CUMBRE DE FONDOS DE AGUA

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Confronting Climate Uncertainty in Water Resources Planning and Investment Design

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Outline

Tema 01 – Traditional planning process
Tema 02 - Recent approaches to planning: robust decision making under uncertainty
Tema 03 - The example of Mexico: Cutzamala System
Tema 04 – 5 key takeaways

TRADITIONAL PLANNING APPROACH

Traditional planning process: 'Predict and Act'

What would be the future?

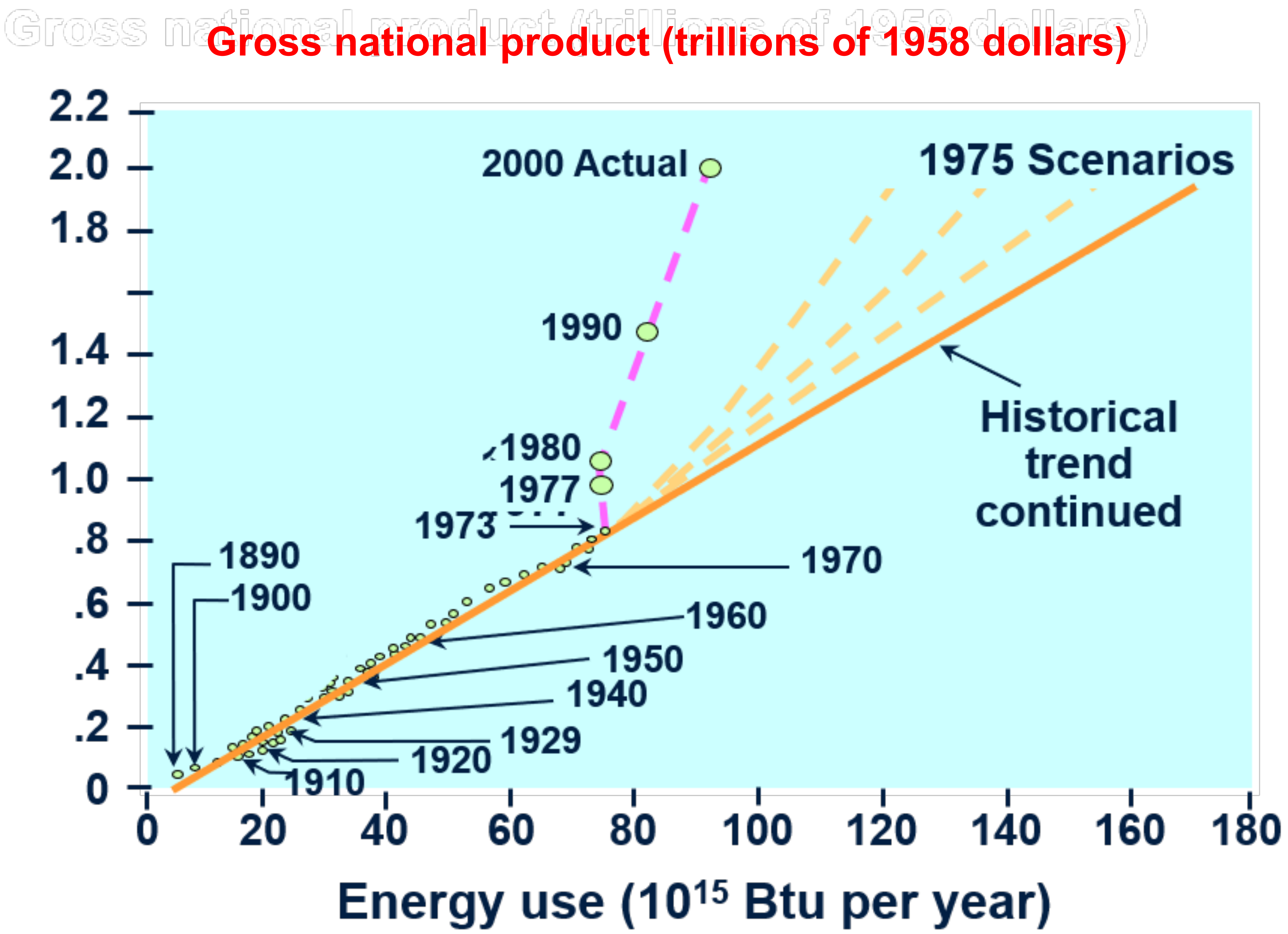
What is the best decision according to our future scenario?

To what extend our decision depends on our forecast?

This method is not effective when facing uncertainty and/or we have different views from decision makers and stakeholders.

Year 2000?Forecasting in 1900….

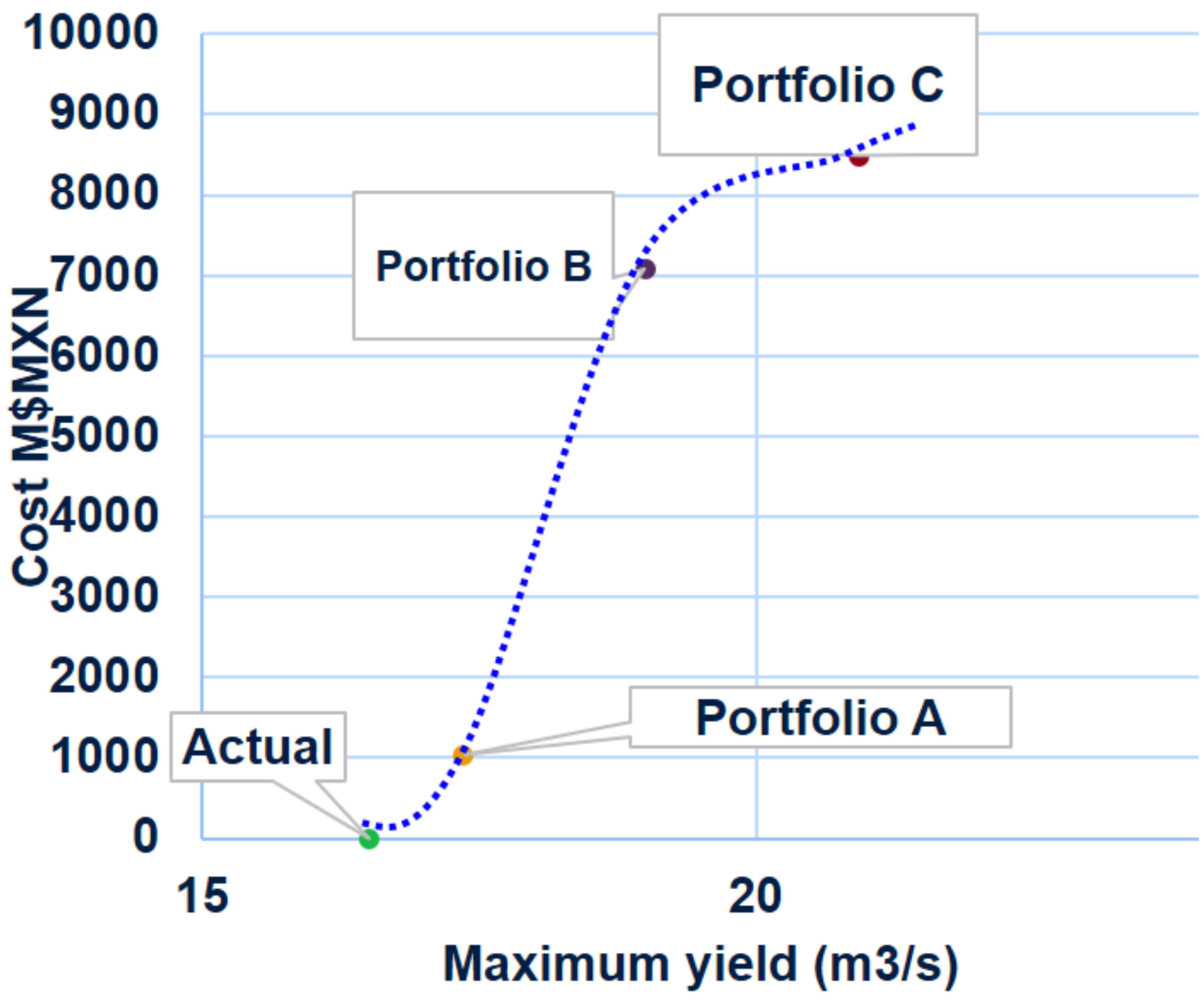
Another example of the challenges of forecasting



Traditional planning approach

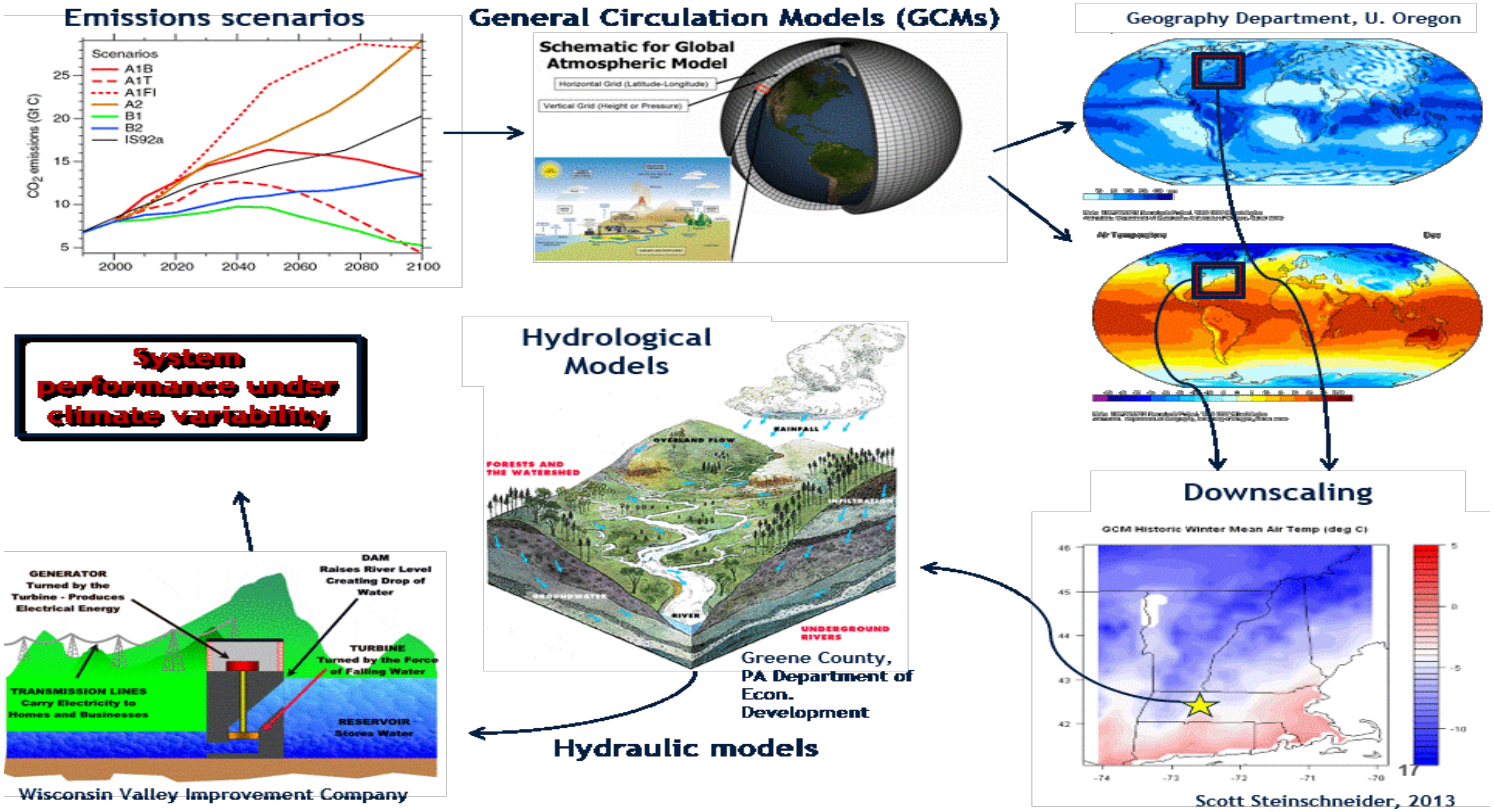
Engineers determine solutions which minimize costs

What happens when shocks?
Climate change?
Social equity?
The environment?

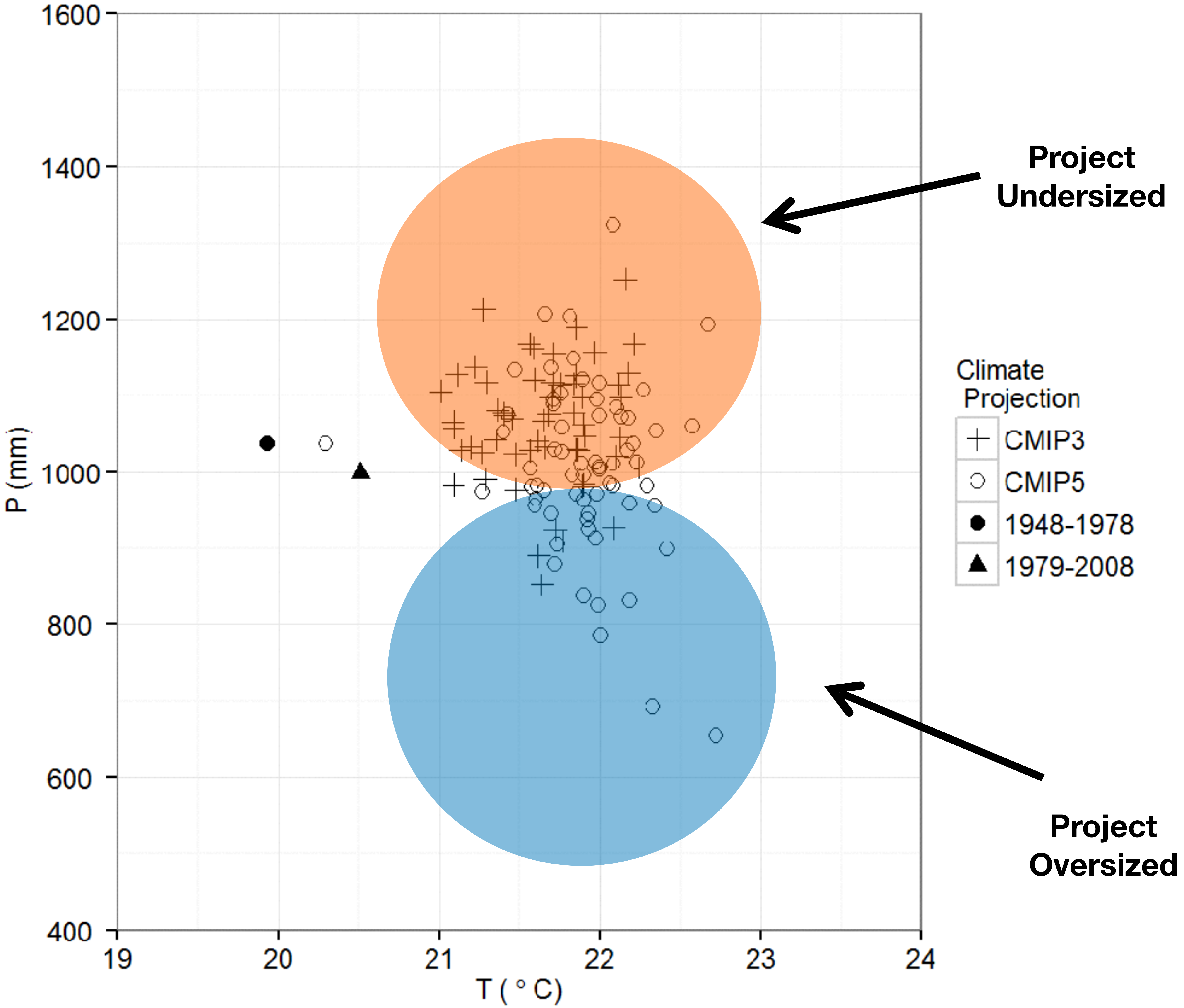


Traditional planning leads to fragile solutions

Uncertainty and climate

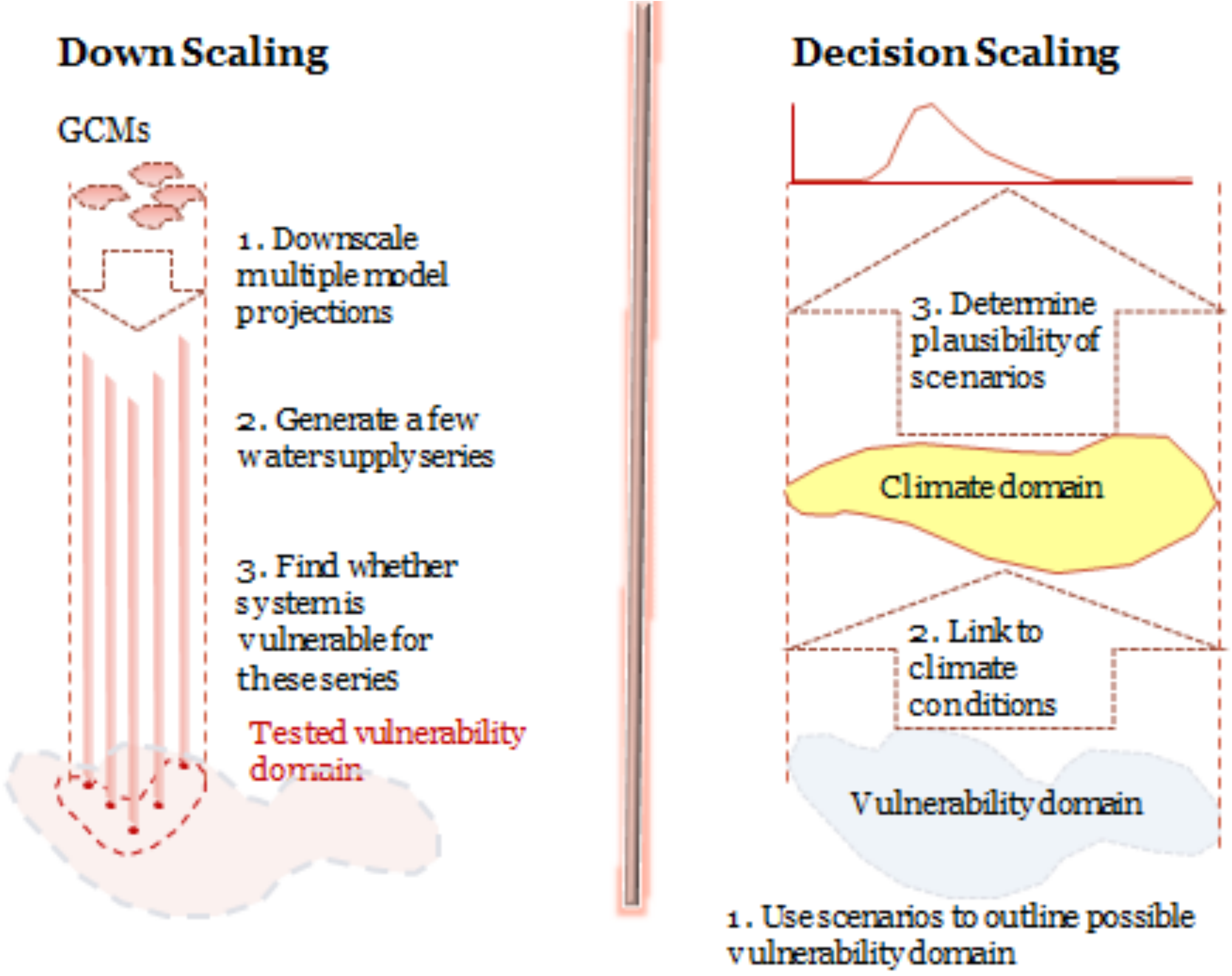


The challenge of planning



GCMs: To use or not to use? That is not the question…..

Perhaps they should be used ***differently***. The GCM outputs should ***supplement*** and ***inform*** the predictions from hydrologic models rather than ***drive*** the hydrologic models"



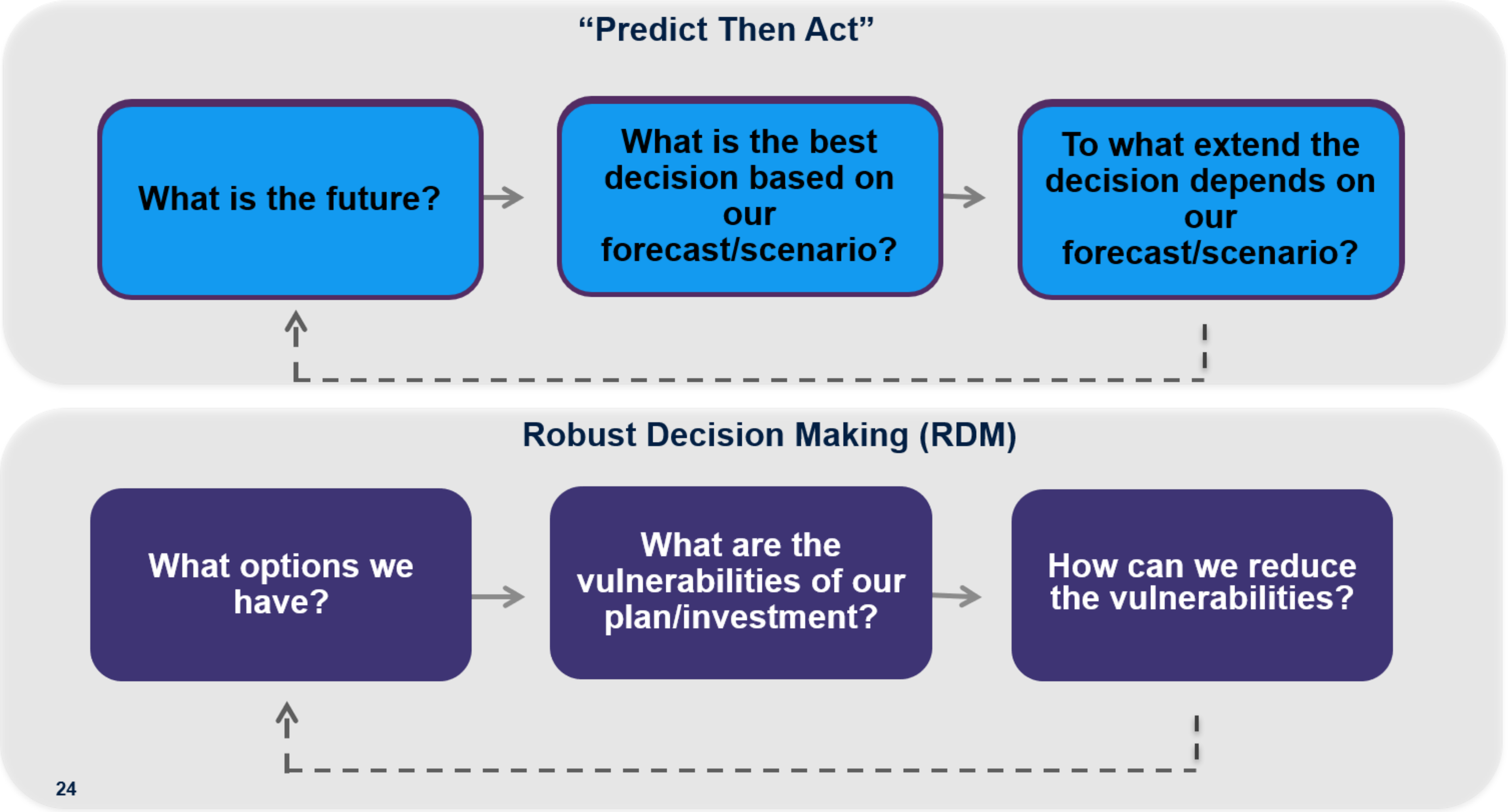
Source: Brown and Werick (2011): A decision analytic approach to managing climate risks. JAWRA

And climate is only one source of uncertainty. We have many others

- Systems performance
- Extreme events
- Demand
- Policy, Institutions, Regulations
- Economic and population growth
- Social aspects
- Land use change
- Tariffs and revenues
- Security, cybersecurity, terrorism

ROBUST DECISION MAKING UNDER UNCERTAINTY

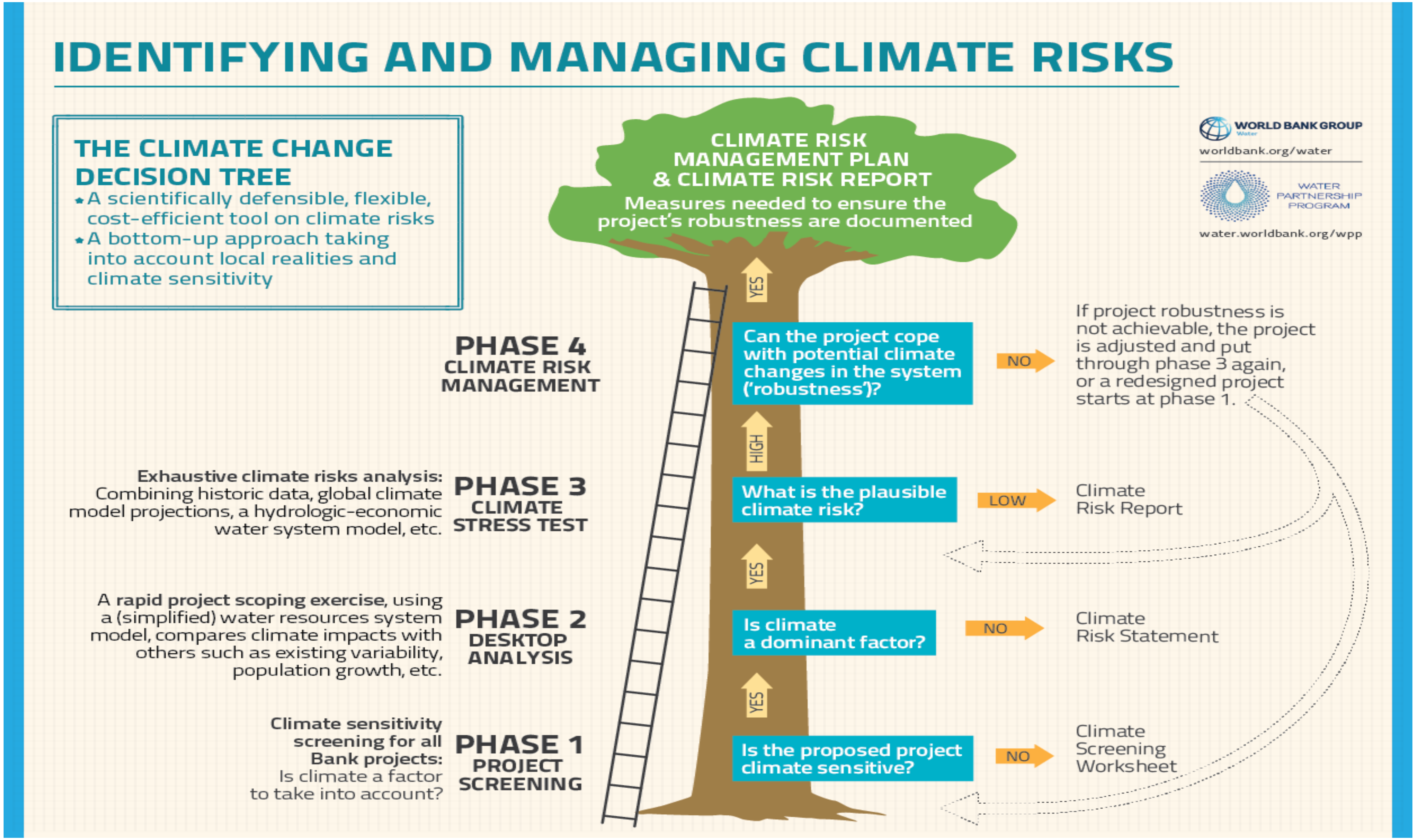
Robust Decision Making (RDM) methods ask: What are the limitations of our plans and investments and how can we improve them?



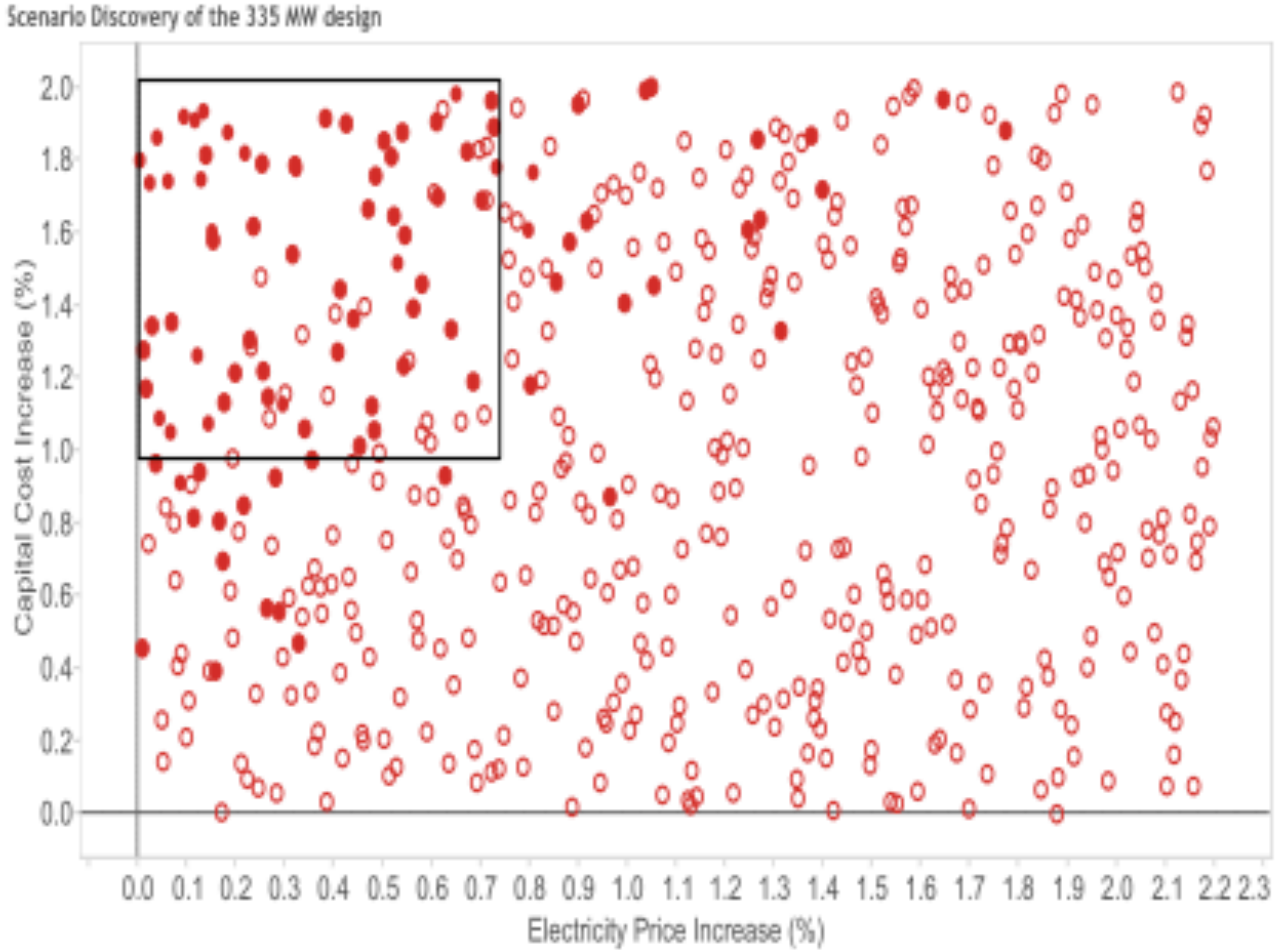
Motivations for a Robustness-Based Approach

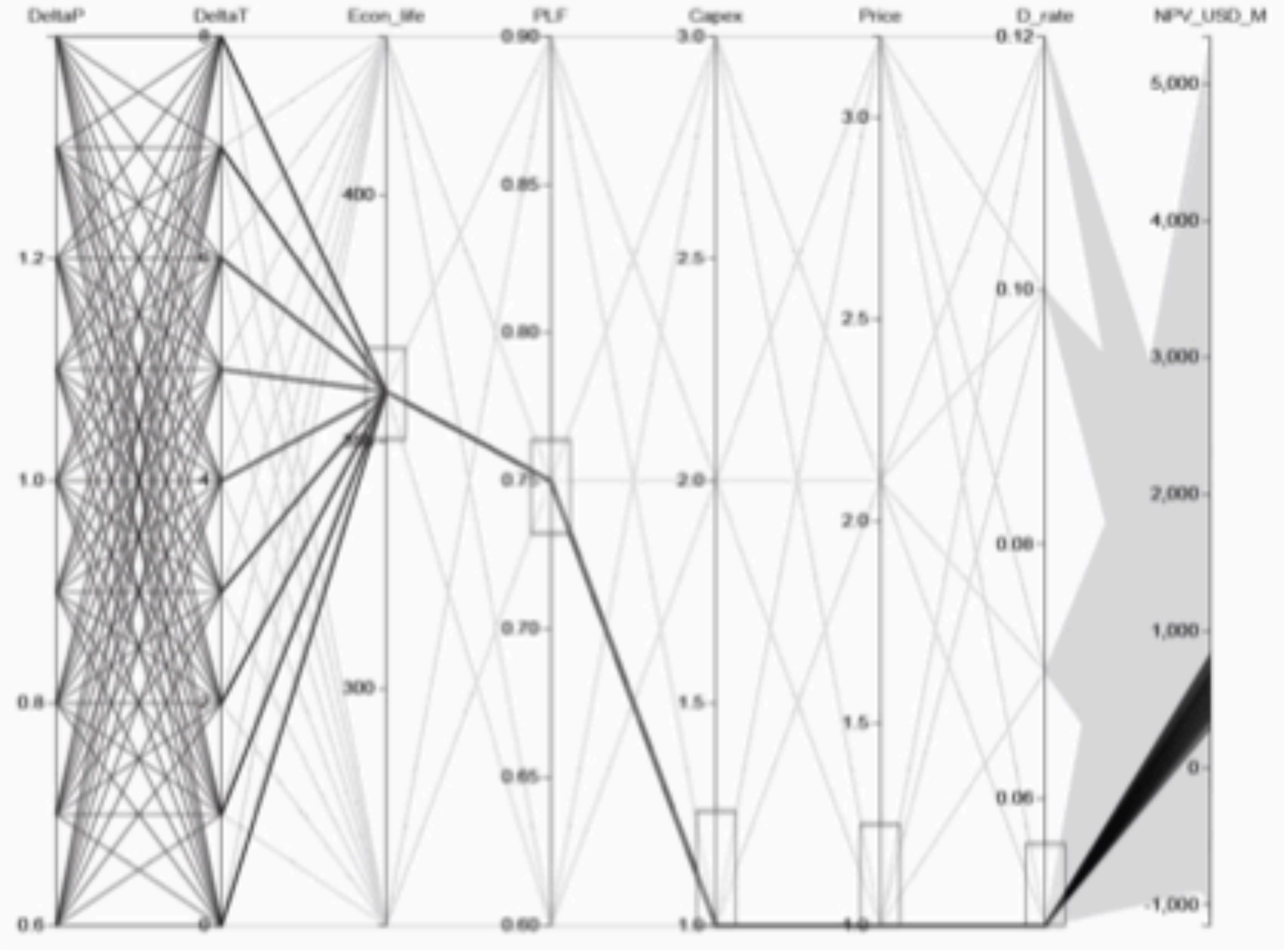
We don't try to guess what the future conditions will be, we try to be robust and flexible

Addressing uncertainties



Addressing uncertainties

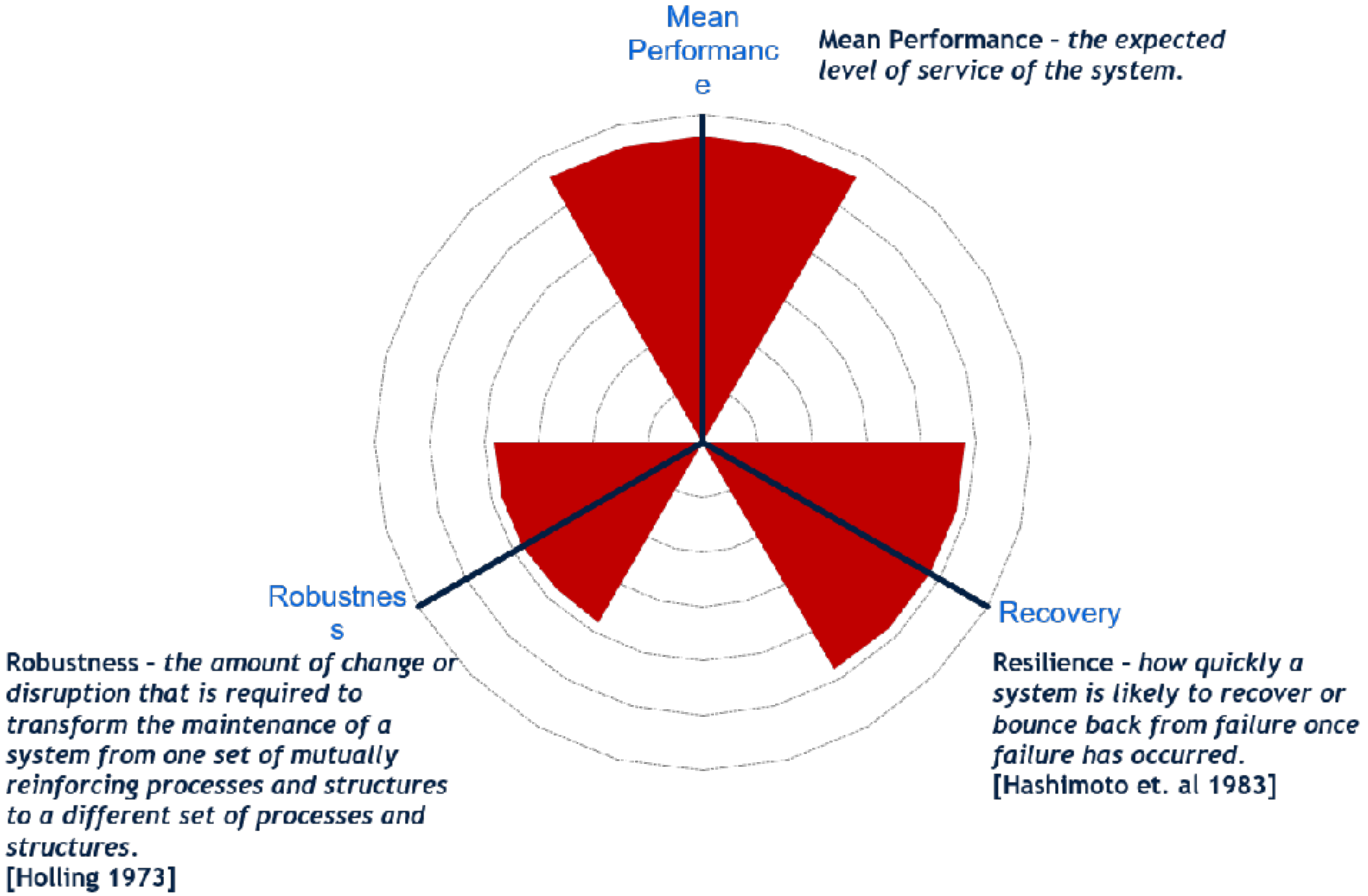




The need to incorporate other metrics

What would we like to know:
-how often and
-how bad the system fails,
-and if it fails how can it recover?
-How is the performance under multiple plausible future climate states?

- Reliability = number of failures
- Vulnerability ~ maximum damage
- Resilience ~ recovery
- Sustainability ~ trend in performance
- Robustness = project performance over plausible climate range



An example: Cutzamala System

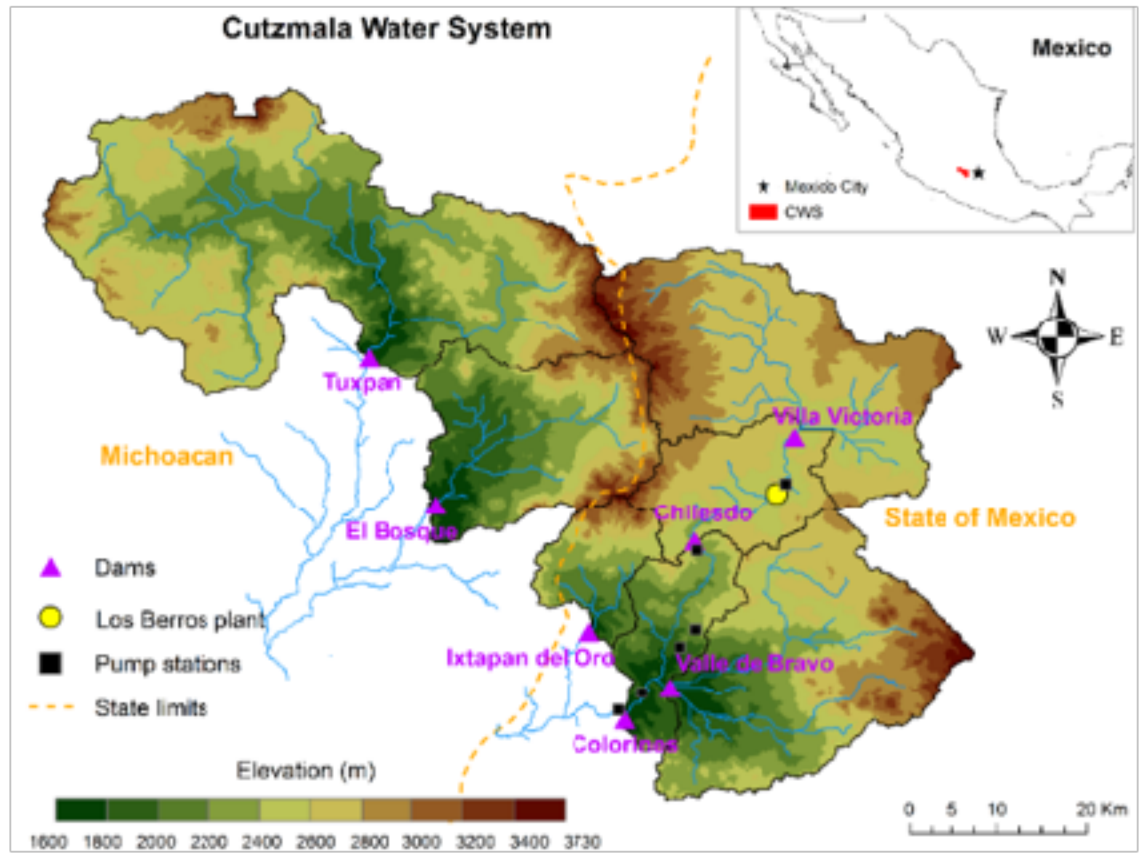
Significant challenges in the Valley of Mexico

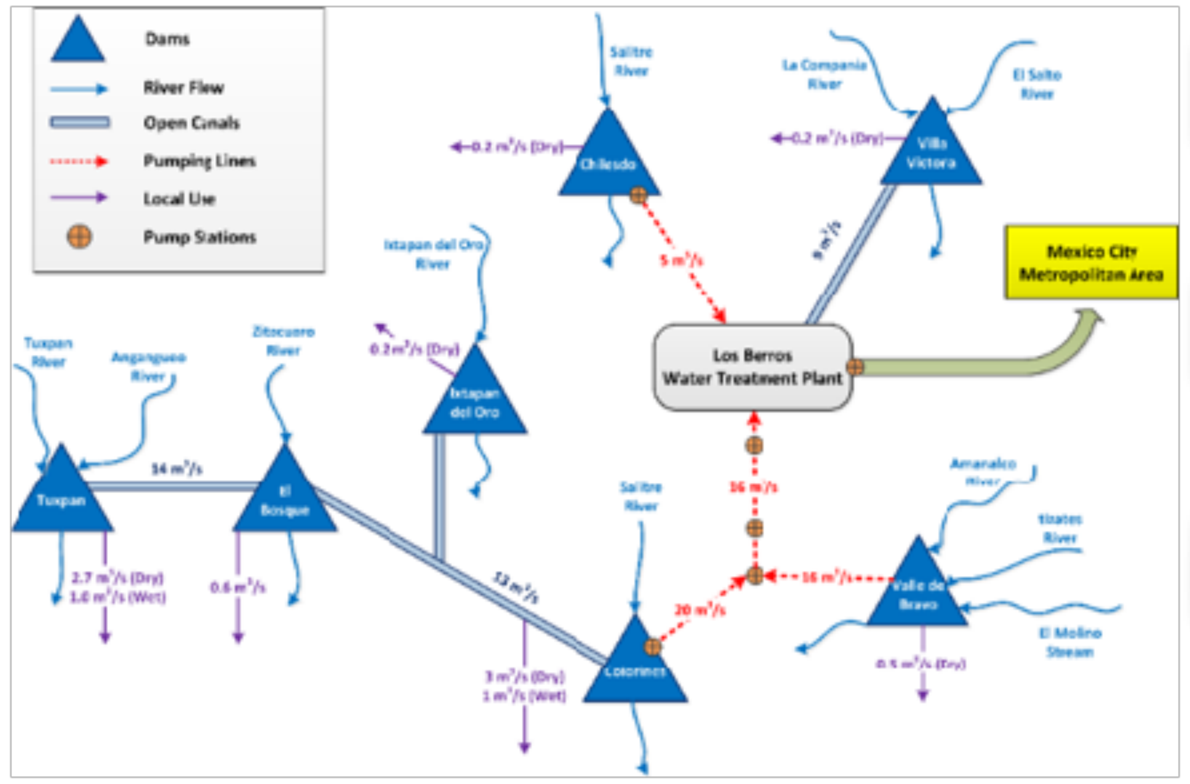
By 2025, the percent of Mexico City's population with access to acceptable quality of water service is projected to decrease from 82% to 28%.

- Overexploitation of the aquifer is currently estimated at double the recharge rate,
- Subsidence in the city ranges from 4 to 26 cm per year, depending on part of city
- Losses in the distribution system are estimated to be 42% of the total water supplied to the city (this includes water not accounted for, illegal capture and leakages).
- Equity and inclusivity are major issues; water scarcity and shortages are borne disproportionately by the poor.
- Urban flooding and storm water management are a chronic problem.
- The system is highly vulnerable to earthquakes and slow to recover

Collaborative modeling framework

Cutzamala





Inputs

Temperature*

Precipitation*

(HYMOD)

Objectives

(metrics based on performance targets)

Max MCMA Target Deliveries*

Max Agricultural Target Delivery *

Max equity of allocation

* *Indicates variable treated as uncertain in the analysis*

Internal Variables

Systems Model

- Network (Pipes & Canals)
- Pipe and Canal Capacity
- Reservoir capacities *
- Reservoir and pumping station operations
- Agricultural withdrawals*

Decision Variables

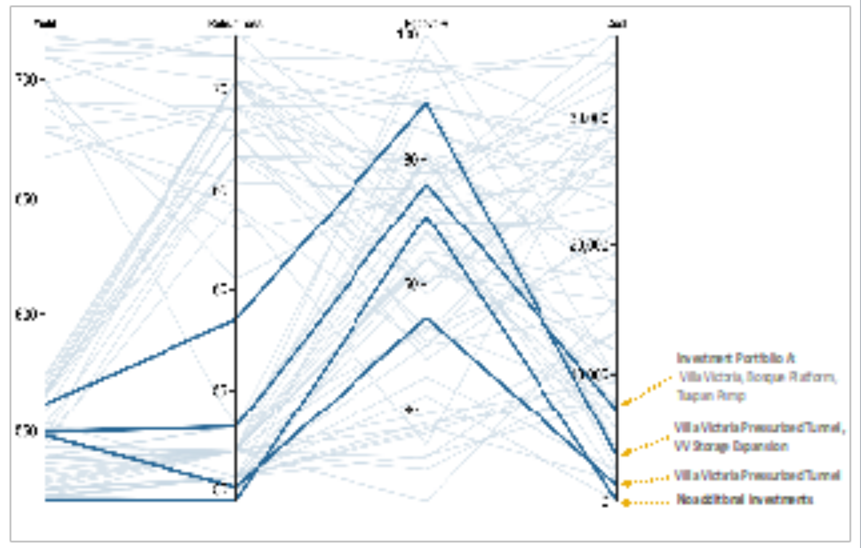
- Investment options
- Reservoir operations

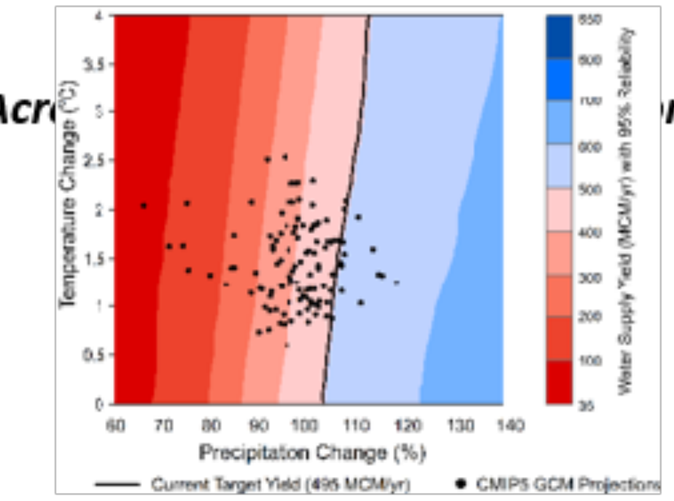
Outputs

Simulated vs Target Deliveries

Performance Metrics

Investment Portfolios



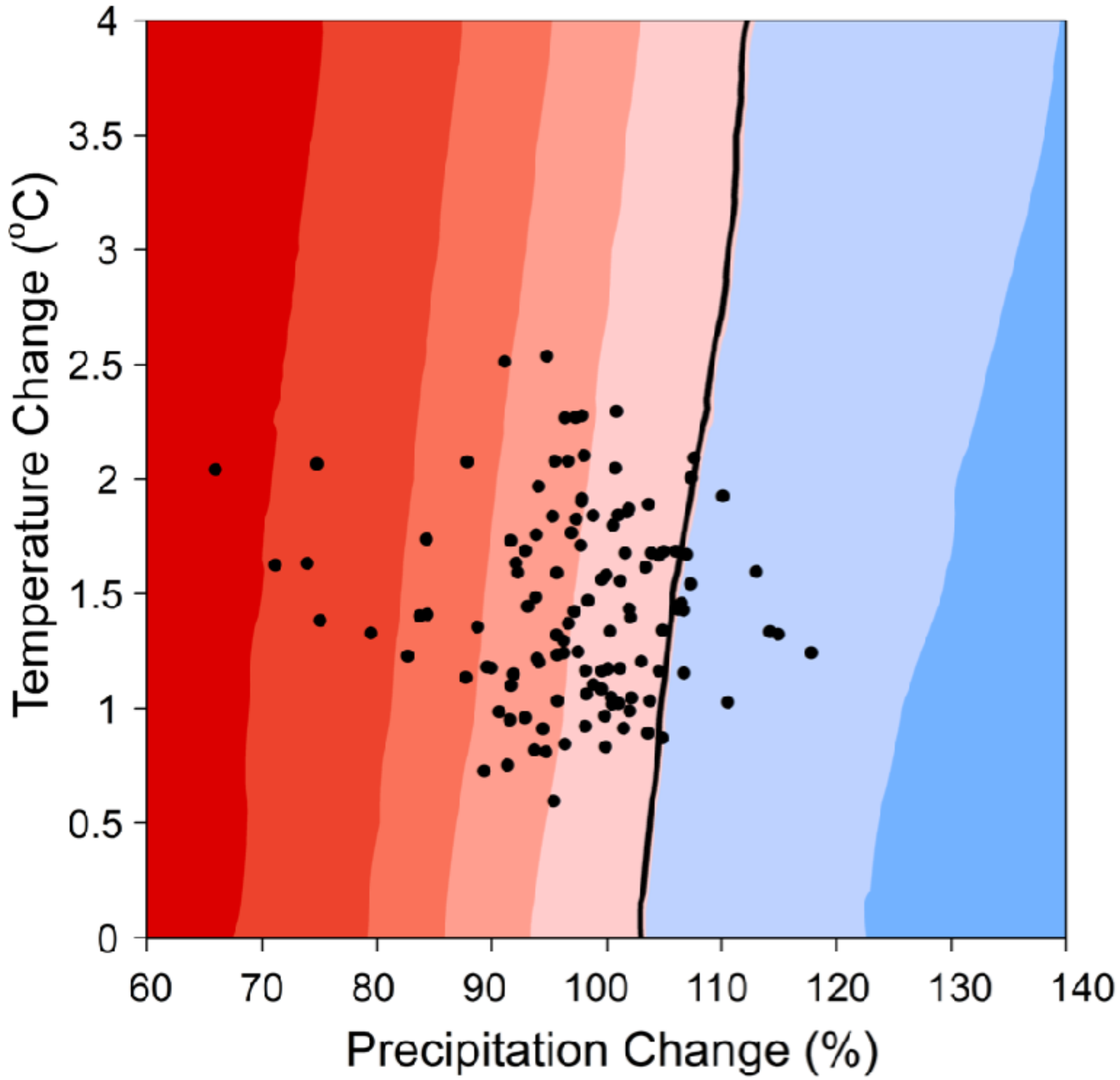


Some results: comparing investments

- Current system is very vulnerable to climate change.

- The system can be substantially improved through reoperation of current infrastructure as well investment in connectivity within the systems.

- Evaluation of options in relation to resilience metrics helps to produce solutions that will be robust to multiple futures.



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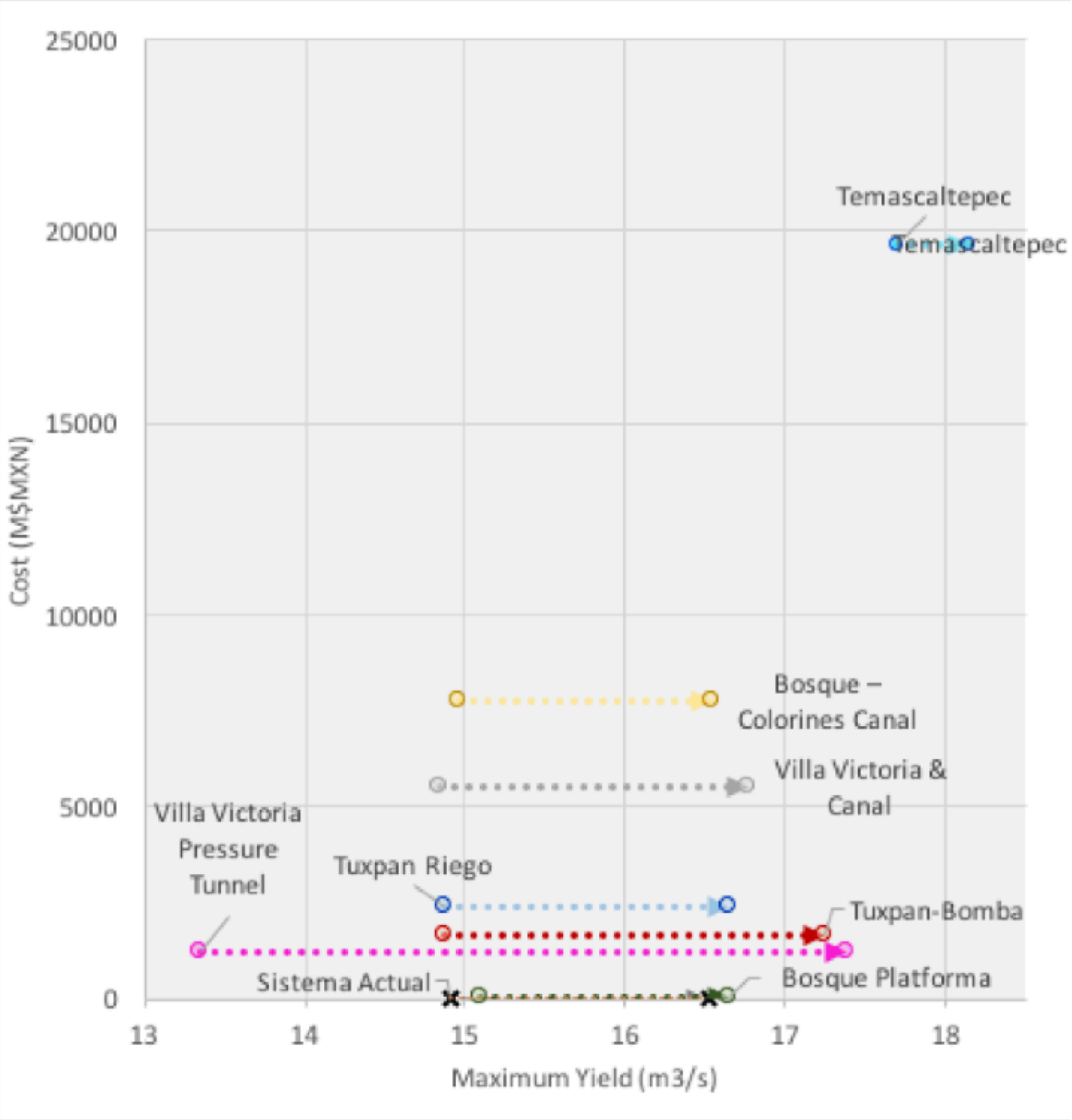

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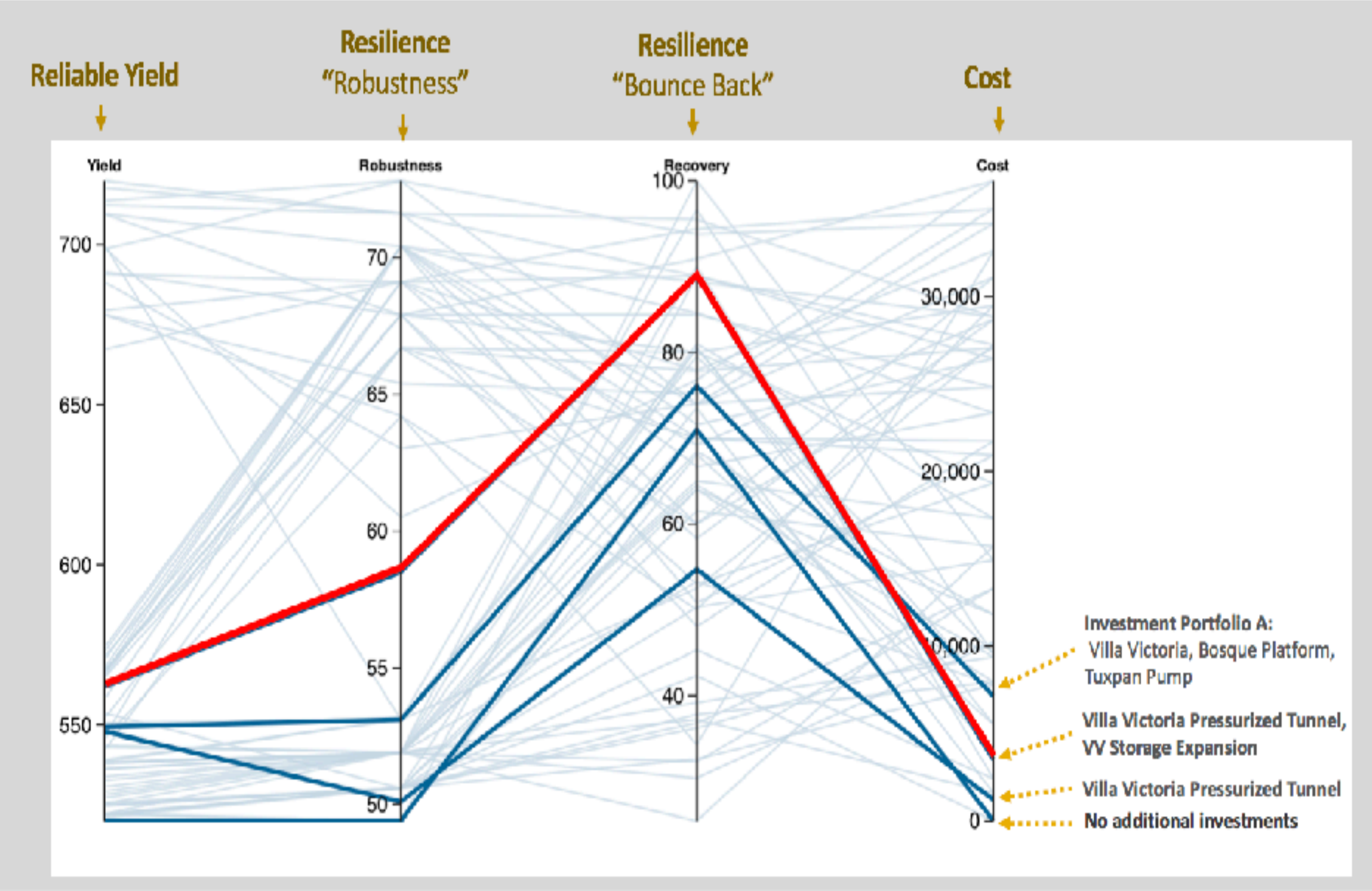

Tradeoff comparison of investments across multiple objectives

Inversión	Rendimiento Máximo (m3/s)	Confiabilidad (%)	Recuperación (dias)	Desempeño durante sequia (%)	Costo (MM$MXN)
Sistema Actual	14.87	94.6	>6	87.0%	-
Bosque Plataforma	15.09	97.2	3	98.0%	$ 25.21
Tuxpan -Bomba	14.87	94.6	>6	87.0%	$ 1,639.63
Tuxpan Riego	14.87	94.1	>6	86.3%	$ 2,425.19
Villa Victoria & Canal	14.84	94.1	3	92.4%	$ 5,538.20
Bosque – Colorines Canal	14.97	96.0	>6	90.4%	$ 7,782.53
Temascaltepec	17.69	98.5	3	99.3%	$ 19,675.53

5 KEY TAKEAWAYS

5 Key Takeaways

- Facing a new reality with multiple challenges. Need to move for risk and probabilities to embracing uncertainty
- Climate change is an aggravating factor that cannot be analyzed in isolation from other factors
- Traditional planning and investment design processes and methods are not sufficient
- Different approaches exist and have been applied for over a decade and help to mitigate the perfect storm
- Approaches need to be bottom up and with the participation of key stakeholders

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