Eco-Engineering Resilience

Integrating Ecosystems into Robust Water Management

John Matthews, AGWA
alliance4water.org
johoma@alliance4water.org

Ted Grantham, USGS

Caitlin Spence, UMass, Amherst

LeRoy Poff, CSU

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AGWA Alliance for Global Water Adaptation
alliance4water.org

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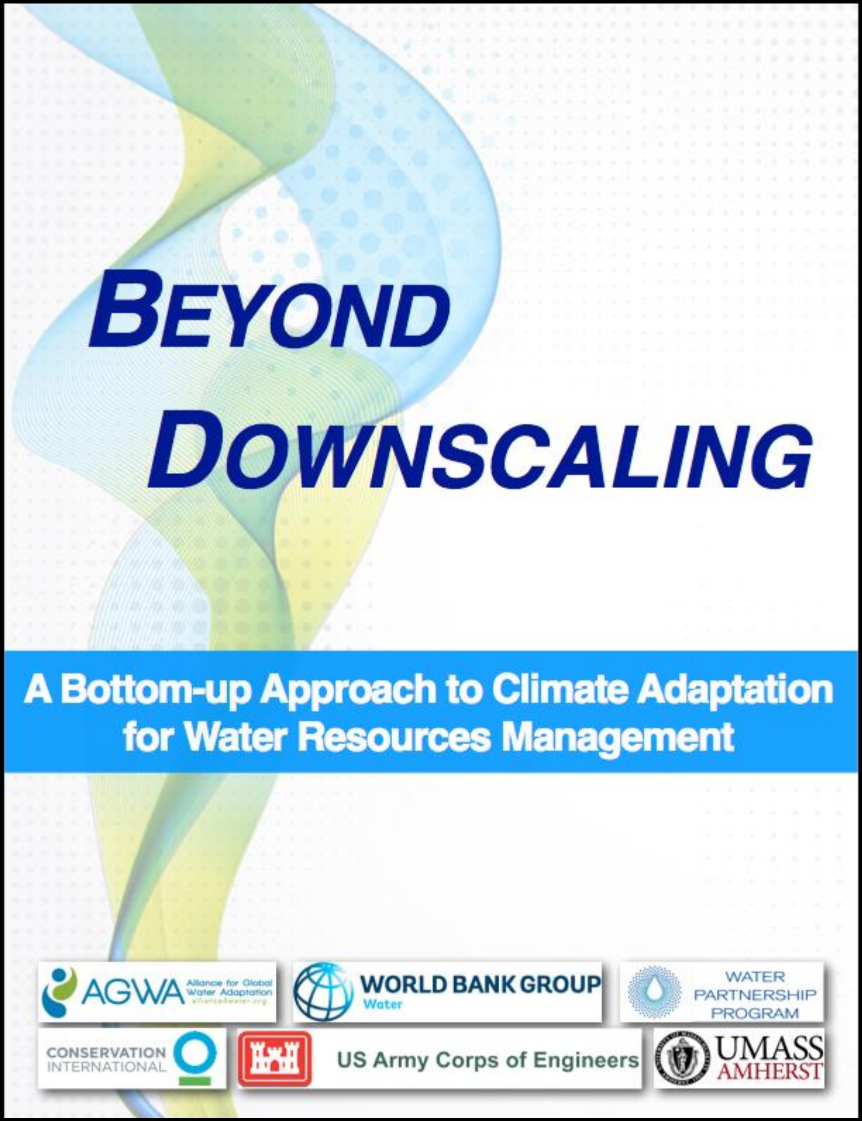
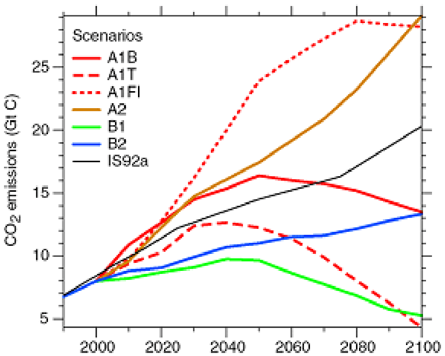
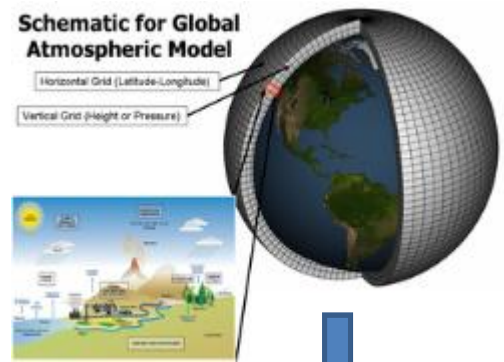


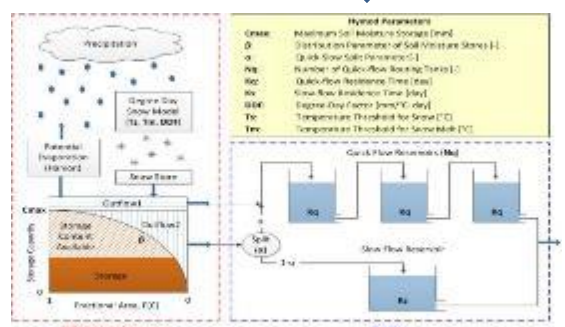
How do we integrate the *environment* in *engineering* decisions?



Emission Scenarios

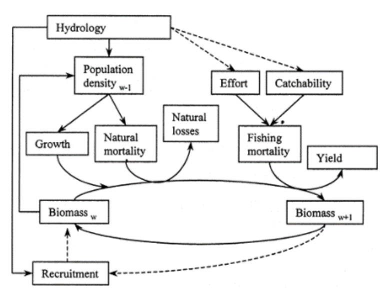
GCM projections as starting point for risk assessment





Hydrologic Model

Ecological Model

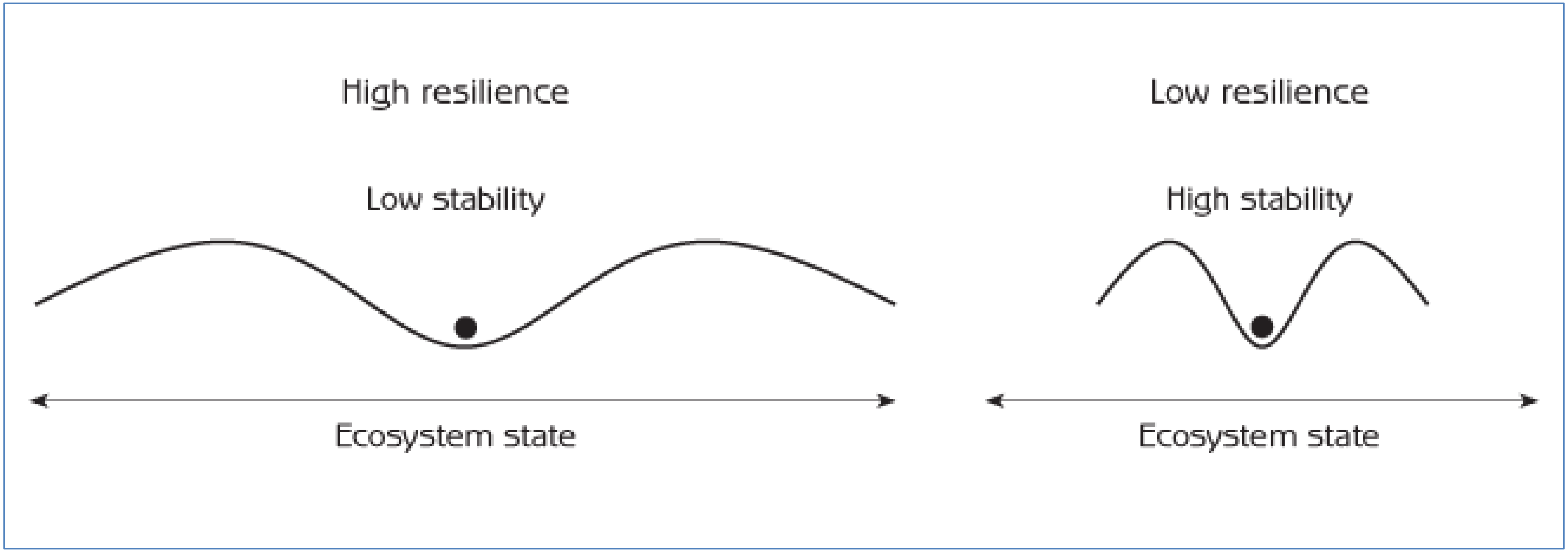


POSSIBLE FUTURE STATES

DECISION?

Managing for ecological resilience

Enhance capacity of ecosystem to withstand and recover from disturbance



Principles of ecological resilience

Rivers are:

1. Dynamic systems – characterized by variation in flows, sediment, nutrients, and salinity. Extremes are often what matter most.

2. Connected systems – longitudinal (upstream/downstream) and lateral (floodplain) connectivity is important for facilitating movement of organisms and enhancing ecosystem productivity.

3. Heterogeneous environments – characterized by structural complexity and gradients from local to catchment scales

Defining ecological performance criteria

scale

Species– endangered spp, indicator spp, fisheries population targets

Community structure –species composition and diversity

Local-scale habitat heterogeneity – structural habitat complexity

Ecosystem functions – range of variation in flows, sediment transport, nutrients, and salinity

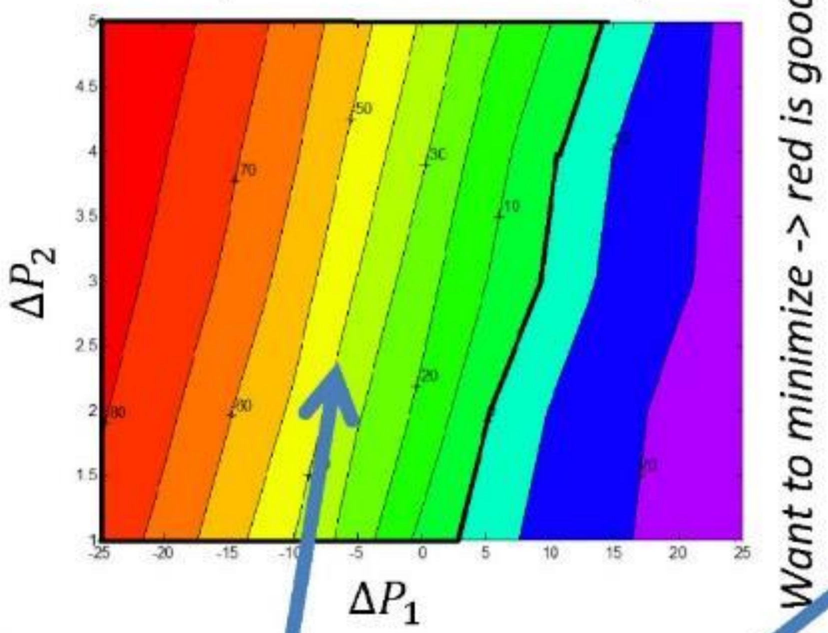
River network connectivity – degree of longitudinal and lateral connectivity/fragmentation

Macro-scale habitat heterogeneity – landscape variation in habitat types

Stress test sample plots

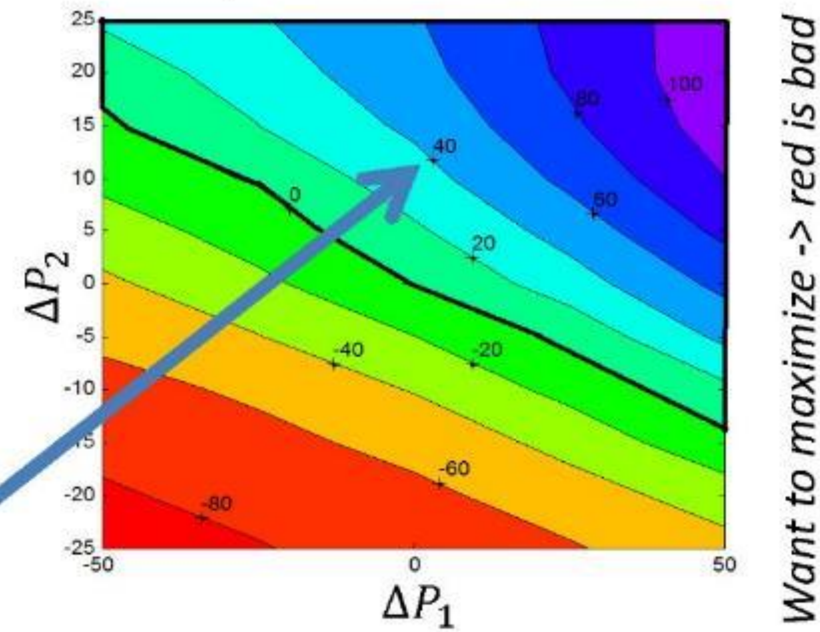
Engineering performance metric:

Expected Annual Damage



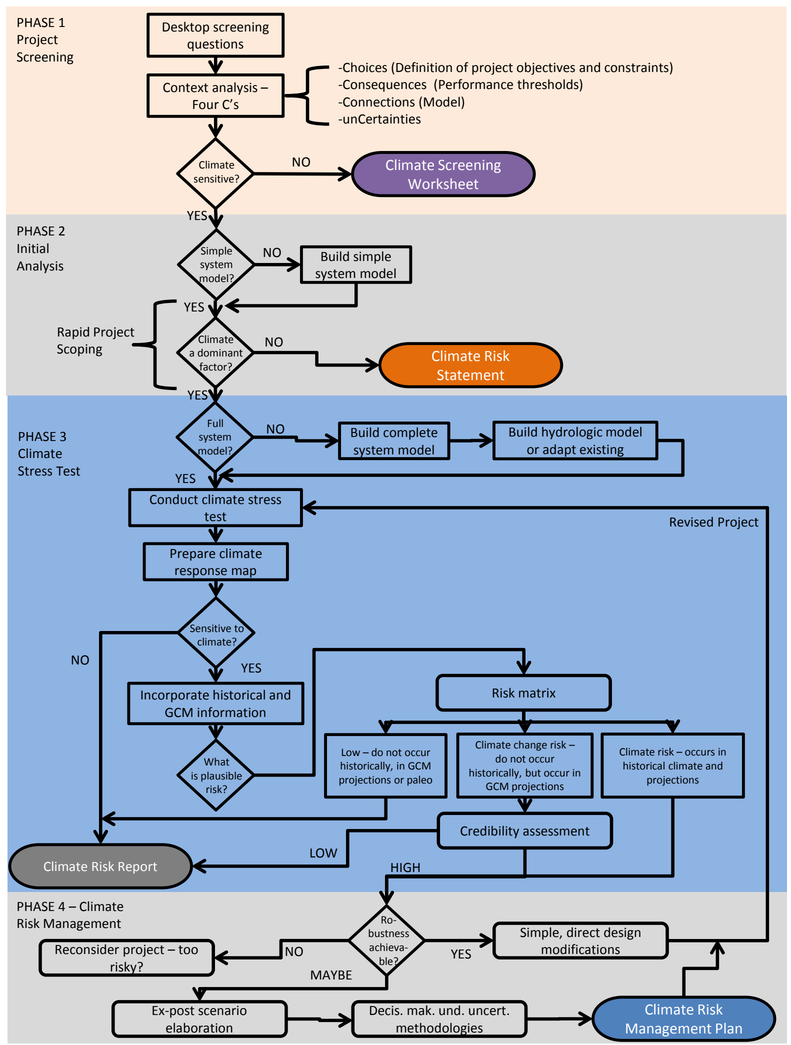
Ecological resilience performance metric:

Expected Annual Habitat



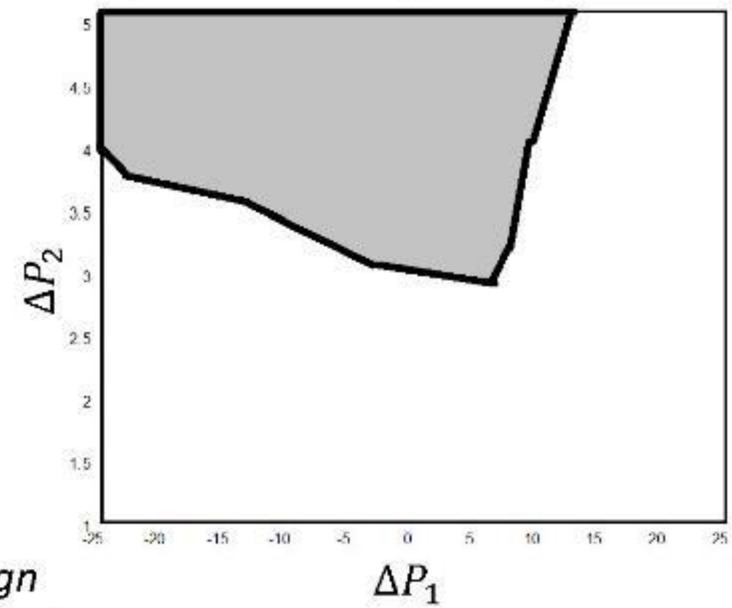
Region of acceptable performance

Analysis in the context of stakeholder-driven decision making

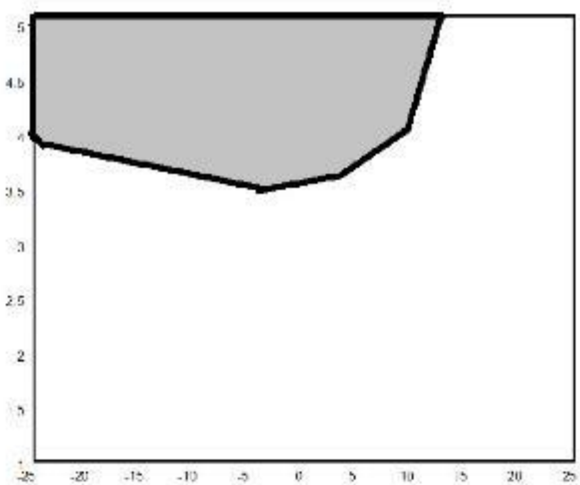


Goal: Maximize area of overlap

Climate space with acceptable performance:



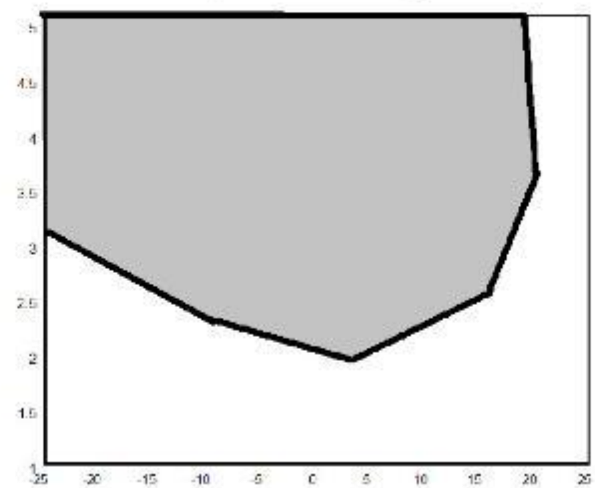
Inferior Design



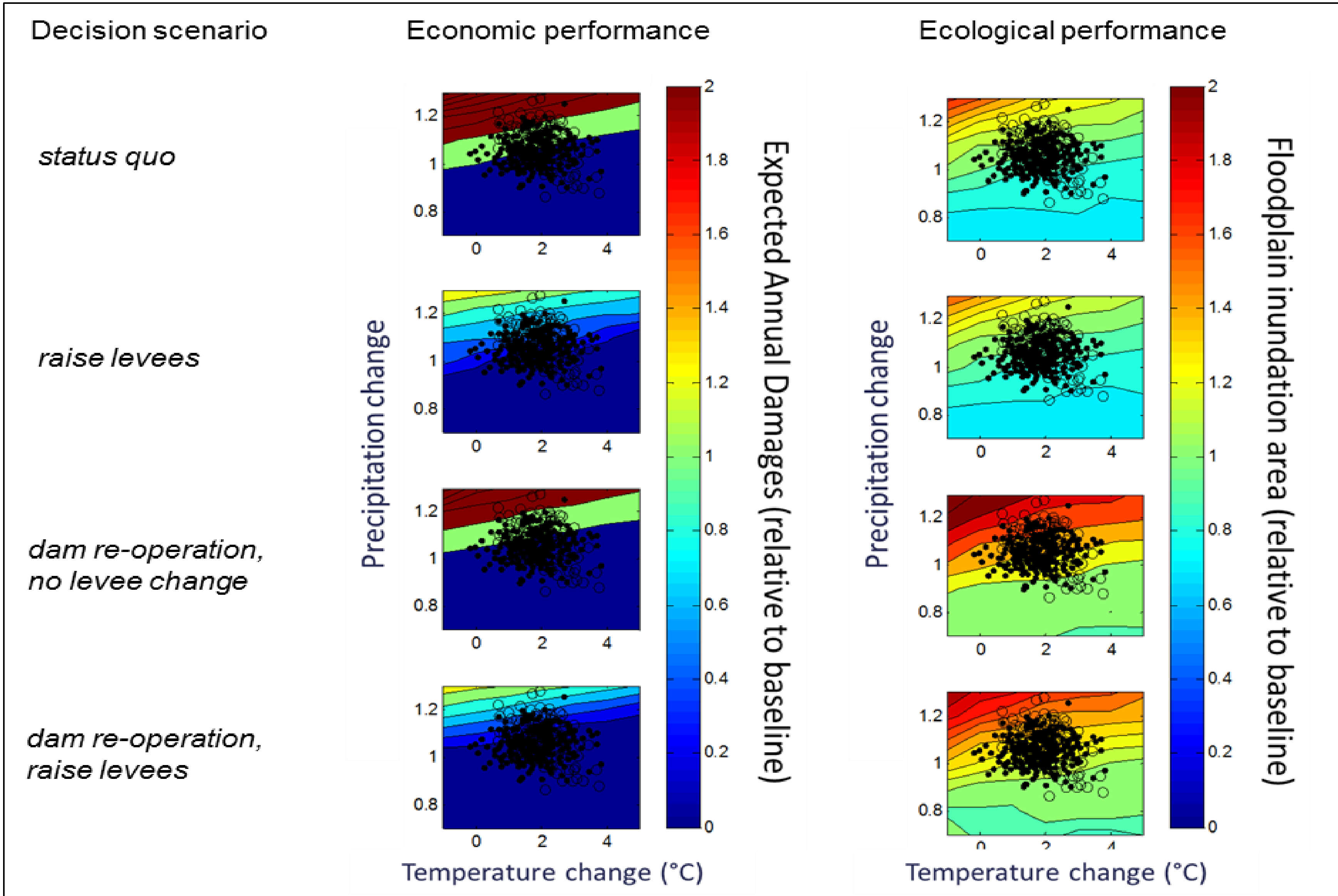
Reduced mutual robustness

Increased mutual robustness

Superior Design



Comparing alternatives' climate sensitivity



Mutual satisficing: Floodplain area and cost

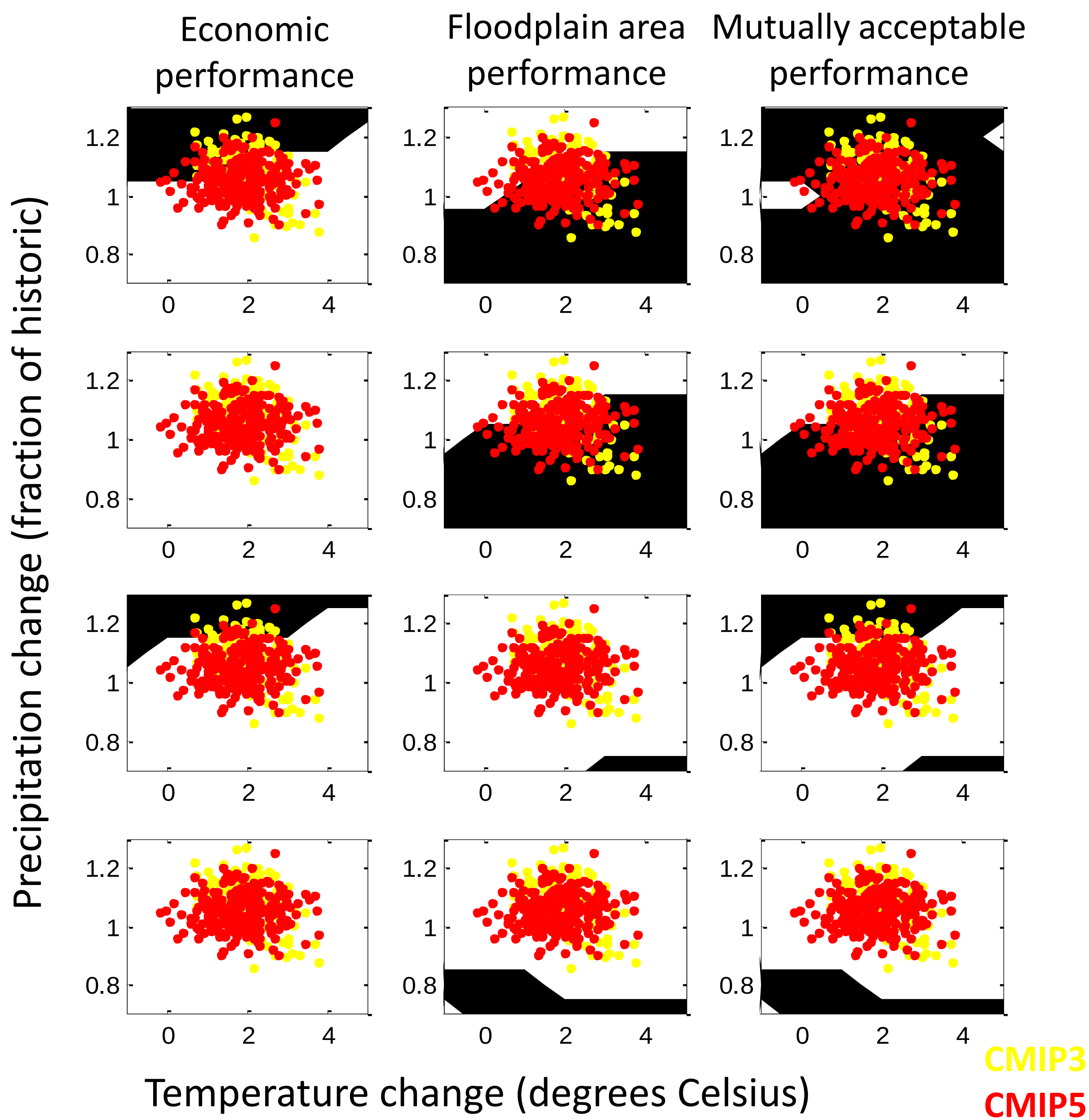
Adaptation Portfolio

Status quo

Levees raised 9 feet
No re-operation

No levee change
Reservoir re-operation

Levees raised 9 feet
Reservoir re-operation



Economic threshold = 1.5x historic baseline
Area threshold = 1x baseline

Is this useful?

- Climate projections inform **(but do not determine)** the decision process
- Decision scaling is **stakeholder-centered and has a strong consensus-based** framework that integrates with technical perspectives, even in highly uncertain environments; *it is perfect for transboundary management*
- Although developed originally for engineers, **eco-engineering decision scaling can easily be implemented for existing approaches** to species- or ecosystem-services oriented approaches
- However, **it is most powerful in low-data environments, when we can compare the three critical "resilience" variables**
- Simultaneously assessing economic and ecological performance of water systems leads to selecting mutually robust adaptation portfolios
- This process can occur early in a project cycle rather than including the environment at the end, as with an EIA, and it allows for direct analysis of tradeoffs at the beginning

Thanks!

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