Benefits Modeling with RiverWare and Corps Water Management System (CWMS) in Tulsa District

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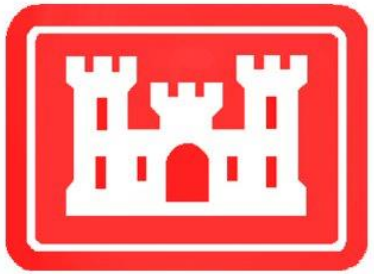


US Army Corps of Engineers®
Tulsa District

2019 Flooding Near the Arkansas, Neosho, Verdigris Rivers Confluence

Image from News on 6 and ADS

Why Model Flood Damages Reduced?

- Yearly reporting required by Congress on flood damages reduced.
- Provide regulated and unregulated datasets for studies and planning projects.
- Visualize extents of flooding with and without projects using latest calibrated hydraulic models.
- Structure by structure damage assessment using the latest National Structure Inventories (NSI).
- Uses Cropland Data Layers (CropScape) to determine Agricultural Flood Damages reduced.
- Legacy process uses depth-damage curves developed in the 60's and 70's which is time and recourse intensive to update.

How has Tulsa District modeled H&H outputs for flood damages reduced in the past?

1990's-2016: PC version of Hydrologic Engineering Center (HEC) 1

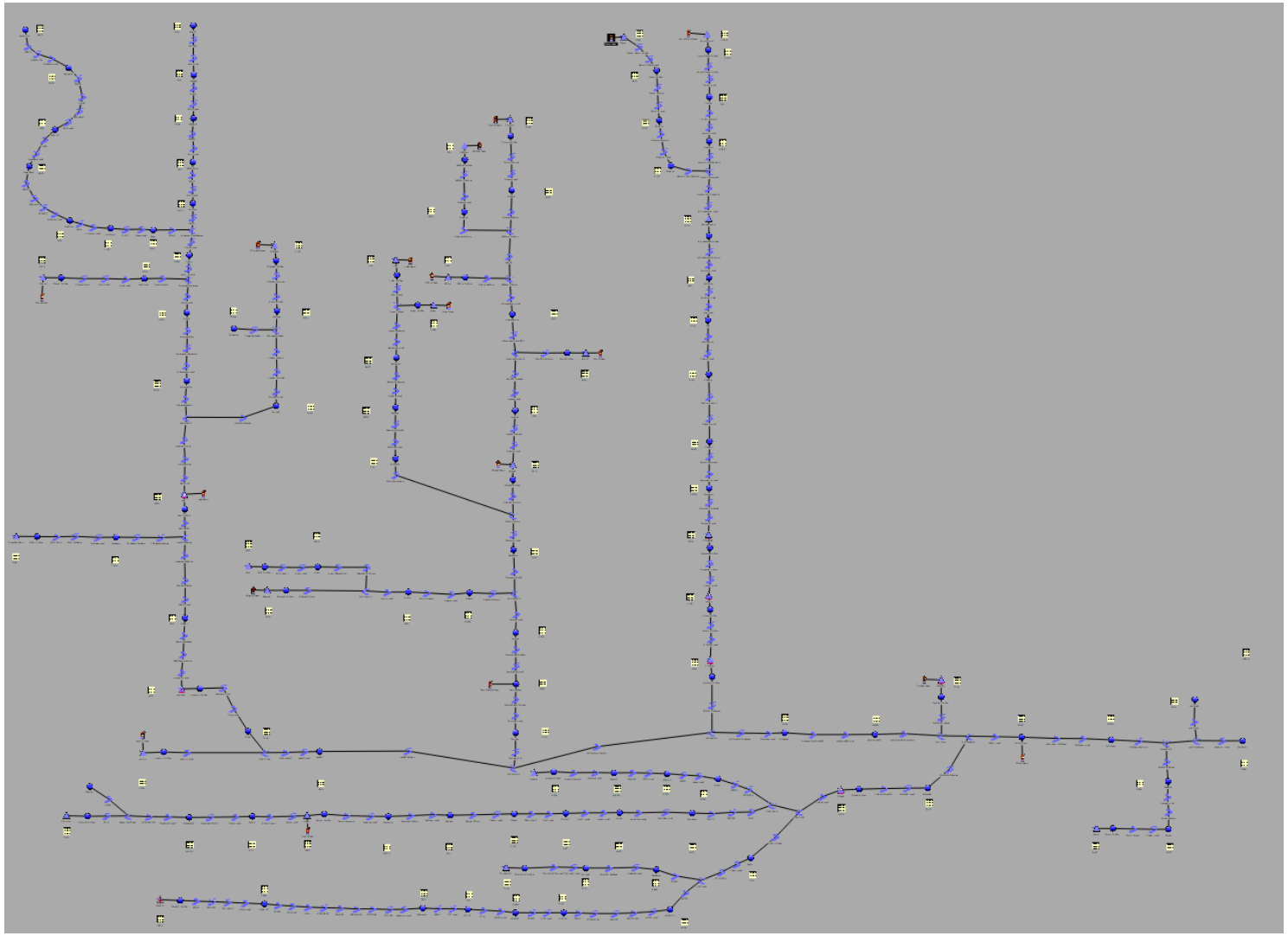
2016-2023: HEC-1 converted to RiverWare

2023-future: RiverWare with results then used in CWMS

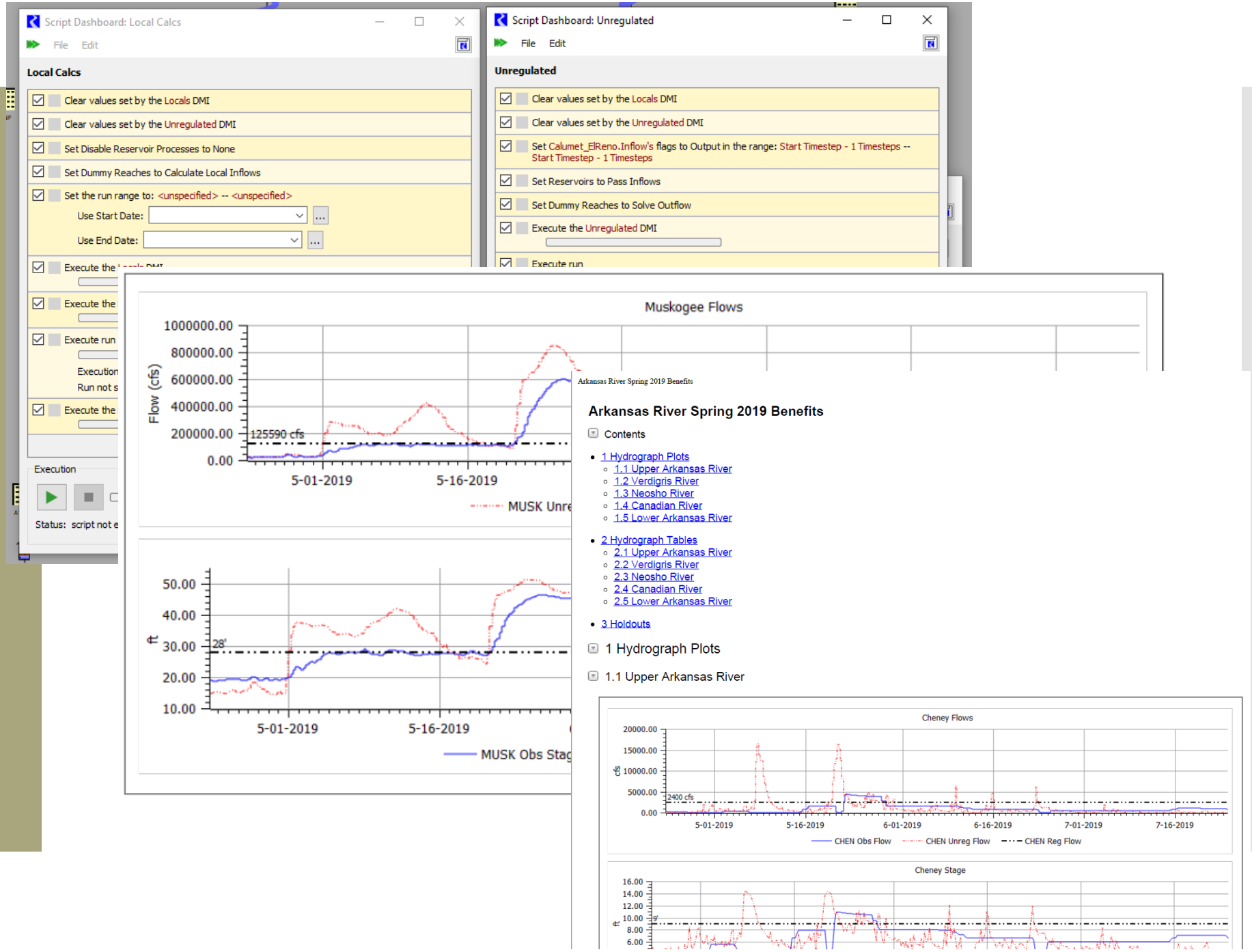
How Tulsa District models Benefits Currently

- 6-hour timestep model run for each separate flood event.
  - Run models throughout the year to check for times when unregulated flow are above regulating.
- Use only post event observed data from all stream and dam gages.
- Run observed data through a "Locals" script in RiverWare to calculate incremental locals for each non-headwater gage.
  - Simple routing model that takes routed flow from upstream and observed flow at the gage to subtract what the local flow for that drainage area is.
- Export locals to DSS and clean negative flows out.
- Import observed and locals through the "Unregulated" script in RiverWare.
  - Turn off all reservoir methods to only pass inflow.
  - Input headwater observed data and local inflows below.
  - The Unregulated script generate plots and tables of regulated "observed" vs unregulated flow and stage.
  - Final step of the script is to generate the report to send to our economist.
- District Economist takes RiverWare data and applies to older damage curves to convert from stage-flow to dollar amount of damages reduced.
- End of each fiscal year data is sent to Congress.

Current RiverWare Modeling Layout – Arkansas River



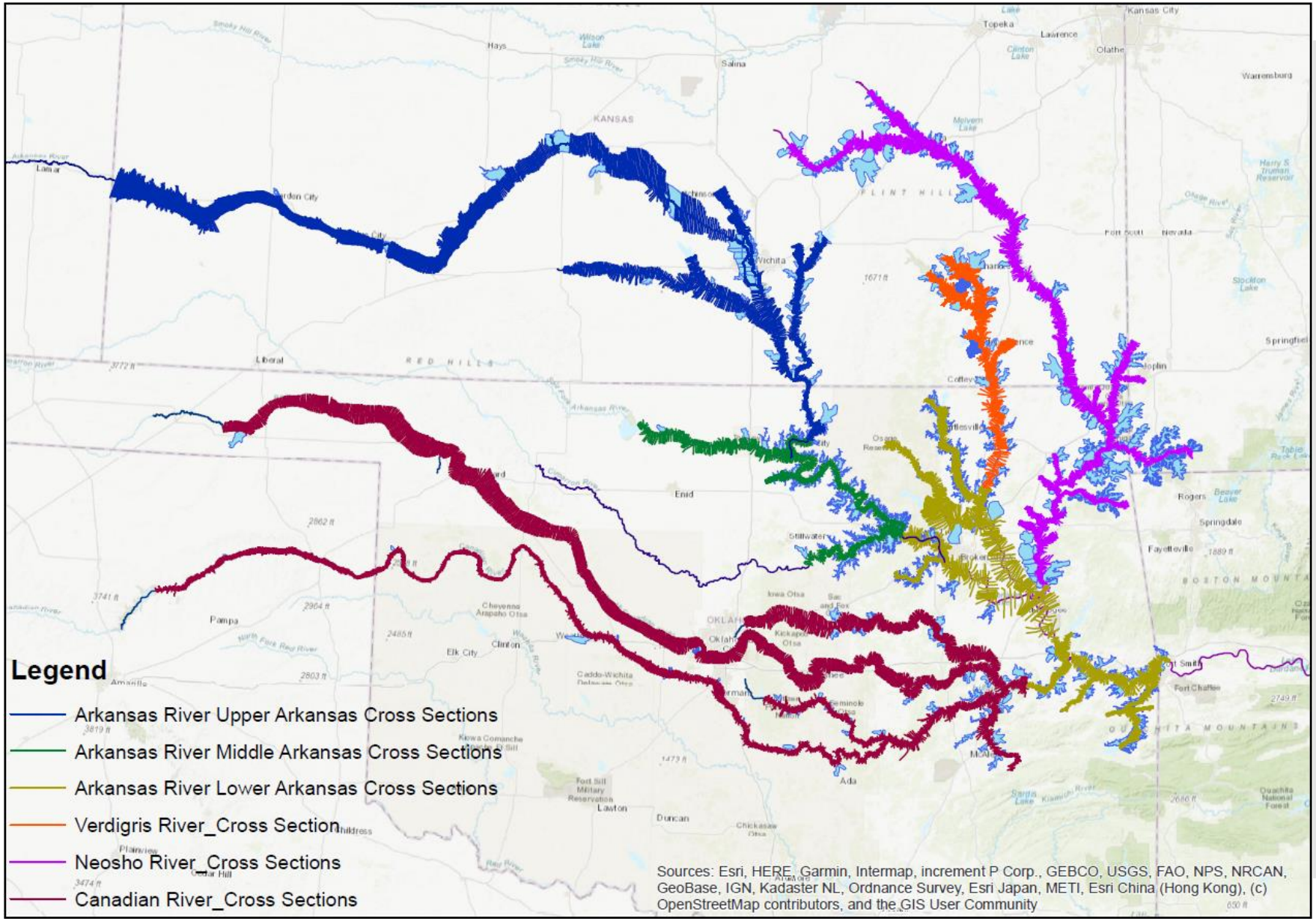
Current Modeling Snapshots



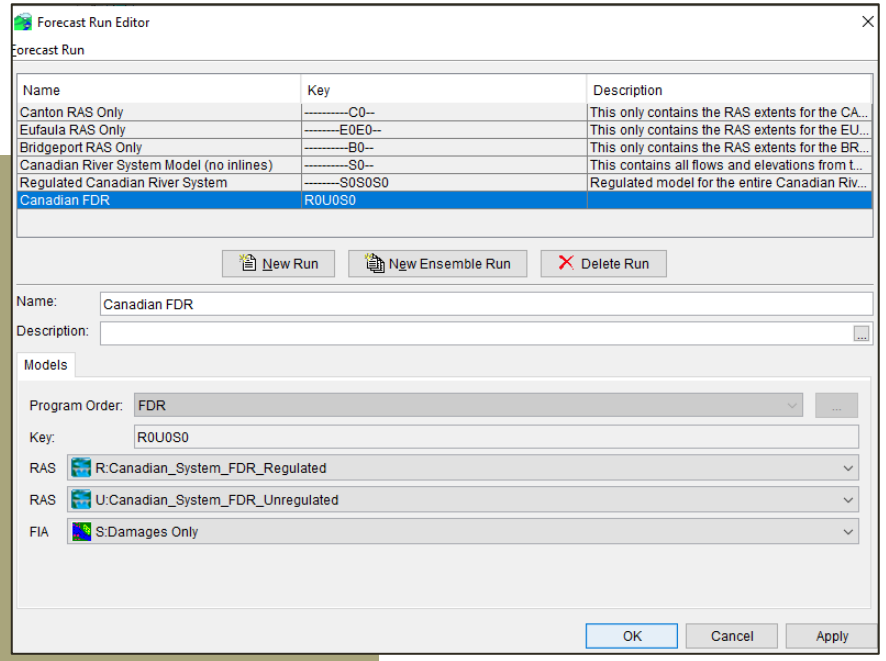
Work In Progress Benefits Modeling in RiverWare and CWMS

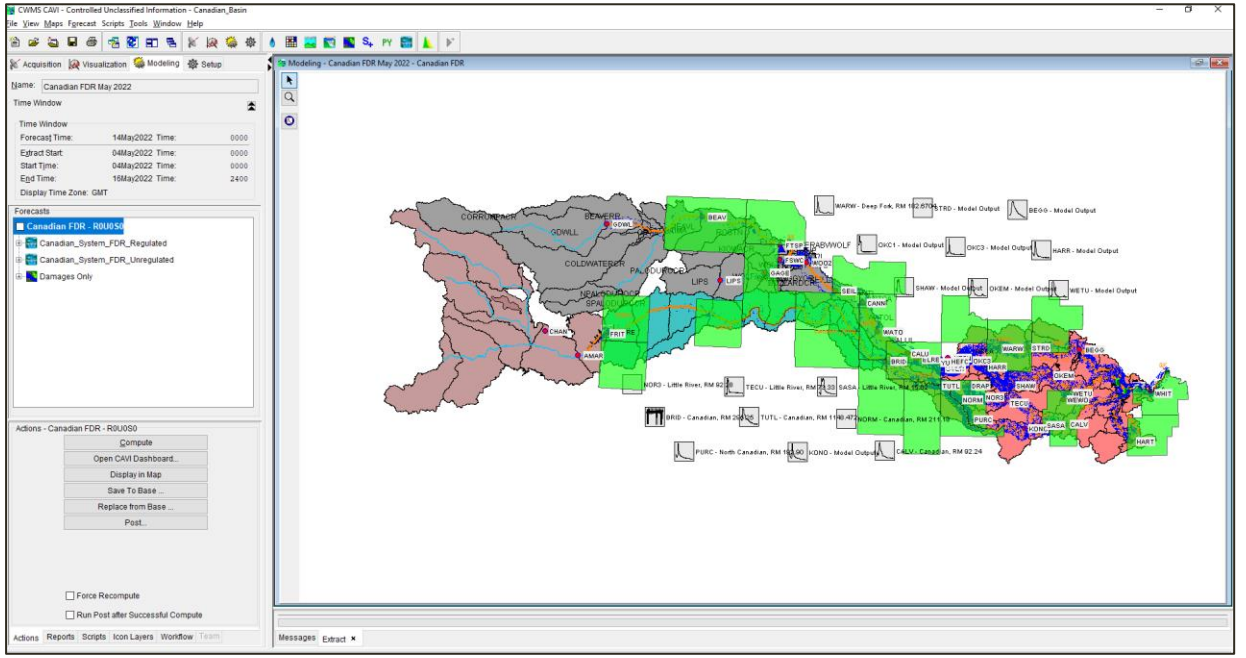
- Utilize RiverWare to calculate locals using a 1-hour timestep and "holdouts" for project distribution.
- RiverWare output is applied to the CWMS suite of modeling to compute flood damages reduced
  - HEC-Control and Visualization Interface (CAVI) connects the CWMS models through forecast alternatives and data extraction capabilities.
  - Data results are imported from standalone HEC-DSS-Vue file output from RiverWare to forecast.dss file used for the flood damage reduced forecast alternative
  - Hydrology outputs from Riverware are boundary conditions for HEC-River Analysis System (RAS)
  - RAS results then passed into HEC-Flood Impact Analysis (FIA) for the economic analysis
- RAS used to create mapping, depth, timing datasets.
- FIA contains land use and structure information to estimate damages.

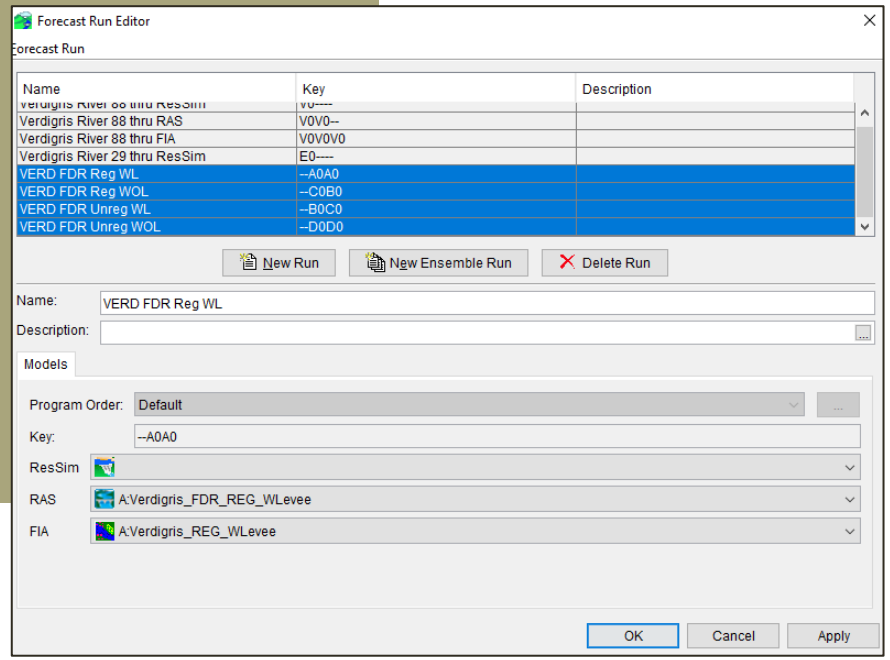
CWMS RAS and FIA Model Extents for Flood Damages Reduced

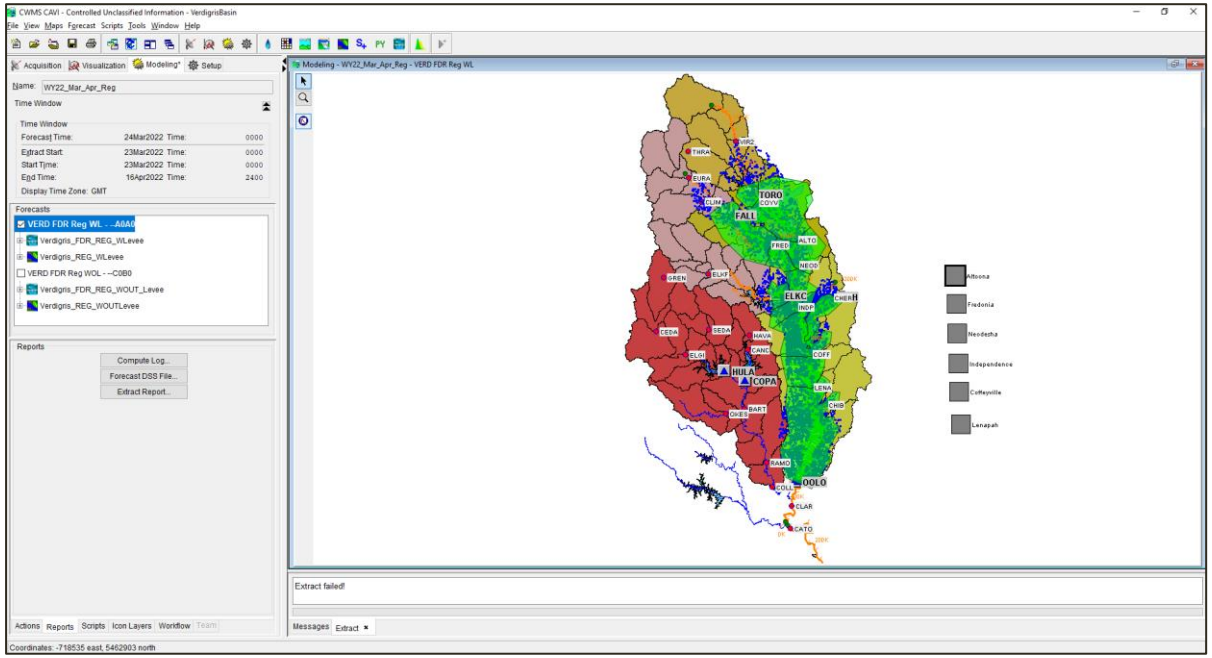


CAVI Example

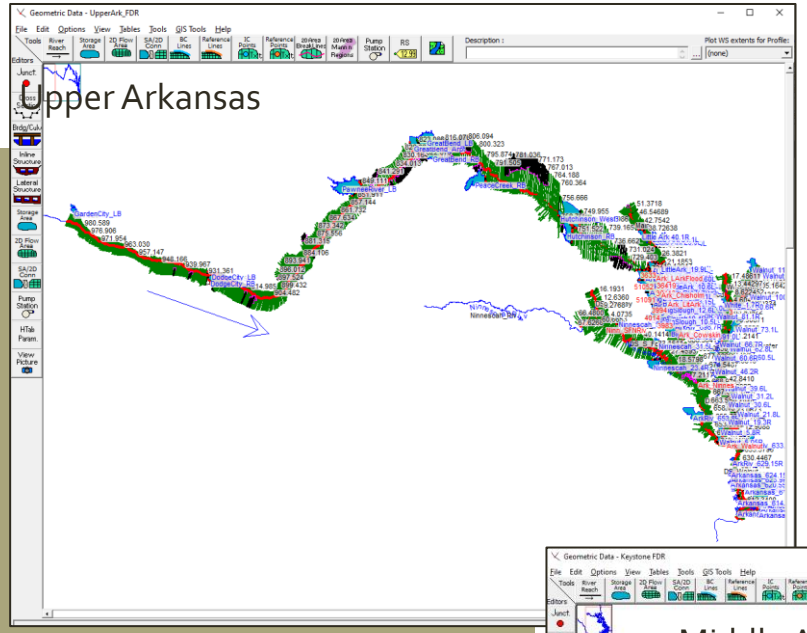


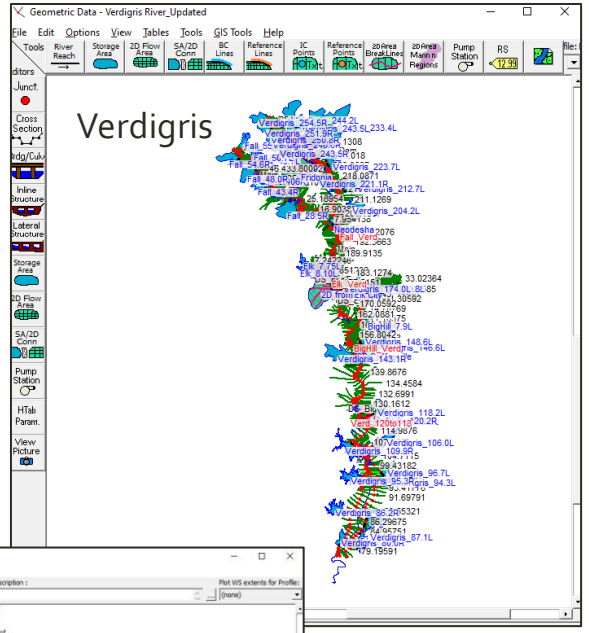


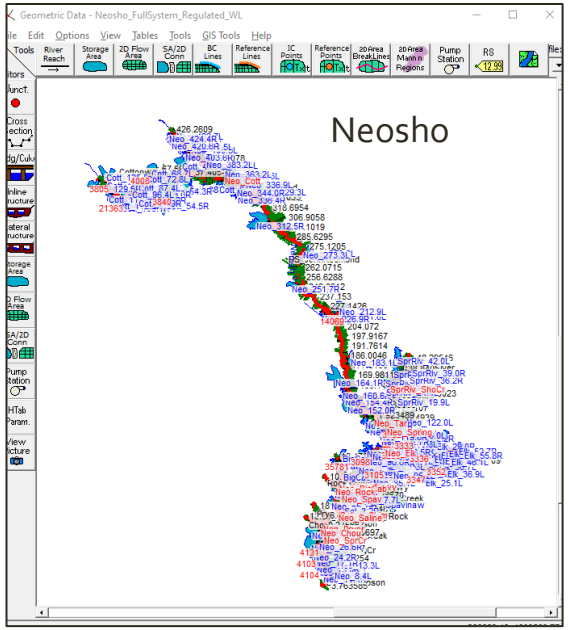


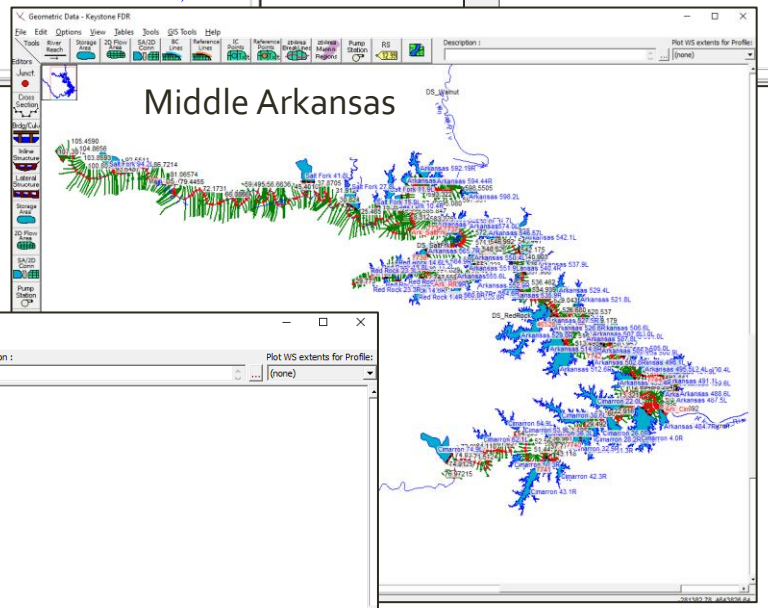


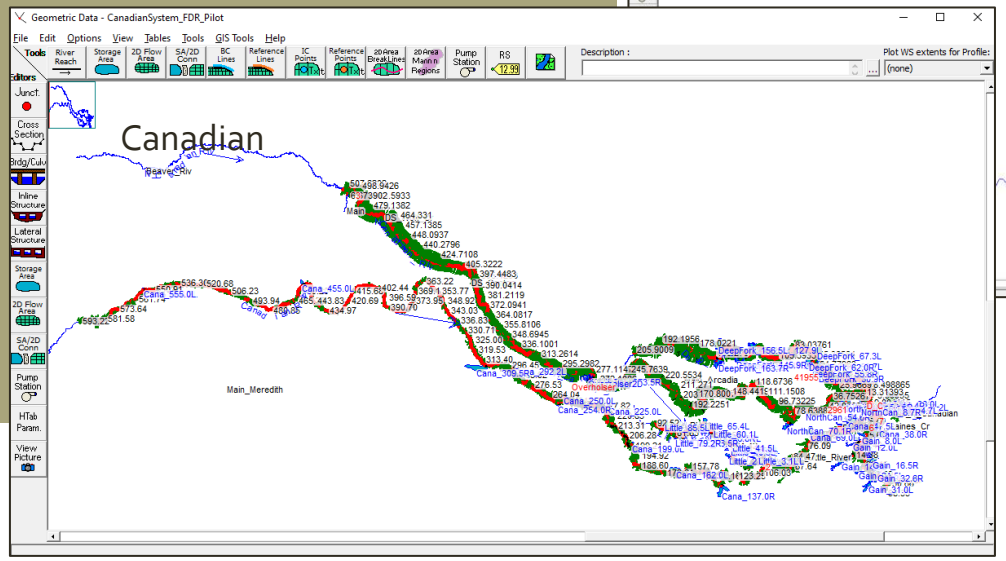
RAS Example

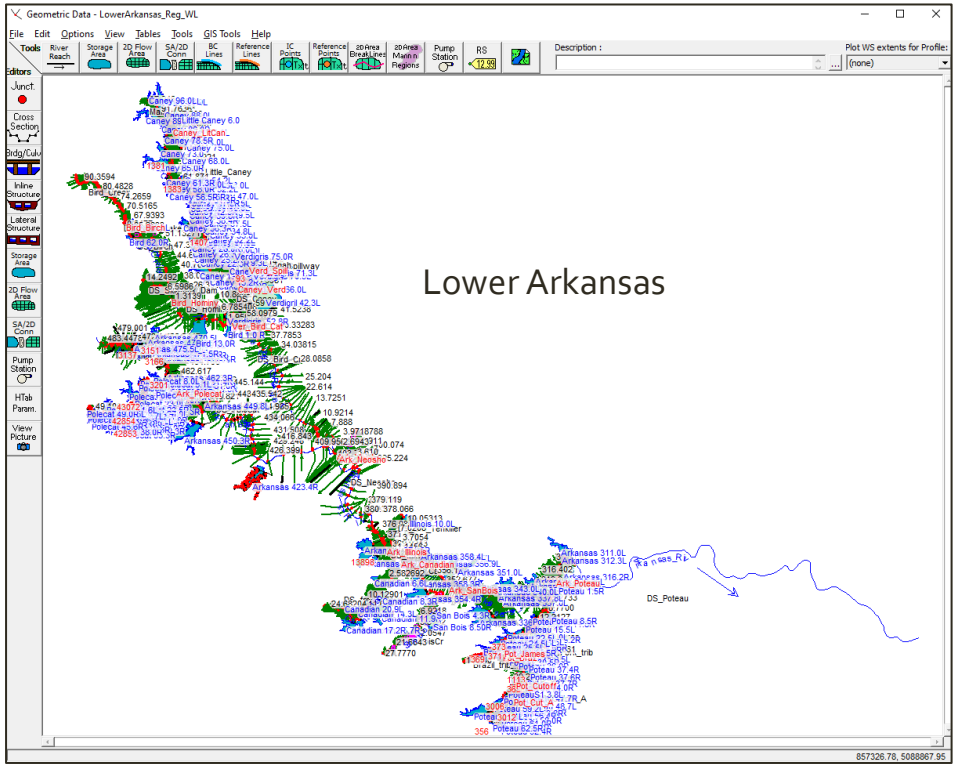

Upper Arkansas


Verdigris

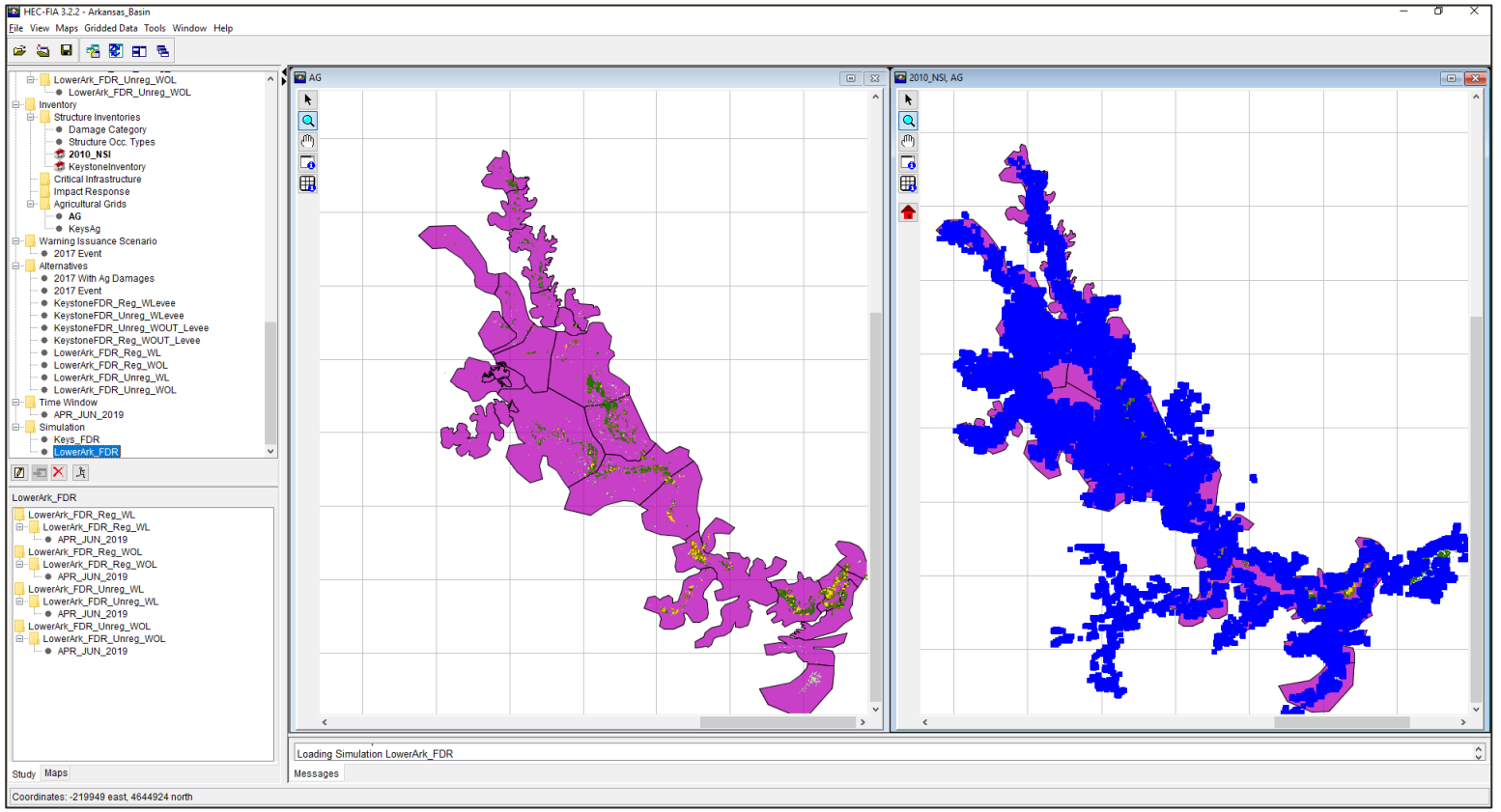

Neosho

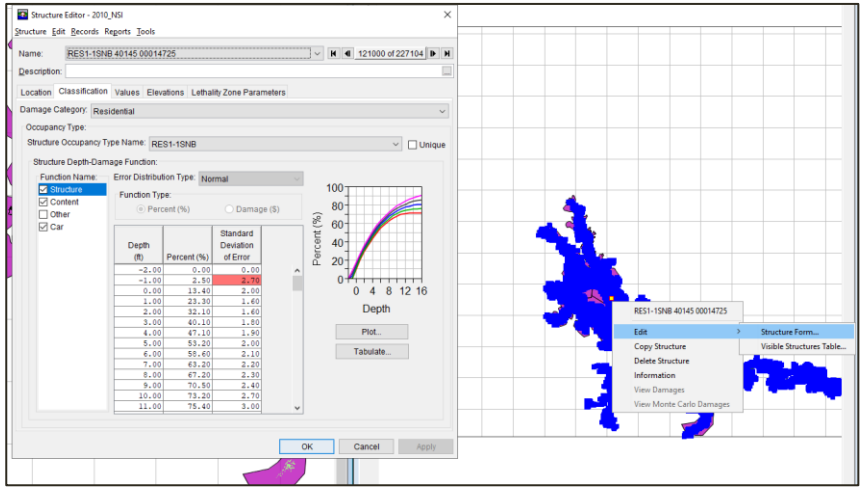

Middle Arkansas

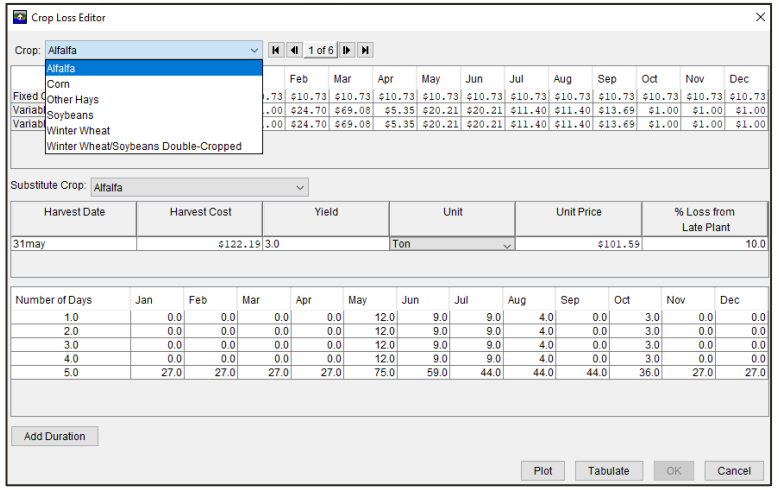

Canadian


Lower Arkansas

FIA Example


HEC-FIA 3.2.2 - Arkansas_Basin
File View Maps Gridded Data Tools Window Help
AG
2010_NSI, AG
Loading Simulation LowerArk_FDR
Messages
Study Maps
Coordinates: -219949 east, 4644924 north


Structure Editor - 2010_NSI
Depth
Percent (%)

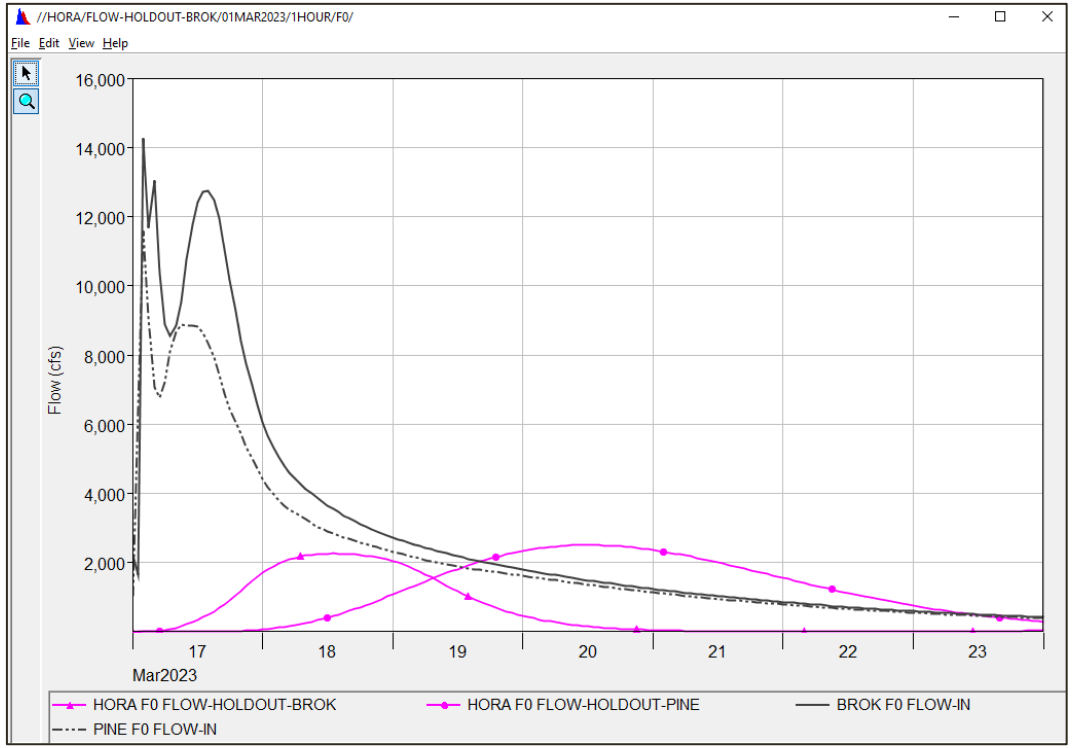

Crop Loss Editor
Crop: Alfalfa
Alfalfa
Corn
Other Hays
Soybeans
Winter Wheat
Winter Wheat/Soybeans Double-Cropped
Substitute Crop: Alfalfa
Harvest Date
Harvest Cost
Yield
Unit
Unit Price
% Loss from Late Plant
31may
$122.19
3.0
Ton
$101.59
10.0
Number of Days
Add Duration
Plot
Tabulate
OK
Cancel

Improvements of New Modeling Methods

- By switching to hourly modeling better results on start/end times and peaks of any flooding.
- Uses most current inventory data for economic analysis (structure and agricultural damages)
- Better understanding of impacts on individual locations due to ability to map entire flood in RAS versus using a static table of depth vs damage for an entire reach for current methods.

Work Currently Underway

- Compute Reservoir Holdouts in RiverWare
  - Currently – Using RiverWare computed volumes to compute percent holdout for reservoirs contributing to each damage reach.
  - In Progress – Single Reservoir routing to determine holdouts flows for damage reaches. Holdout record from RiverWare is used as FIA impute to compute percent holdout applied for each reservoir for the damage reach.



What Are Holdouts, and Why We Use Them

- When determining how to allocate flood damages reduced to each flood control project USACE uses "Holdouts" as a way to apportion these percentages.
- Anytime a reservoir inflow is greater than an outflow during a flood event this incremental storage is accumulated as a holdout for that project and is used for accounting and allocating benefits.
- Our legacy method accumulated all of the incremental volume holdouts and reported a single total volume which was then used to apportion reservoir benefits to downstream gages.
- With CWMS we will be using routed holdouts to better dynamically attribute the benefits based on timing and flood mapping.

Questions?