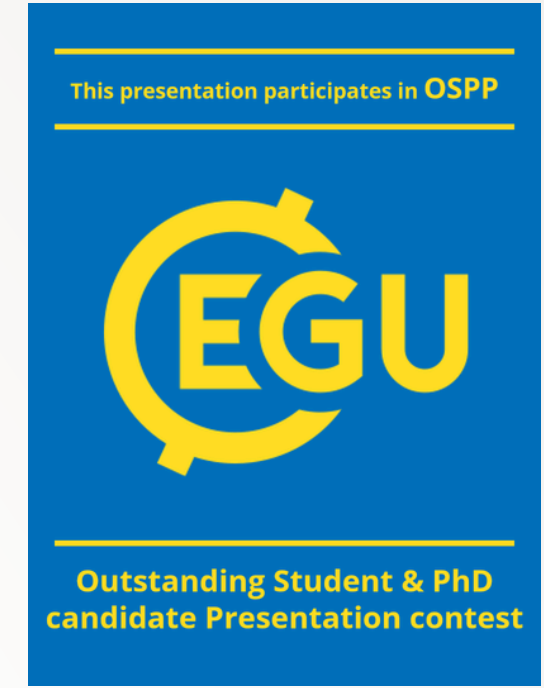
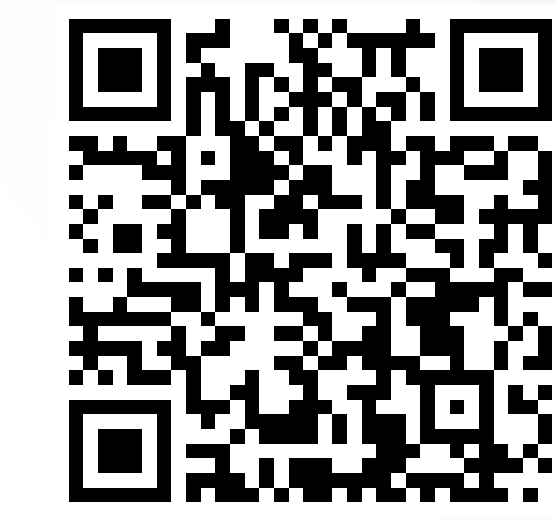


EGU26-15748 SPATIOTEMPORAL EVOLUTION OF FLOW DELCINE & WATER CONSUMPTION IN A HIGHLY REGULATED TRANSBOUNDARY RIVER: THE LOWER RIO GRANDE/BRAVO

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BACKGROUND & INTRODUCTION

The Lower Rio Grande/Bravo extends from below Falcon Dam to its mouth near Brownsville, Texas, and Matamoros, Mexico. **Starr, Hidalgo, Cameron, and Willacy counties** are collectively known as the **Lower Rio Grande Valley (LRGV)** on the U.S. side (Baker & Dale, 1961). This region is managed under the 1944 Water Treaty between U.S. and Mexico by the International Boundary and Water Commission (IBWC).

Challenges in the LRG

- Governance
- Damming
- Climate Change
- Agriculture
- Urbanization
- Population Growth

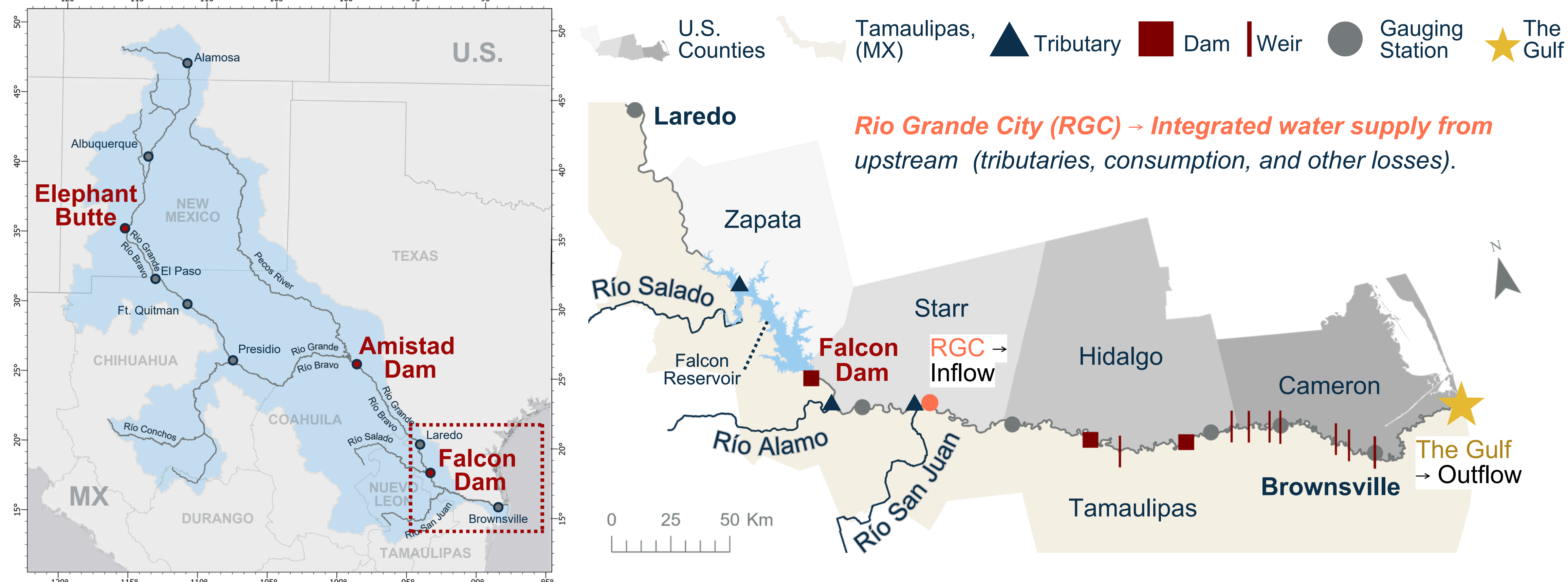
Scientific Gap

Water management is well documented (Fipps, 2001; USBR, 2013; Ewing & Gonzalez, 2016; TWDB, 2022). Yet, **lacks of a quantitative understanding of discharge evolution and water budget over the past century.**

Key Questions

- How current flows compare to near-natural conditions?
- How have water regulation under the Treaty and damming altered flow over time?
- How much change in flow is due to human activity?

STUDY AREA—The Lower Rio Grande Valley (LRGV)



METHODS—Water Mass Balance & Potential Water Savings

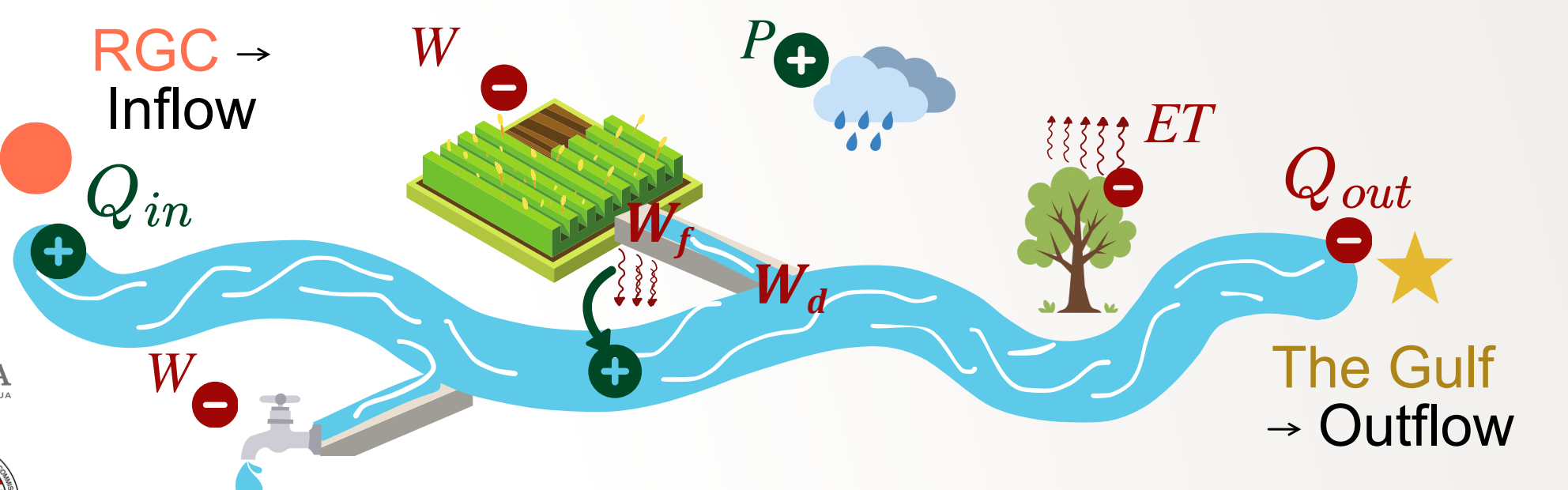
$$\Delta S = P - ET - Q - W \rightarrow \Delta S = Q_{in} - Q_{out} \rightarrow Q_{in} = Q_{out} + W_{binational} + R$$

ΔS = change in water storage, P = precipitation, ET = evapotranspiration, Q = inflow-outflow, W = human withdrawals, R = residual ($P, ET, seepage, groundwater, uncertainty$).

Conveyance efficiency values from binational irrigation systems provide potential water savings; we present: **(A) current** conveyance losses (median), **(B) moderately improved** conditions (Q75), and **(C) optimal** performance (max. observed efficiency):

$$E_c = \frac{W_f}{W_d} \rightarrow Loss = U_{irr} \left(\frac{1}{E} - 1 \right)$$

E_c = conveyance efficiency
 W_f = water delivered to field
 W_d = water diverted
 U_{irr} = irrigation withdrawals



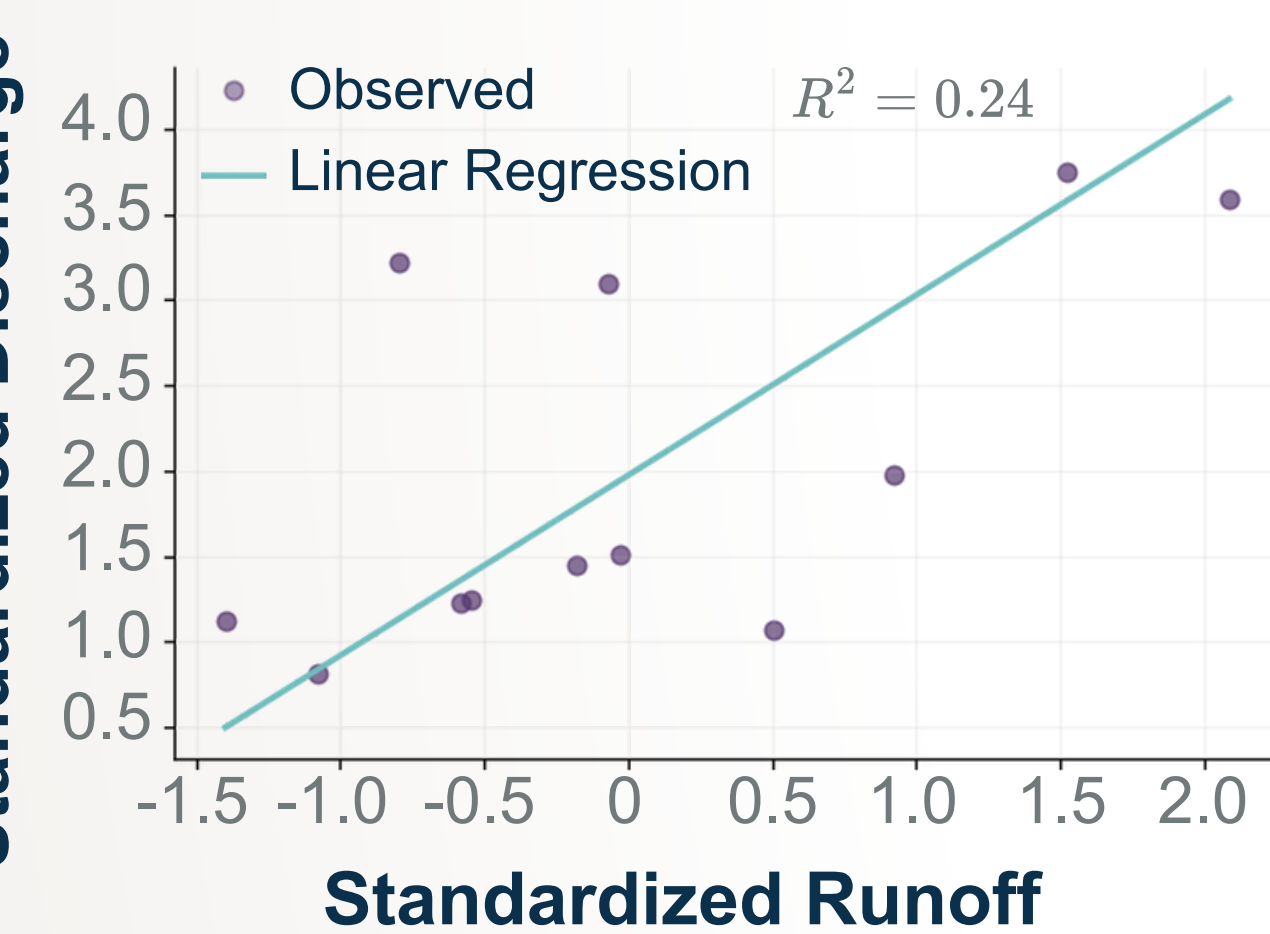
Country	Current	Moderate	Optimal
U.S.	70%	79%	95%
MX	65%	76%	83%

(Rodell et al., 2015; Pan et al., 2021; FAO, 1989; Howell, 2003; Fipps, 2000; Iriaguez-Covarrubias et al., 2018)

METHODS—Modeled-Natural Water Discharge (1900-2025)

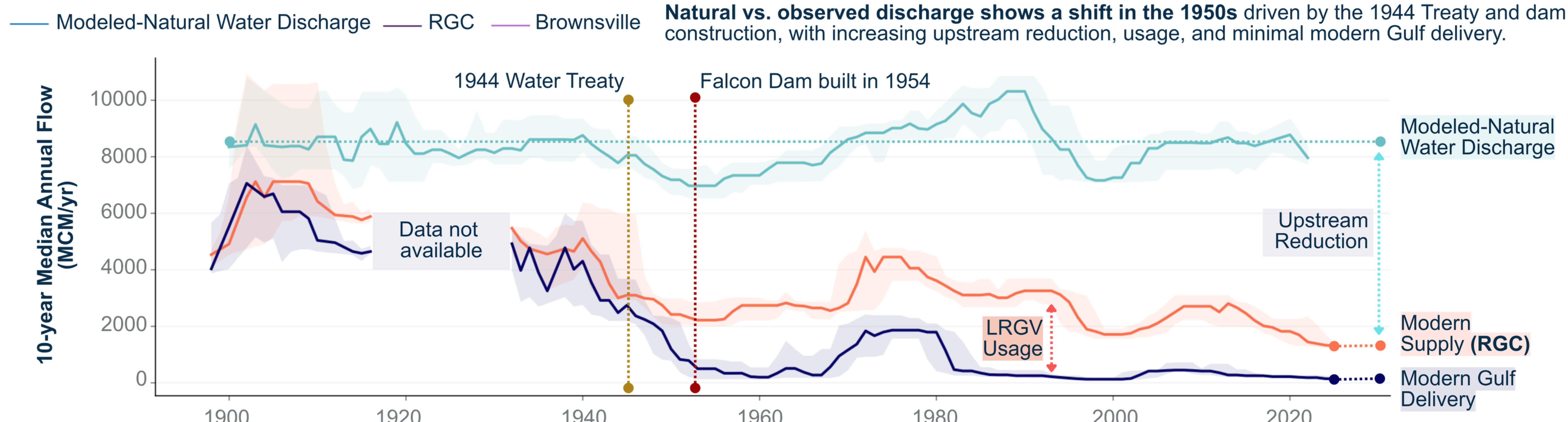
We used reconstructed runoff from the GRUN dataset (1902–2025) across the entire Rio Grande Basin to model natural river discharge. Standardized runoff was correlated with standardized discharge for the period 1900–1913 ($n = 14$) using linear regression:

$$Q_{RGC}^Z = \beta \times Runoff^z + c$$



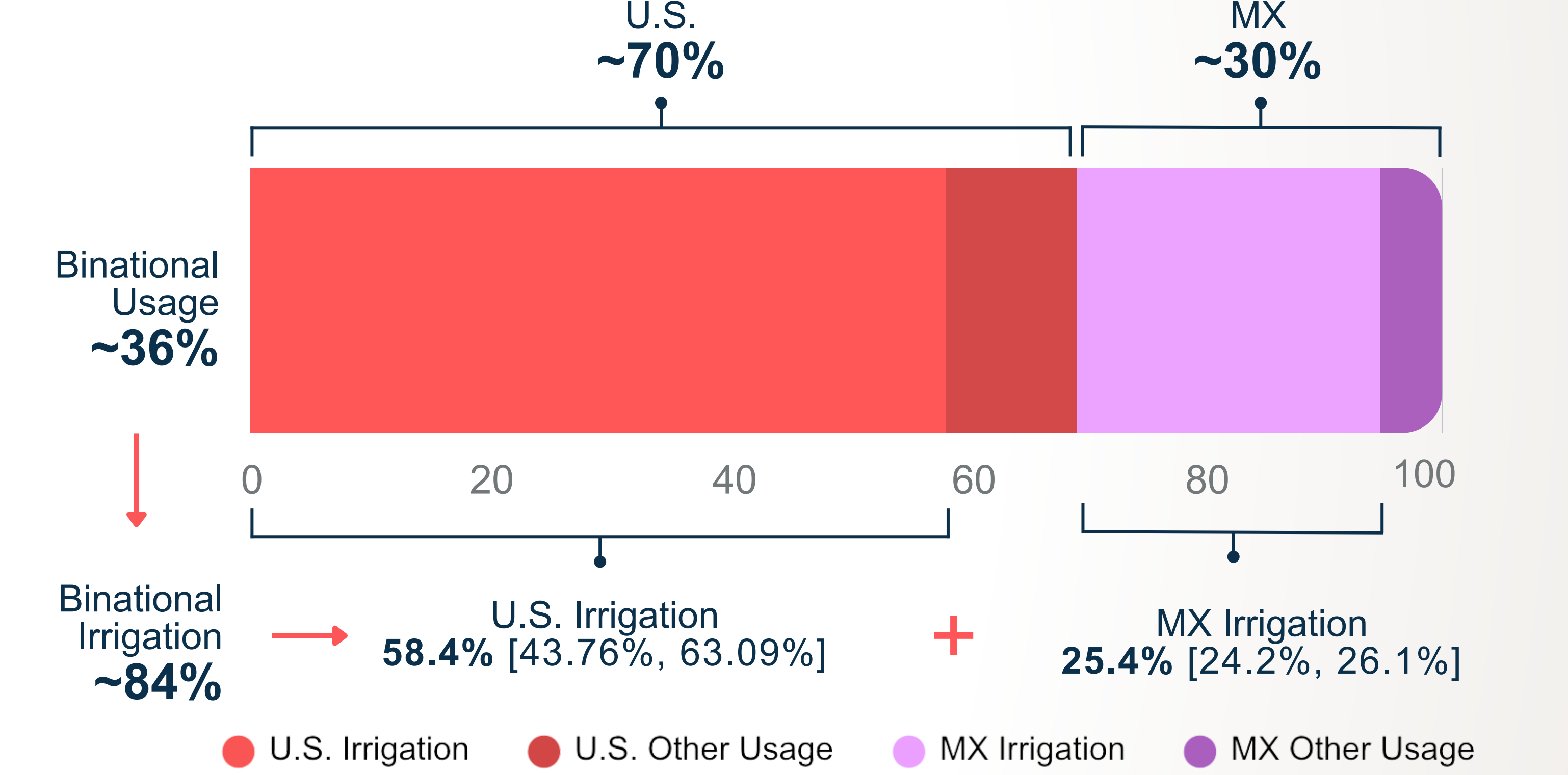
The resulting relationship was then extrapolated to 2025 and converted back to dimensional units to represent natural flow conditions. Differences between reconstructed (GRUN) and observed discharge (IBWC) were used to determine temporal change in upstream supply at RGC and Gulf delivery.

RESULTS—Temporally Decreasing Water Supply & Delivery to Gulf

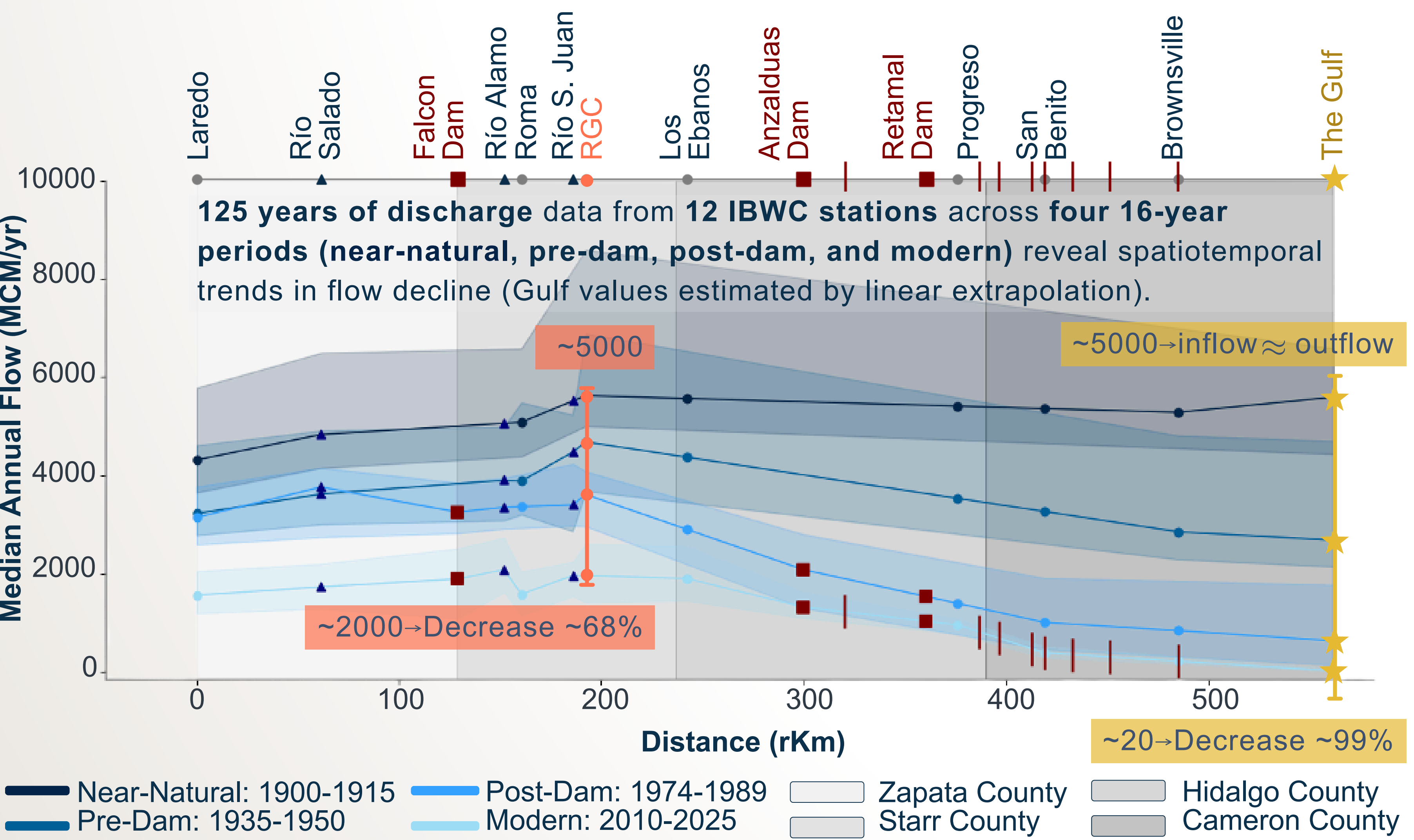


Natural vs. observed discharge shows a shift in the 1950s driven by the 1944 Treaty and dam construction, with increasing upstream reduction, usage, and minimal modern Gulf delivery.

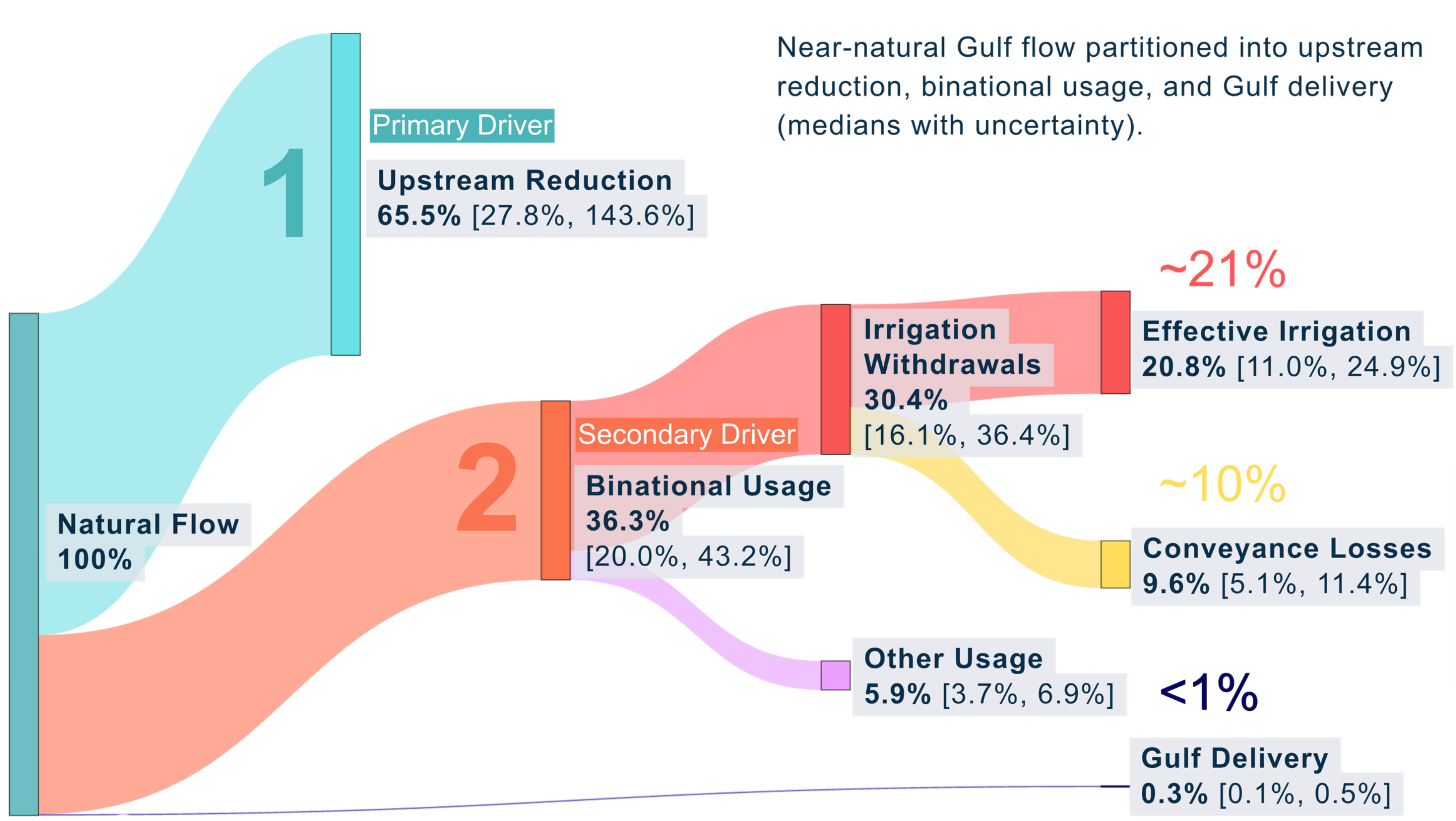
RESULTS—Modern Binational Water Usage (2010-2025)



RESULTS—Spatiotemporal Evolution of Discharge (1900-2025)

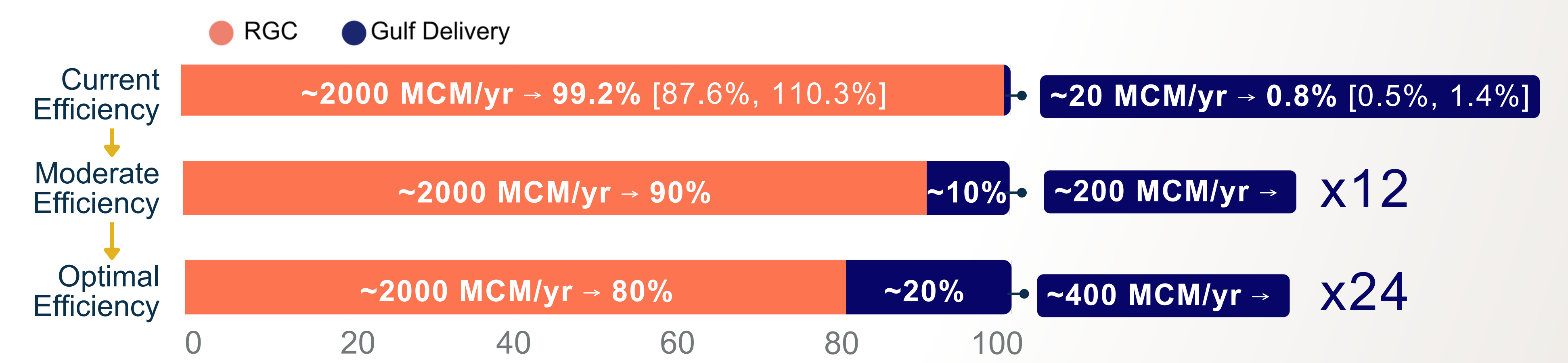


RESULTS—Water Budget from 1900 to 2025



Near-natural Gulf flow partitioned into upstream reduction, binational usage, and Gulf delivery (medians with uncertainty).

RESULTS—Increasing Gulf Delivery Through Improved Irrigation Conveyance



CONCLUSION & ACKNOWLEDGEMENTS

- Flow to the Gulf today declined by 99% relative to the near-natural period, from 5000 to 20 MCM/yr
- Modern flow decline is driven by upstream and LRGV water use under anthropogenic influence
- Nearly all water supplied to the LRGV is consumed via binational use, with the U.S. accounting for 70%
- Improving irrigation efficiency in the LRGV can increase Gulf delivery up to 24x current flow, equivalent to ~20% of water supply at RGC

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