Leverage it! Part 1: Models, Gages and Topo… Forecasting Flood Damage

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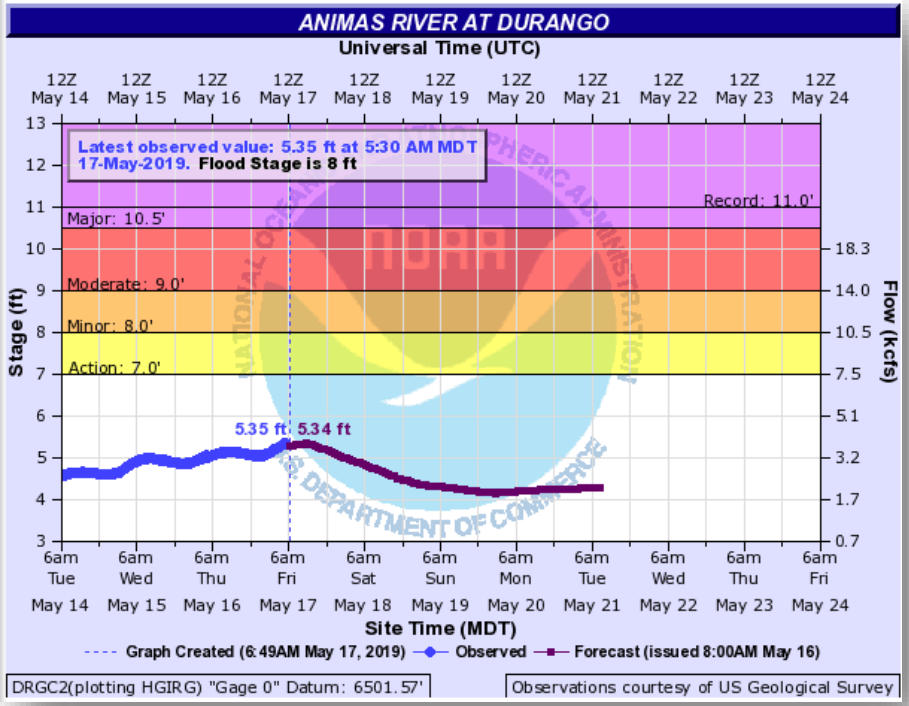
I have models, gages, and topo…

- ✓ We have hydraulic models for our streams.
- ✓ We have an alert gage system.
- ✓ We have NWS predictive stream gages.
- ✓ We have digital topo for our streams.

Can I leverage that existing data to forecast flood inundation and damage???



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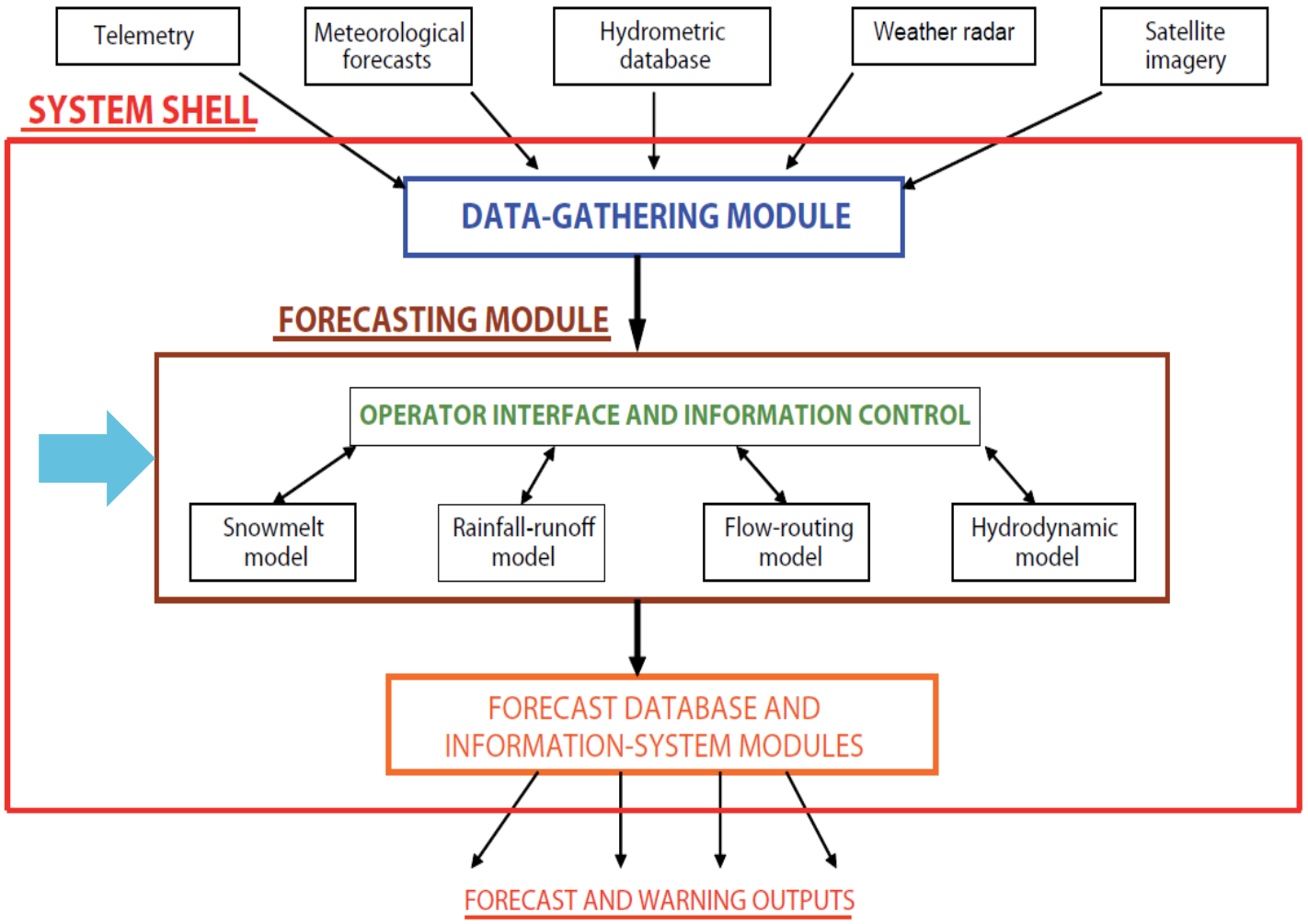
Agenda

- Colorado Feasibility Study and DHS Study Recaps
- Colorado Pilot Study Tasks
  - Site Selection
  - H&H Updates
  - Raster Development
  - Risk Assessment & Flood Forecasting Metrics
  - Climate Change Modeling Results

Feasibility and DHS Recaps

Feasibility: Flood Forecasting and Warning System



From 2011 WMO Manual on Flood Forecasting and Warning, http://www.wmo.int/pages/prog/hwrp/publications/flood_forecasting_warning/WMO%201072_en.pdf

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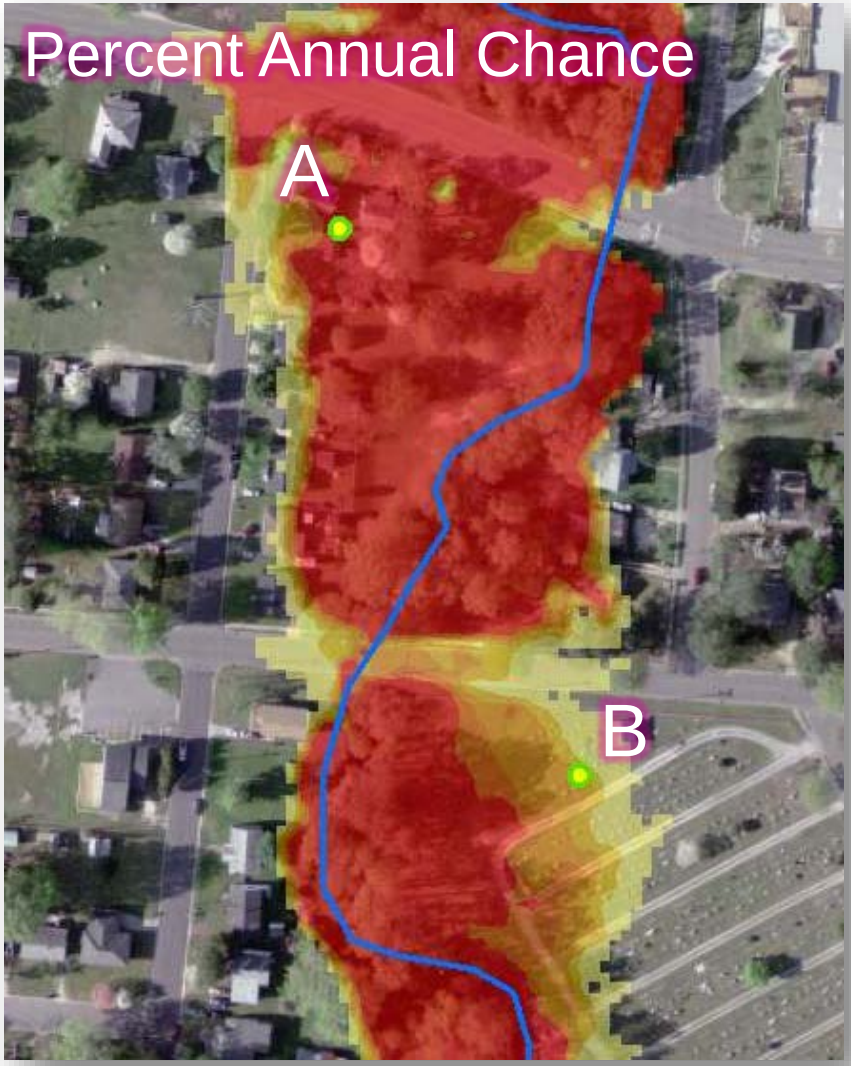
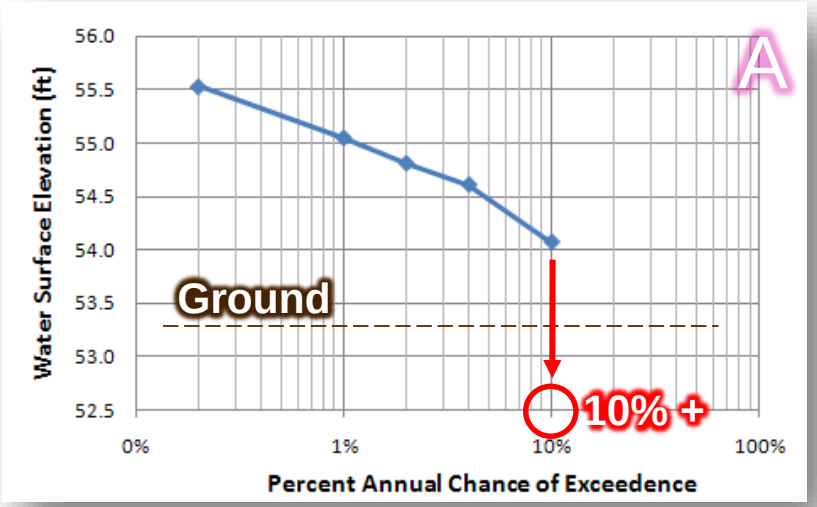
Adapting Risk MAP Products for Flood Forecasting

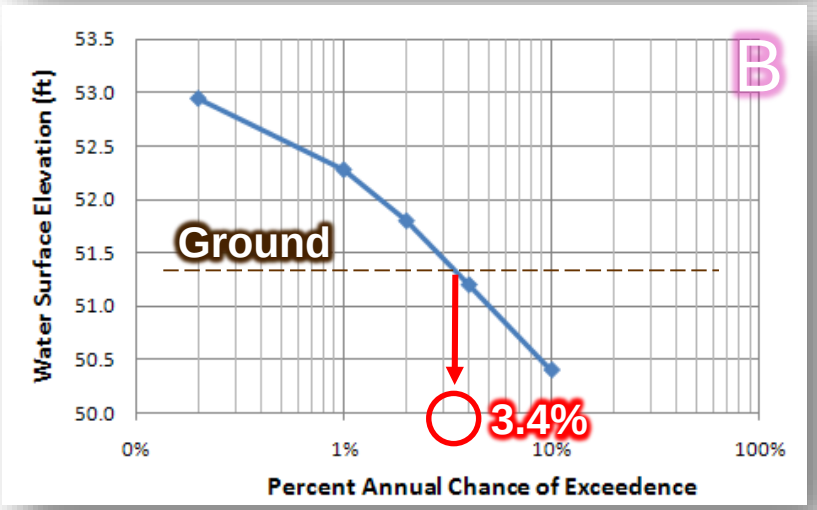
	Flow	Profiles	Boundaries	Depth	Loss
50%-ann. chance	✓	✓	✓	✓	✓
20%-ann. chance	✓	✓	✓	✓	✓
10%-ann. chance	✓	✓	✓	✓	✓
4%-ann. chance	✓	✓	✓	✓	✓
2%-ann. chance	✓	✓	✓	✓	✓
1%-ann. chance	✓	✓	✓	✓	✓
0.2%-ann. chance	✓	✓	✓	✓	✓
0.1%-ann. chance	✓	✓	✓	✓	✓
0.05%-ann. chance	✓	✓	✓	✓	✓
PMF	✓	✓	✓	✓	✓

Additional “Composite” raster datasets: Flow, Gage stage, Loss

Percent Annual Chance Grid Development Process







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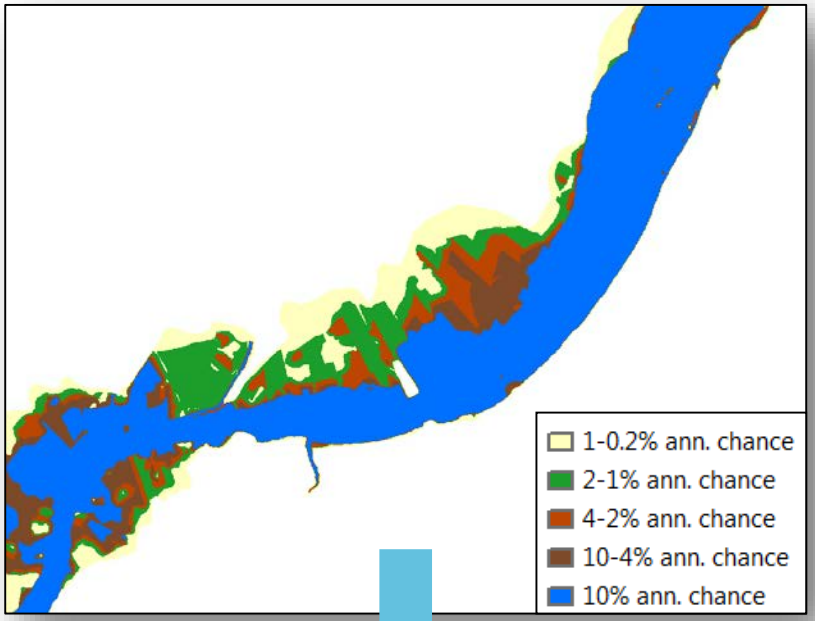
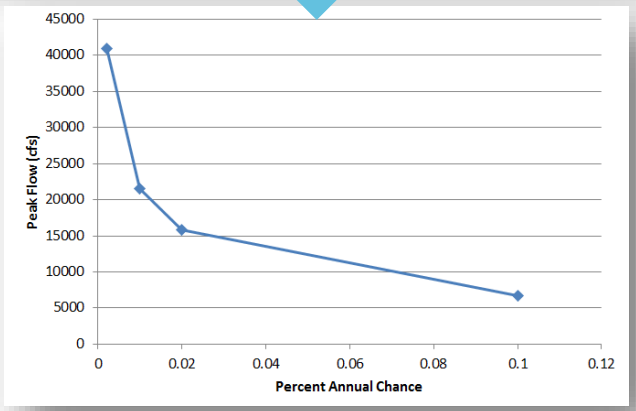
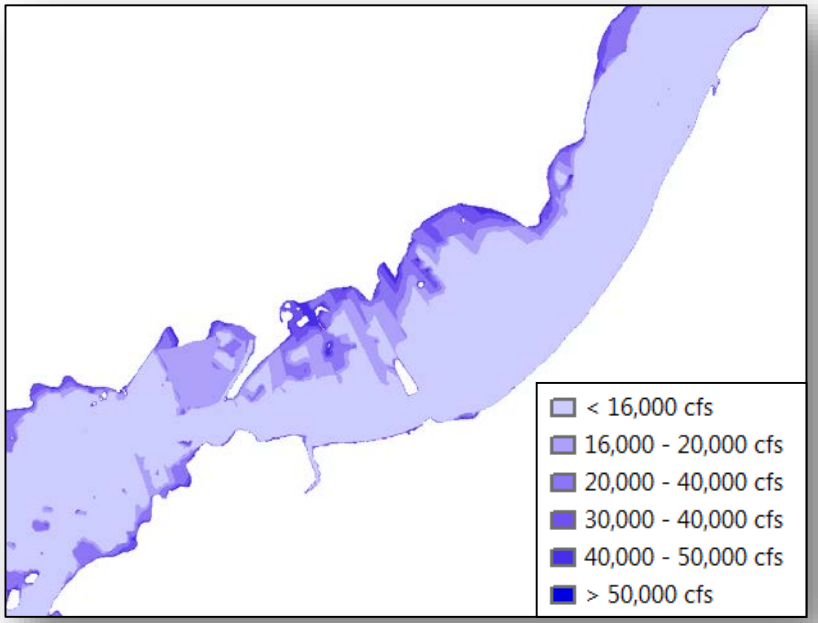
Creating Composite Datasets





Percent annual chance raster and “rating” curve can be used to produce other composite rasters like peak flow



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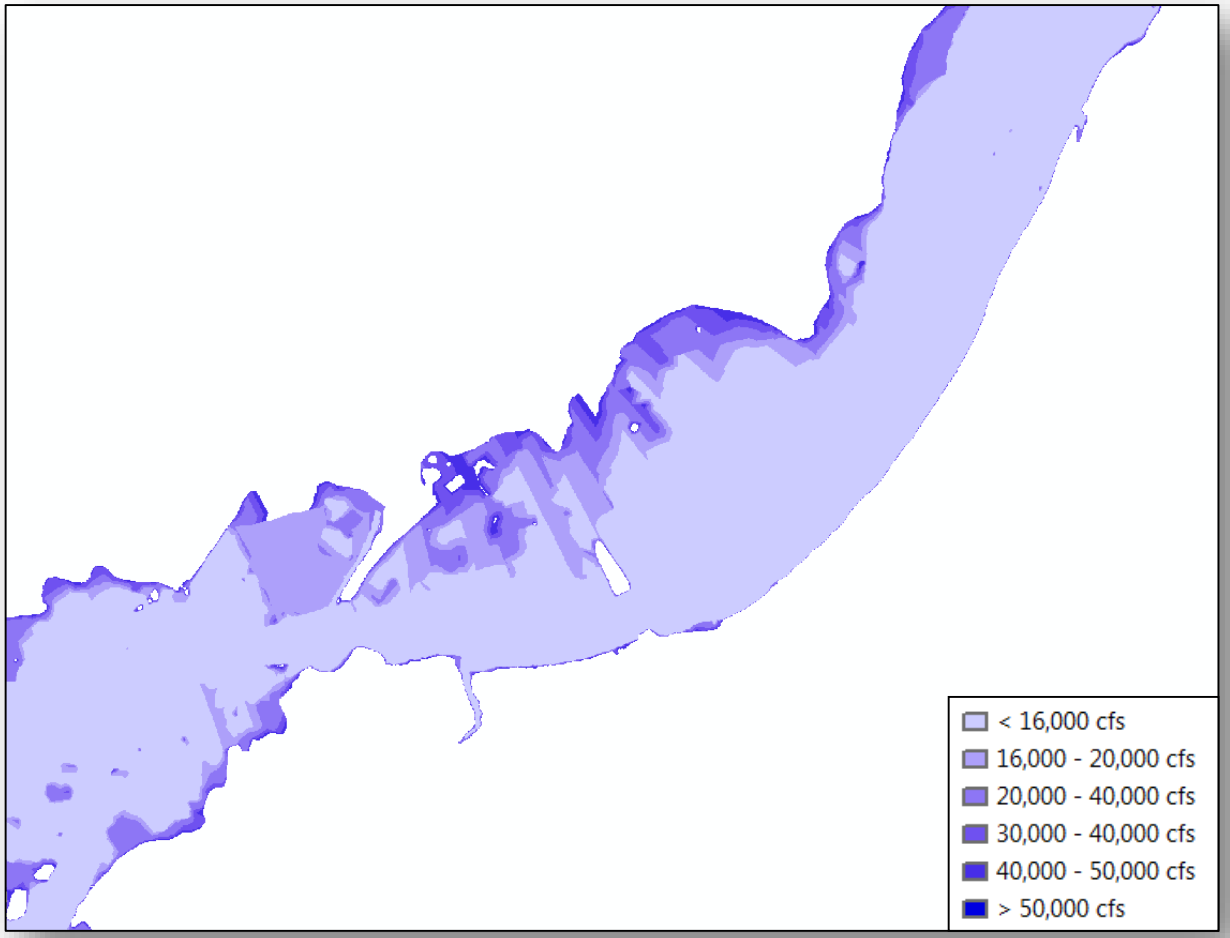
Flood forecasting questions: Flood inundation for a certain peak flow amount

- Rainfall-runoff model may produce a peak flow estimate for a future event
- **Peak Flow Composite Raster** can quickly show inundation limits



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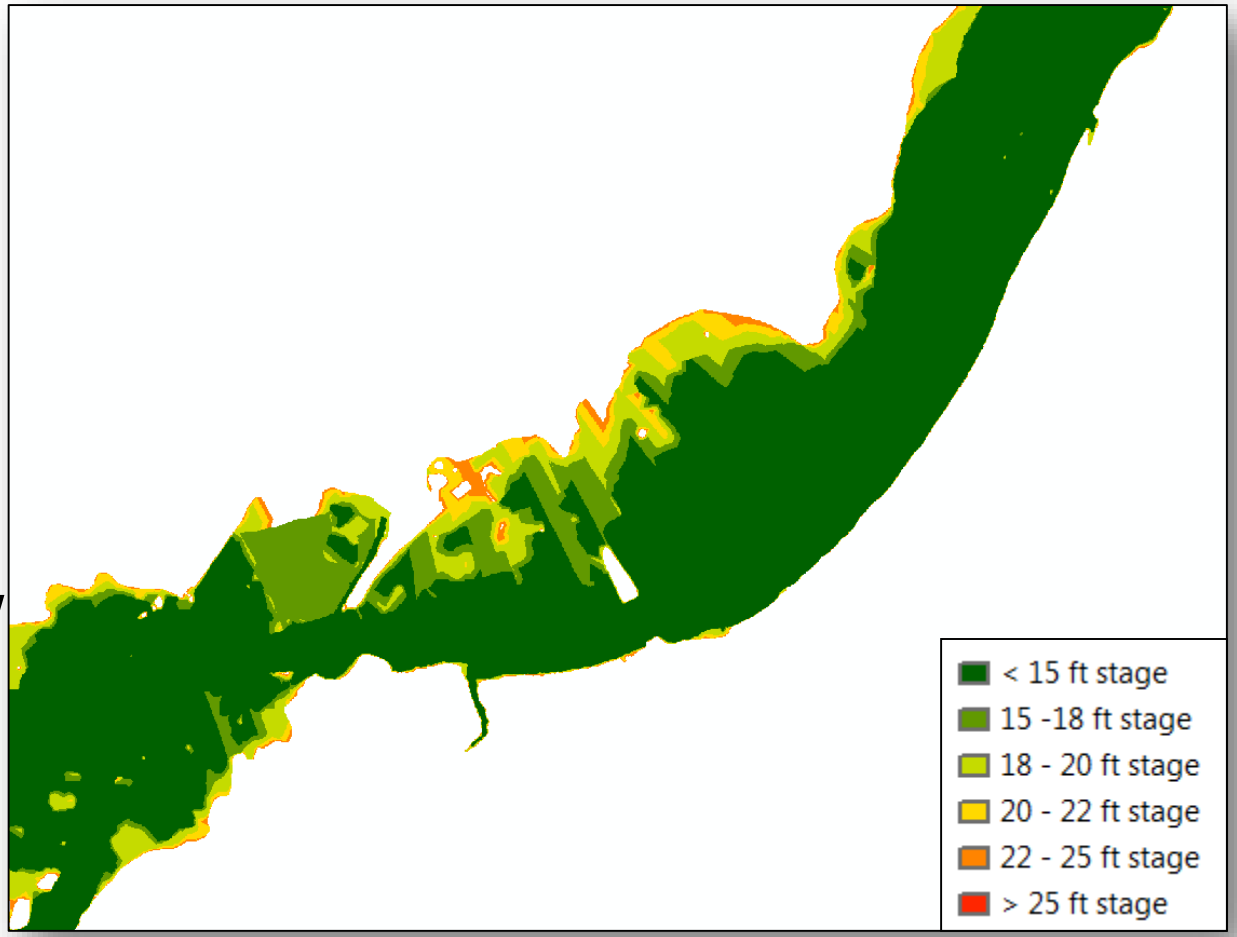
Flood forecasting questions: Flood inundation for a certain gage stage

- Predicted maximum stage for river gauge for current ongoing event
- **Gage Stage Composite Raster** can show inundation limits associated with each stage



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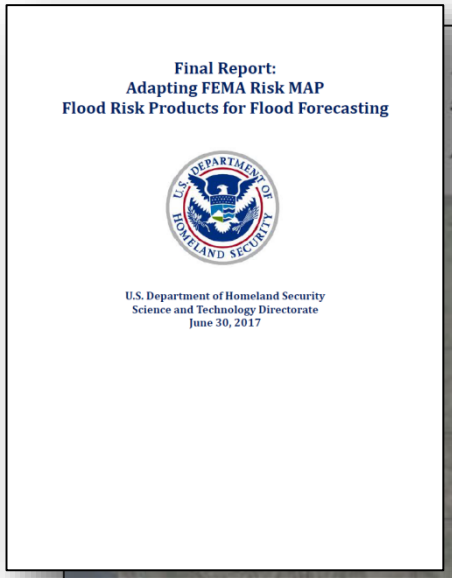
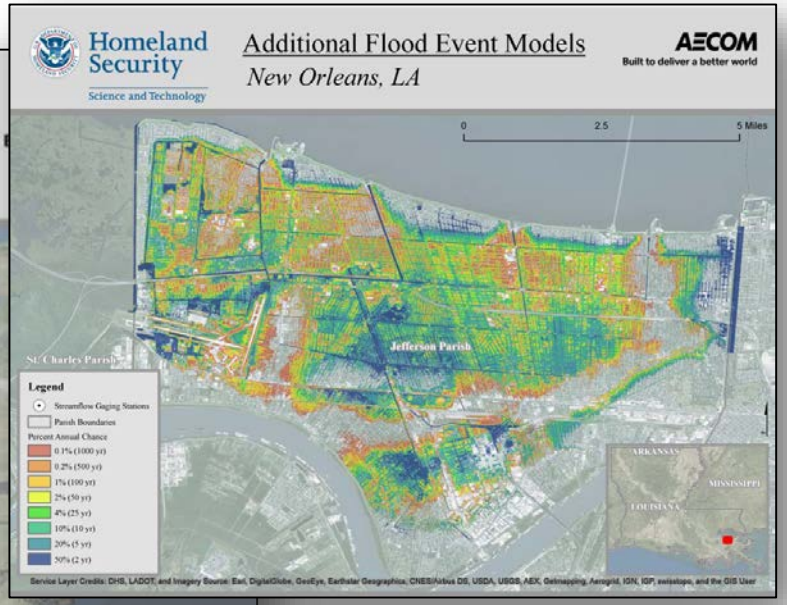
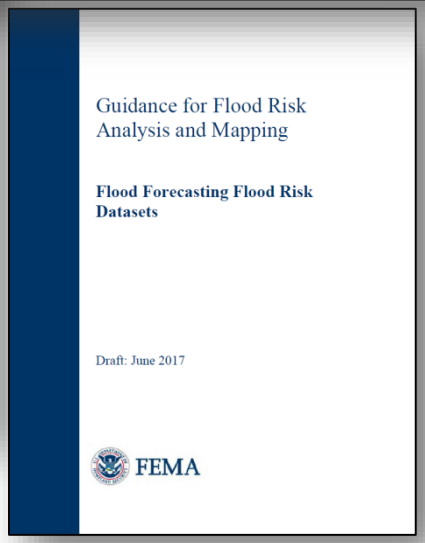
DHS Flood Forecasting Project







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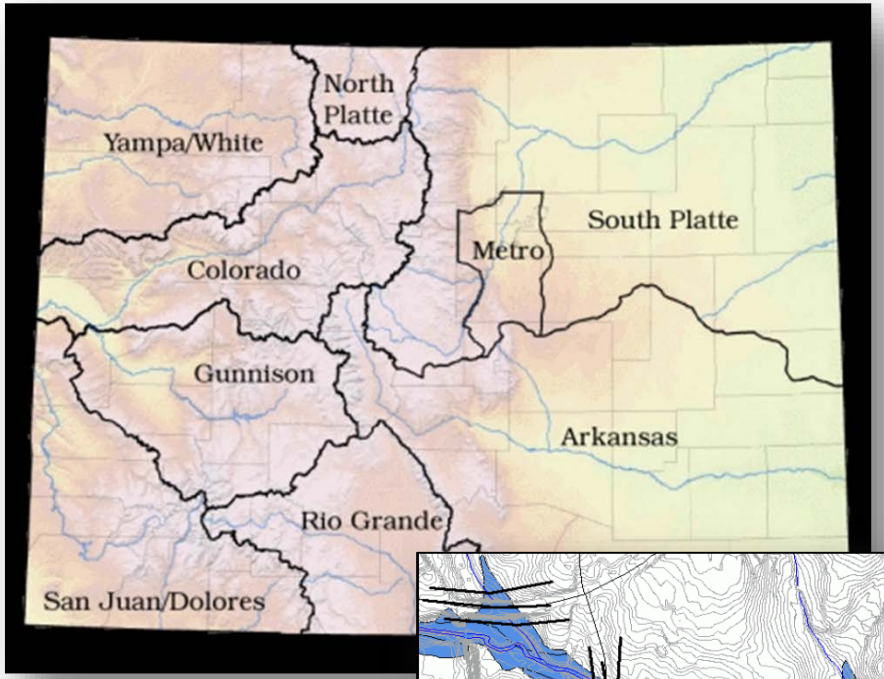
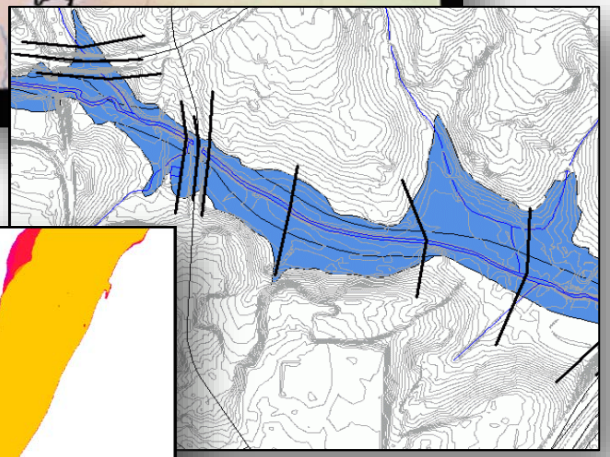
Colorado Pilot Study

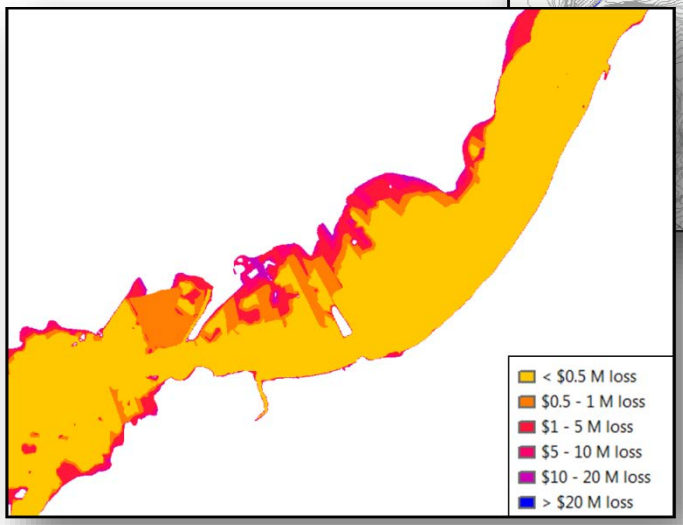
Site Selection

Criteria

- Locations with range of hydrologic and terrain conditions
- Leverage existing modeling and non-regulatory Flood Risk Products (FRPs)
- Feasibility for additional return periods







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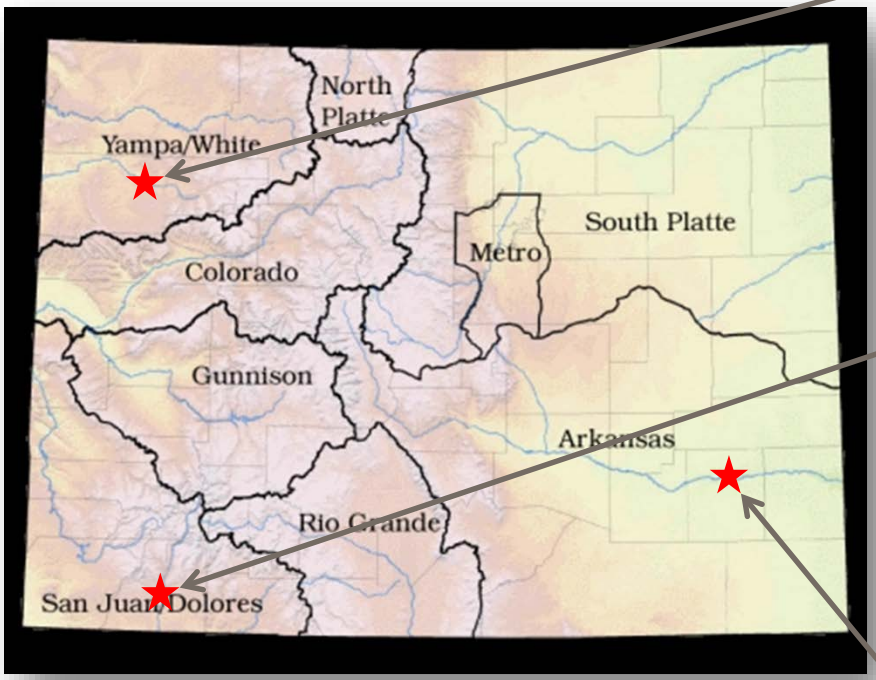
Selected Sites



#1 White River, Rio Blanco County, CO

- Zone A & AE with FW
- Mountain & Northwest Hydrologic Regions
- Hydrology: LPIII Gage Analysis
- Hydraulics: HEC-RAS 5.0.3

#2 Animas River, LaPlata County, CO

- BLE
- Southwest Hydrologic Region
- Hydrology: LPIII Gage Analysis
- Hydraulics: HEC-RAS 5.0.3

#3 Arkansas River, Lamar, CO

- Zone AE with FW
- Plains Hydrologic Region
- Hydrology: LPIII Gage Analysis
- Hydraulics: HEC-RAS 4.0

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Hydrology Updates

Extend Hydrology

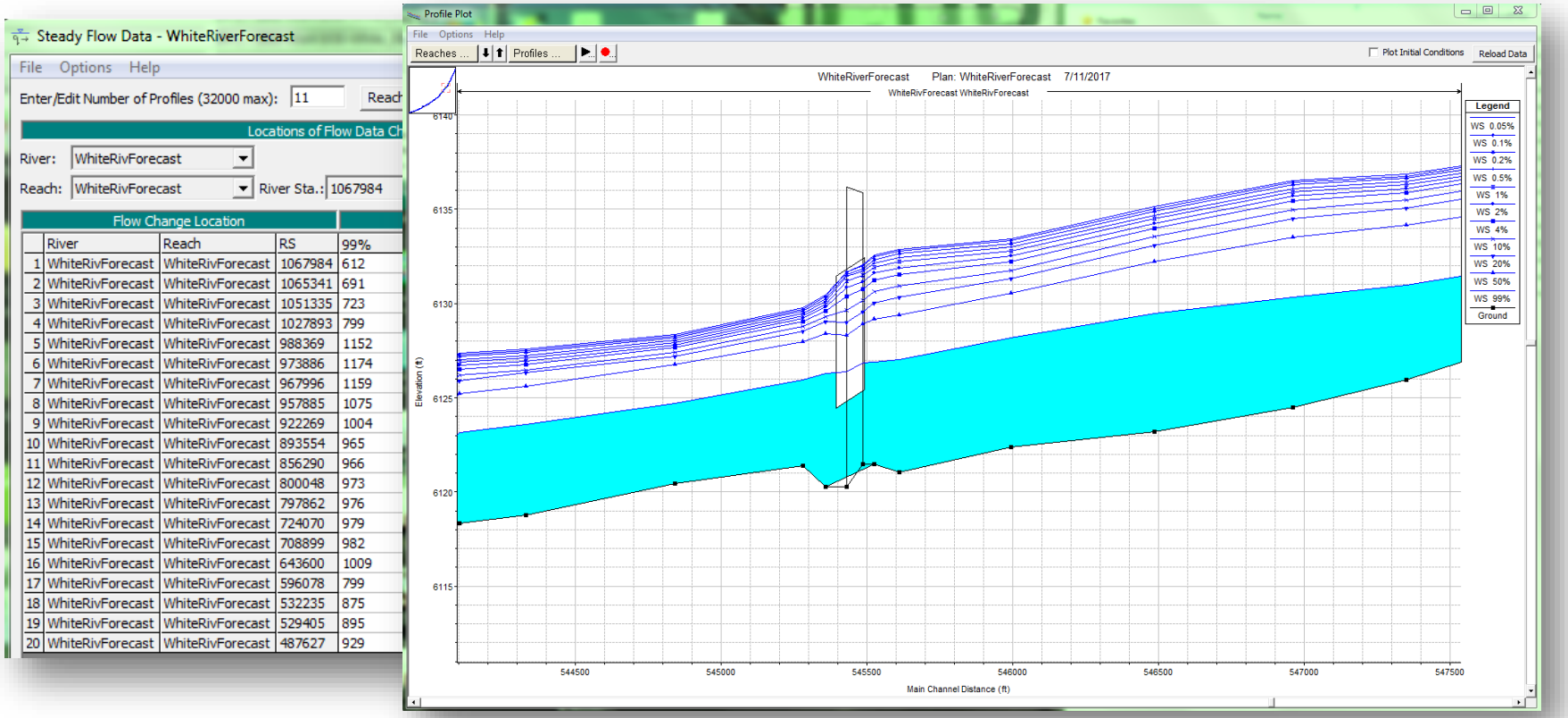
- NFIP Original Standard 10%, 2%, 1%, and 0.2%
- NFIP Current Standard 10%, 4%, 2%, 1%, 1%+, and 0.2%
- Full Range needed for Forecasting:
  99% (1-year) to 0.05% (2000-year)

Methods

- Gage Analysis – Easy, Add return periods to analysis.
- Regression Analysis – 99%, 0.1%, and 0.05% require Log/Log Curve Fitting
- Rainfall Runoff – 99% through 0.1% possible through adding rainfall, but model debugging would be cumbersome, may need to instead consider Log/Log Curve-Fitting

Hydraulic Updates

– Incorporate additional recurrence intervals



– Debug to resolve crossing profiles

- Ineffective Flow Areas, some channel banks

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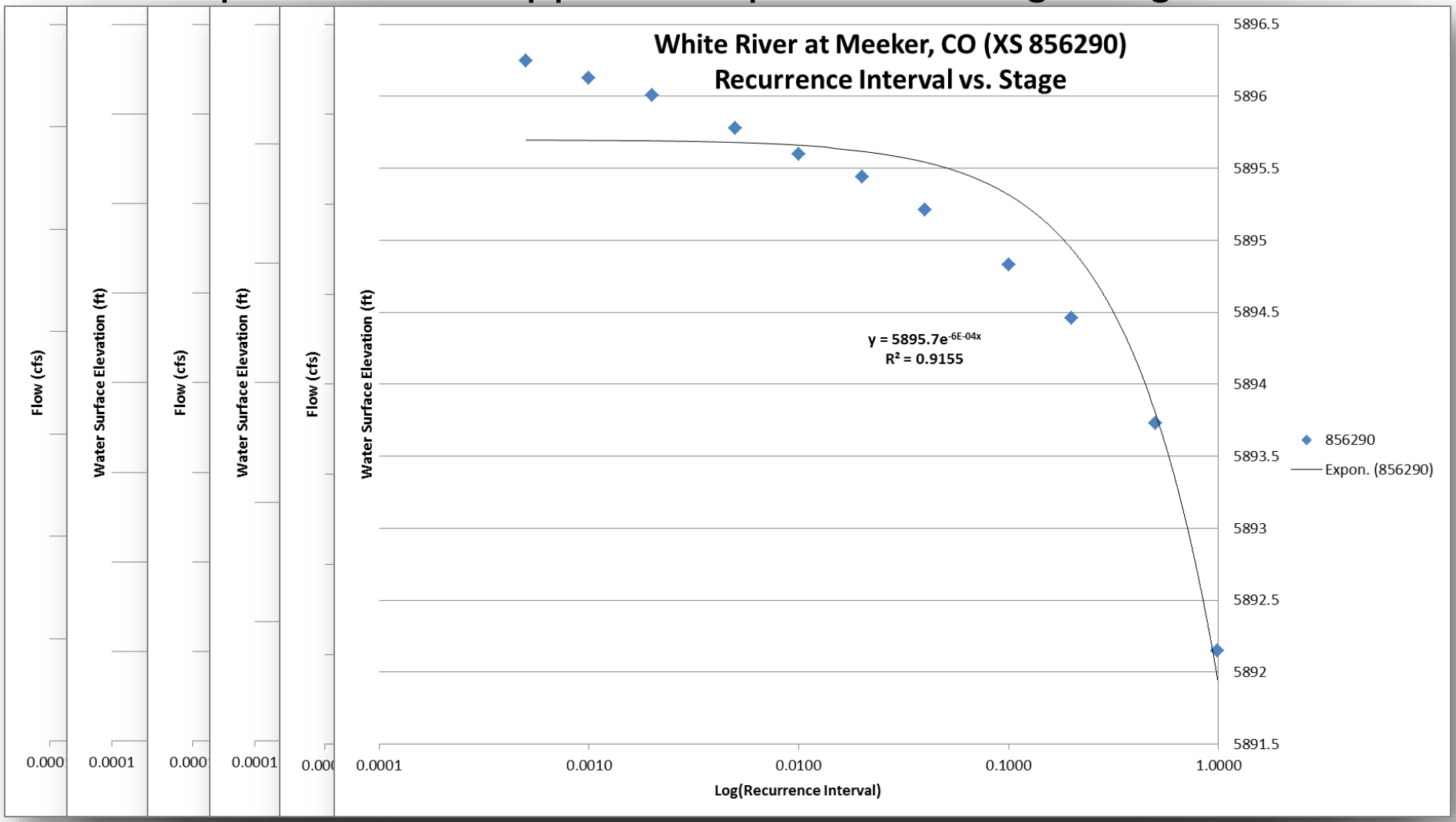
Rating Curves

Develop curves to support interpolation using the grids



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Model Output Grids

Output WSEL Grids and Depth Grids

- WSEL for Percent Annual Chance & Composites
- Depth for Hazus

Rating Curves + Model Output Grids = Results

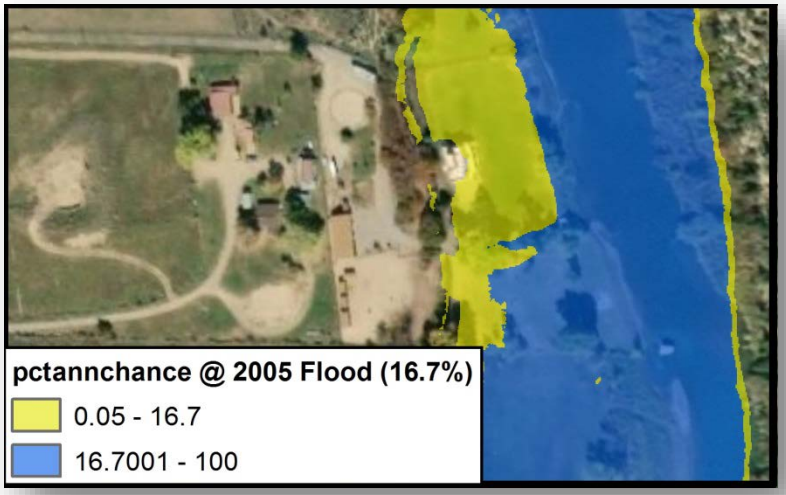
– Percent Annual Chance

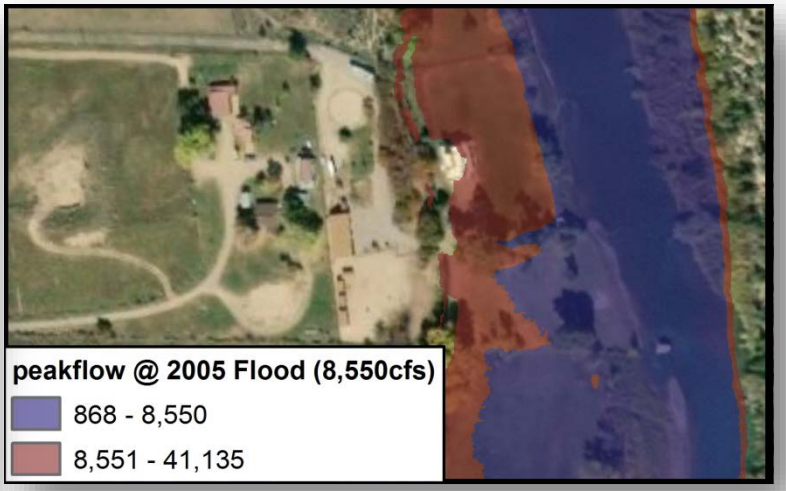
– Peak Flow Composite

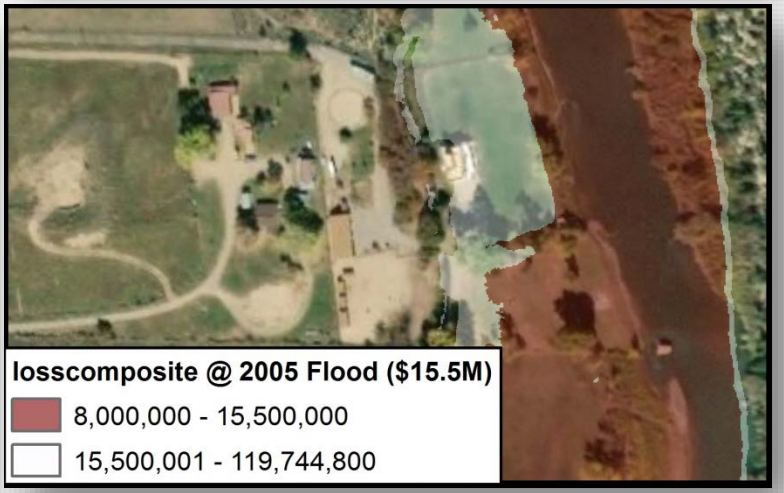
– Gage Stage Composite

– Loss Composite

Animas River Composite Grids







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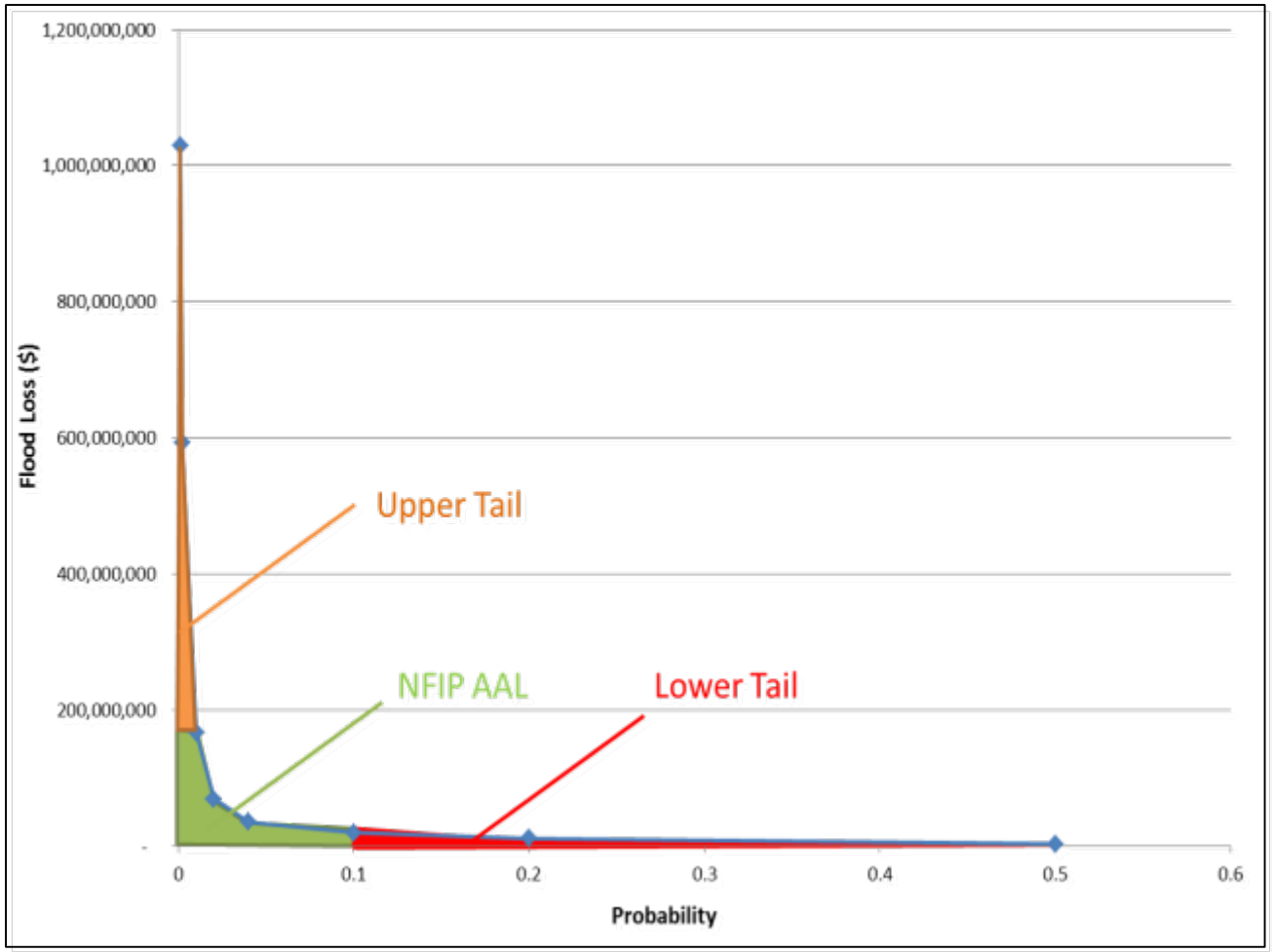
From DHS Study:
Risk Assessment and Flood Forecasting Metrics

- Compare Flood Loss (from models like Hazus) and associated Average Annualized Loss (AAL) for range of events
- NFIP AAL = AAL for events within FEMA regulatory NFIP floodplain (10%, 4%, 2%, and 1%-annual chance events)
- Flood Forecasting AAL = AAL for all events modeled (99%, 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, 0.2%, 0.1%, and 0.05%-annual chance for this CWCB study)
- Flood Forecasting AAL Ratio =
  Flood Forecasting AAL / NFIP AAL

From DHS Study:
Risk Assessment and Flood Forecasting Metrics

- Lower Tail = Portion of AAL below 10%-annual-chance event
- Upper Tail = Portion of AAL above the 1%-annual chance event losses
- Average DHS Study AAL Ratio = 2.73



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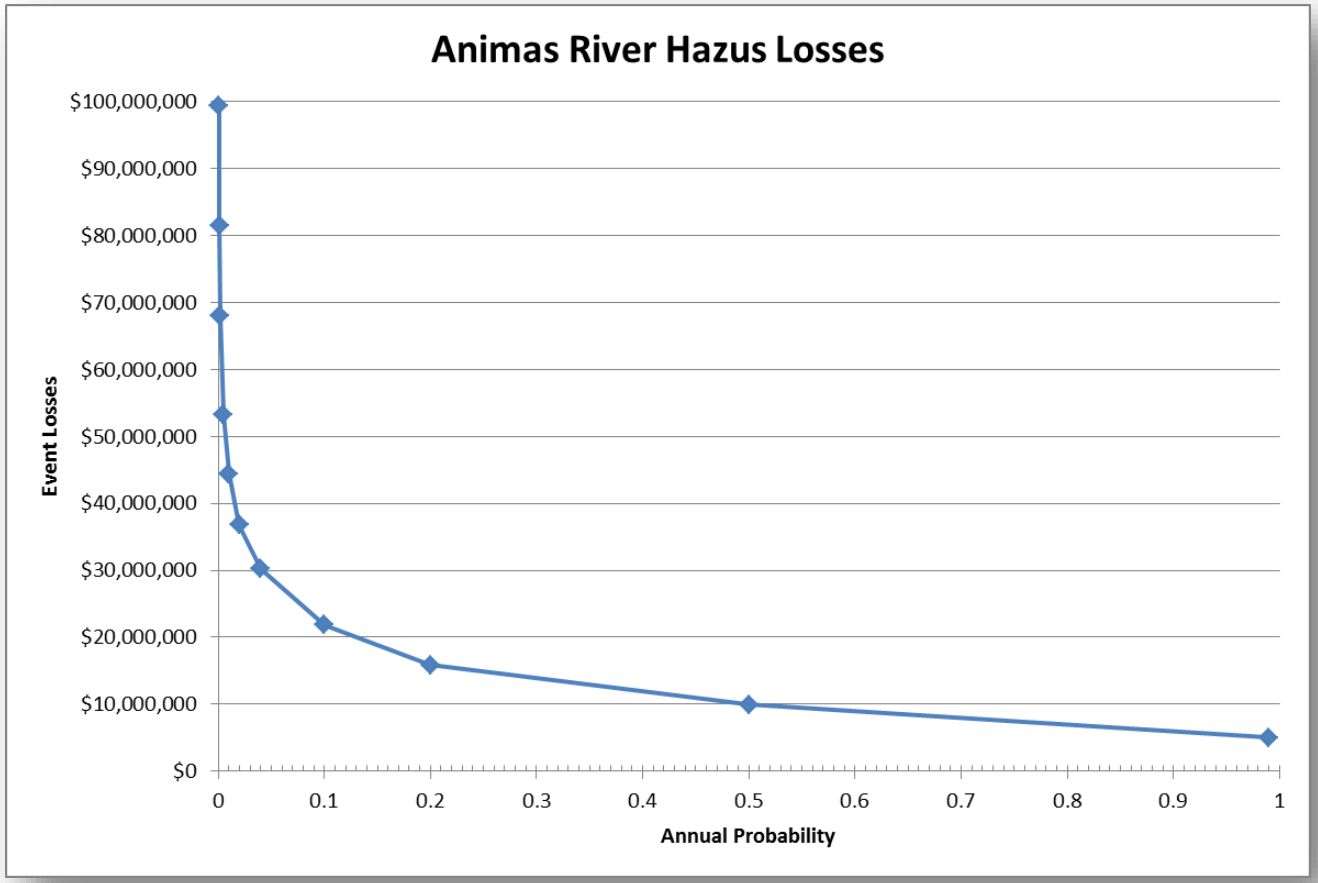
Animas River: Risk Assessment

- NFIP AAL = $3.1 M/year
- Flood Forecasting AAL = $12.7 M/year
- Lower Tail = 74%, NFIP AAL = 24%, Upper Tail = 1%
- Flood Forecasting AAL Ratio = 4.11



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Path forward in Colorado

CWCB's PMRs in Colorado include the WSEL grids, depth grids, and % Annual Chance Grid based on FEMA standard frequencies at this time.

- ✓ Many NWS predictive gages in CO = Can advance to forecasting inundation
- ✓ Can run Hazus for potential damages
- ✓ Dovetails with FEMA's Risk Rating 2.0 efforts

Possible next step: Developing a guidebook for developing composite grids to share with communities

Potential for leverage: Communities could leverage funding to request the composite grids.

Colorado Climate Change Modeling

What did the climate change analysis tell us about peak flows?

- Arkansas River in Lamar needs better data, but likely climate impacts will be minimal
- Animas River and White River will likely see drastic decreases in peak flows
  - Warmer Spring was strongest factor in peak flow equations and saw biggest changes
  - Warmer Fall also had an impact, although weaker than Spring factor
  - Precipitation change was weakest factor, with White River seeing likely increase in Winter/Spring and Animas with little likely change
- Losses had larger relative changes than Peak Flow

Questions?

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