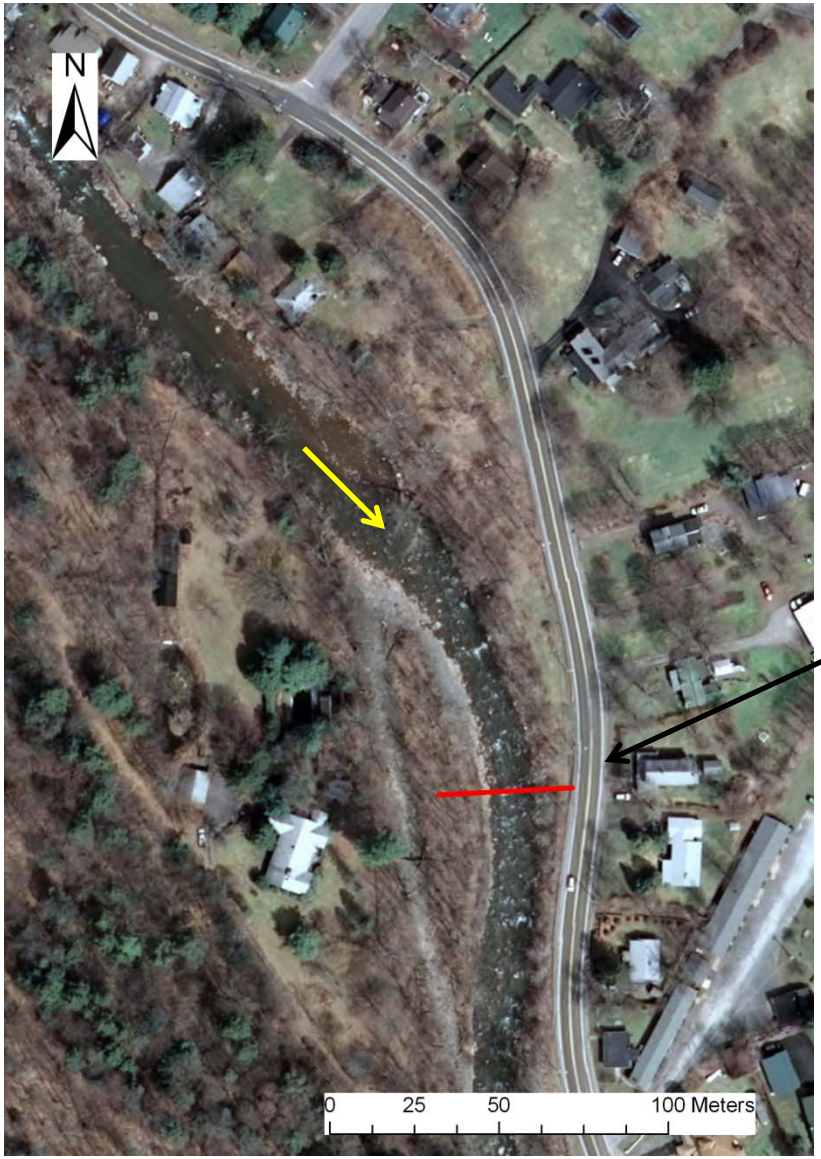
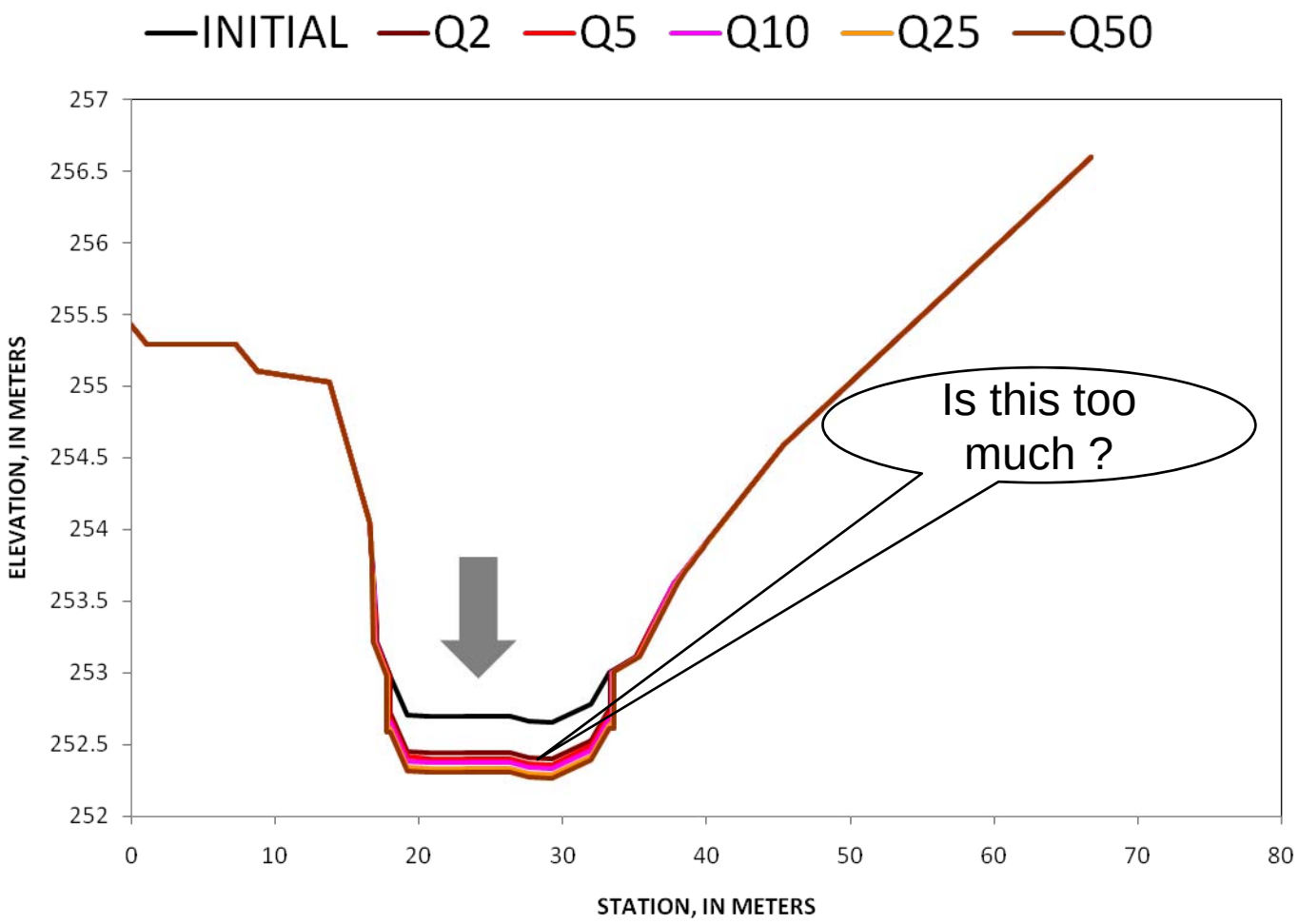
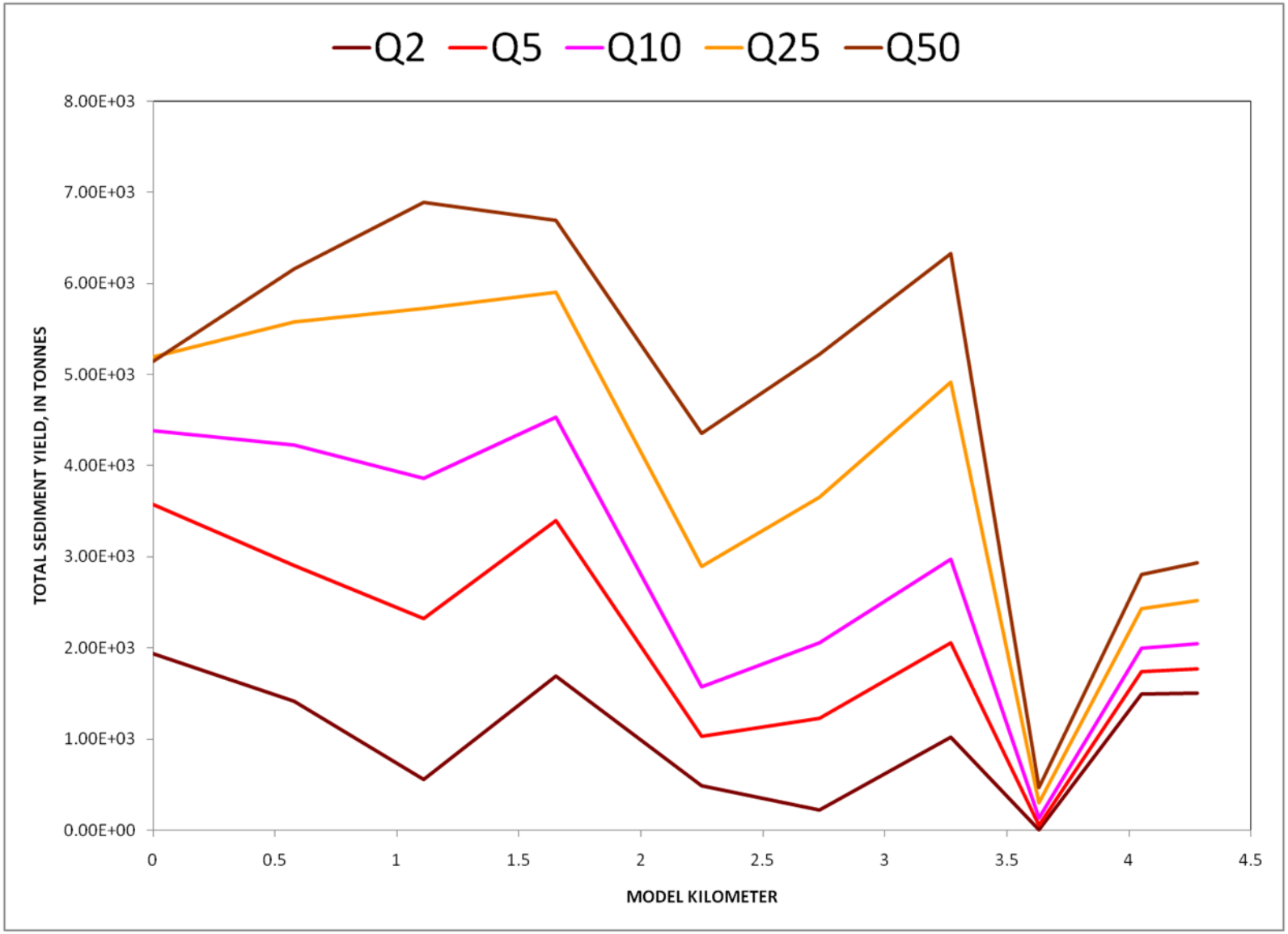


channel constriction

Results - XS2 geometry



Results – Sediment Yield



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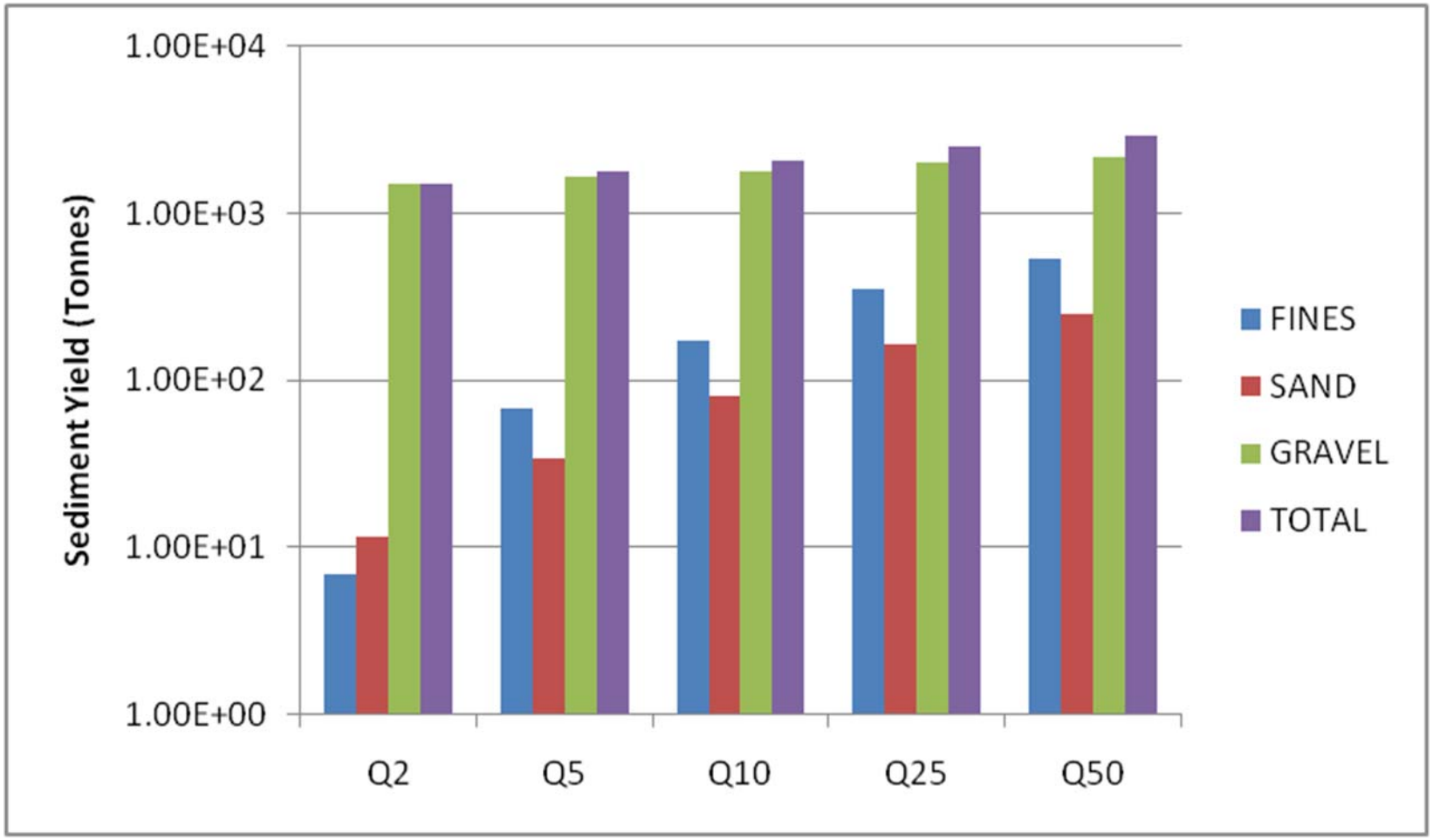

Warner Creek confluence with Stony Clove Creek – Pre and Post Hurricane Irene

Photos: Danny Davis

Summary & Conclusions

- A preliminary test of CONCEPTS model in a mountain setting
- This is work in progress!
- Model capable of simulating sediment deposition, degradation and transport by size classes
- Model results highly sensitive to input data
    - Channel geometry
    - Bed material composition
- Realistic simulation in the study region requires model changes
- A potential tool for developing scenarios ?
    - Management
    - Climate change

Future work

- Better characterization of stream bed
  - Include stream bed sediment size classes observed in the Catskills (Large cobbles & Boulders!)
  - Needs model modification
- Collect site specific data
  - Resistance to erosion properties
  - Representative channel geometry
- Compare model runs with monitoring data
  - Channel geometry over time/ historical
  - Water quality (fine sediment)
- Develop scenarios

Acknowledgements

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THANK YOU!