

Unpacking the Social and Environmental Controls on the Scalability of Water Conservation Programs



Colorado
State
University



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Concerns About the Future Lead to Calls for Conservation

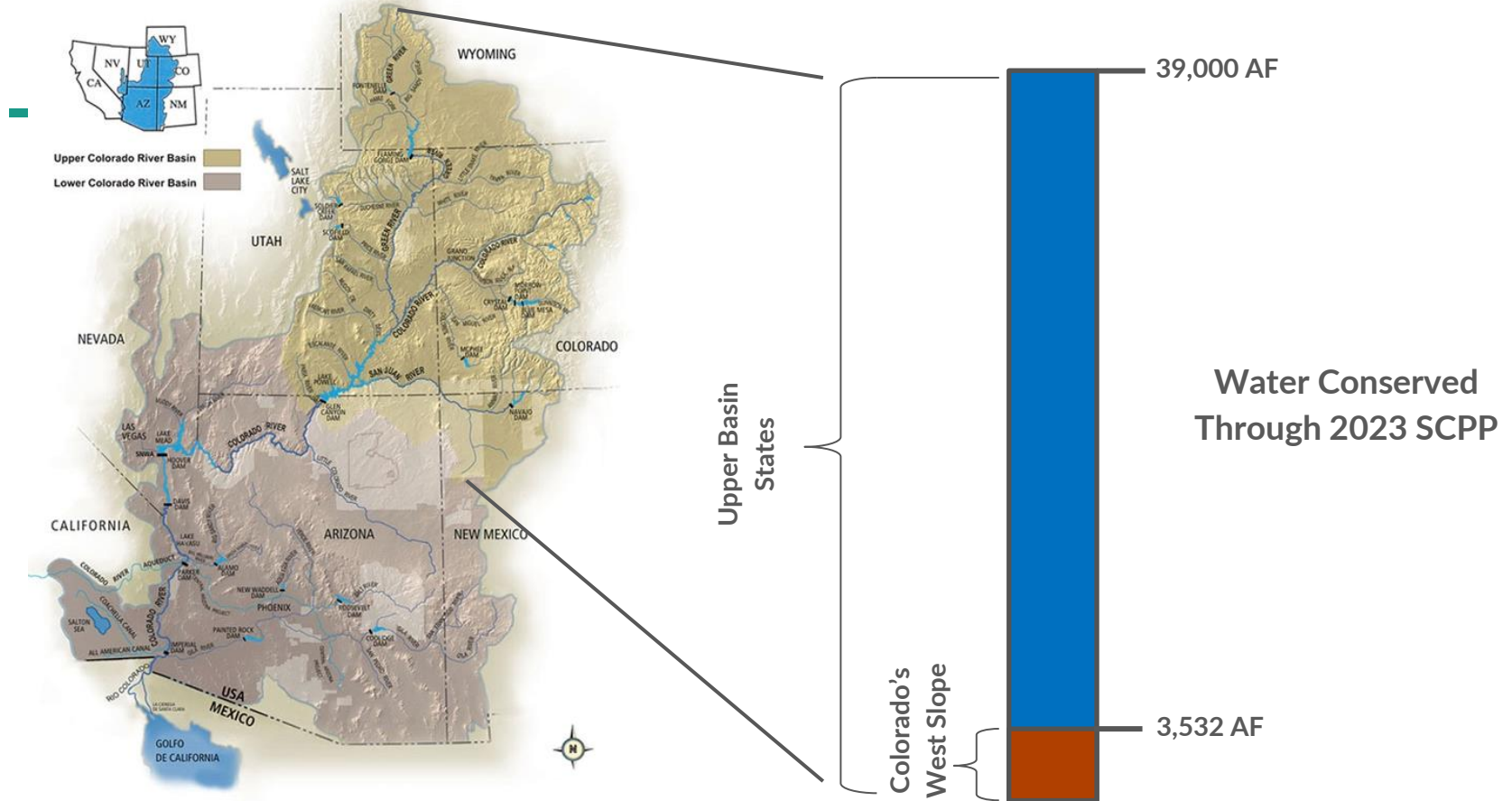
USBR: “In order to avoid a catastrophic collapse of the Colorado River System and a future of uncertainty and conflict, water use in the Basin must be reduced [...] by **2 million to 4 million acre feet** starting in 2023.”

Colorado Water Plan: “[...] share at least **50,000 acre-feet** of agricultural water using voluntary alternative transfer methods by 2030.”

UCRC 5-Point Plan: “Consider an Upper Basin **Demand Management** program as interstate and intrastate investigations are completed.”

“[...] reauthorize the **System Conservation Pilot Program** and for funding to support the Plan through September 2026.”

Hurdles to Effective Conservation are Evident



Map Source: Colorado River Water Conservation District



Water saved through upper-basin program unlikely to move needle in Powell

by Heather Sackett May 12, 2023

The effort shows that upper-basin water managers are willing to do their part to prevent the system from crashing, but that part is small compared with the cuts they say are

Will \$125 million program assist Colorado River water conservation?

Austin Corona, Special to the Aspen Daily News Apr 24, 2023

May 8, 2023 | Denver Post

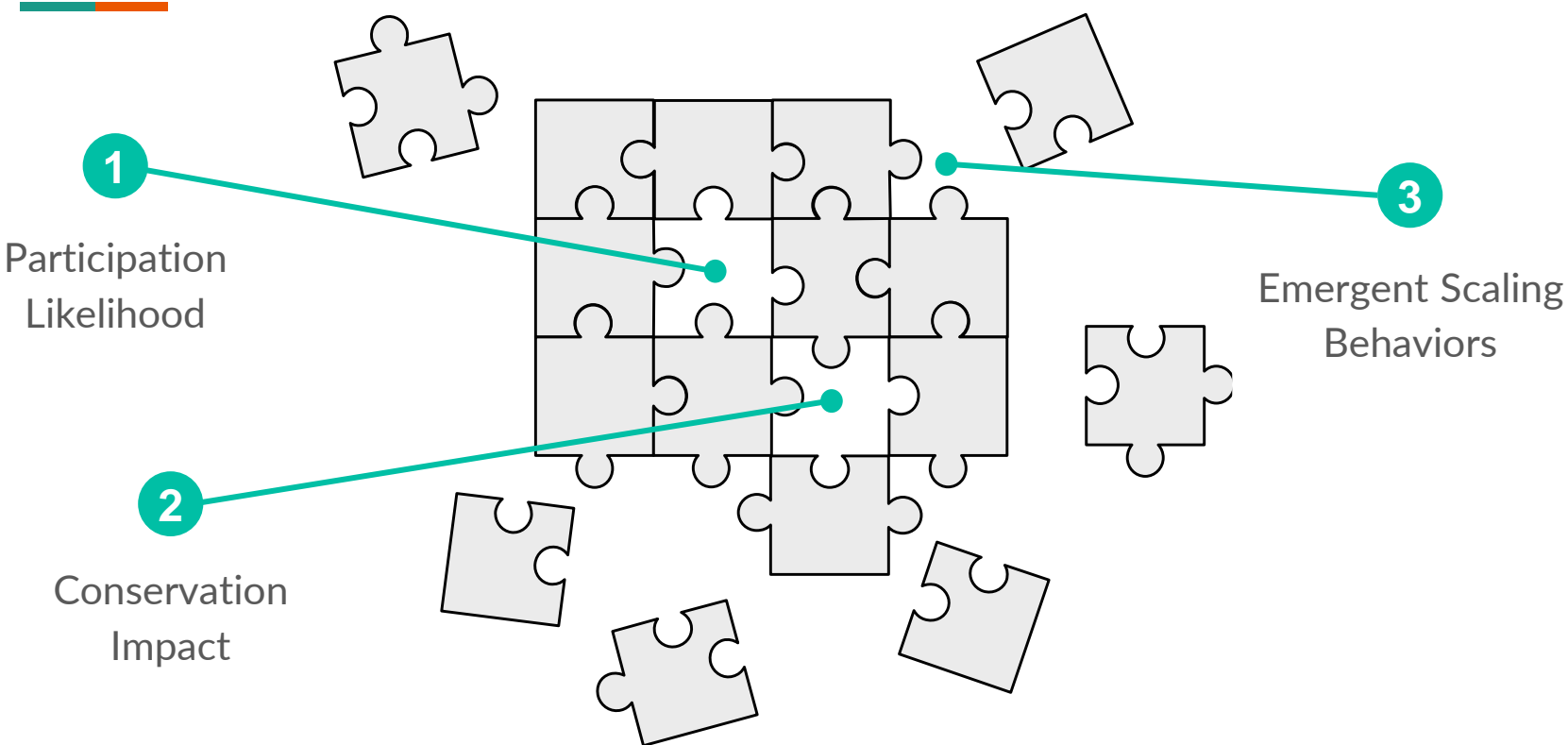
A PLAN TO PAY FARMERS TO USE LESS OF THE COLORADO RIVER COMES UP DRY

Guiding Question

How do linked social and environmental characteristics conspire to limit or promote the success of large-scale water conservation programs on Colorado's Western Slope?



Where are the Knowledge Gaps?



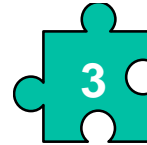
Linked Research Questions



1 What socio-economic and environmental factors help characterize the likelihood of water users' participation in water conservation programs under different policy regimes?



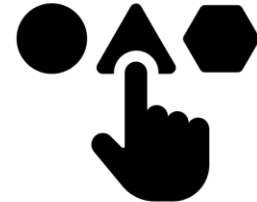
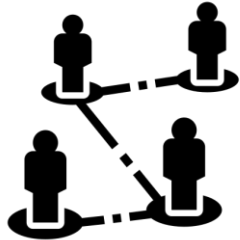
2 What consumptive use reductions can be expected at the field scale by limiting irrigation water application both in timing and magnitude across the Western Slope?



3 How do attitudes toward conservation among different demographic groups and the interaction of individual actors within social networks conspire to limit or promote large-scale conservation program effectiveness under climate scenarios and/or policy regimes?

1 Participation Likelihood

- 01 | Distribute quantitative social survey to agricultural water users on Colorado's Western Slope.
- 02 | Collect information about attitudes toward potential future water conservation programs and preferences for specific program attributes.



1 Demographic Characteristics

2 Attitudes towards Conservation

3 Discrete Choice Experiment

1 Participation Likelihood

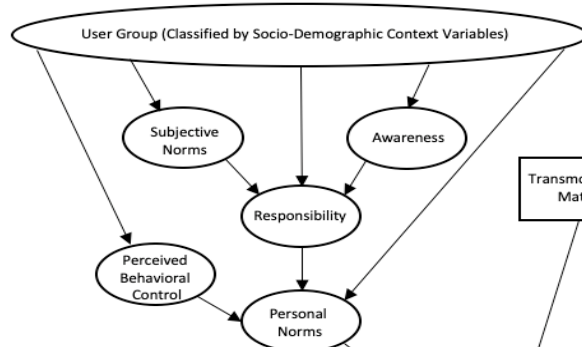
Discrete Choice Experiment Attributes

- 01 | **Conservation action** that a water user would choose to be enrolled in
- 02 | The **compensation** received on a per acre basis for participation in the conservation program
- 03 | The percentage of the user's **total irrigated acreage** under conservation
- 04 | Whether water conserved by Western Slope users is **matched by Front Range** users
- 05 | Whether conserved water is **shepherded downstream** past other users to the state line.

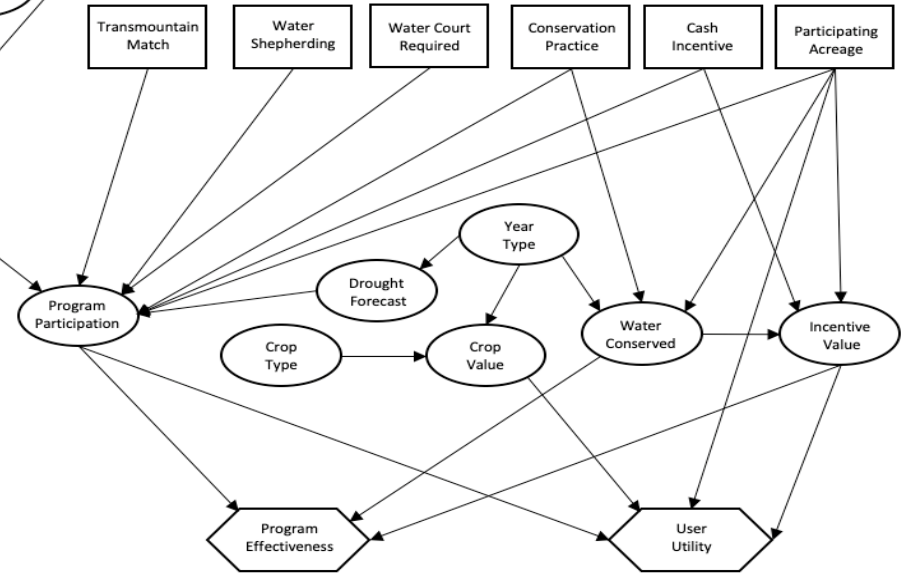
Sample DCE Choice Set

	Option 1	Option 2	Neither of these
Conservation Action	Full Season Curtailment (Apr 1 - Oct 31)	Full Season Curtailment (Apr 1 - Oct 31)	Maintain normal irrigation practices
Compensation Per Participating Acre	\$1600	\$1600	
Irrigated Acreage Under Conservation	50%	25%	
East Slope Match	Yes	No	
Water Shepherding/Protection	Yes	No	
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1 Participation Likelihood



Bayesian Belief Network



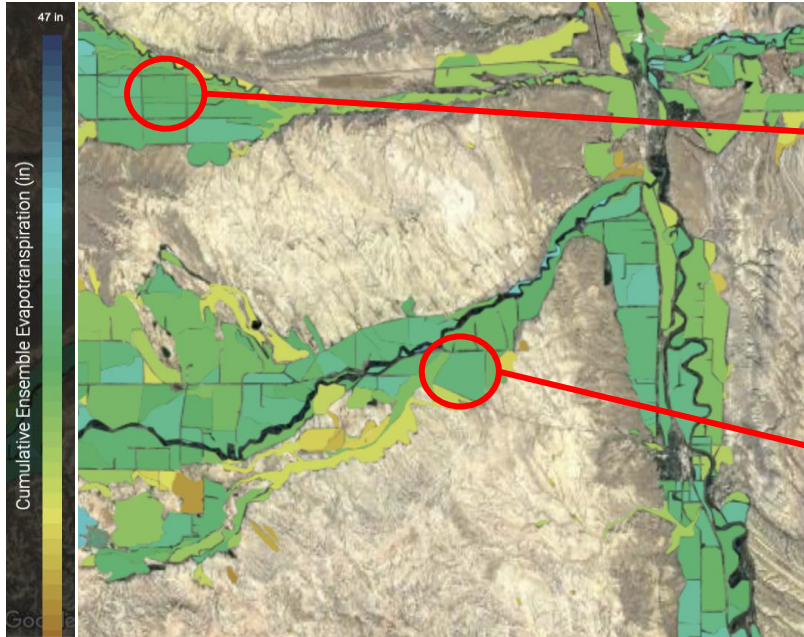
Example Insights:

What is the likelihood that a water user with less than 100 acres who earns less than \$60,000/year from agricultural activities will participate in a split-season fallow program at \$300/acre?

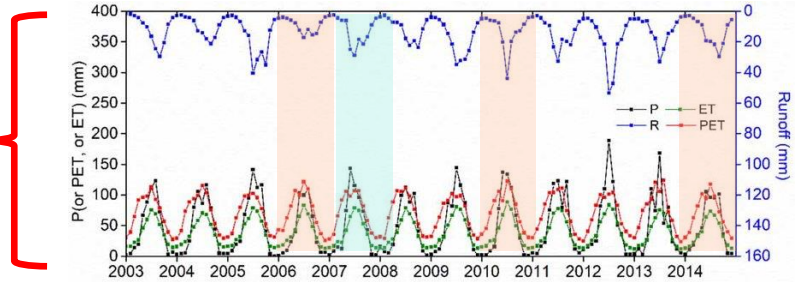
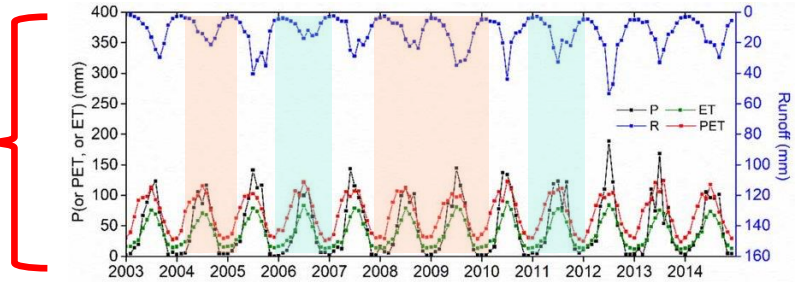
How does that likelihood change if any conserved water is matched by TMDs?

2 Conservation Impact

01 | Identify fields across West Slope where conservation was recently enacted or where administration of water rights creates a proxy for water conservation activities.



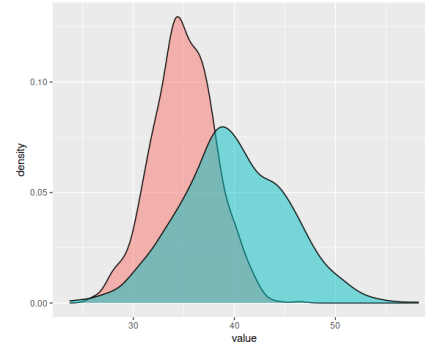
02 | Compute AET/PET time series for each field and conservation action type (e.g. none, full-season fallow, split-season fallow, etc.). Compute conserved CU distributions.



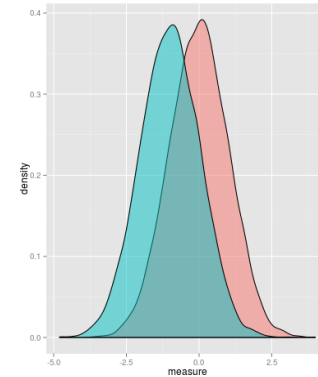
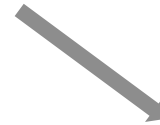
2 Conservation Impact

Example Insights:

What is the distribution of conserved consumptive use savings that might be expected from alfalfa fields at 6000' under split season irrigation?



How about at 8000'?



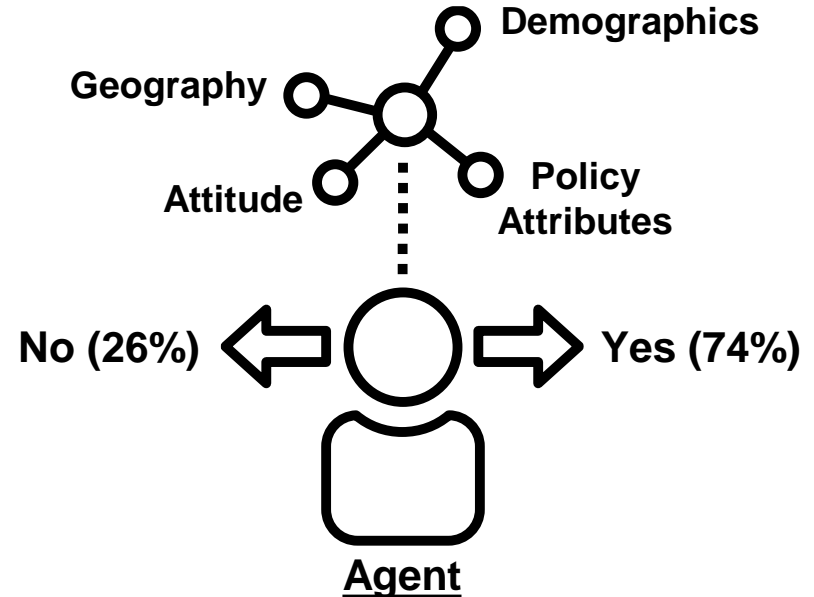
3 Emergent Scaling Behaviors

01 | Build an Agent-Based Model (ABM) that reflects the decision pathways identified in Phase 1. Loosely couple the ABM with StateMod model for the Colorado River Basin.

02 | Use Phase 2 results to estimate consumptive use reductions under different conservation actions for fields represented in the model.

03 | Simulate voluntary/temporary conservation program participation by networks of individual actors over time, under different climate scenarios and conservation program/policy regimes.

1 Bayesian Belief Network



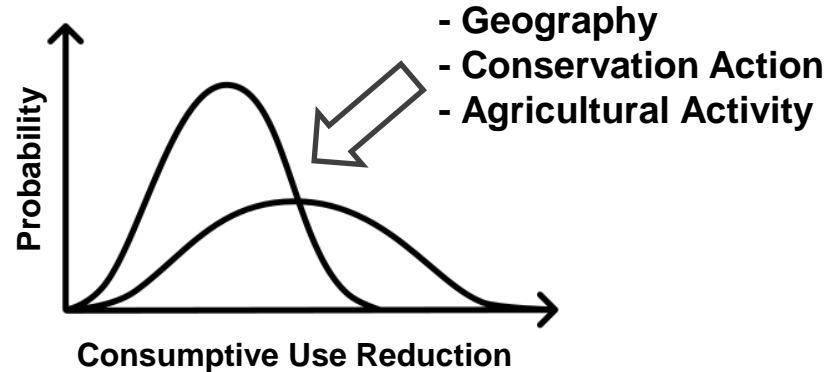
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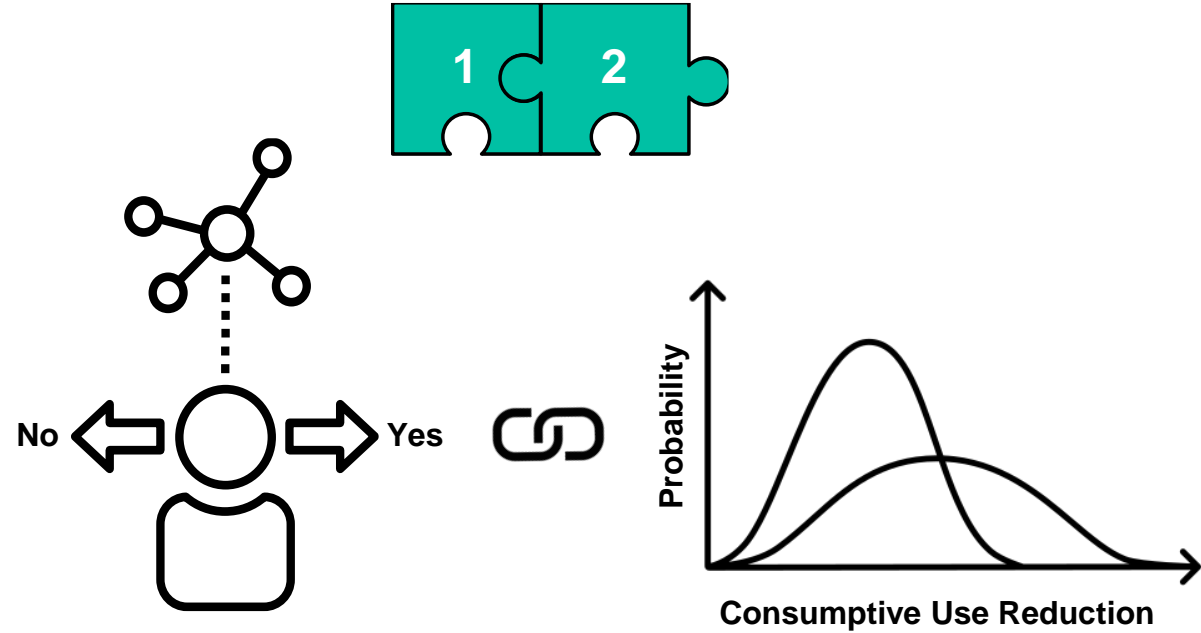
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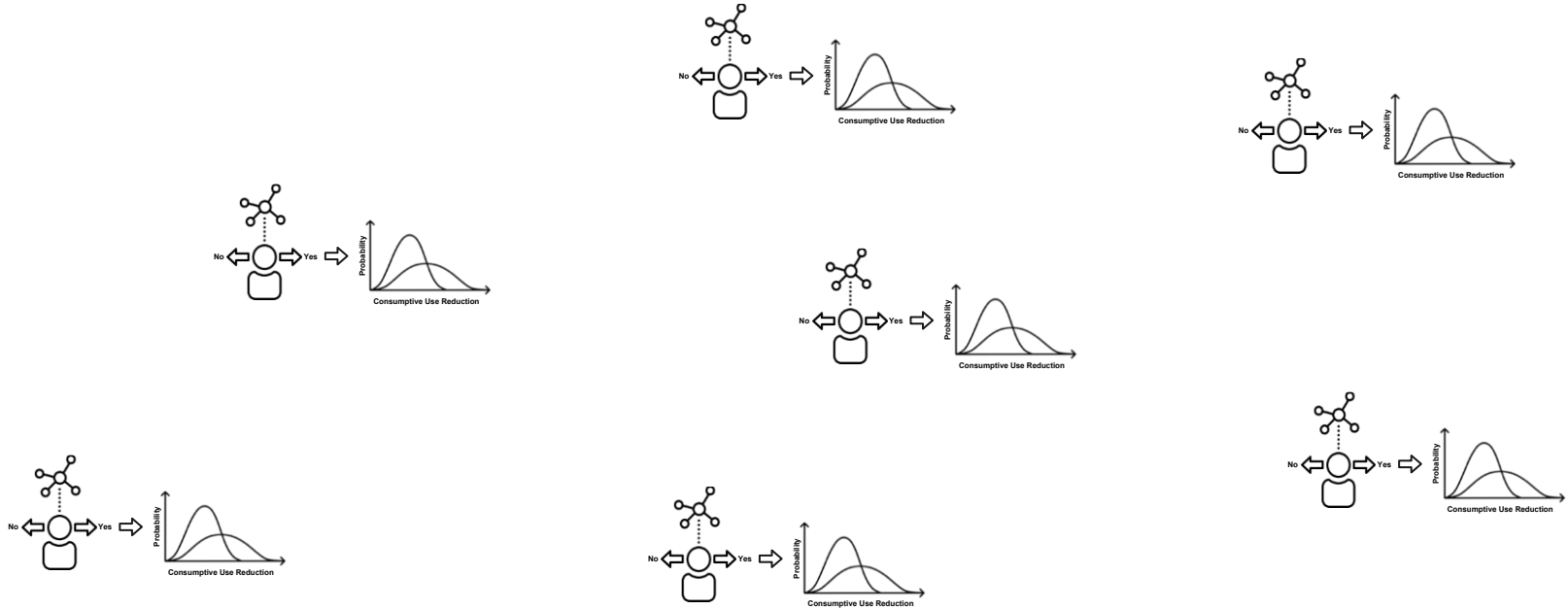
2 Consumptive Use Reduction Probability



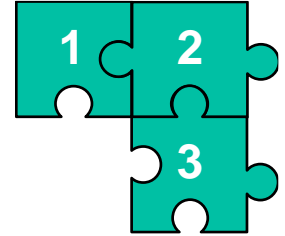
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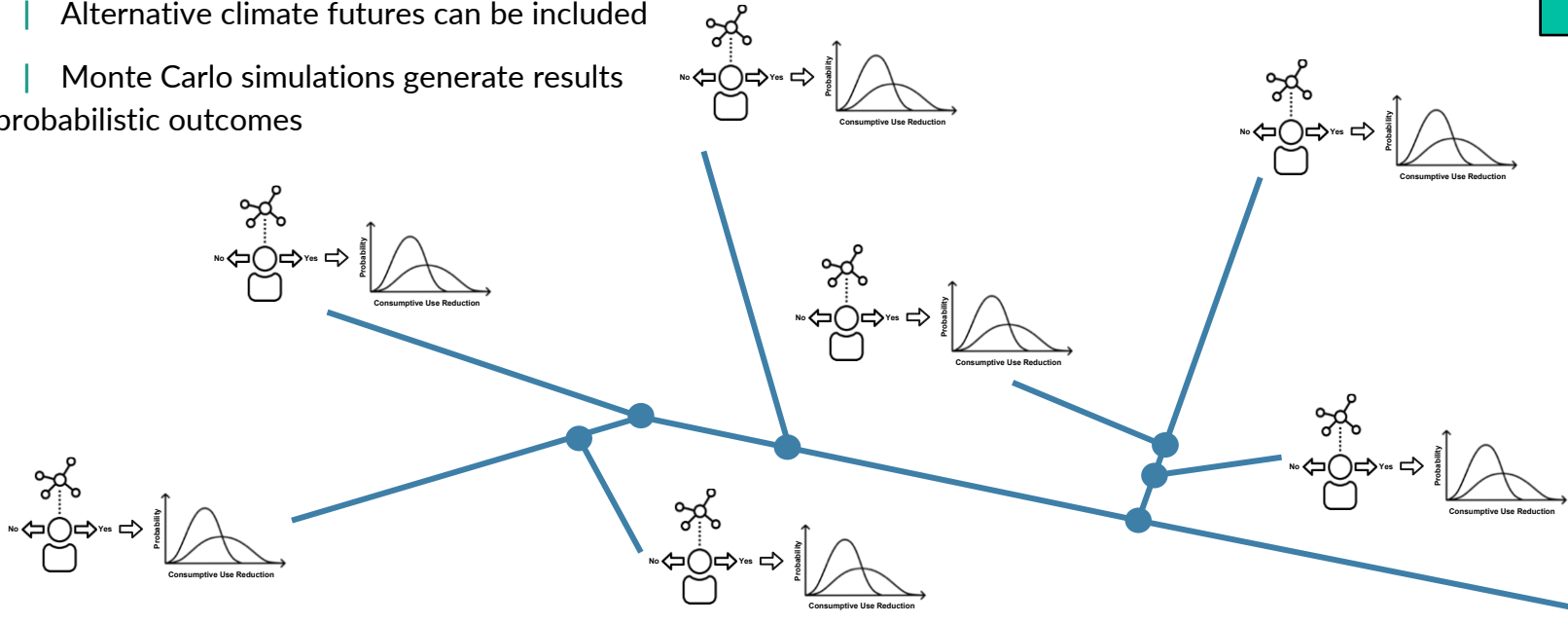
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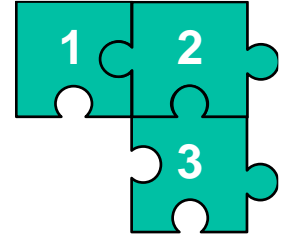
3 Emergent Scaling Behaviors



- 01 | Water rights allocation and administration accounted for
- 02 | Alternative climate futures can be included
- 03 | Monte Carlo simulations generate results as probabilistic outcomes

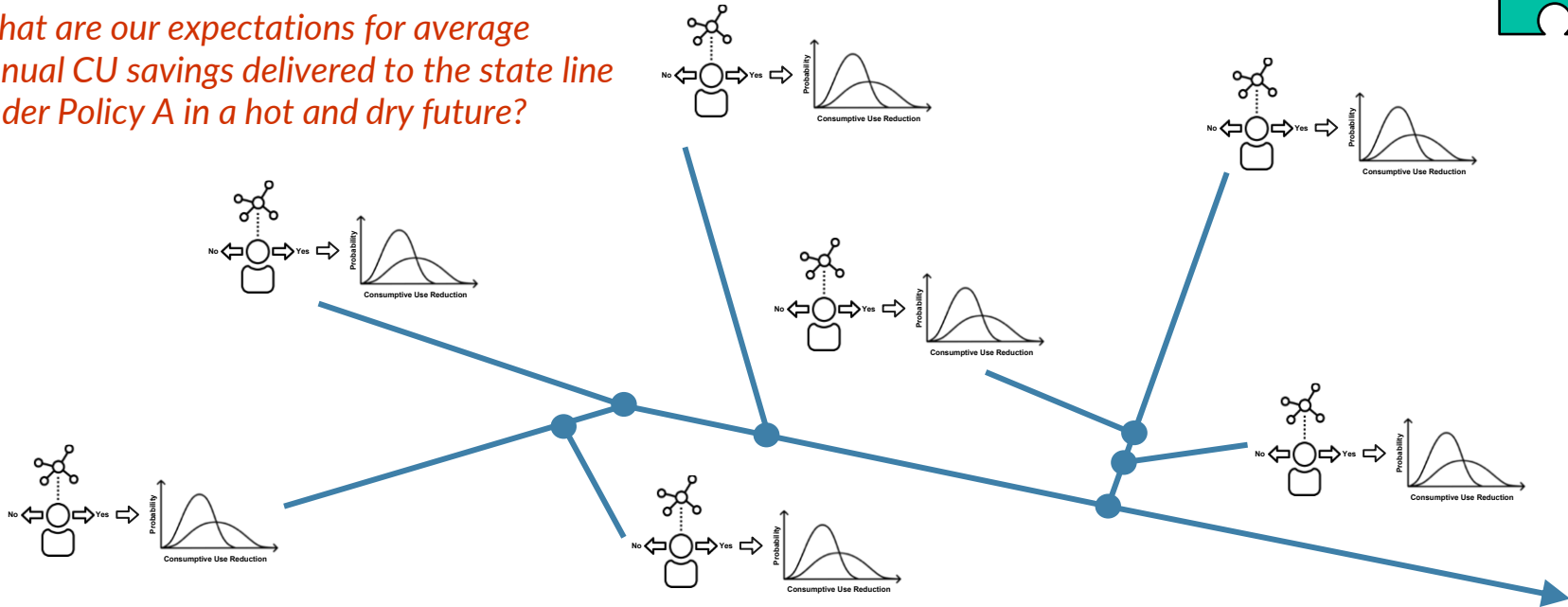


3 Emergent Scaling Behaviors



Example Insights:

What are our expectations for average annual CU savings delivered to the state line under Policy A in a hot and dry future?



Reflection Point

- ✓ Significant uncertainty exists in the “scaling-up” of water conservation programs
- ✓ The high levels of sustained annual participation in water conservation programs needed to yield tangible quantities of water is not guaranteed.
- ✓ Recent observations of SCPP participation rates in Western Colorado underscores both of these points

Expected Outcomes and Benefits of this Applied Research Project



For Water Users:

- Communicate perspectives, opinions and attitudes about water conservation to policy makers and program managers

For Policy Makers:

- Better understanding of the attributes or social and environmental circumstances that limit or promote water conservation participation and effectiveness at scale



Thank you.

Research Partners:

**Colorado
State
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Dr. Neil Grigg

Systems Engineering, Colorado State University

Dr. Dana Hoag

Agricultural and Resource Economics, Colorado State University

Dr. Daniel Mooney

Agricultural and Resource Economics, Colorado State University

Dr. Perry Cabot

Extension, Colorado Water Center, Colorado State University

ROARING FORK



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