Identifying anthropogenic and natural controls on groundwater return flows in a highly managed irrigated river basin

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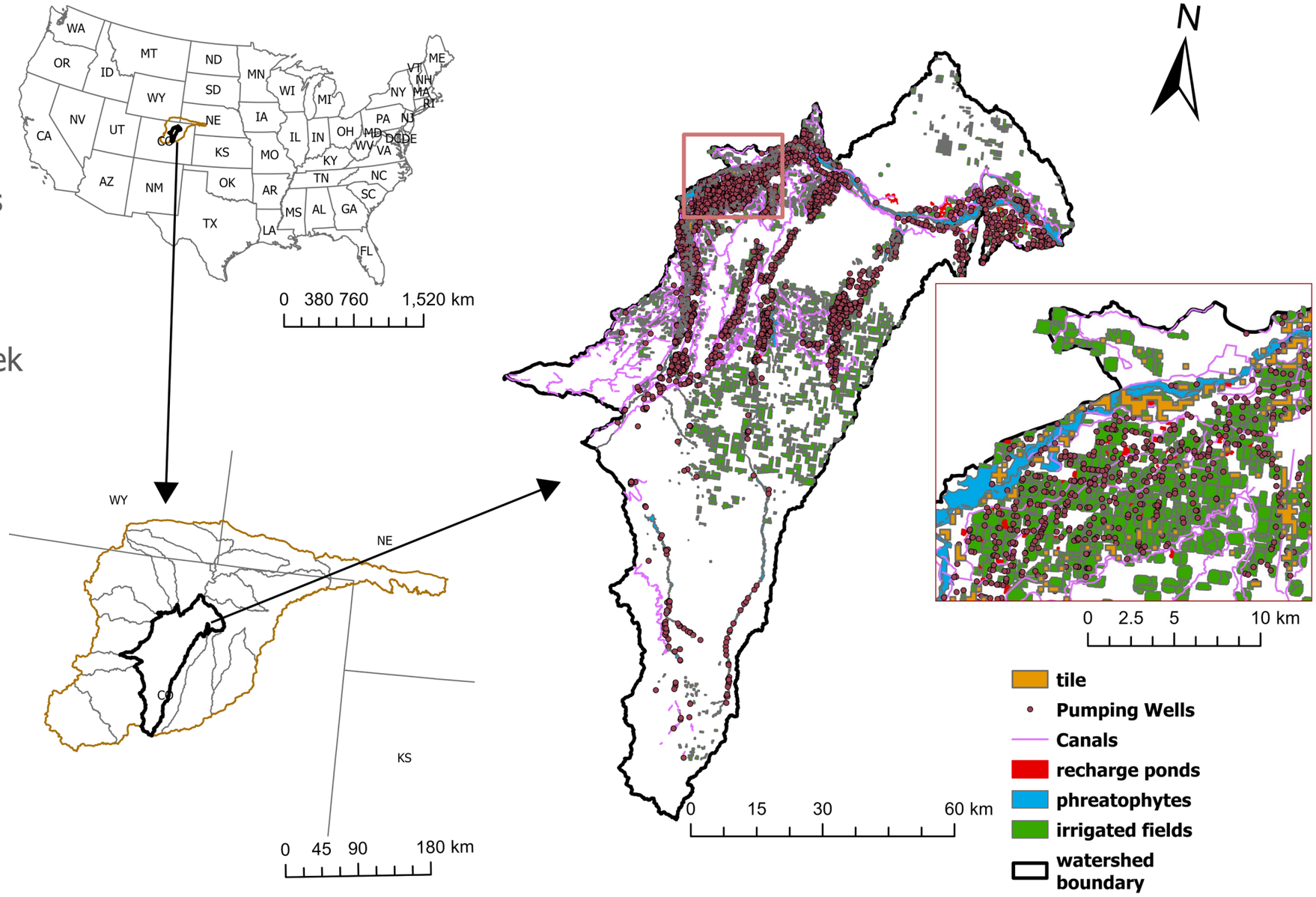
Background

- South Platte Basin spans across Colorado, Wyoming, and Nebraska.
- South Platte Middle Cherry Creek watershed highly managed and irrigated.
- 7440 km^2 area.
- Includes the urban areas of Denver and downstream agricultural areas



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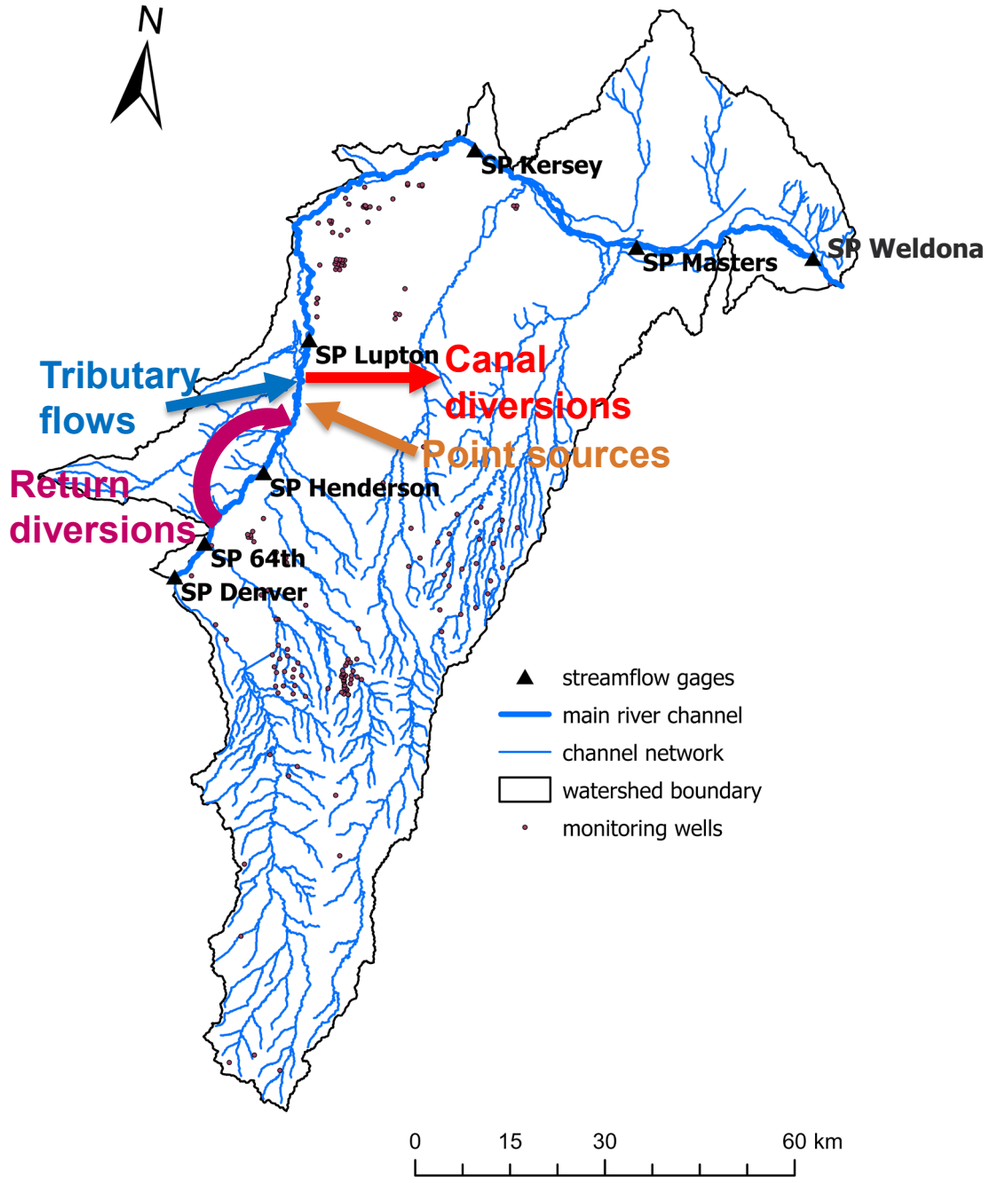
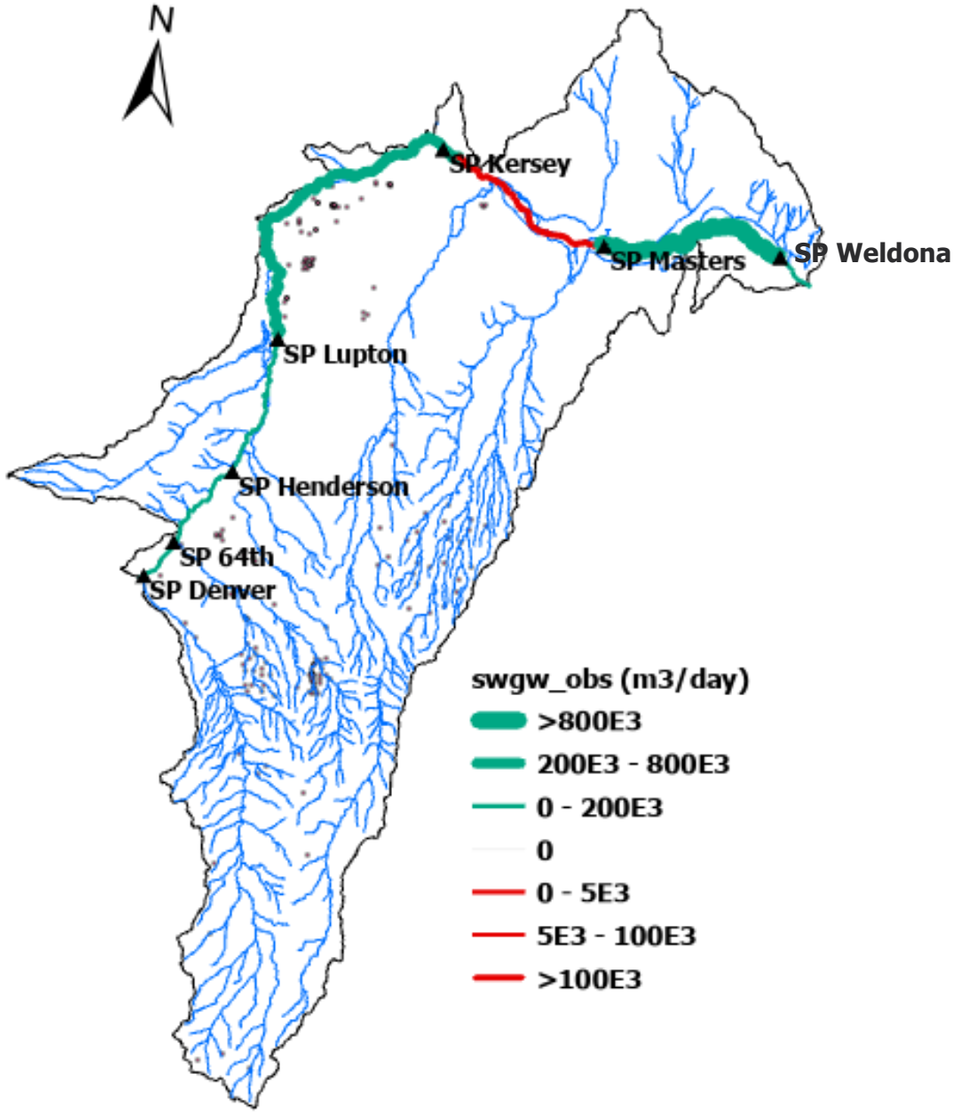
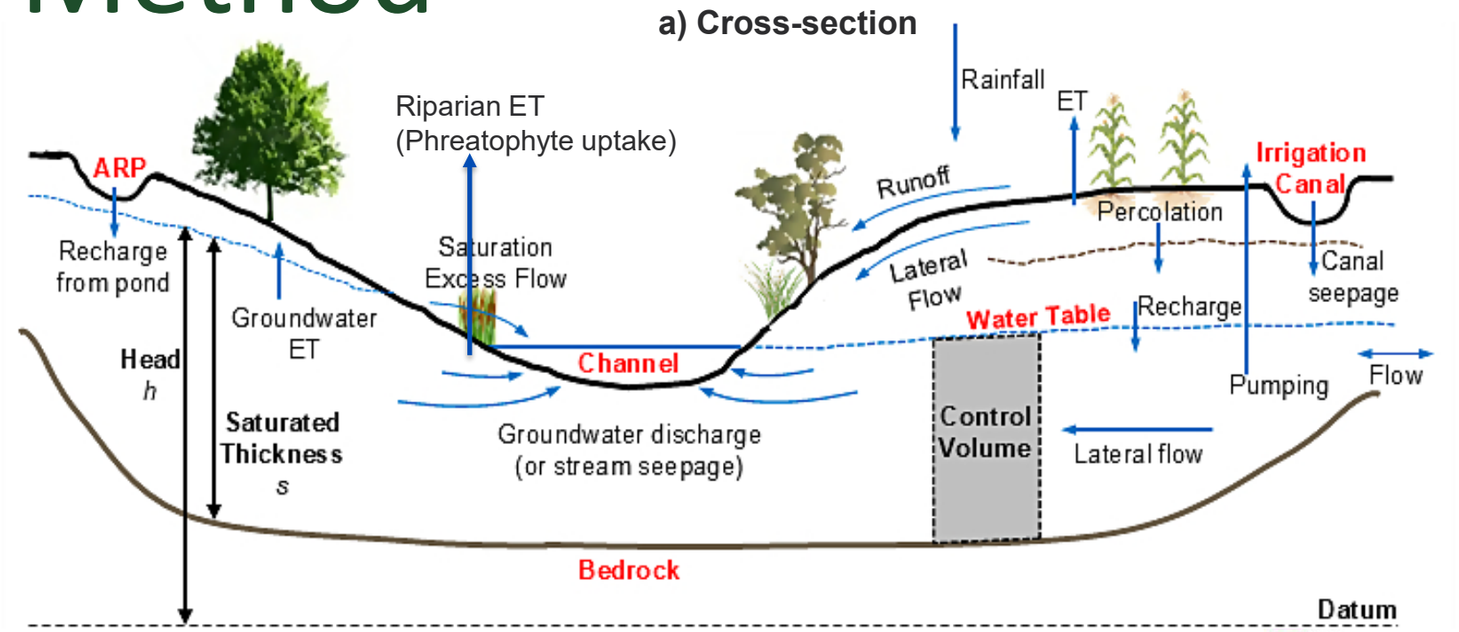

N
SP Kersey
SP Masters
SP Weldona
SP Lupton
SP Henderson
SP 64th
SP Denver
Tributary flows
Canal diversions
Point sources
Return diversions
streamflow gages
main river channel
channel network
watershed boundary
monitoring wells
0
15
30
60 km

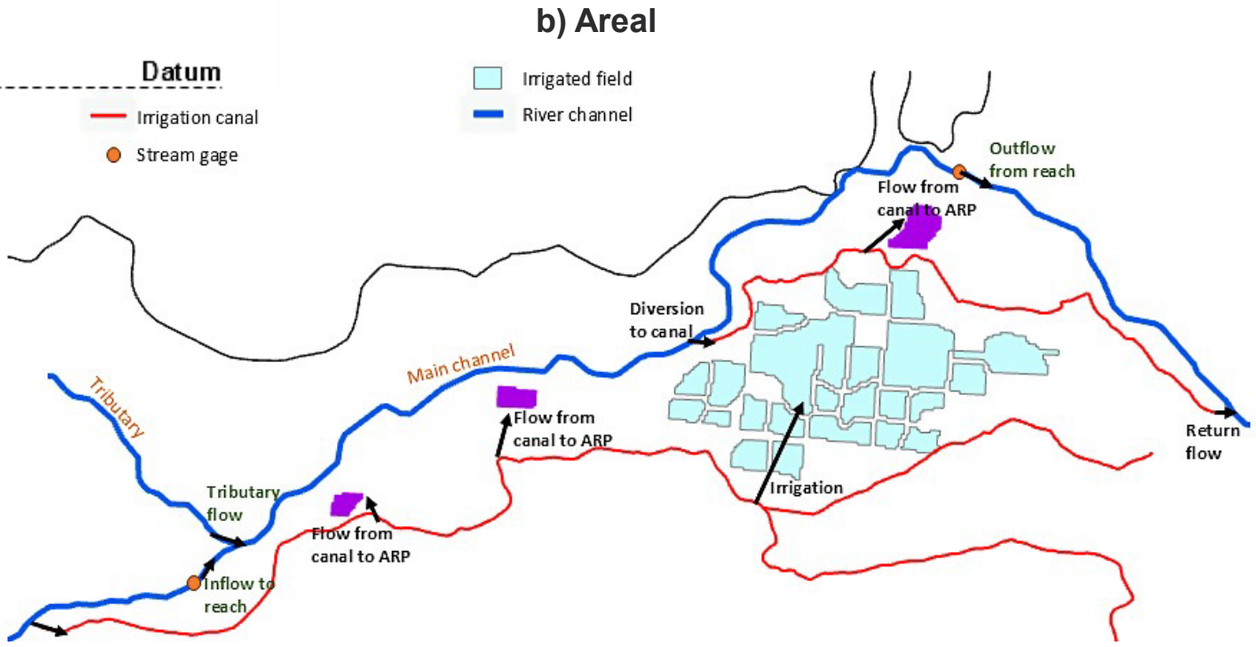

N
SP Kersey
SP Masters
SP Weldona
SP Lupton
SP Henderson
SP 64th
SP Denver
swgw_obs (m3/day)
>800E3
200E3 - 800E3
0 - 200E3
0
0 - 5E3
5E3 - 100E3
>100E3

Objective

- To comprehensively simulate all major hydrologic fluxes in a highly managed semi-arid river basin, and account for the drivers of groundwater-channel exchanges

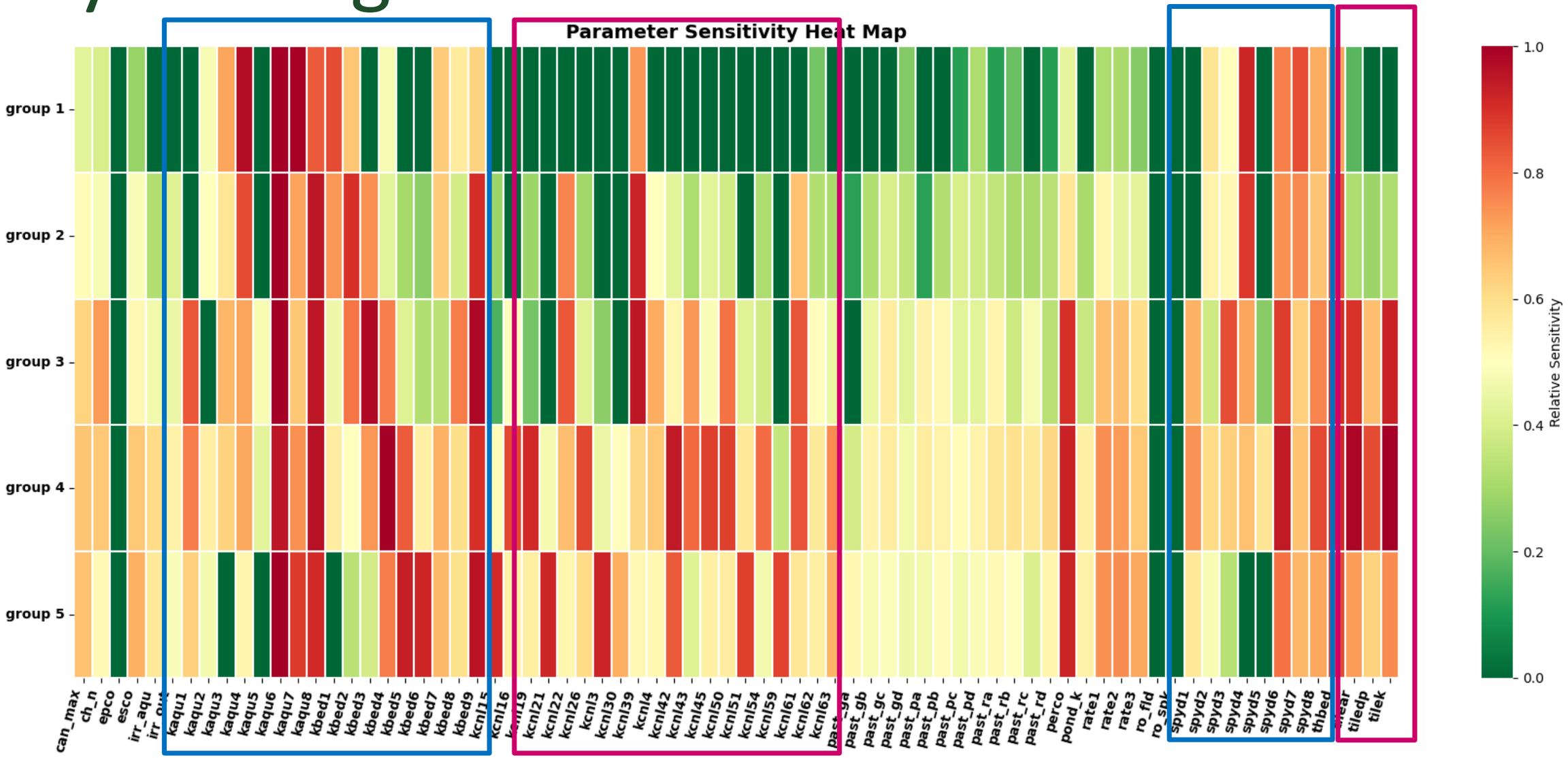
Method



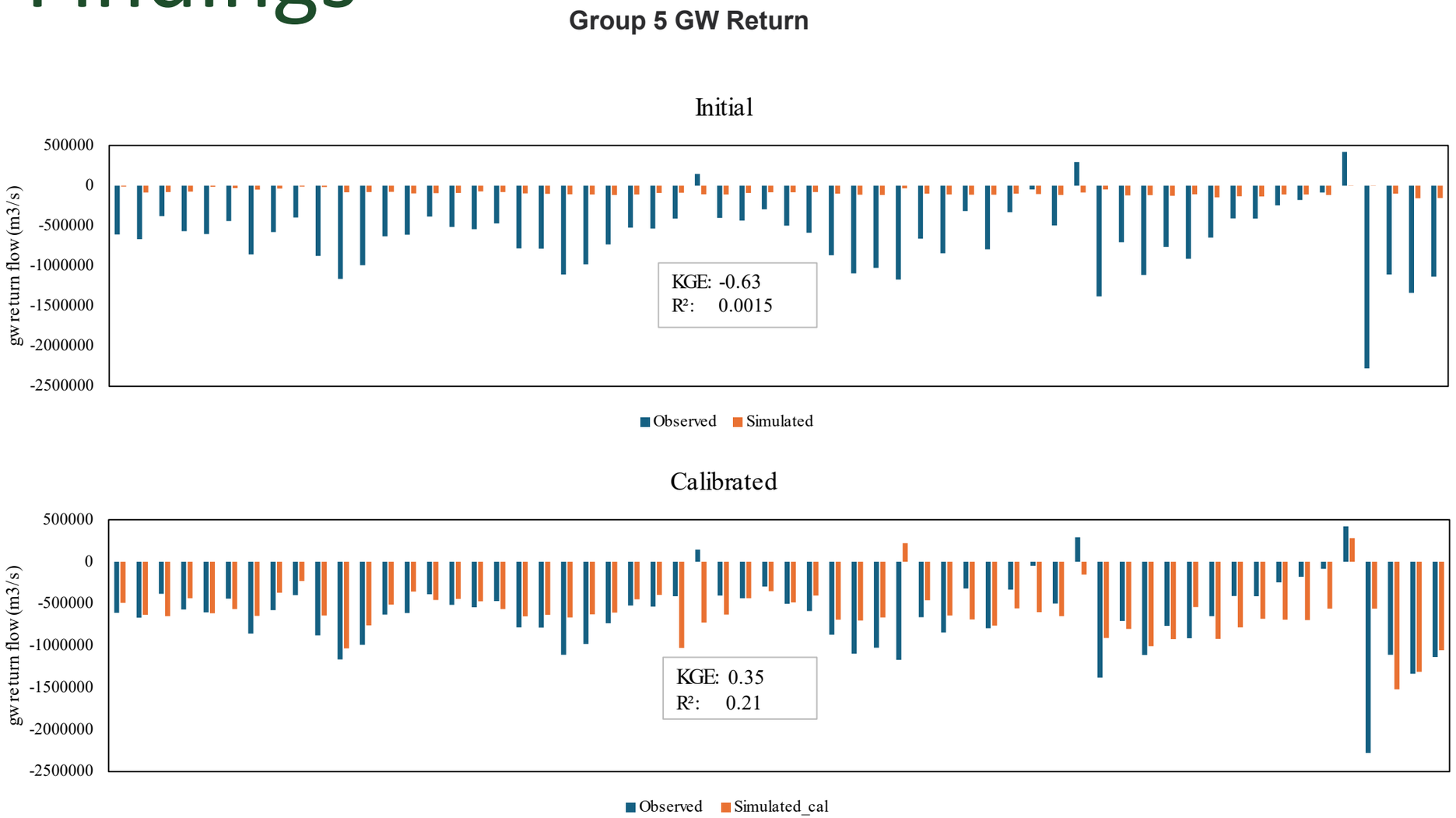


- The SWAT+gwflow was run for the South Platte Middle Cherry Creek watershed from 2011 to 2015 using gw head observations for 2011 as initial conditions.
- Observed streamflow data for upstream watersheds incorporated in model
- Daily timestep
- Calibrated with groundwater resturn observations from 2011 to 2015

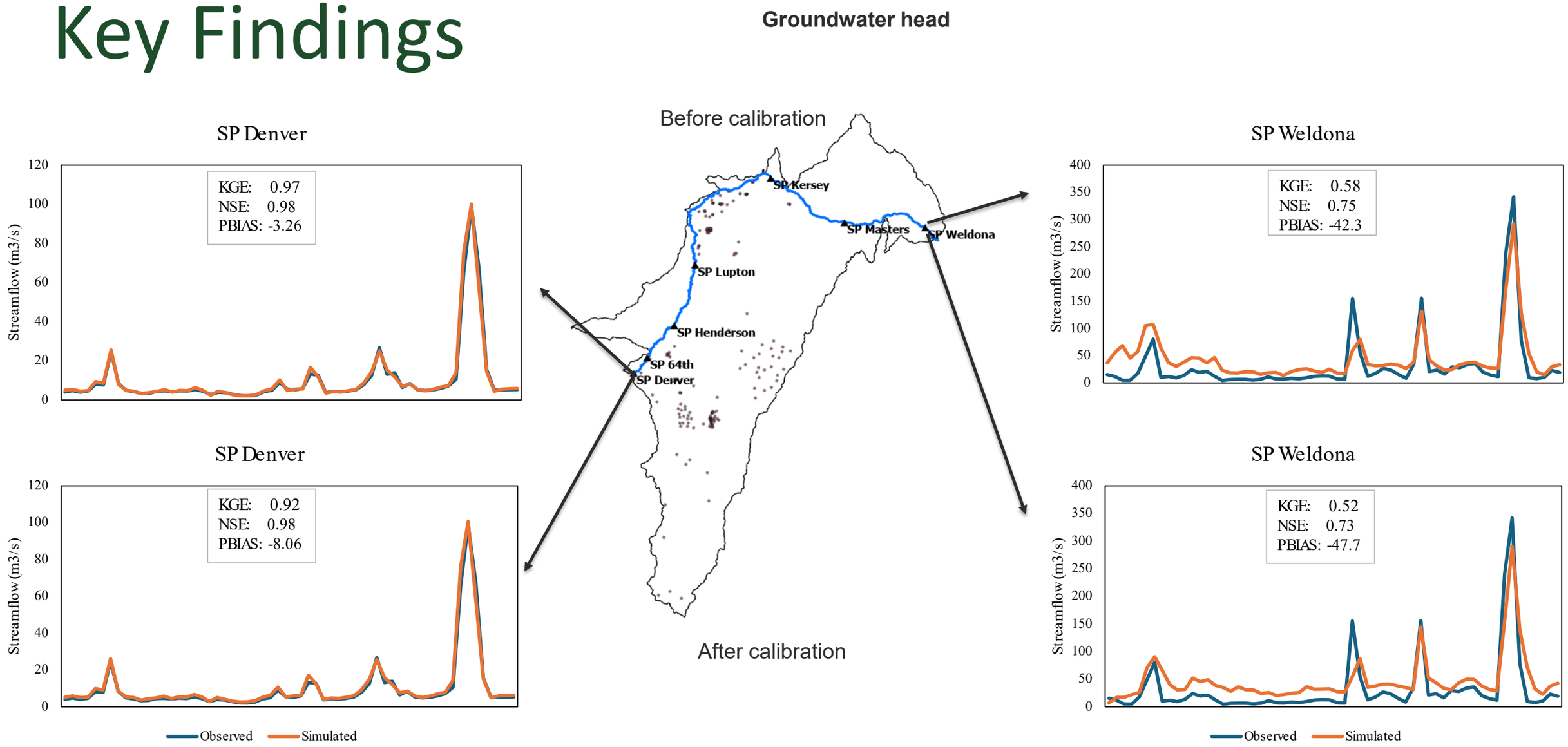
Key Findings



Key Findings



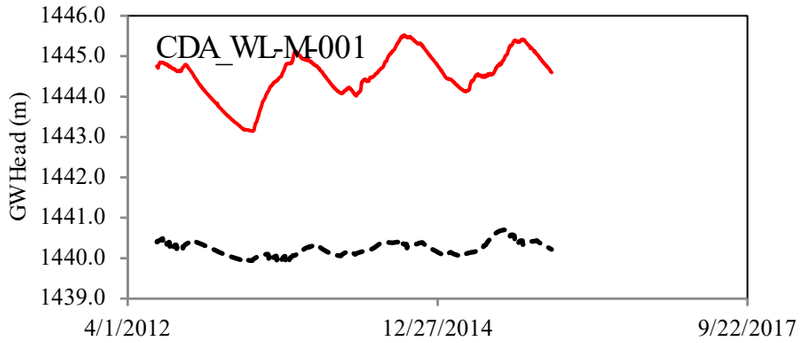
Key Findings

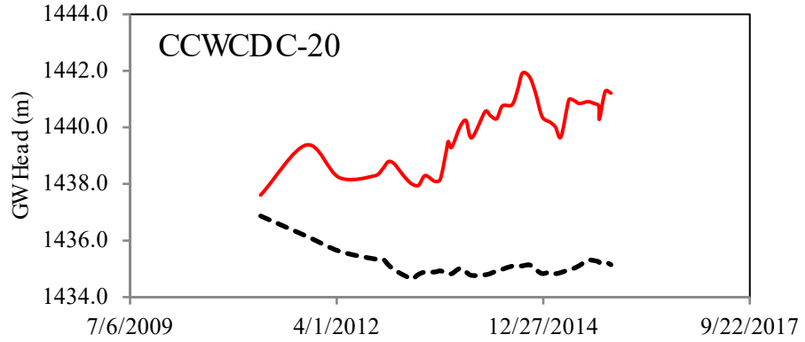


Key Findings

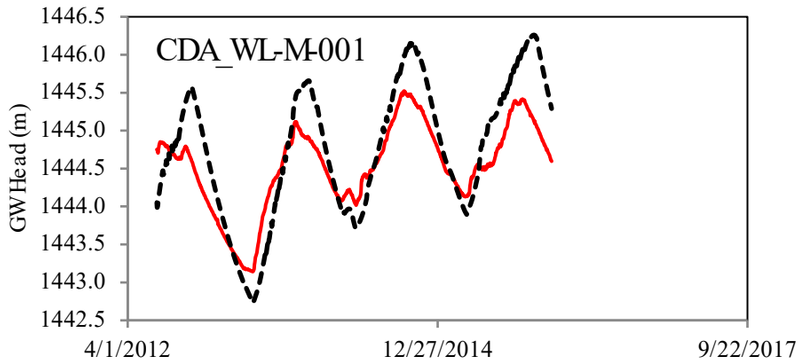
Groundwater head

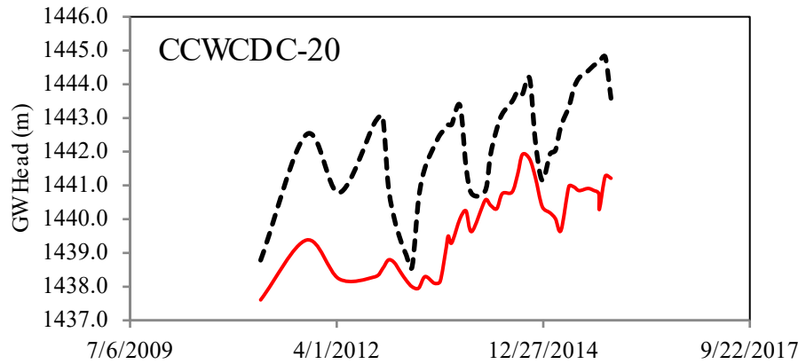
Before calibration





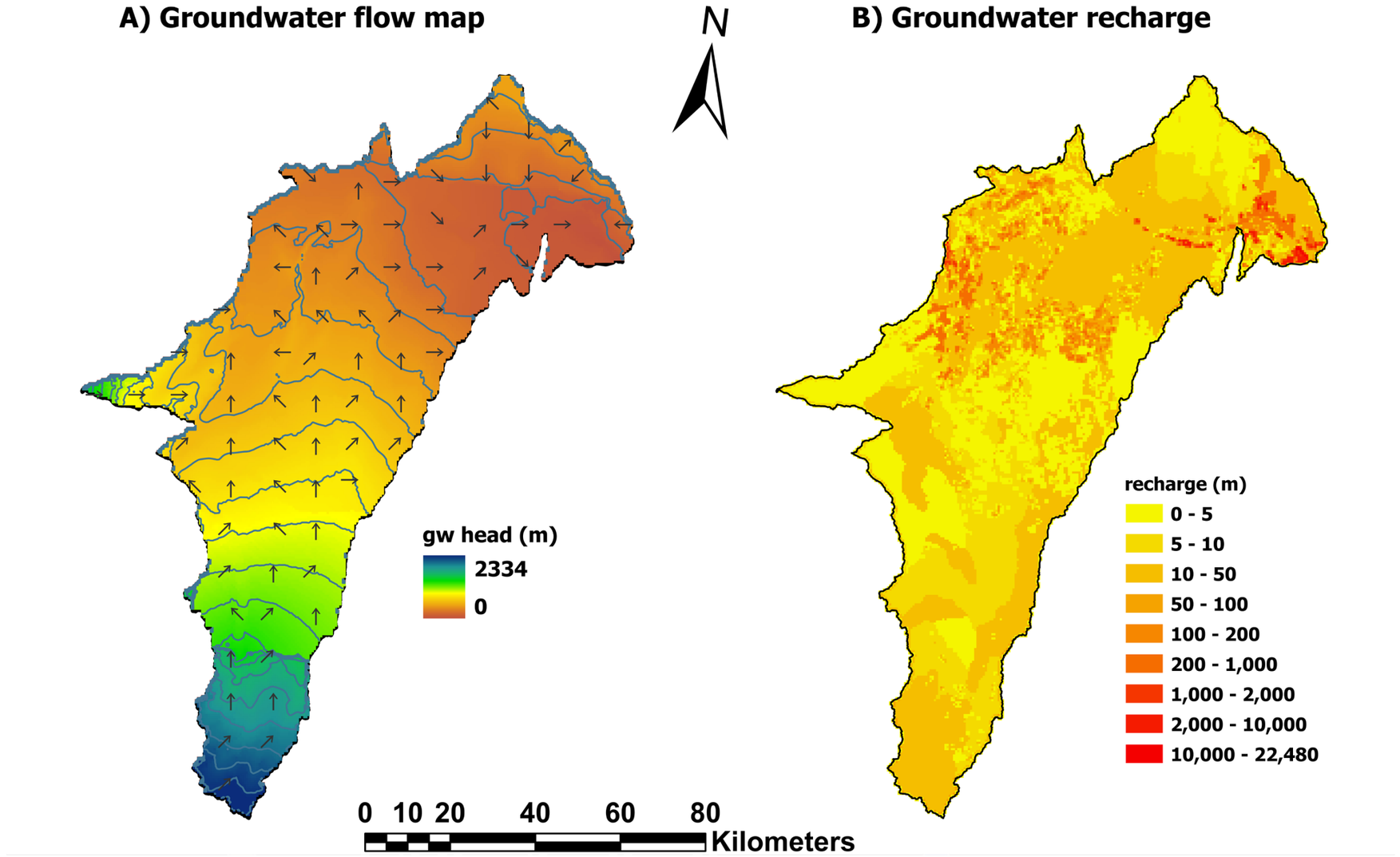
After calibration





simulated **observed**

Key Findings



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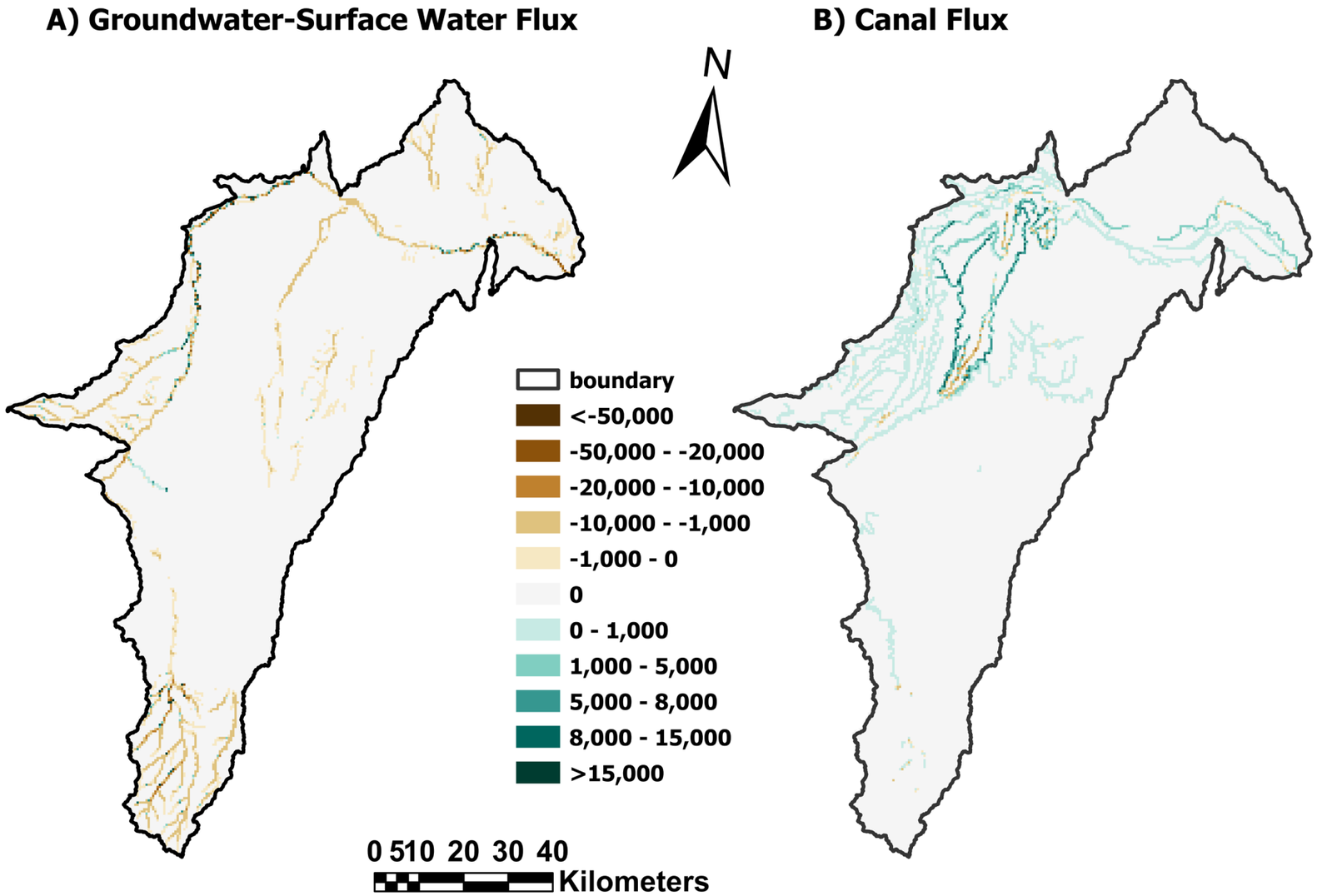

Conclusions

- Results demonstrate that incorporating groundwater return flow observations significantly improves model performance and confidence in water balance estimates.
- Aquifer properties (natural controls) largely drive groundwater return flow in upstream sections of the watershed, while both aquifer properties and anthropogenic activities (irrigation, canal seepage, etc.) control at downstream sections.
- Findings highlight the importance of multi-objective calibration and provide a framework for improving surface–subsurface water management in irrigated regions.

Next Steps

- Perform further analyses on recharge ponds, phreatophytes, tile drainage, groundwater transit times, etc.
- Determine controls or drivers of streamflow.
- Do field-scale analyses of simulated ET vs ET estimates.
- Run scenarios to assess how various management practices affect groundwater return flow.

THANK YOU