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A Tale of Two Models: Projecting Water Scarcity for the Colorado River Basin

Nicole D. Jackson

American Geophysical Union – 2021 Fall Meeting

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U.S. DEPARTMENT OF ENERGY | NNSA

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Water scarcity is a growing concern globally that depends on multiple considerations and may evolve across scales

Agricultural Water Management
Volume 77, Issues 1–3, 22 August 2005, Pages 4-20

Multi-scale modeling for water resources planning and management in rural basins

F.B. Victoria [a], J.S. Viegas Filho [b], L.S. Pereira [c], J.L. Teixeira [c], A.E. Lanna [d]

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ENVIRONMENTAL RESEARCH LETTERS

OPEN ACCESS

Hydro-climatic trends and water resource management implications based on multi-scale data for the Lake Victoria region, Kenya

A J Koutsouris[1], G Destouni[1], J Jarsjö[1] and S W Lyon

Published 6 August 2010 • Published under licence by IOP Publishing Ltd
Environmental Research Letters, Volume 5, Number 3
Citation A J Koutsouris *et al* 2010 *Environ. Res. Lett.* **5** 034005

Applied Geography
Volume 31, Issue 1, January 2011, Pages 321-328

Scale invariance of water stress and scarcity indicators: Facilitating cross-scale comparisons of water resources vulnerability

Shama Perveen [a], L. Allan James [b, 1]

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Environmental Modelling & Software
Volume 59, September 2014, Pages 98-108

Featured Article

An operational, multi-scale, multi-model system for consensus-based, integrated water management and policy analysis: The Netherlands Hydrological Instrument

Willem J. De Lange [a], Geert F. Prinsen [a], Jacco C. Hoogewoud [a], Albert A. Veldhuizen [b], Jarno Verkaik [a], Gualbert H.P. Oude Essink [a], Paul E.V. van Walsum [b], Joost R. Delsman [a, d], Joachim C. Hunink [a], Harry Th.L. Massop [b], Timo Kroon [c]

Current Opinion in Environmental Sustainability
Volume 40, October 2019, Pages 72-80

A nexus modeling framework for assessing water scarcity solutions

Taher Kahil [1], Jose Albiac [2], Guenther Fischer [1], Maryna Strokal [3], Sylvia Tramberend [1], Peter Greve [1], Ting Tang [1], Peter Burek [1], Robert Burtscher [1], Yoshihide Wada [1]

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https://doi.org/10.1016/j.cosust.2019.09.009

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Article | Open Access | Published: 26 March 2021

Evaluating the economic impact of water scarcity in a changing world

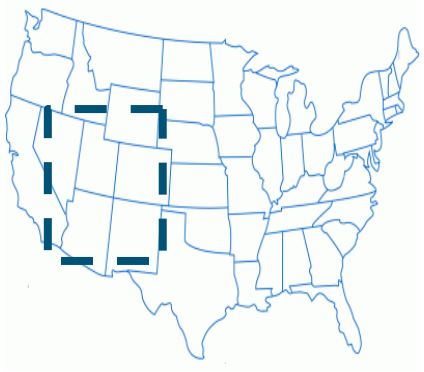
Flannery Dolan, Jonathan Lamontagne, Robert Link, Mohamad Hejazi, Patrick Reed & Jae Edmonds

Nature Communications **12**, Article number: 1915 (2021) | Cite this article

The United States' Colorado River Basin (CRB) is a critical water resource that is now requiring management action

CRB by the numbers

- Spans 7 states
- Provides water to over 40 MM people
- Irrigates 5.5 million acres of land
- Critical water resource for:
  - >22 federally recognized tribes
  - 7 National Wildlife Refuges
  - 4 National Recreation Areas
  - 11 National Parks



Hoover Dam

Ethan Miller, Getty Images (2021)

CNN Weather Climate Storm Tracker Wildfire Tracker Video LIVE TV Edition

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Alicia Keys performs at Dubai Expo 2020

First-ever Colorado River water shortage is now almost certain, new projections show

By Pedram Javaheri and Drew Kann, CNN
Updated 2:47 PM ET, Thu May 27, 2021

npr

Amid A Megadrought, Federal Water Shortage Limits Loom For The Colorado River

CPR News

COVID-19 POLITICS MONEY ARTS ENVIRONMENT SCHEDULE SUPPORT CPR

The First-Ever Colorado River Water Shortage Has Been Declared. What Does That Mean For Colorado?

By Michael Elizabeth Sakas | August 16, 2021

Climate. Justice. Solutions.

Grist

Mark Armao
Indigenous Affairs Fellow

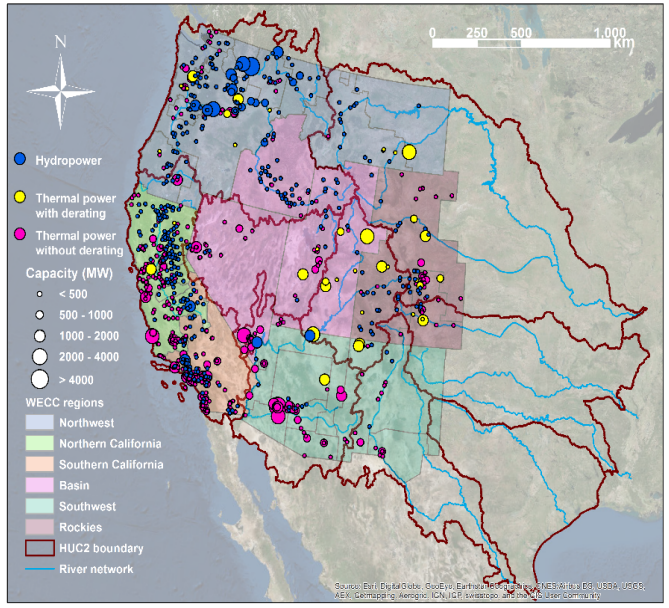
Published Oct 06, 2021

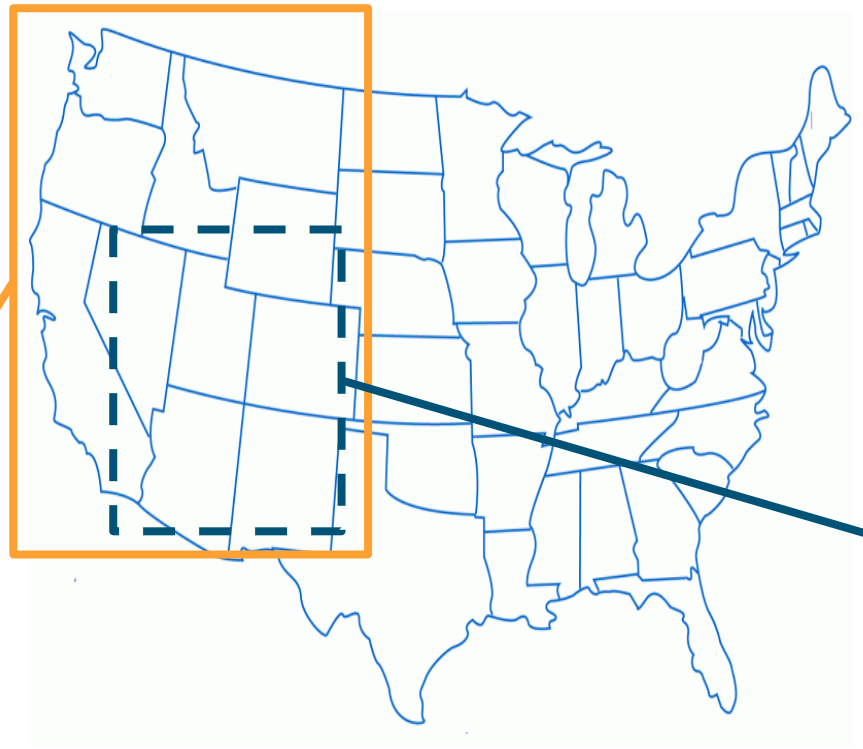
The Colorado River is drying up. Here's how that affects Indigenous water rights

"The basin is free-riding off of undeveloped tribal water rights."

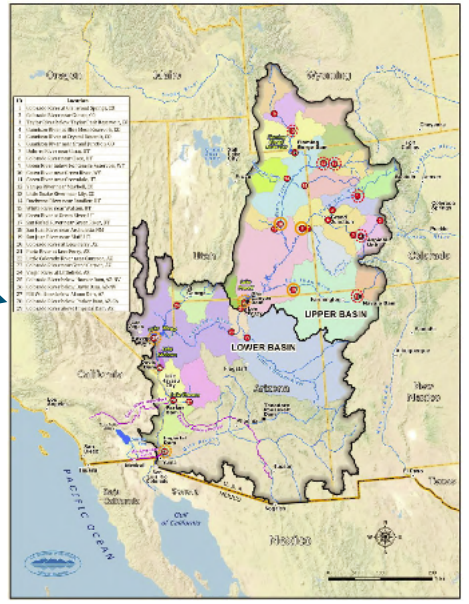
Western United States and the Colorado River basin are examplars for Integrated Multi-Sector, Multi-Scale Modeling (IM3)

Western Interconnect





Colorado River Basin

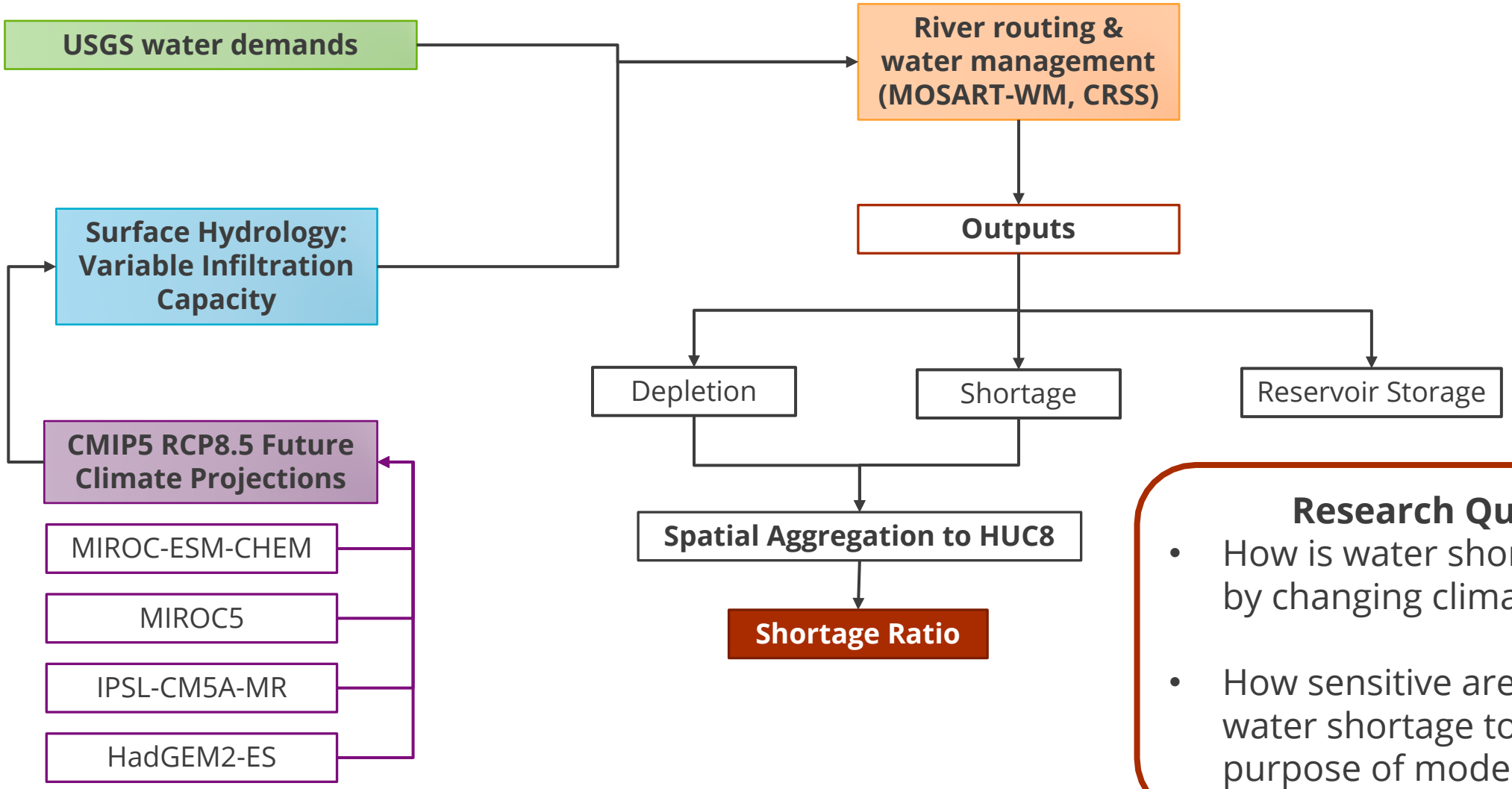


Research Model: MOSART-WM

Planning Model: CRSS (RiverWare)

Study Objective: Compare water shortage projections from different water management models

Common water demands, surface hydrology, and climate projections used across water management models

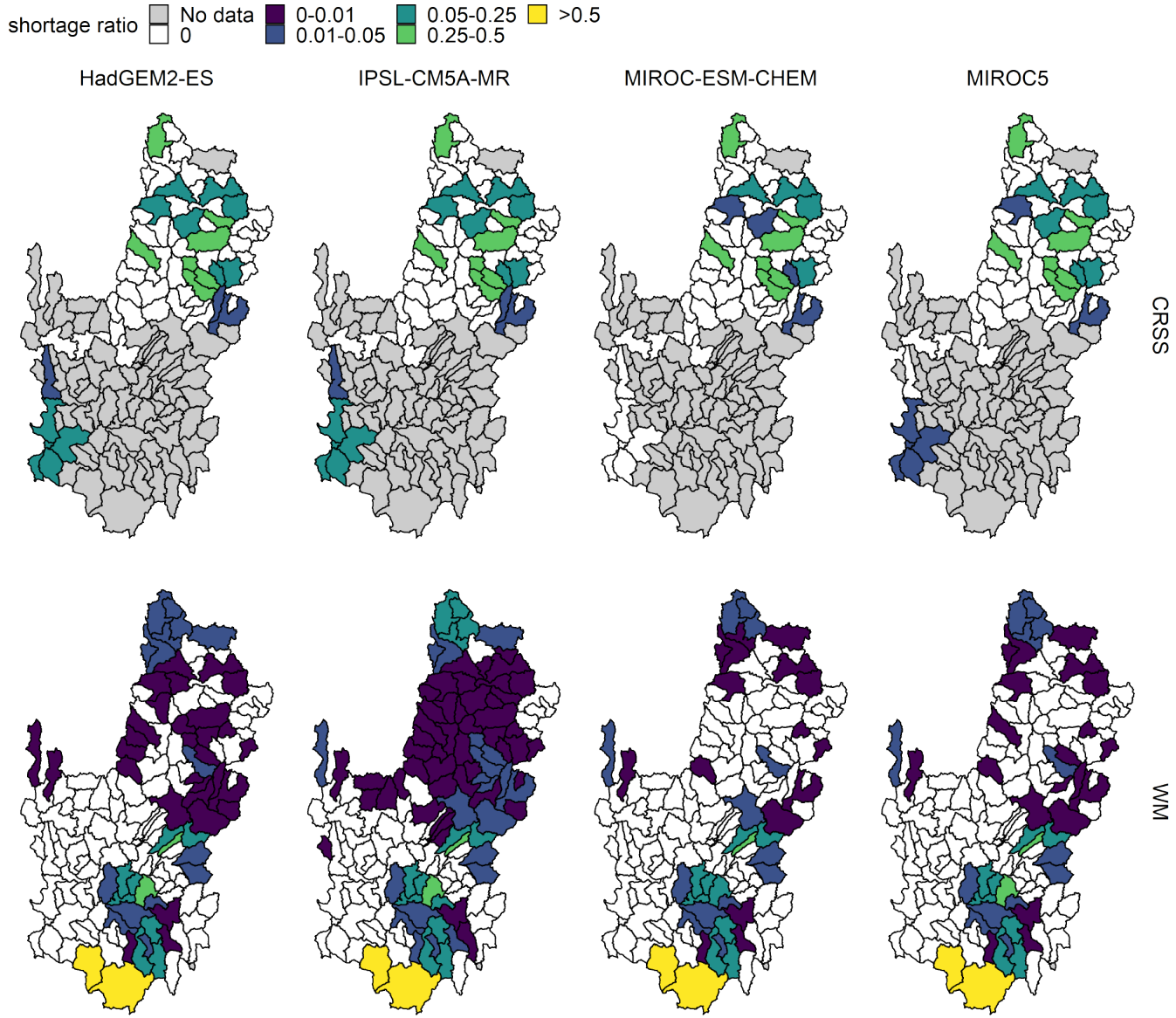


Research Questions:

- How is water shortage impacted by changing climate conditions?
- How sensitive are estimates of water shortage to the scale and purpose of model?

Projections of future water scarcity differ across climate scenarios and water management models

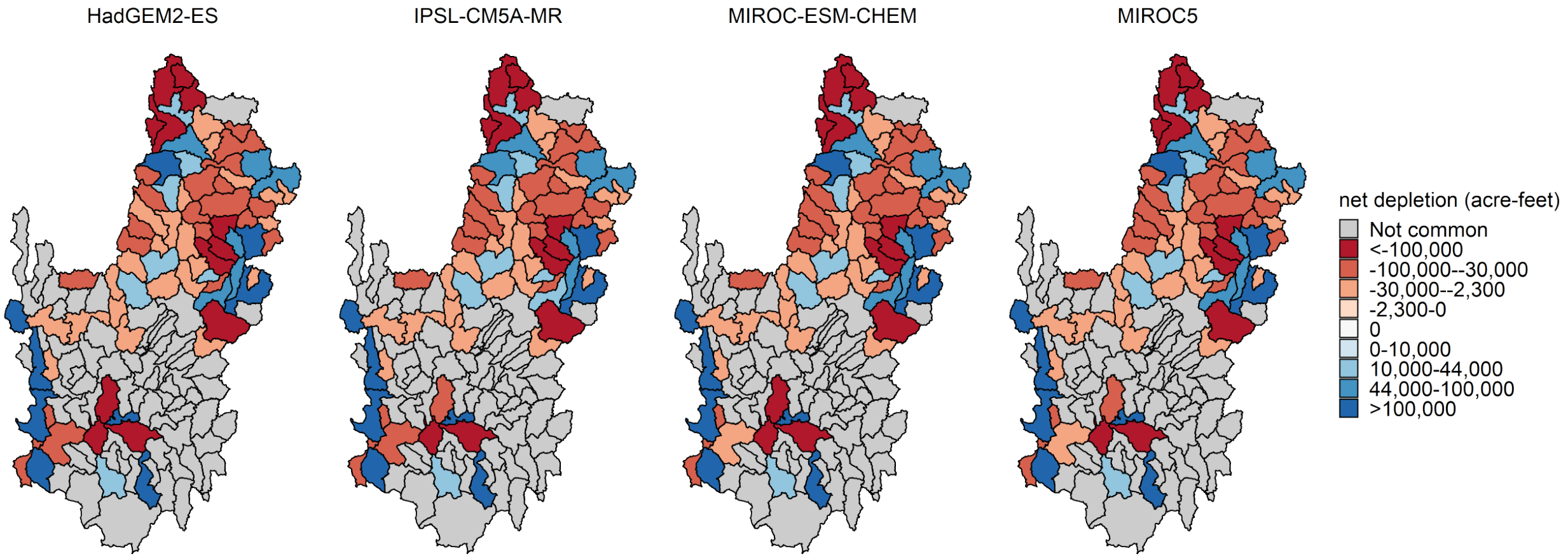
Observed spatial heterogeneity of projected mean water scarcity across climate and water management models



MOSART-WM and CRSS (RiverWare) are fundamentally different water management models

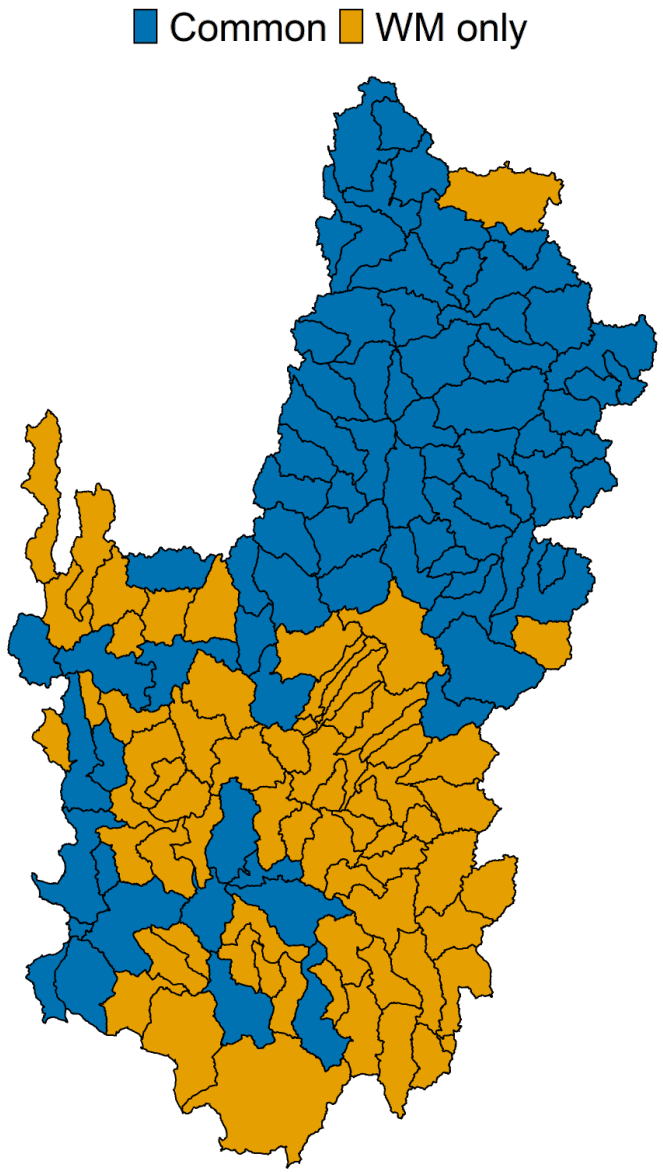
	CRSS (RiverWare)	MOSART-WM
Model Type	Planning	Research
Spatial extent	Colorado River Basin	Western US
Spatial representation	Nodes (users)	Gridded
Water rights	✓	✗
Inter-basin transfers	✓	✗
Reservoir storage	✓ (limited)	✓
Policy shortages	✓	✗

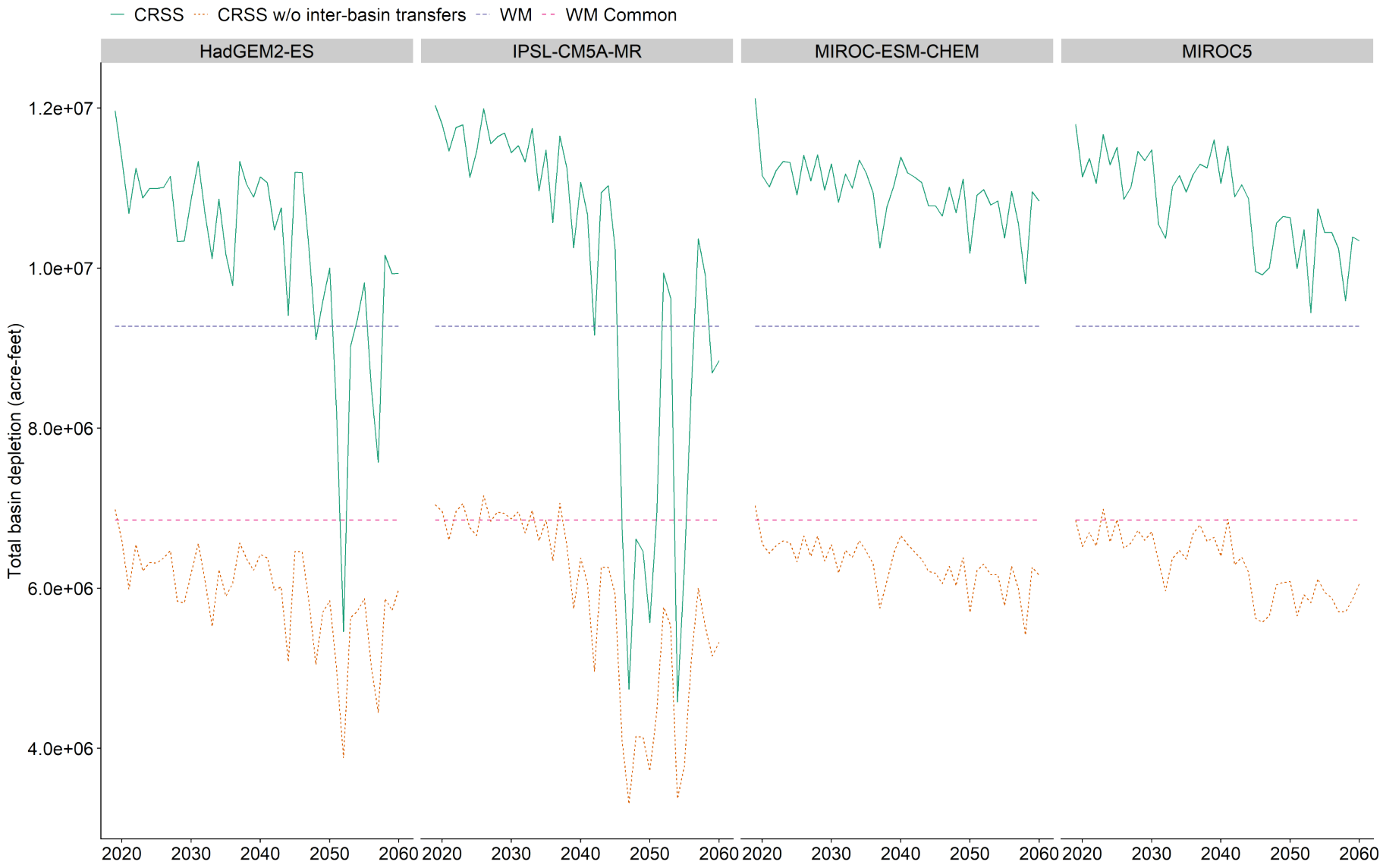
Difference in treatment of inter- and intra-basin transfers affect depletions throughout the basin



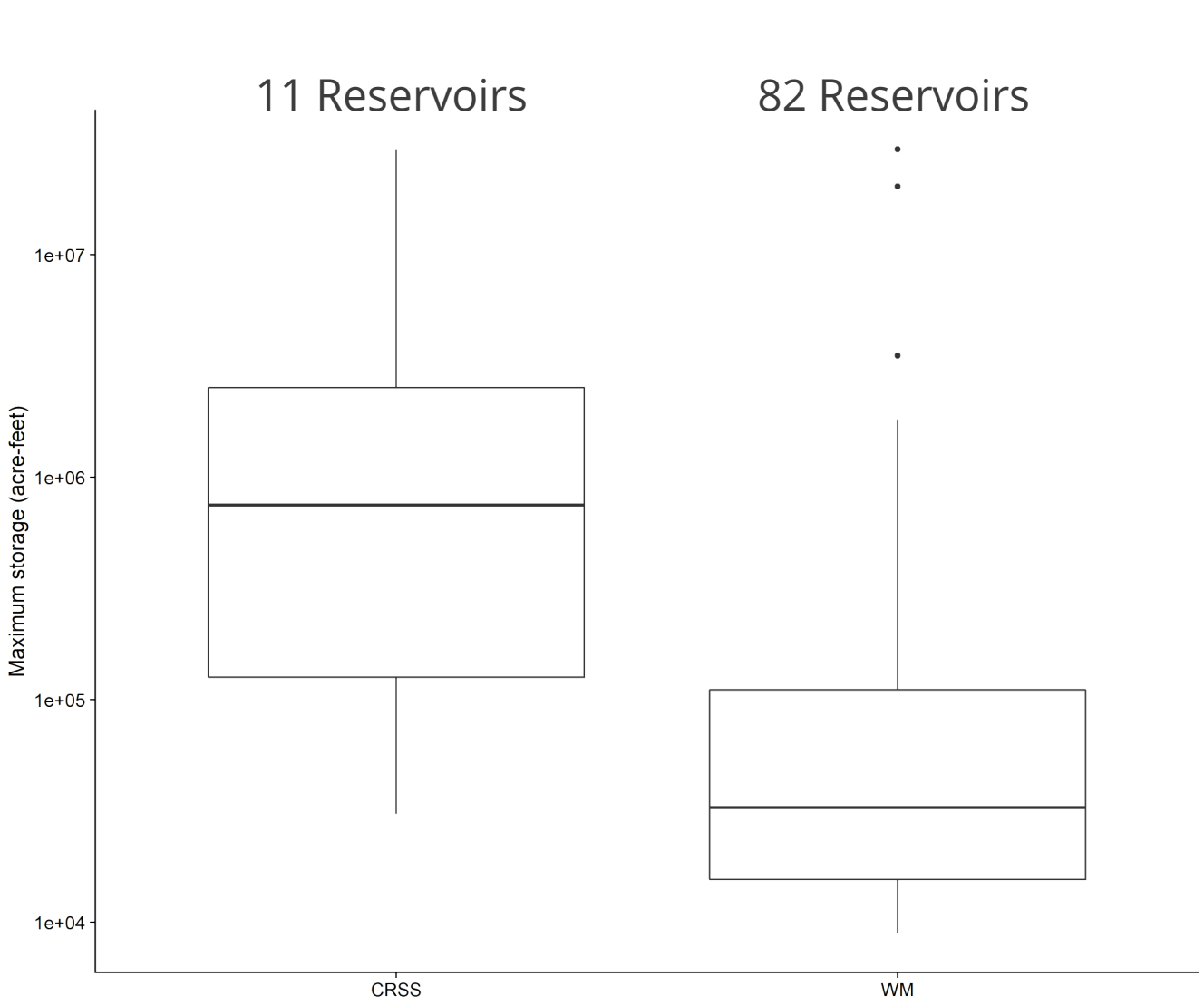
- Redder values: WM higher than CRSS
- Bluer values: CRSS higher than WM

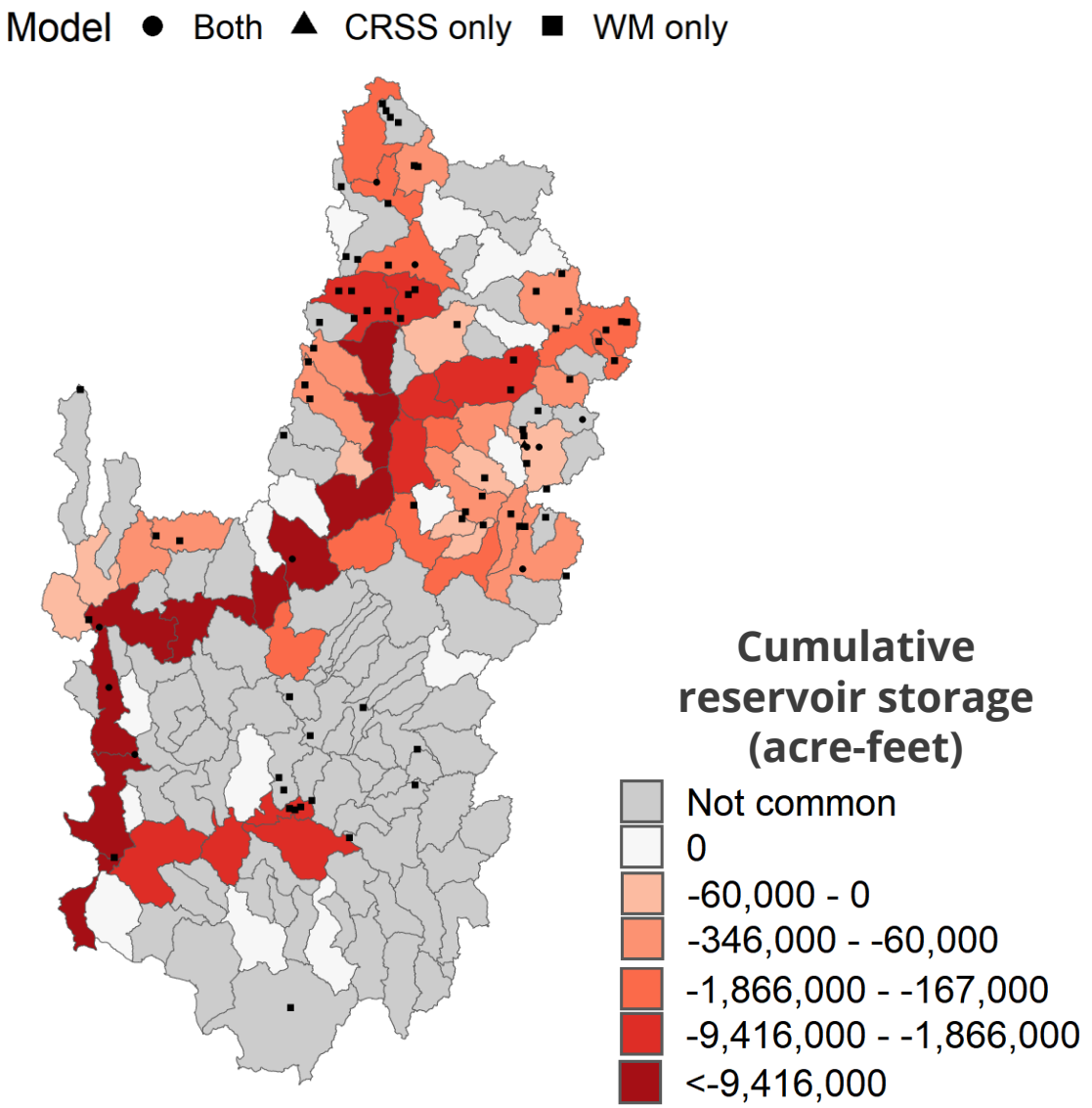
Model representation of the basin and inter-basin transfers affects the basin's depletions over time



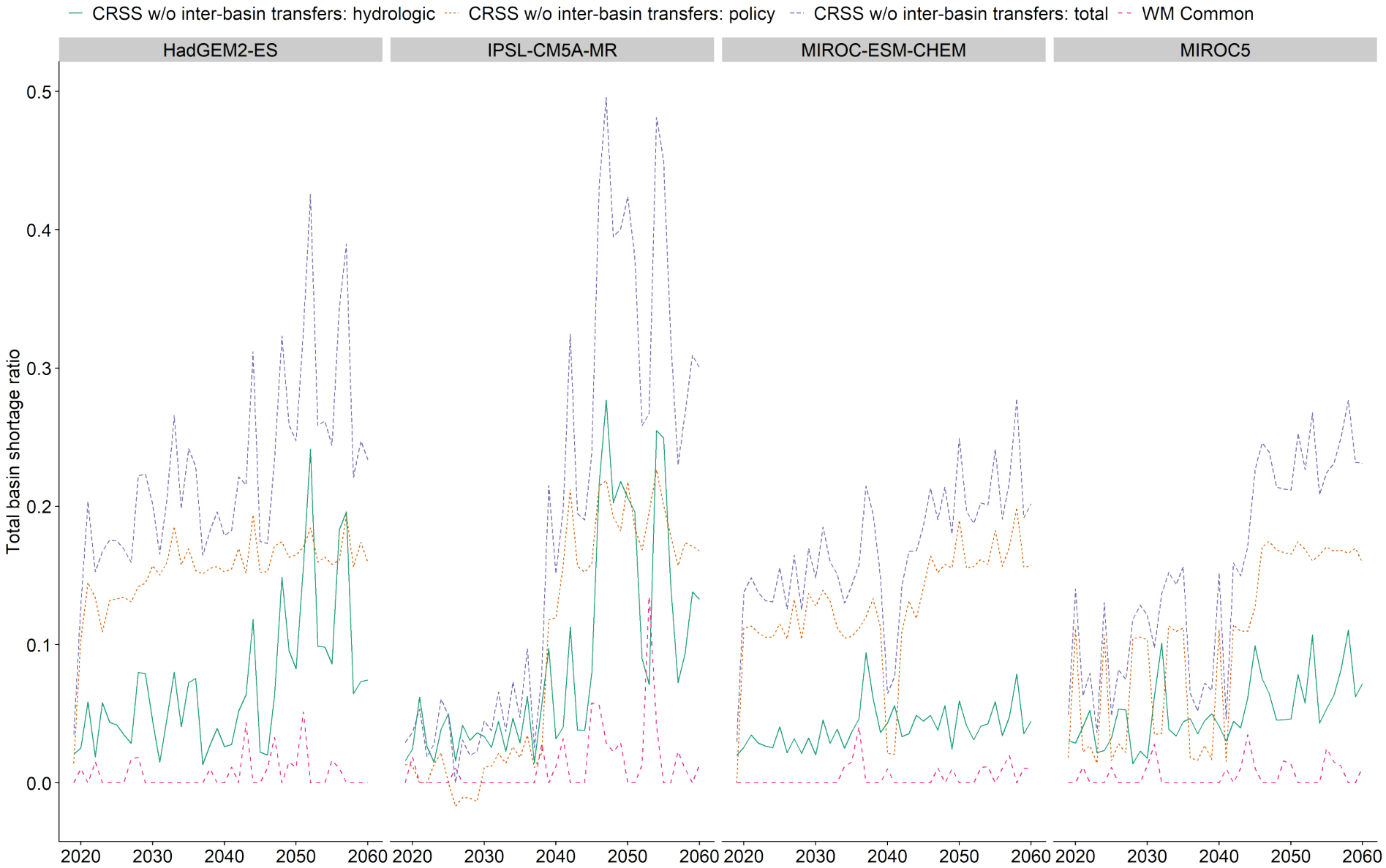


Key differences in number of reservoirs and available storage capacity between CRSS and WM





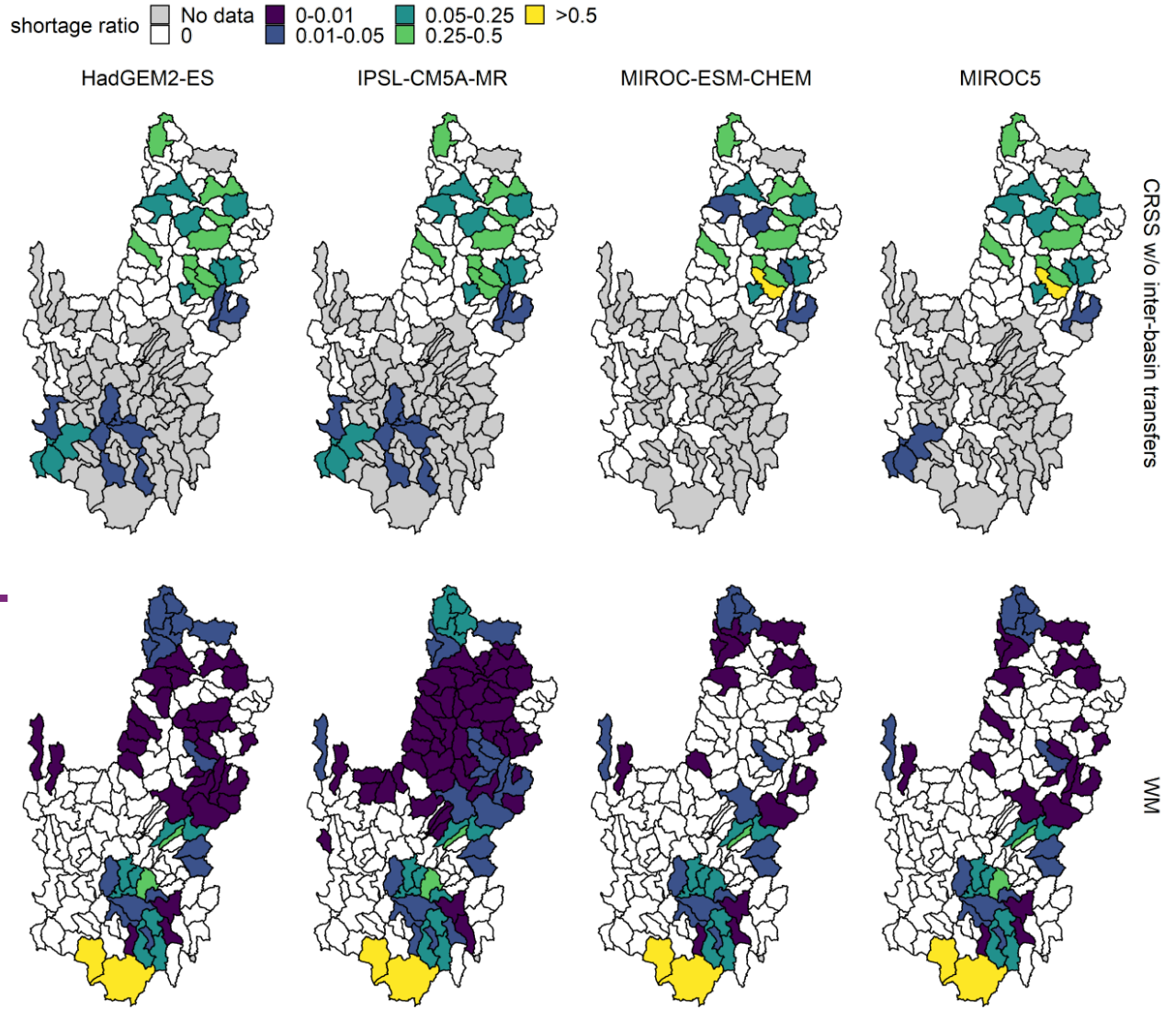
CRSS is not complete but does address nuances with the Colorado Compact and policy shortages



In conclusion, MOSART-WM and CRSS are fundamentally different water management models that yield different results

- Sources of differences
  - Basin representation
  - Operated reservoirs
  - Treatment of inter- and intra-basin transfers
- Be mindful of your study's goals

- On-going and future work directions
  - Couple surface-groundwater dynamics
  - Extend comparison to additional climate projections



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