



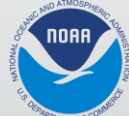
Utah Water Research Laboratory
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Bridging Hydrologic Models and Water Management: The Extended Hydrofabric Framework

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Water Resources Analysis in Managed Basins



Human activities

- Reservoir operations
- Diversions
- Water rights
- Inter-basin transfers



Existing large-scale hydrologic models inadequately represent management processes

- National Water Model (NWM)
- National Hydrologic Model (NHM)
- Major limitation: Lack of standardized water management infrastructure and operational datasets



Current workflows

- Fragmented
- Project-specific
- Difficult to reproduce
- Time Consuming

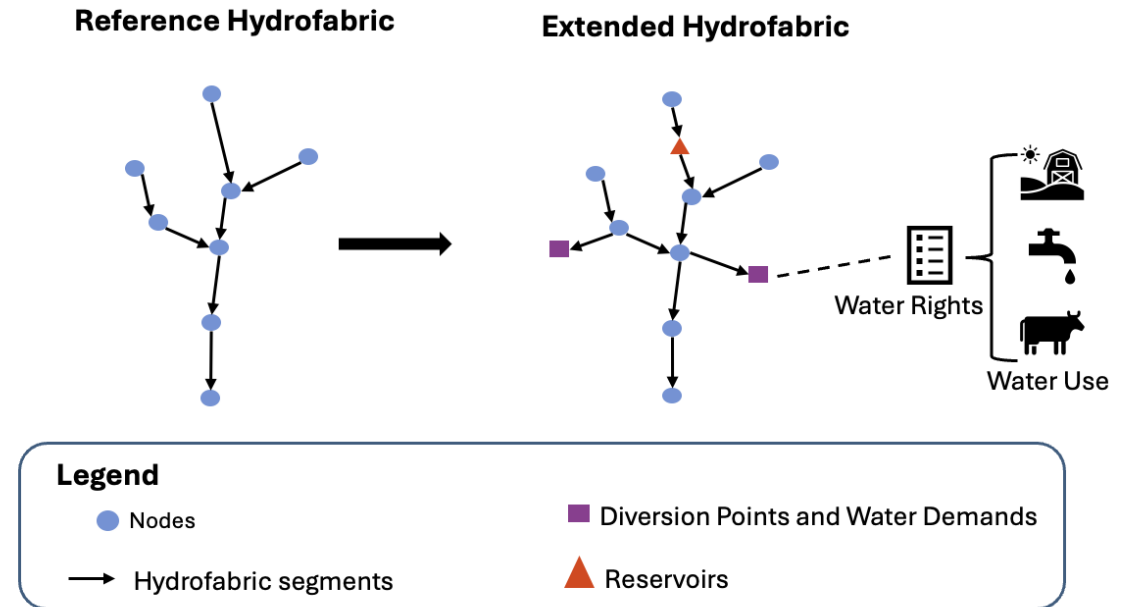
Research Objectives

- **Extended Hydrofabric :**

- Reference hydrofabric
- Reservoirs
- Diversions
- Water rights

- **Coupling Hydrologic Models with WMM**

- Hydrologic Model: natural flows simulation
- WMM: human operations



Automated Workflow for Building the Extended Hydrofabric

- **Inputs**

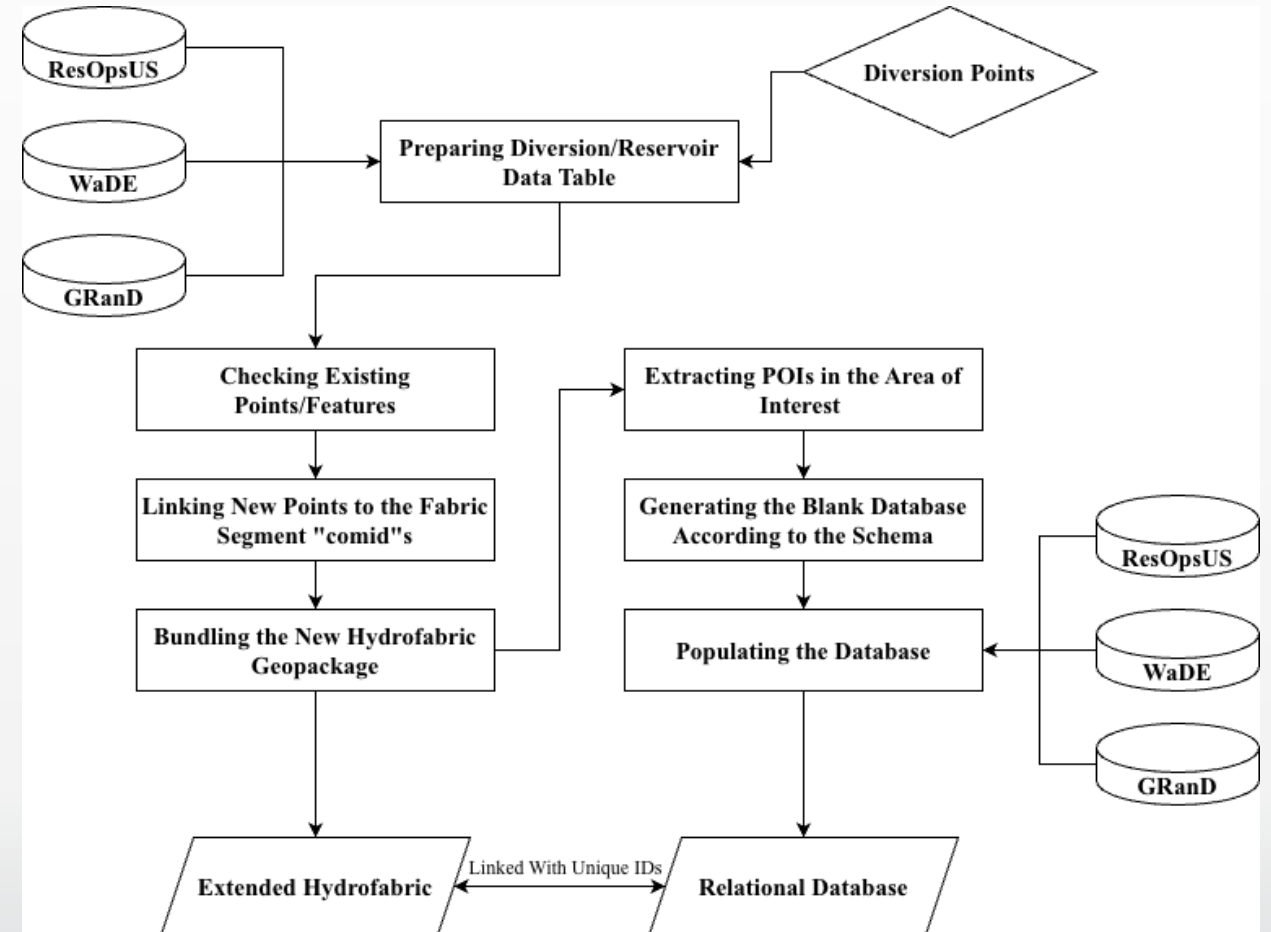
- Reference Hydrofabric
- WaDE (Water Data Exchange Program)
- ResOpsUS
- GRanD (Global Reservoir and Dam Database)
- Diversion datasets

- **Workflow**

- Data harmonization
- Spatial linkage
- COMID assignment
- Relational database population
- GeoPackage generation

- **Outputs** : WMM-ready datasets

- Extended Hydrofabric
- Relational database



Spatial Linkage of Water Management Infrastructure

Goals

- Ensure hydrologic consistency
- Preserve topology
- Enable automated integration

POD Matching Strategy

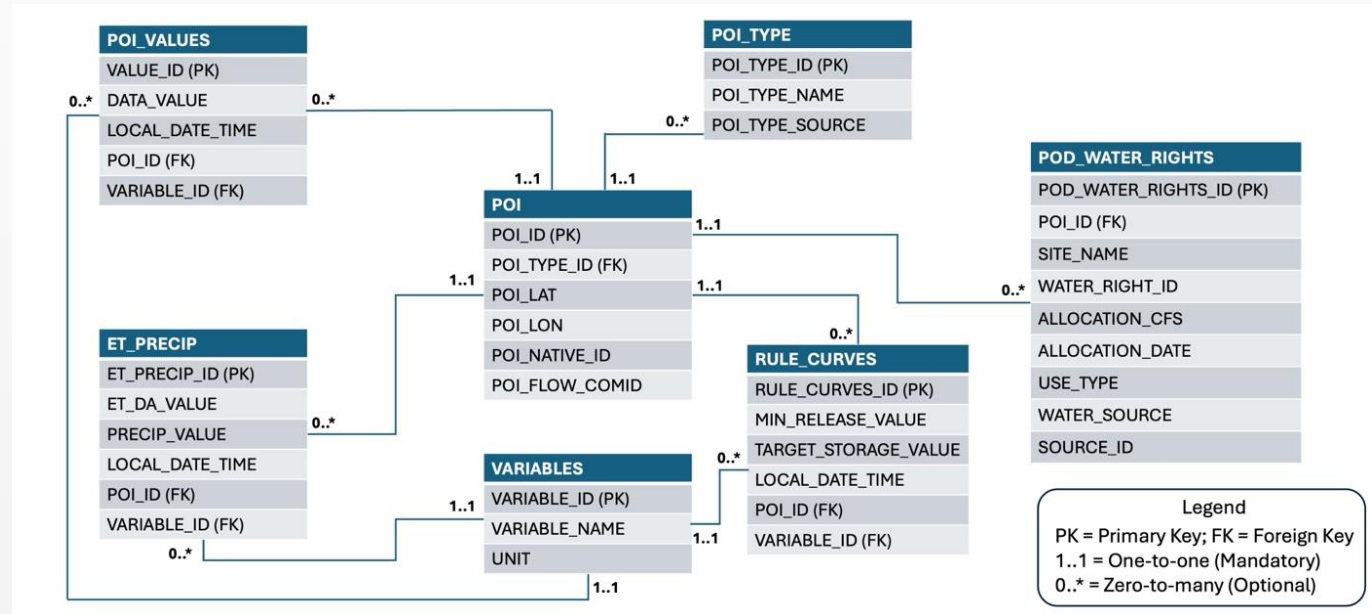
- Tiered algorithm:
 - GNIS ID match
 - Stream name match
 - Stream-order fallback (≥ 3)

Reservoir Matching

- Prioritize LakePond segments
- GNIS name normalization
- Distance-based match
- Manual QA flagging

Relational Database Supporting Water Management Modeling

- **Direct linkage between:**
 - Spatial topology
 - Operational data
 - Administrative records
- **Benefits:**
 - Standardized Data Organization
 - Scalability
 - Reproducibility & Automation
 - Efficient Querying & Retrieval
 - Interoperability



Implementation Results for the UCRB

Infrastructure Integrated

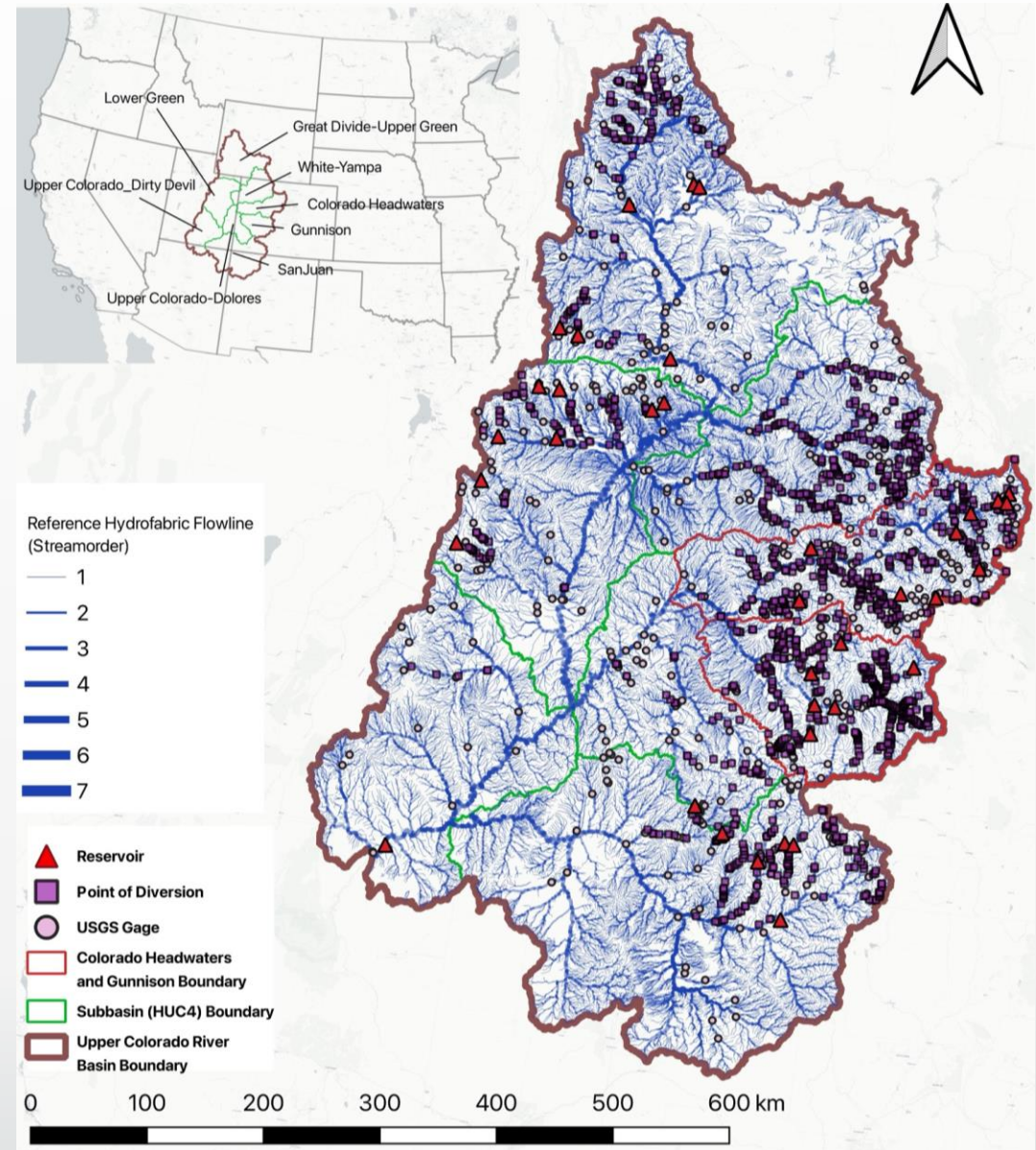
- 1,318 diversion points
- 37 reservoirs

POD Linkage

- 82% GNIS ID match
- 10% GNIS name match
- 8% fallback linkage

Reservoir Linkage

- 78% direct match
- 100% connection validated



Implementation Results for the UCRB

MODSIM model

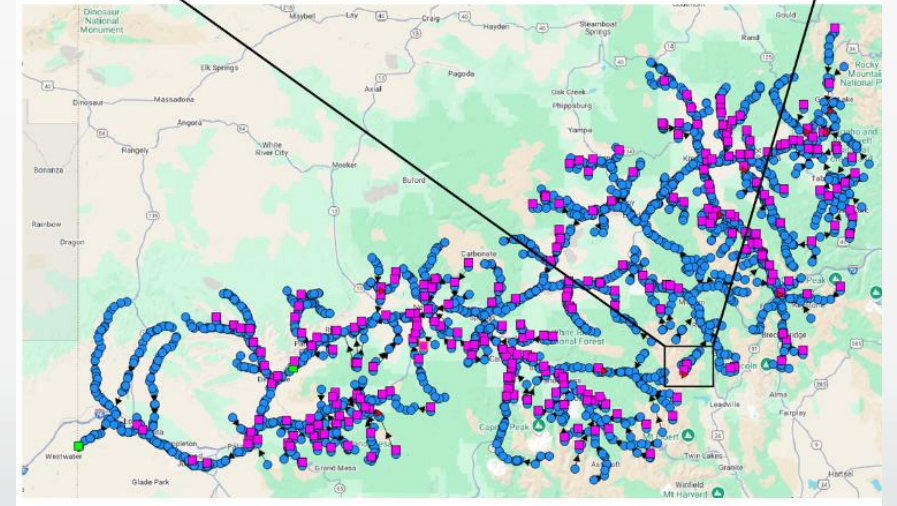
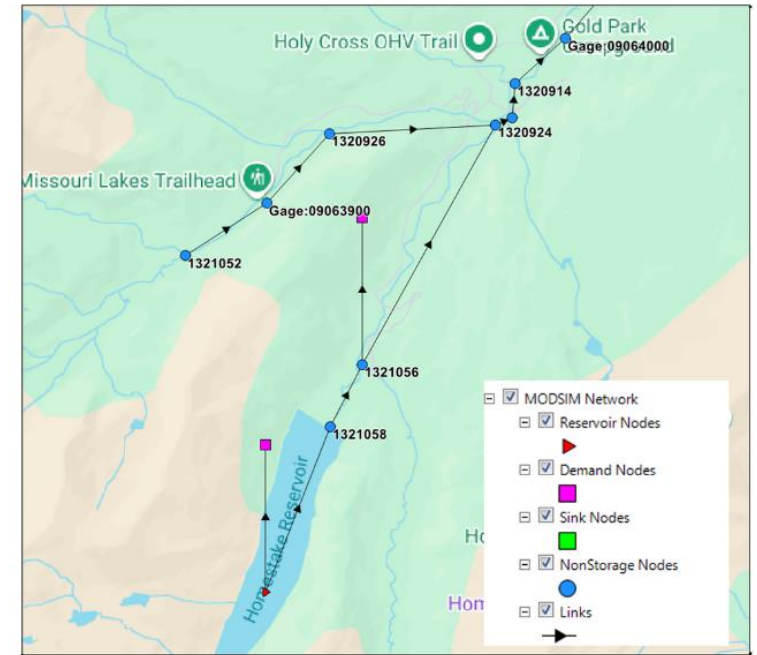
- Colorado River Headwaters (HUC4: 1401)

Components

- Flow network topology
- Reservoir nodes
- Diversion nodes
- Operational parameterization

Input Flows

- Integrated NHM-PRMS hydrologic model outputs



MODSIM model constructed using Extended Hydrofabric

Coupled Model: Initial Results

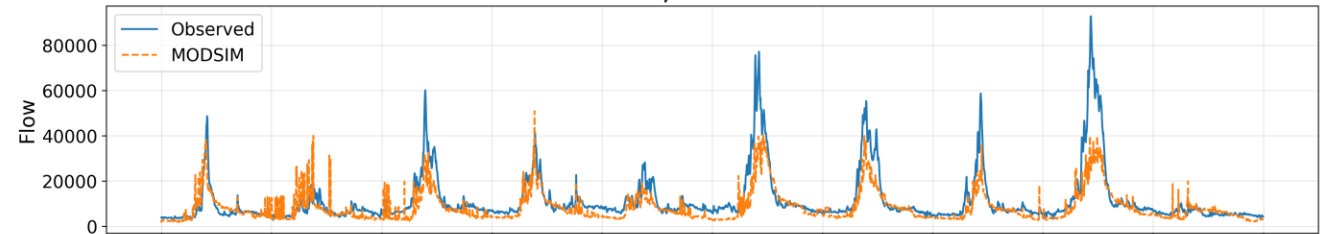
MODSIM + Reservoir Operations show improvements compared to the NHM-PRMS model with HRU parameters calibration

Performance is close to the NHM-PRMS fully calibrated with gage observations

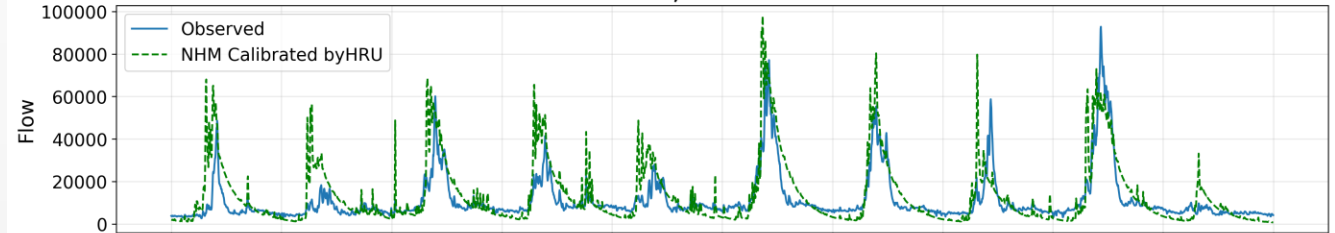
More testing and calibration to improve the (WMM) performance

Watershed Outlet Gage: 09163500

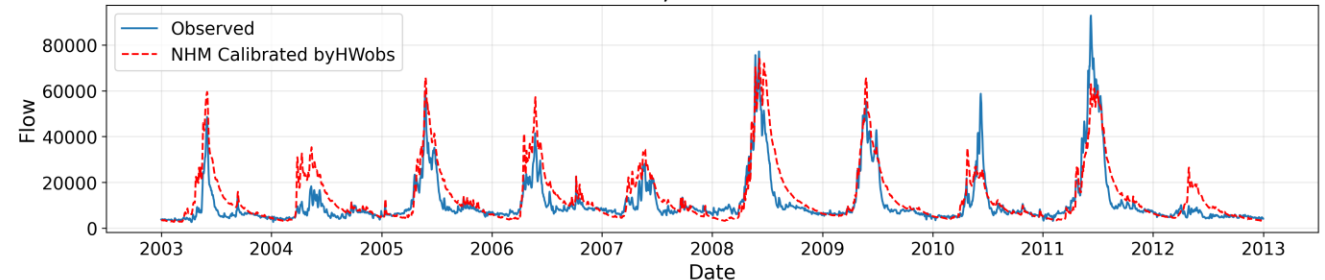
MODSIM Reservoir/Routing
NSE=0.57, RMSE=7450.42



NHM-Calibrated (byHRU)
NSE=0.31, RMSE=9443.65

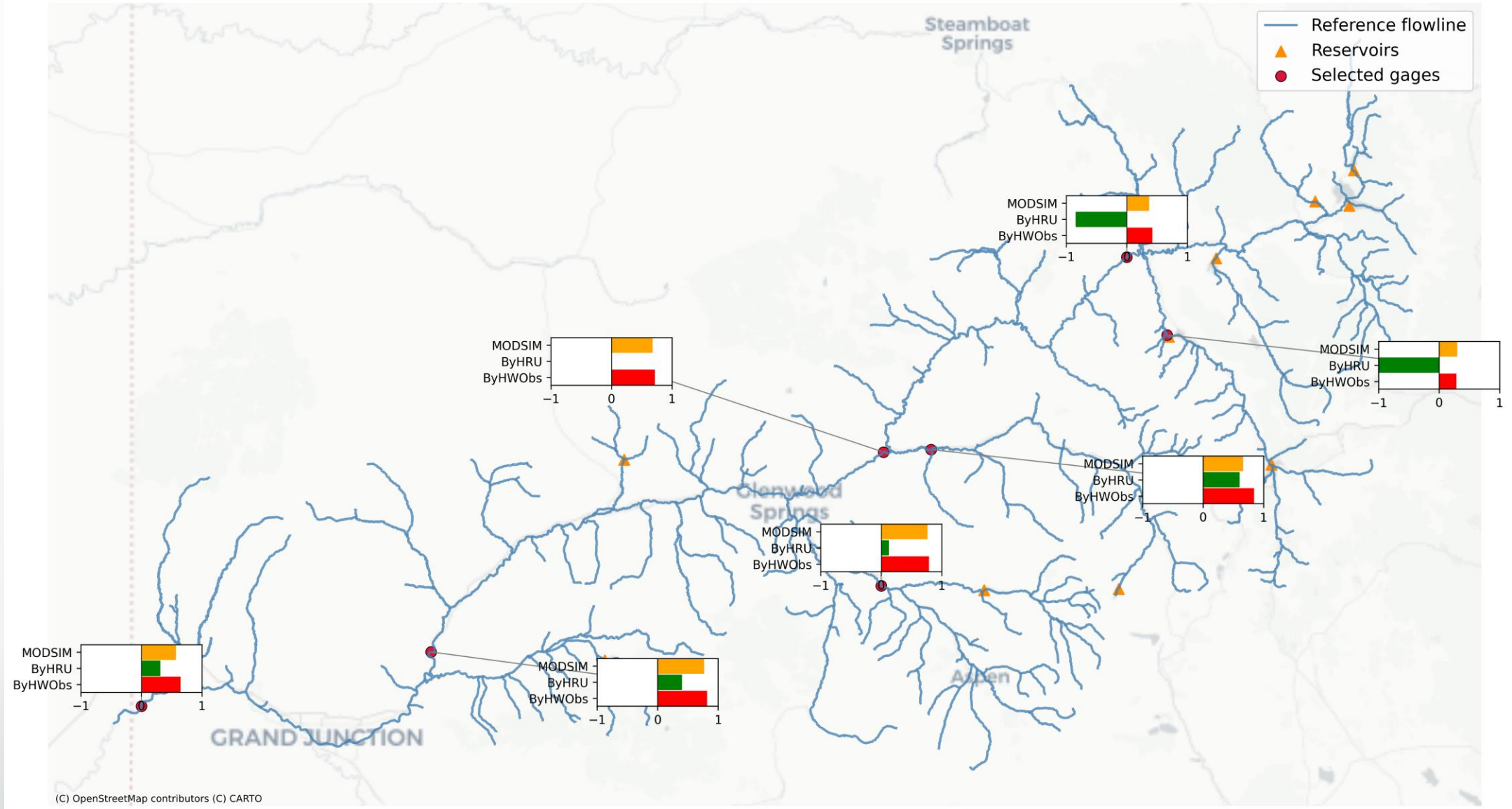


NHM-Calibrated (byHWobs)
NSE=0.65, RMSE=6749.89



Coupled Model: Initial Results

Gage-level Performance of MODSIM and NHM models



Identified Challenges and Remaining Limitations

Data Heterogeneity Across States

- Water management data are maintained by multiple agencies
- Cross-state integration required extensive harmonization workflows

Incomplete and Inconsistent Metadata

- Many diversion records lacked:
 - persistent identifiers
 - consistent stream naming
- This required heuristic fallback approaches during spatial linkage.

Conclusions

Developed scalable Extended Hydrofabric framework

Standardized integration of water management infrastructure

Demonstrated MODSIM construction

Piloting a WMM and hydrologic model coupling

Established foundation for coupled hydrologic-management modeling across CONUS



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Thank You

Questions?



Open Access
Publication



Data Product

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