Long-term Watershed Sediment Transport and Yield Modeling

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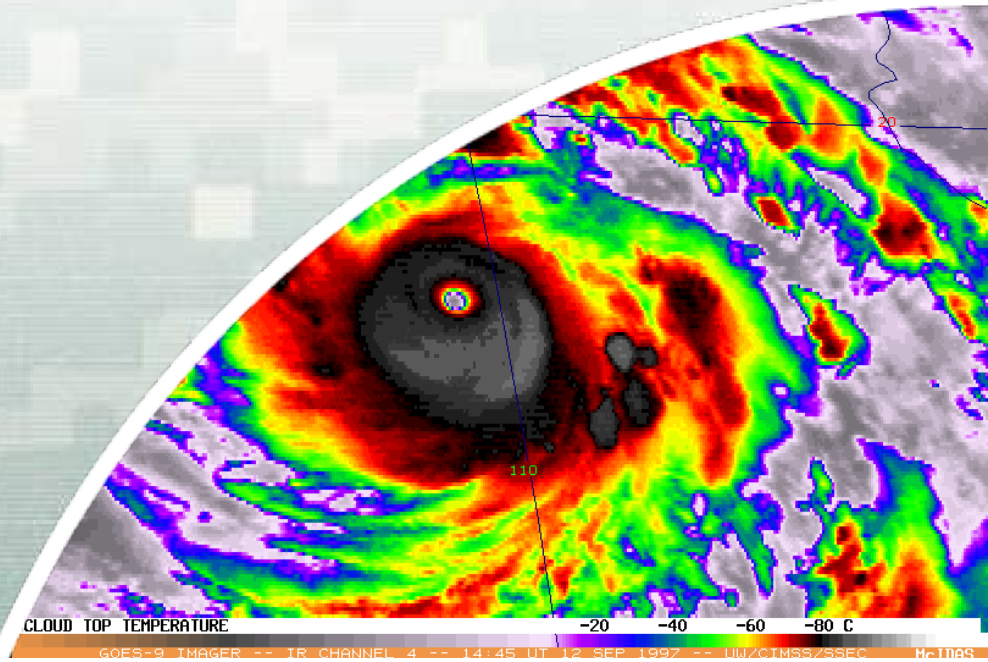
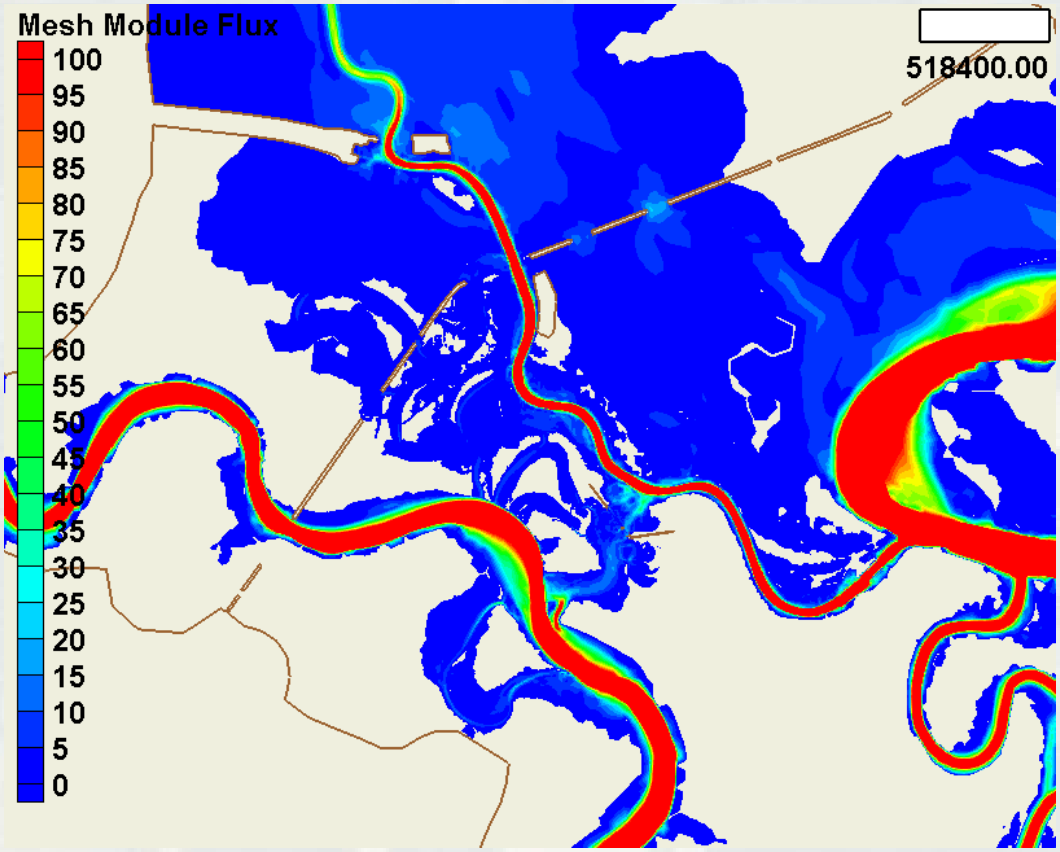


US Army Corps of Engineers

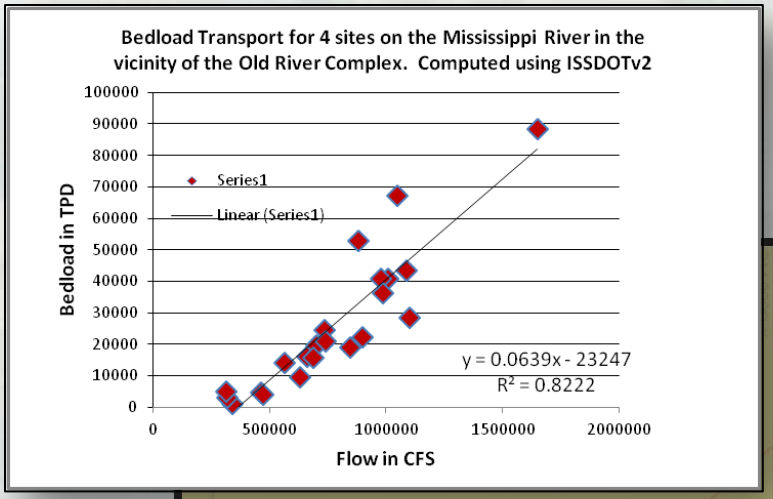
BUILDING STRONG®

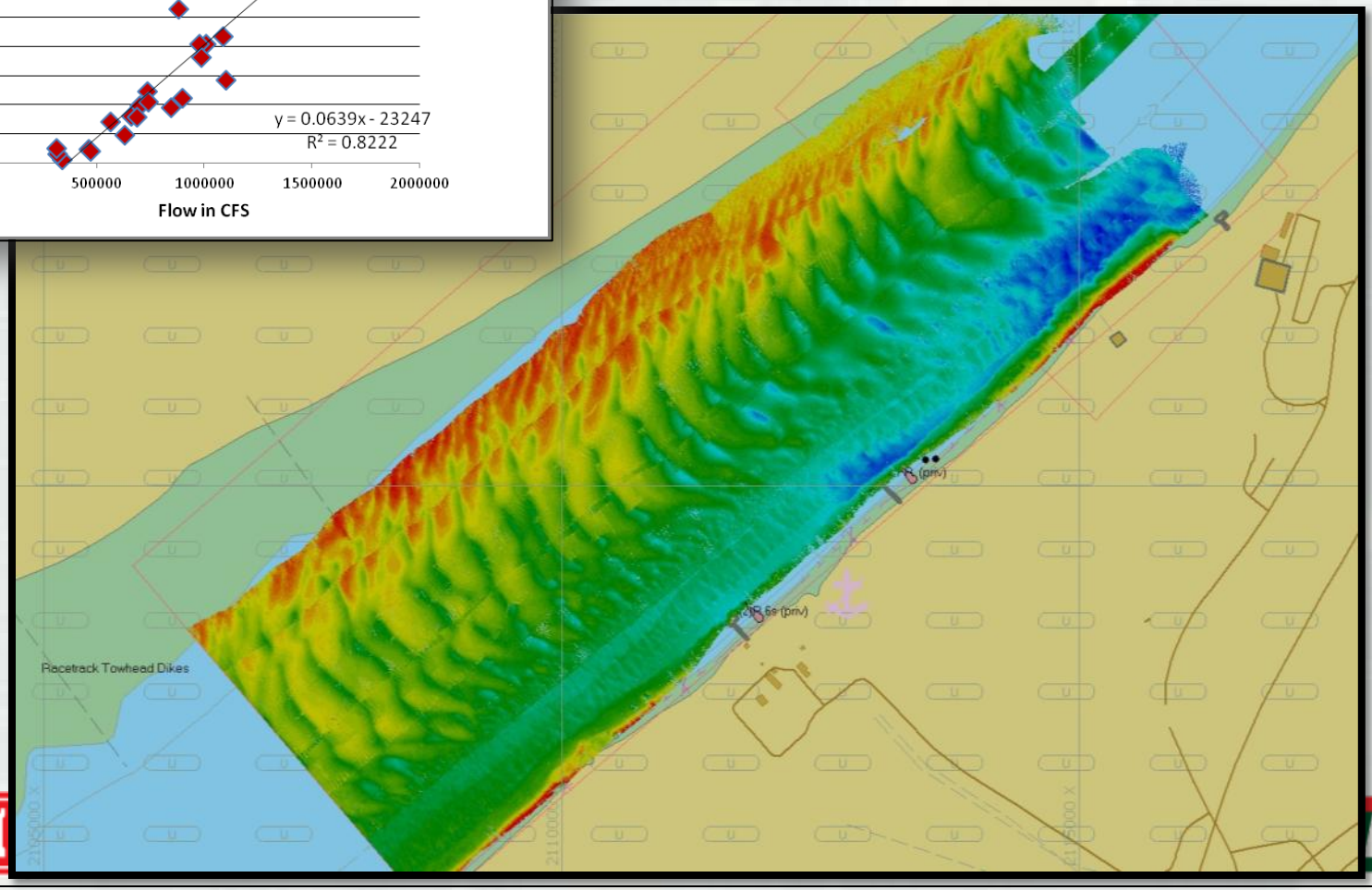
Complex Riverine Hydrodynamics: AdH

- 2D, 3D hydrodynamics
- Full St. Venant dynamics
- Sediment, water quality transport
  - Shoaling, scouring



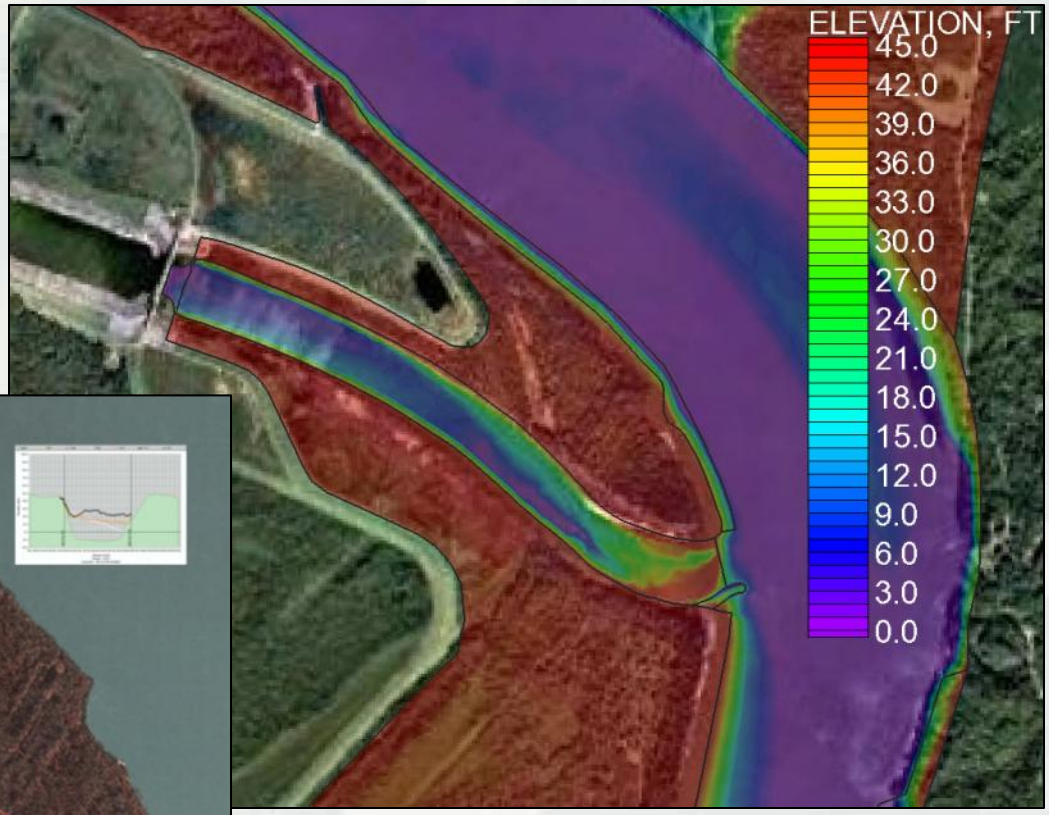
Field Investigations
Bed-load Measurements

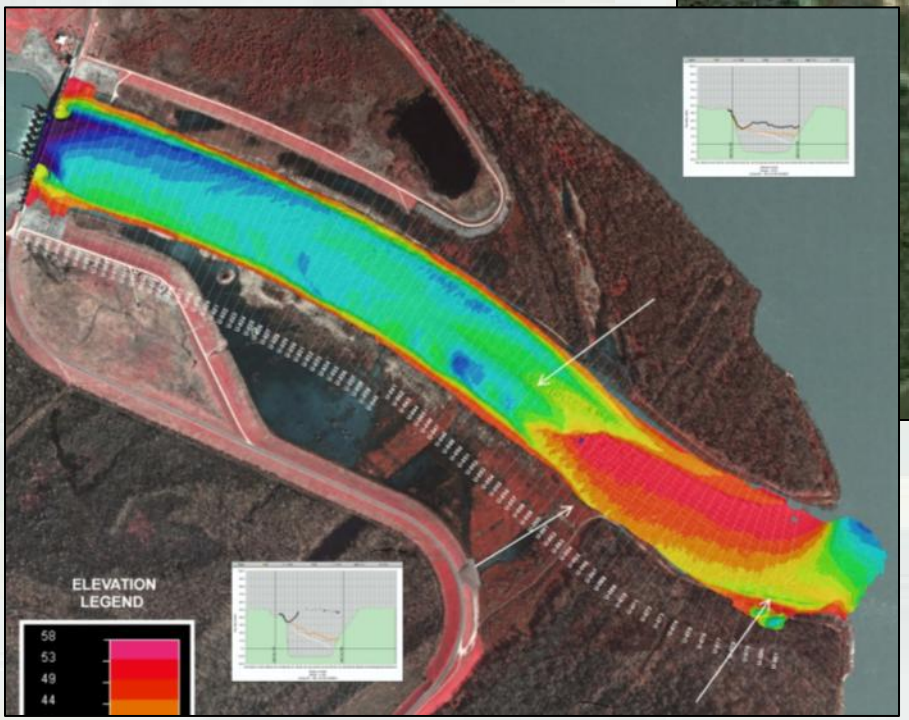




2011 Flood: Shoaling at Auxiliary Channel

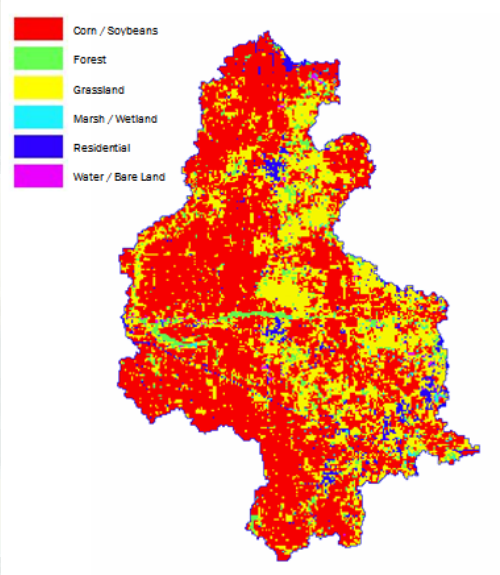
AdH/SEDLIB Model predicted severe shoaling in the Auxiliary Channel Entrance

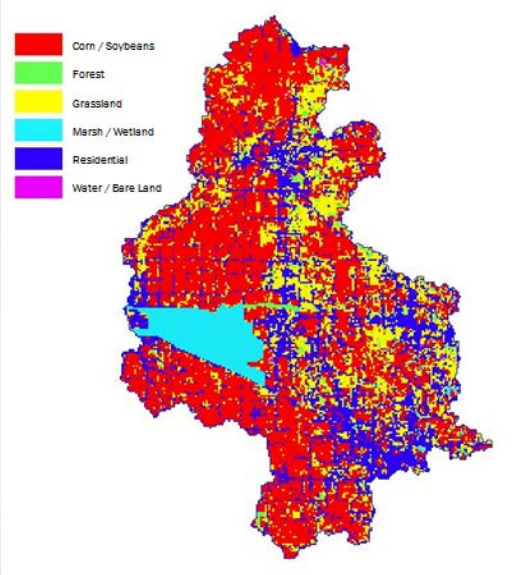


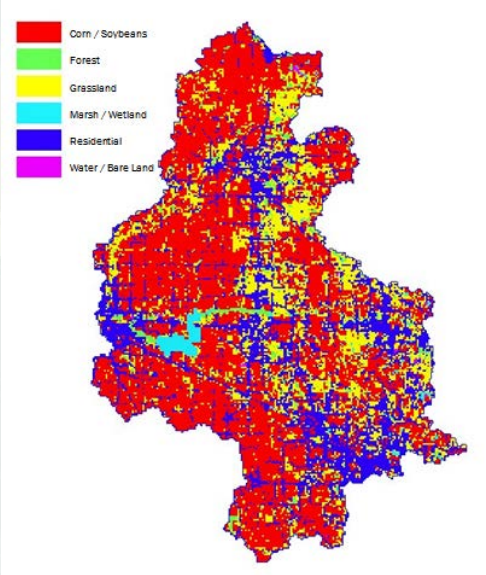


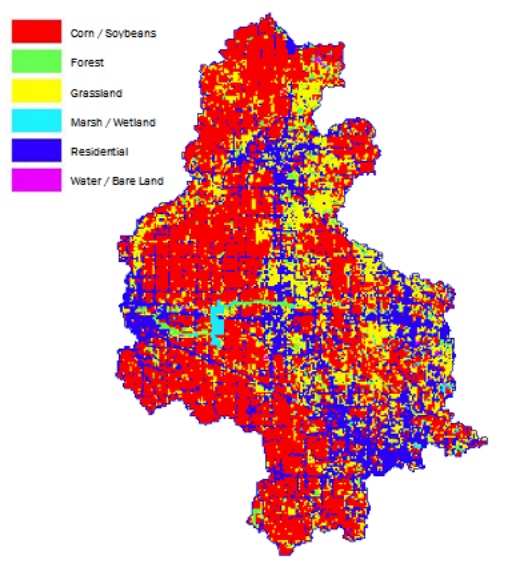
This shoaling was confirmed in subsequent field surveys

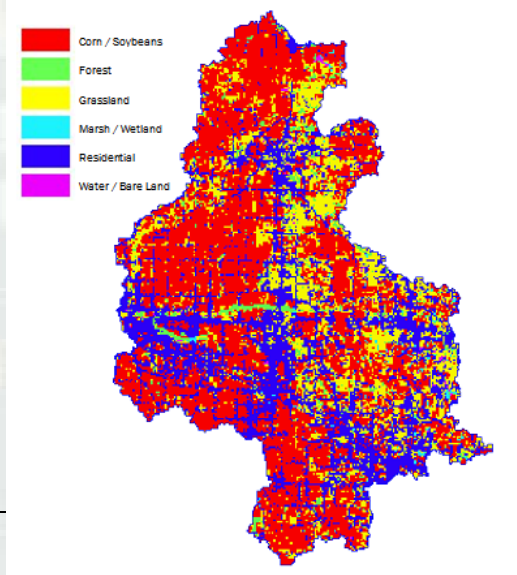
Watershed Management: Kishwaukee Watershed







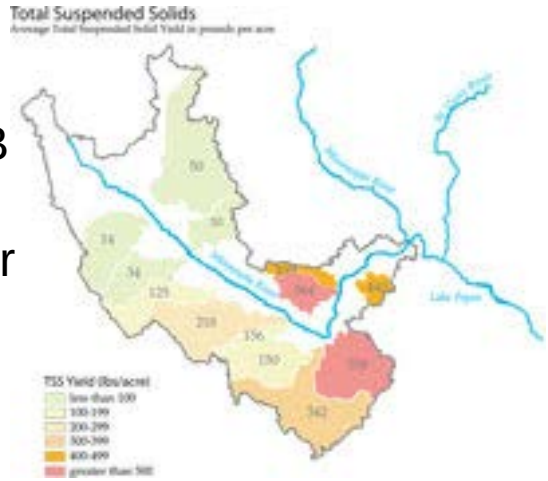




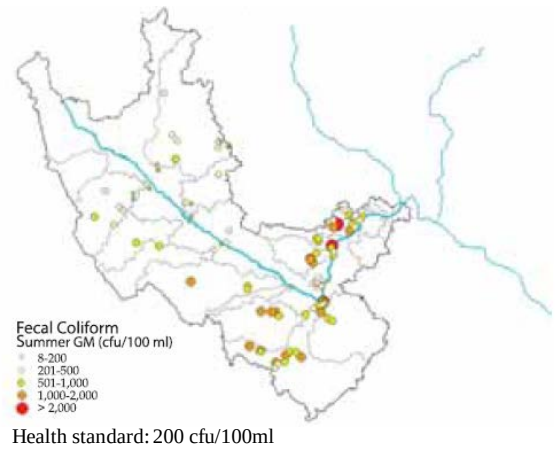
Minnesota River Basin: Watershed Problems

~60% of MRB TSS comes from Le Sueur

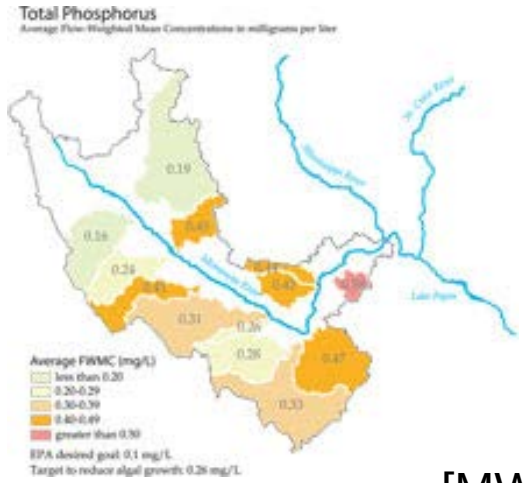
Excessive sediment



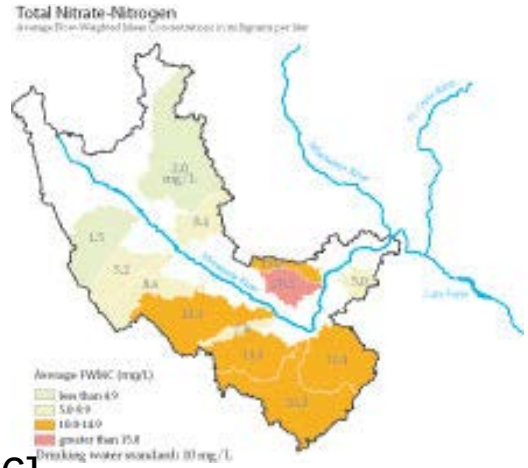
Environmental health: fecal coli.



Nutrient enrichment: P



Nutrient enrichment: NO_3 - N



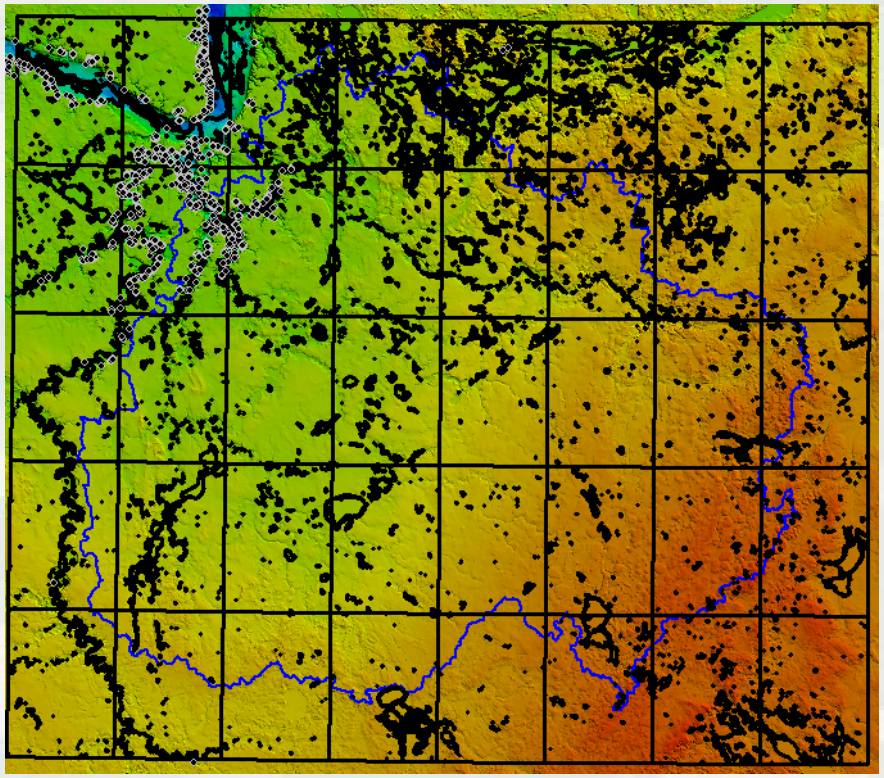
[MWRC, 2006]

Where is the TSS coming from?

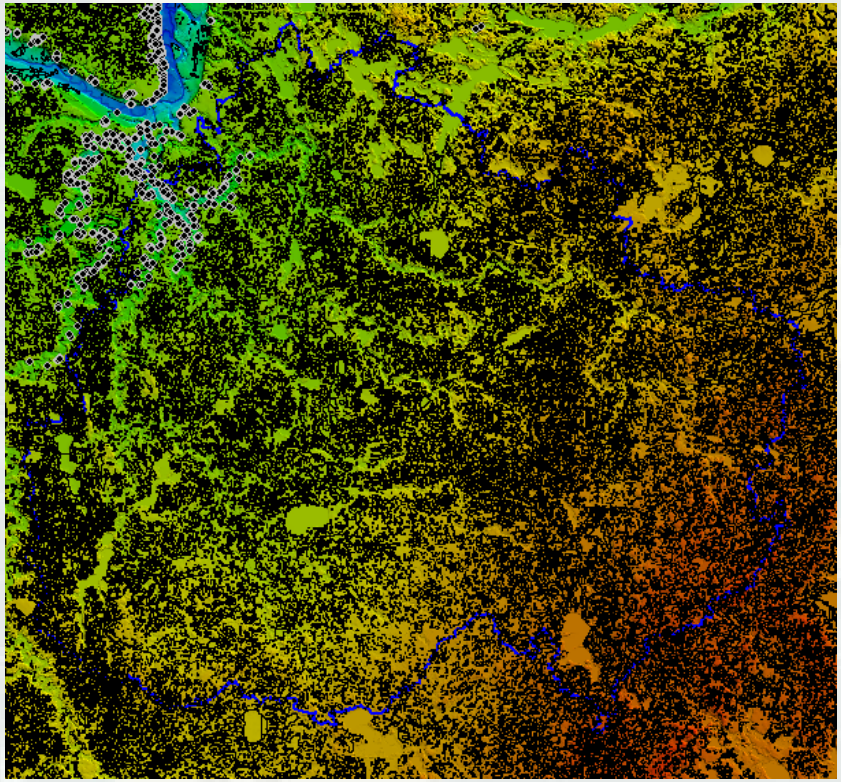
- TSS From Fields: 18%
- TSS From Streams: 82%

Mulla et al. 2009

Minnesota River Basin: Wetlands in the LeSeuer Watershed



Current Depressional and Riverine Wetlands



Restorable Depressional Wetlands

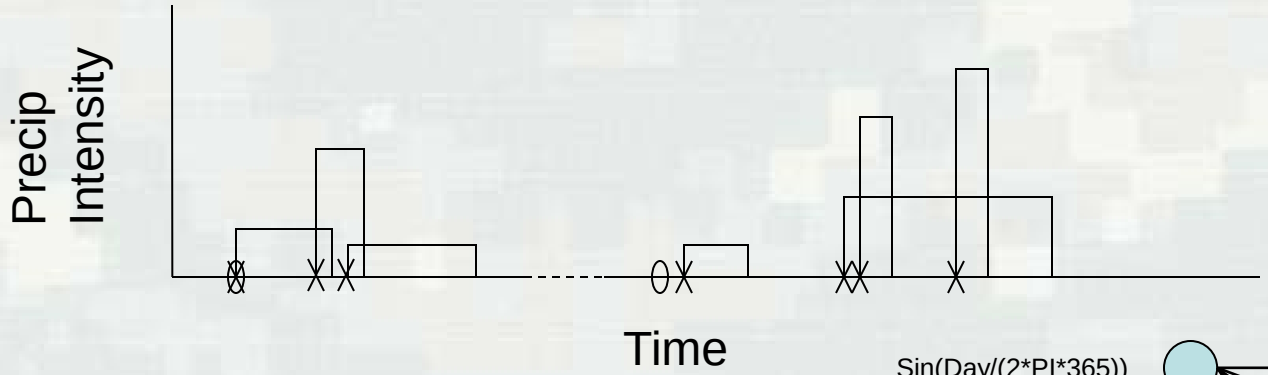
Data from MN DNR

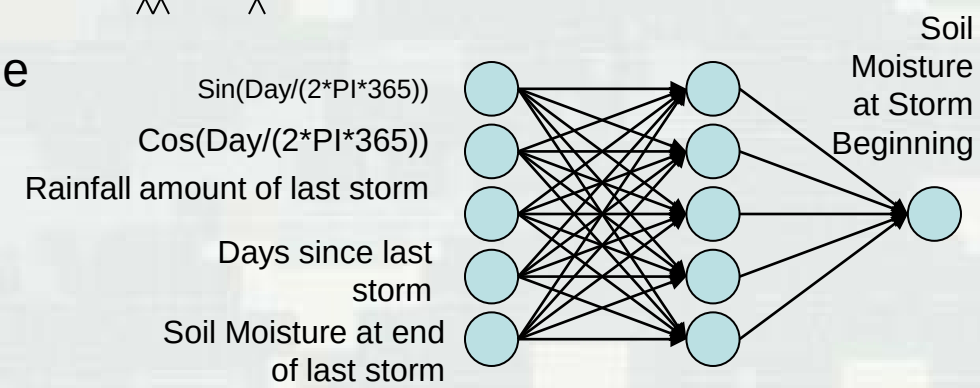
80% Reduction in Wetland Area [MPCA 2009]

Life Cycle Watershed Modeling: FYSSI Overview

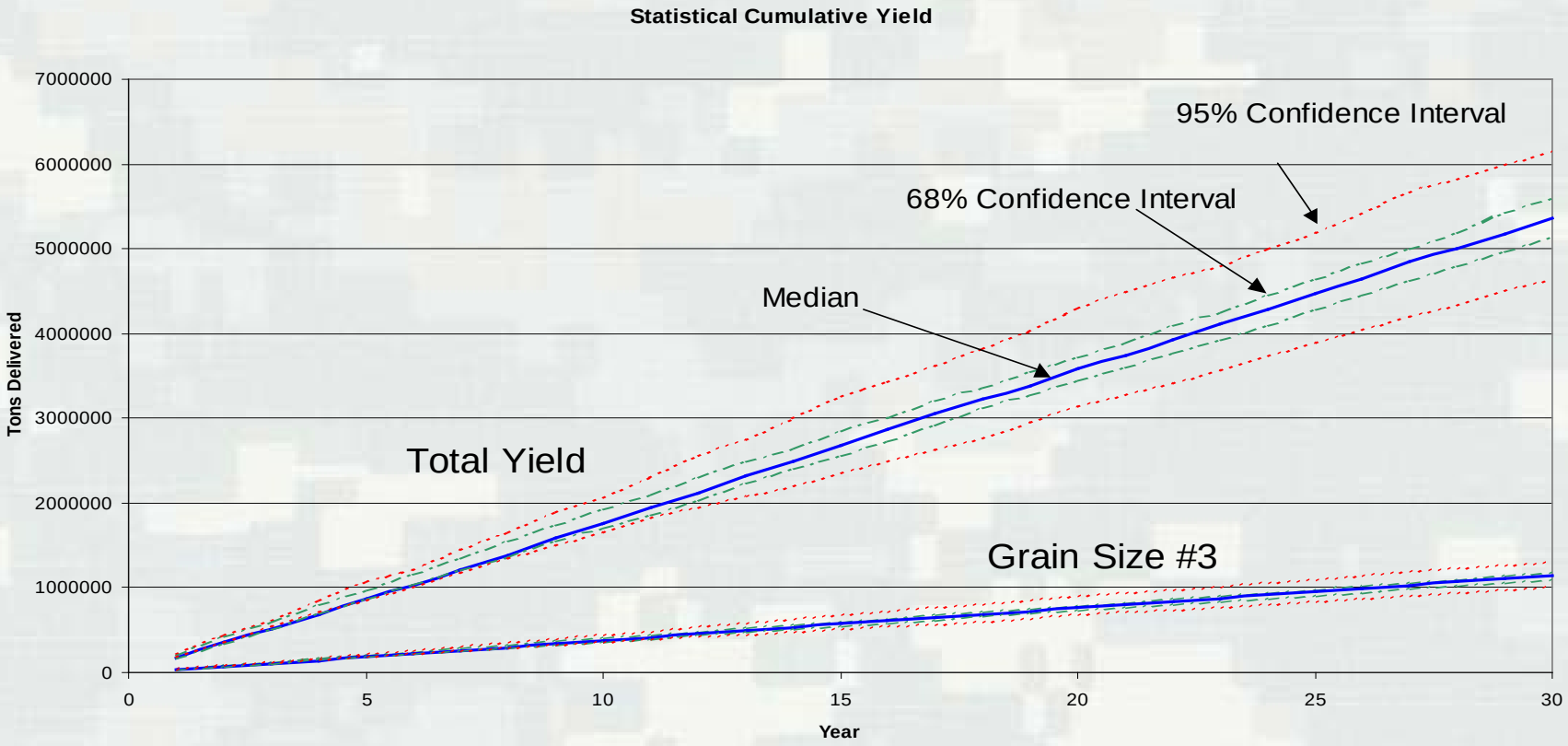
- Goal: Model sediment budget over project lifetime
- Designed to use a high-resolution watershed model to deliver project-lifetime sediment loadings
- Select ranges of parameters of interest
  - Rainfall duration (e.g. 30 min, 2, 6, 24 hr)
  - Rainfall return period (e.g. 6 mo, 1, 2, 5, 10, 50,100 year)
  - Antecedent Soil Moisture (e.g. 10%, 30%, 50%, 70%, 90%)
  - Season of Year (cover, etc.) (e.g. summer, winter)
- Create a database of GSSHA runs
  - e.g. 4x6x5x2=240 runs
- Generate a sequence of storm events for one year, aggregate results from GSSHA runs
  - Do that for each year of the project (e.g. 30 years)
- Do that 1000 times, compute median, +/- 1, 2 standard deviations for each year.

FYSSI


Precip Intensity
Time

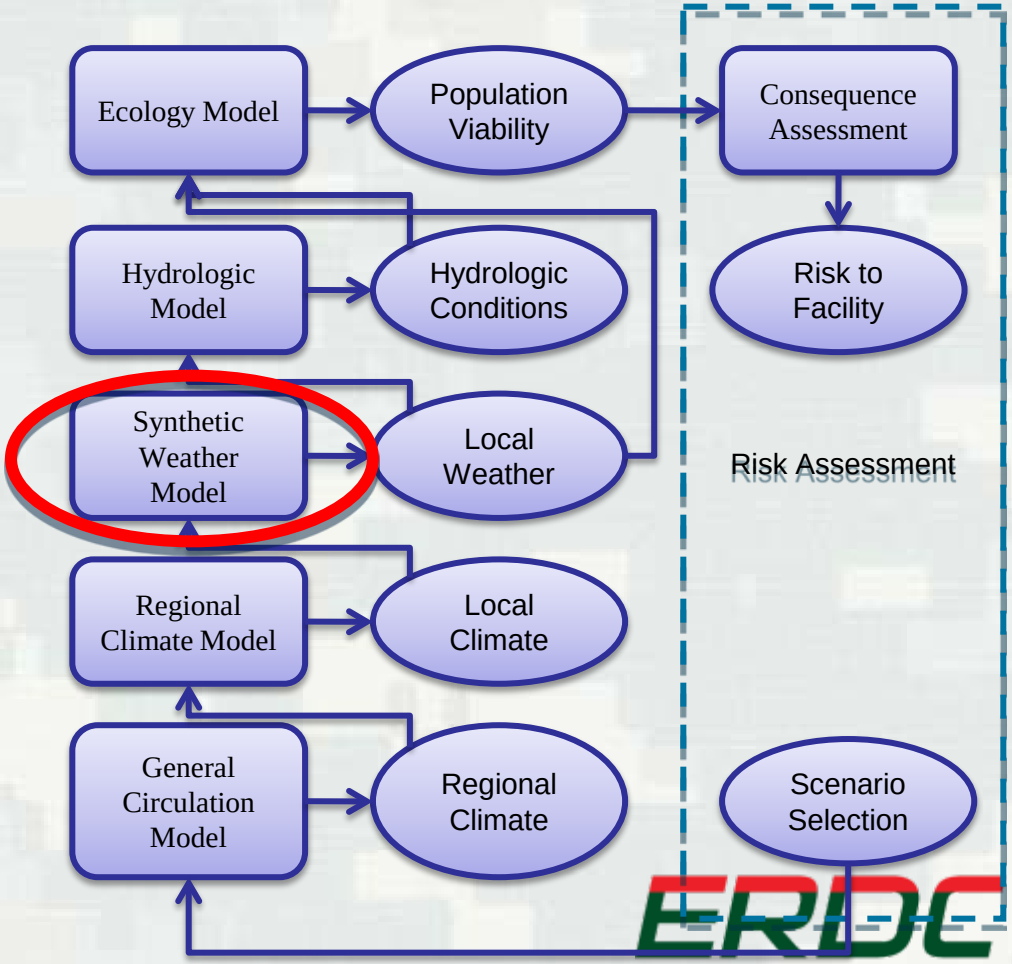

Sin(Day/(2*PI*365))
Cos(Day/(2*PI*365))
Rainfall amount of last storm
Days since last storm
Soil Moisture at end of last storm
Soil Moisture at Storm Beginning

Example Output



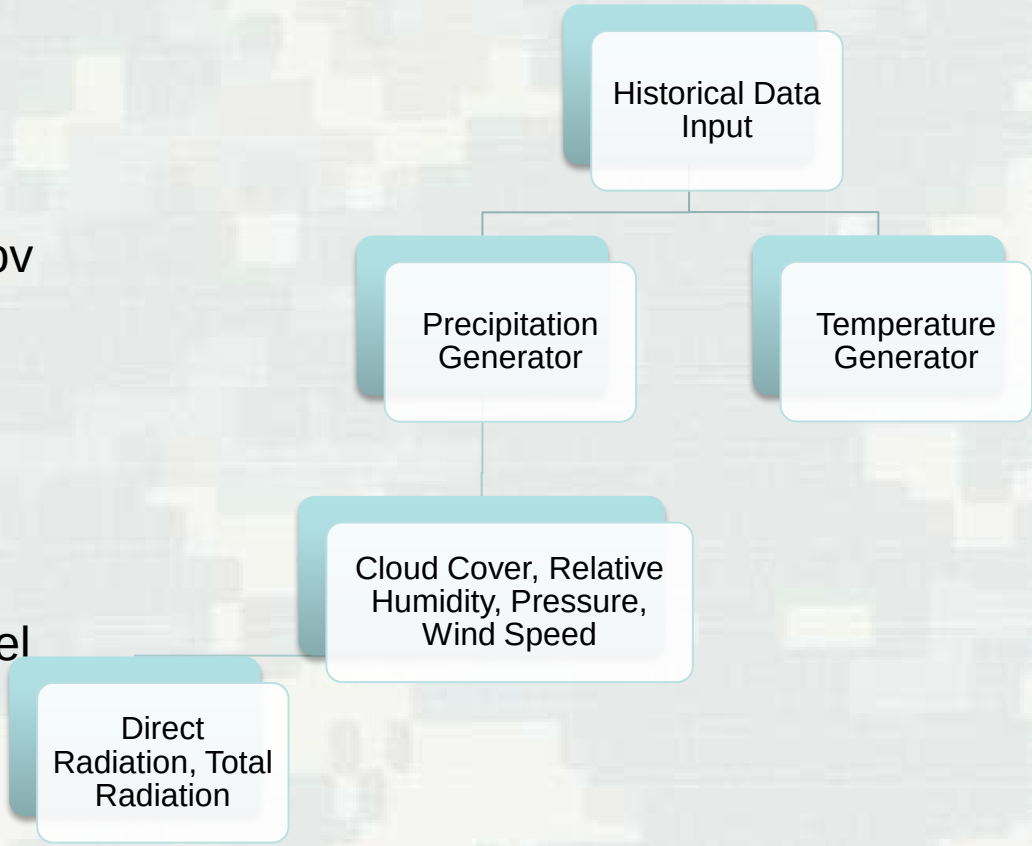
Long-term Weather Modeling: Stochastic Weather Generator

- Created as part of CDR research program
- Being applied to infrastructure project

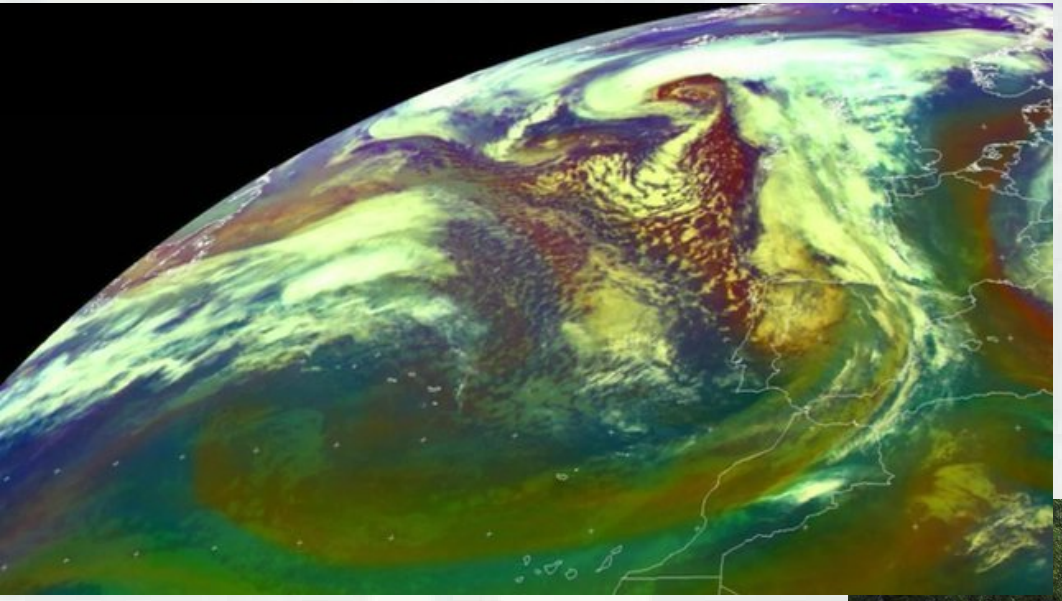
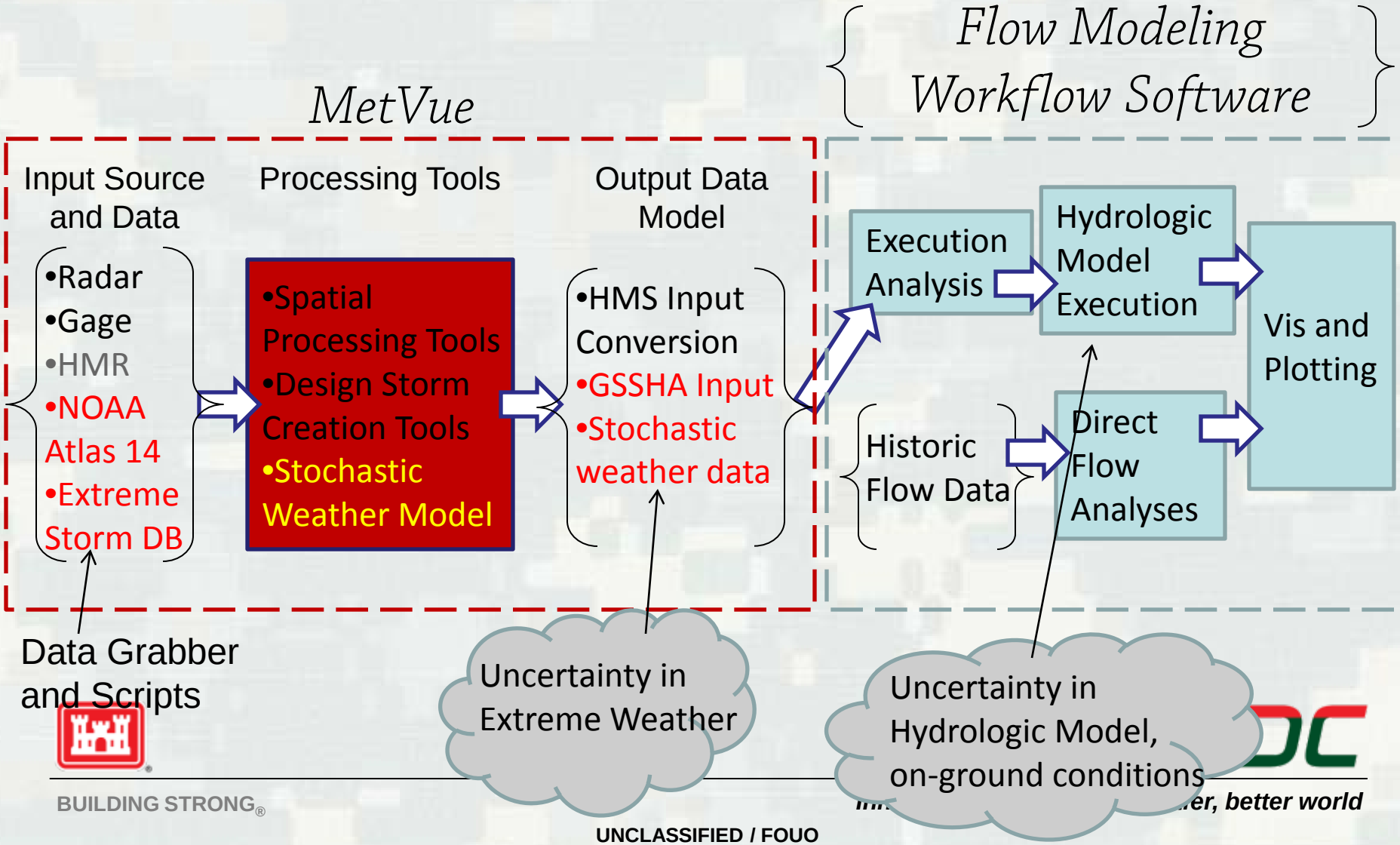


Algorithms

- Precipitation
  - Occurrence/Amount Generator (kernel density estimation)
  - Hourly disaggregation: Markov model vs. Event Distribution model
- Temperature
  - Daily combined model (sinusoid, AR[1], residual)
  - Hourly conditional k-NN model
- Other parameters
  - Euclidean distance comparison conditioned on precipitation
- Direct/Total Radiation
  - Block resampling



Extreme Flow Frequency Project Vision/Background



Spiral 3: End of FY18