Addressing Uncertainties in Water Resources Projects: The Decision Tree Framework – Its history

A thinking process that started in 2008

- A review of Selected Hydrology Topics to Support Bank Operations

- – Workshop HQ November 2008 + BNWPP/HEF Publication
  - Climate variability and change one of the topics discussed
  - Its implications in WR systems management
  - One more factor to consider or different criteria needed? (non-stationarity)

- Uncertainty and Climate Variability in the Design and Operation of Water Resources Projects – WPP/WET publication November 2011
  - Many uncertainties, not only from CC
  - Including those from models and data
  - And also from GCMs

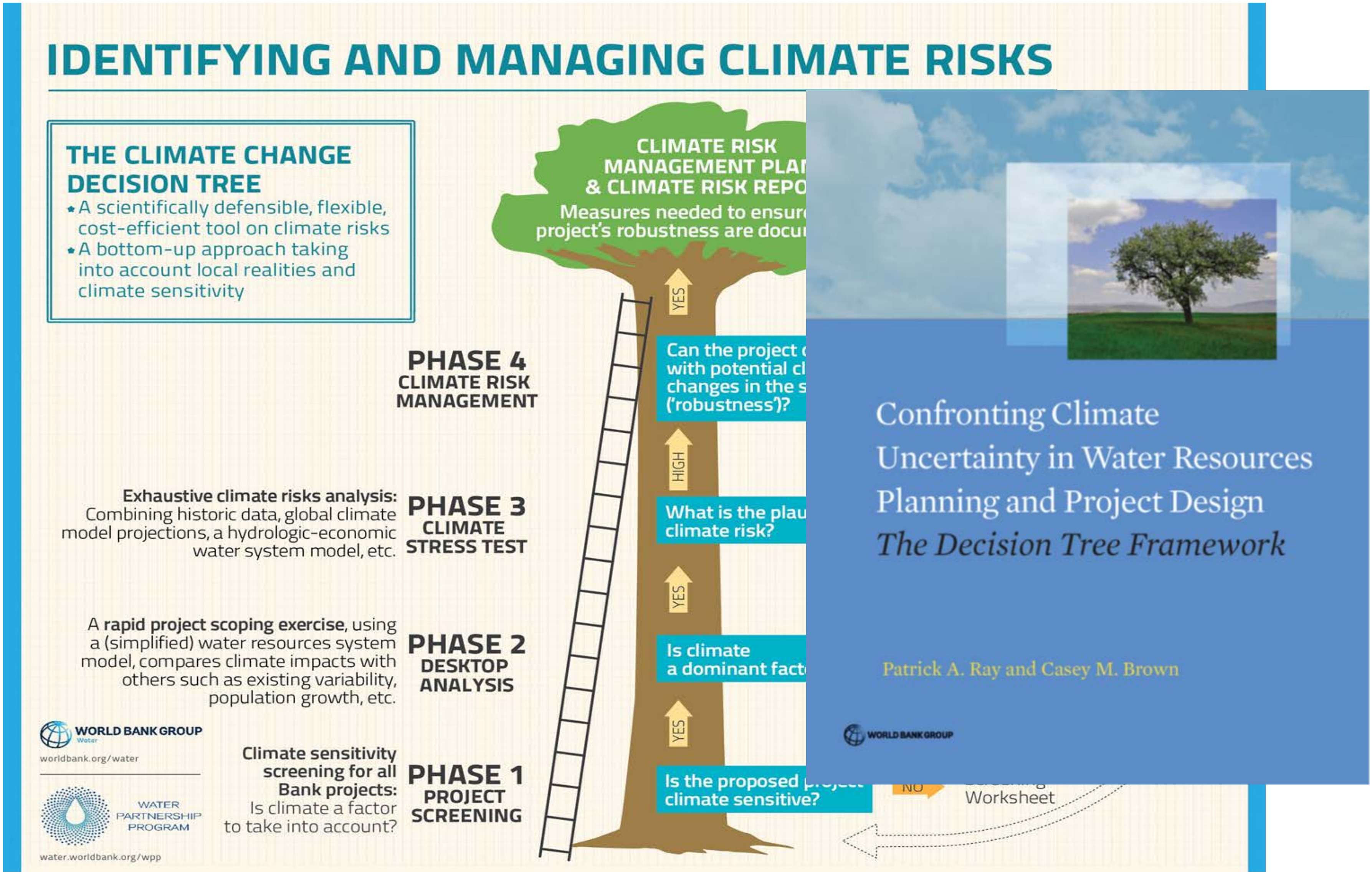
To respond to a practice that was not giving us elements for decision making in investments

To design a reservoir or a spillway for example, what could we do?

- Literature abounds with papers that discuss the outputs from **GCMs,**
- With approaches to **downscale** this climate information to regional scale hydrology, and
- With applications of various physically based and statistical **models** for estimating the hydrologic quantities needed for decision making.
- Was **downscaling GCM outputs** becoming the "norm"?

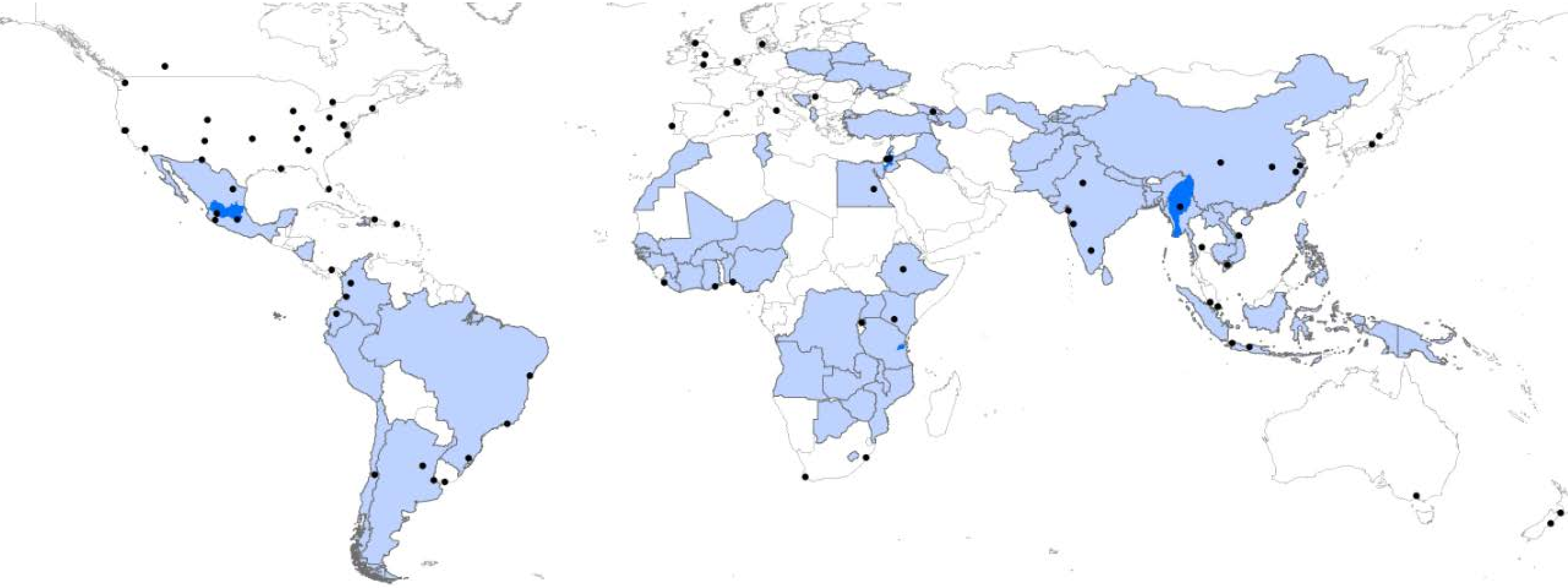
GCMs → Downscal e → Bias correction → Hydrologic model → **Design**

From risk to addressing vulnerabilities



The Opportunity:
Cities, World Bank and Water Resilience:

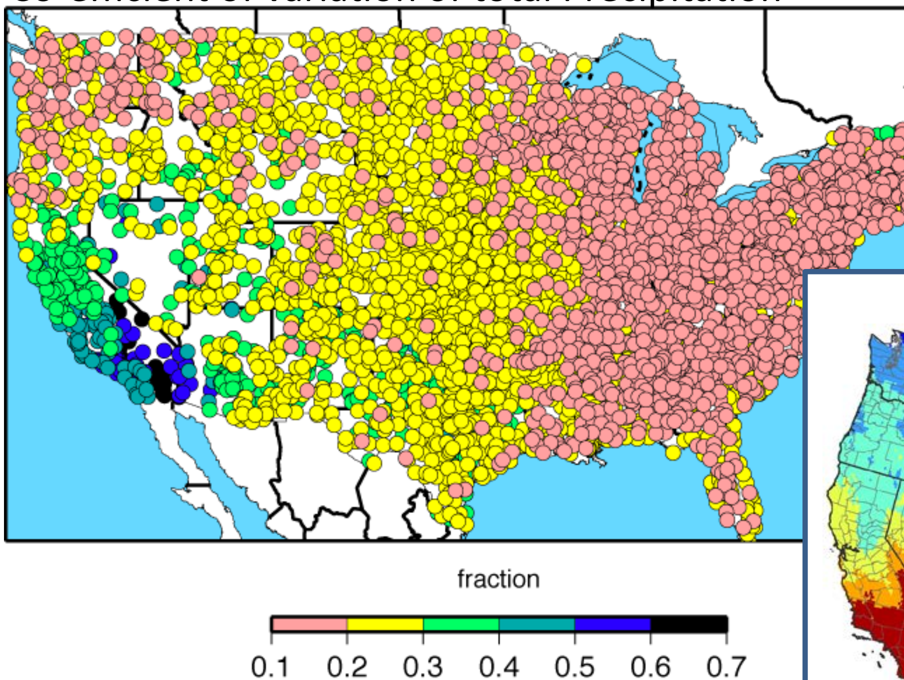
- 65% of Resilient Cities face water related risks
- World Bank water investment portfolio of $6B
- Can we leverage WB investing and Resilience Strategies to ***transform water infrastructure***?



California's Climate Uncertainties are Unique

Natural Inter-Annual Variability

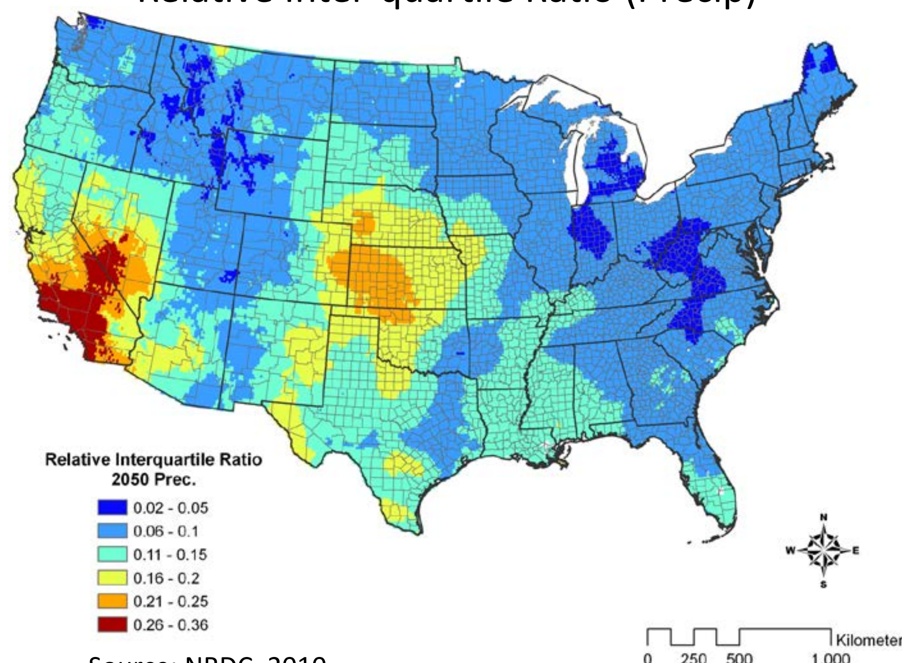
Co-efficient of variation of total Precipitation



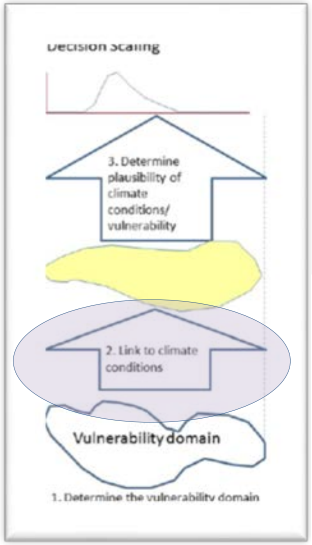
Source: Dettinger, 2011

Climate Model Disagreement

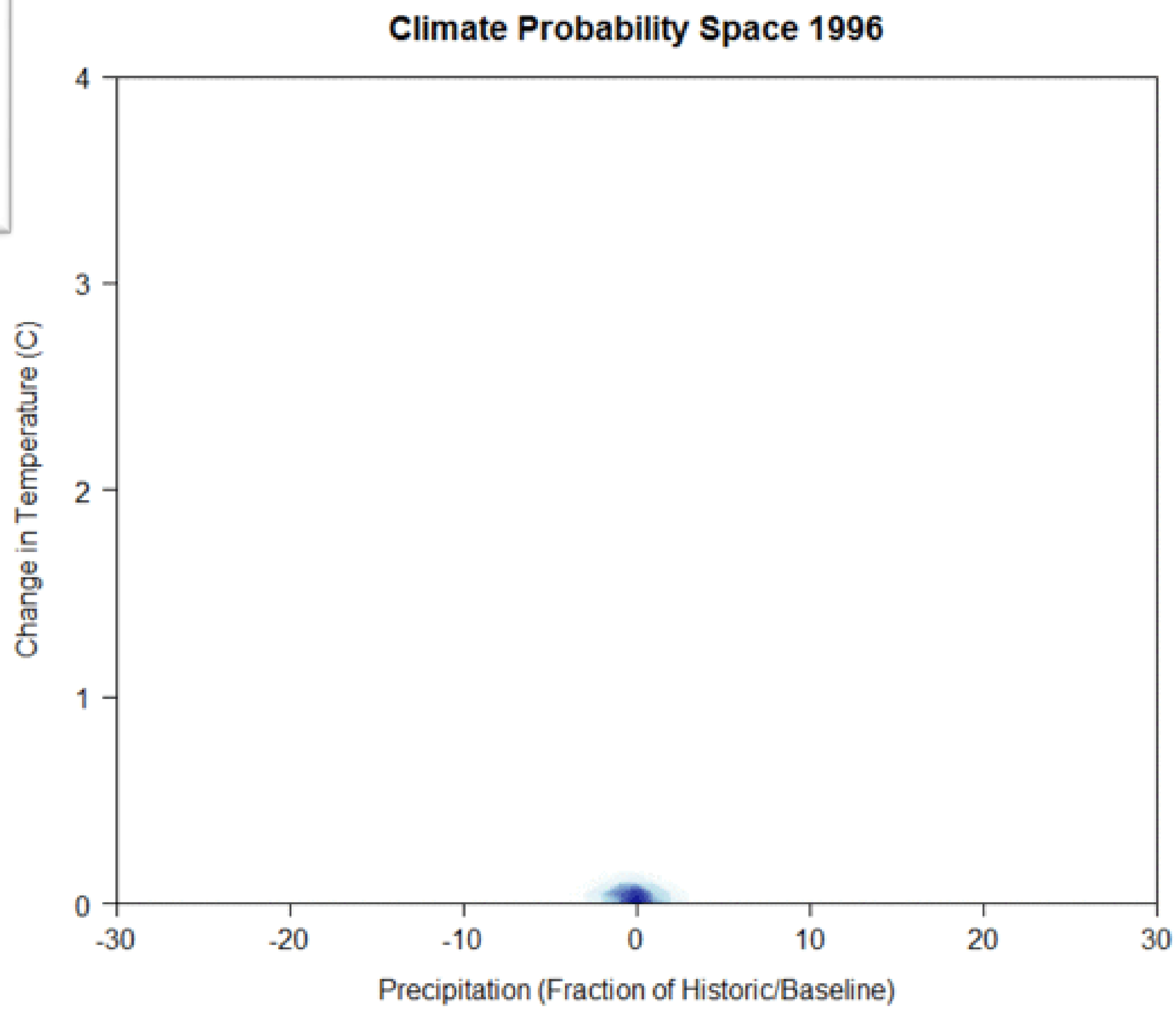
Relative Inter-quartile Ratio (Precip)



Source: NRDC, 2010

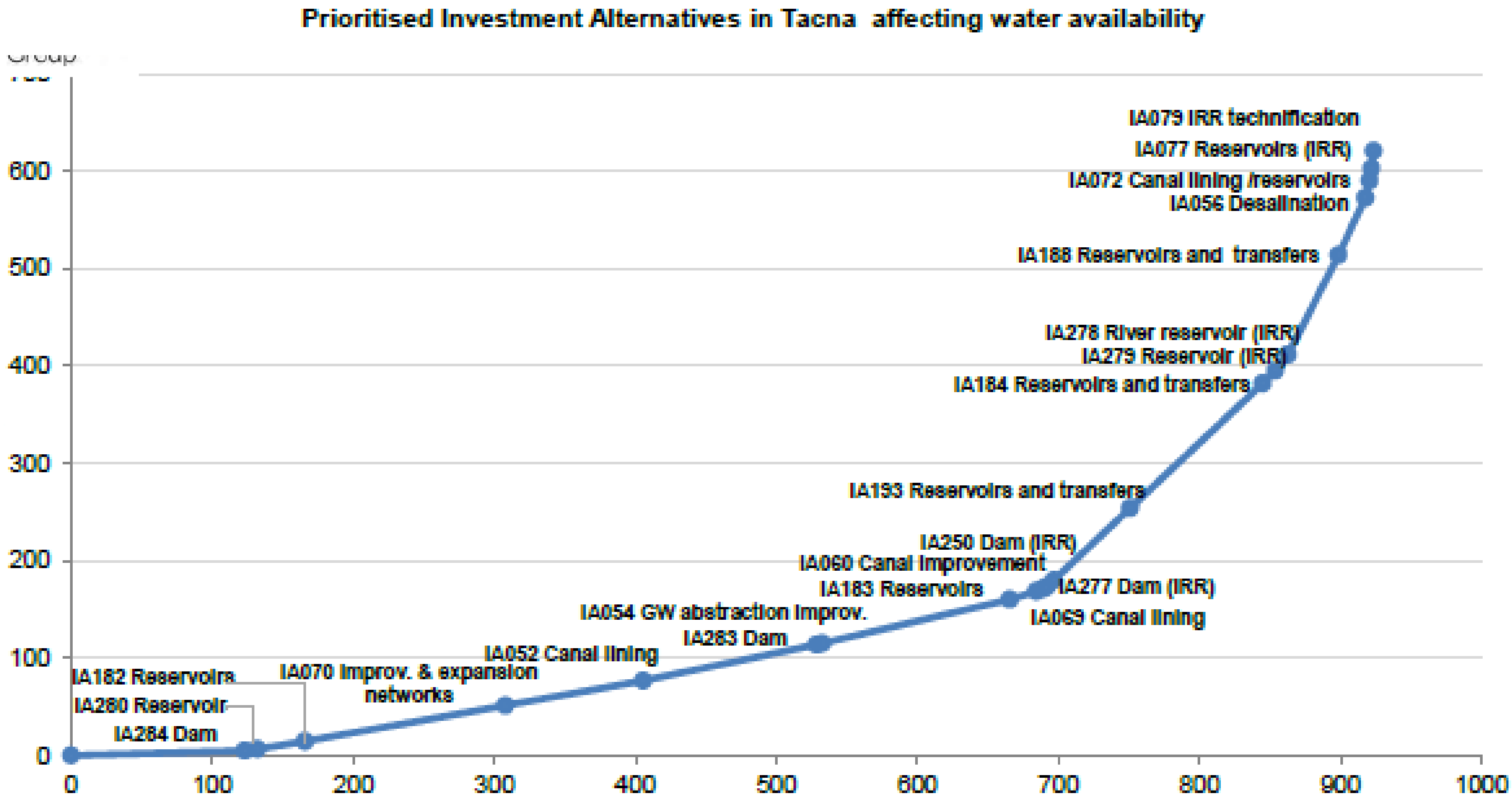


An Uncertain Future Climate



Supply Cost Curve – One Future

Figure 5-20: Cost curve for investment alternatives in Tacna catchment



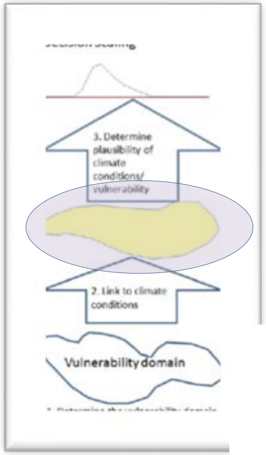
Cost per Investment

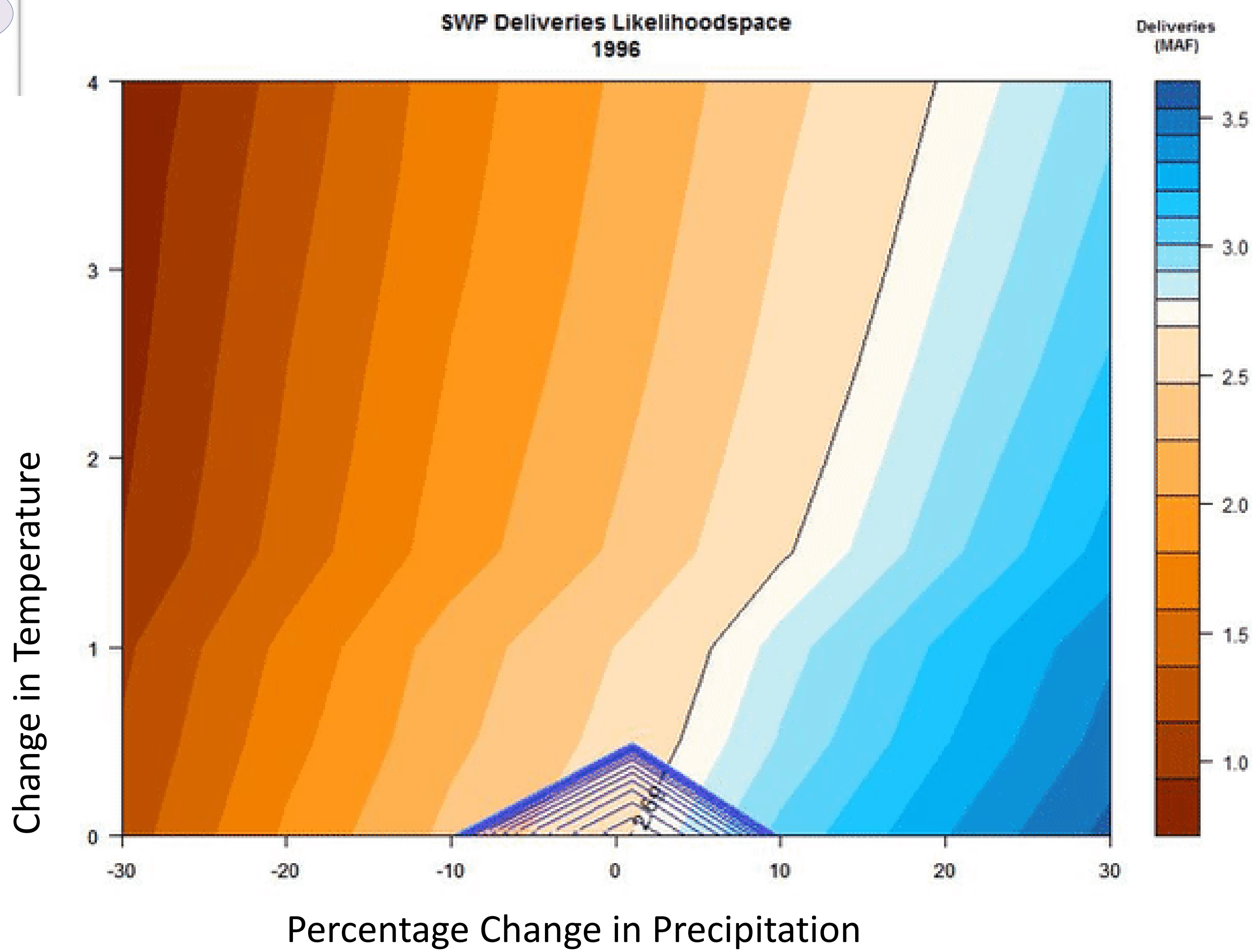
Additional Water per Investment

Resilience by Design

Current Practice		Our Approach
Single objective	the **risk** in current practice	*Multiple objectives*
	Focus on Cost Minimization misses potential resilience benefits, creating fragile systems	Resilience of: • **Economic/Service objectives** • **Social/Equity objectives** • **Environmental objectives**
Single future		*Multiple futures*
	Overconfidence in our expected future leads to	Future Climates Population Growth and Demographic Change Economic Growth and Change Changing Societal Preferences
Single project		*Multiple projects*
	Considering the best design for a single project misses opportunities for integration and diversification	Link urban investment program and policies with investments and policies in the connected river basins, and the evaluation of benefits and costs in each location

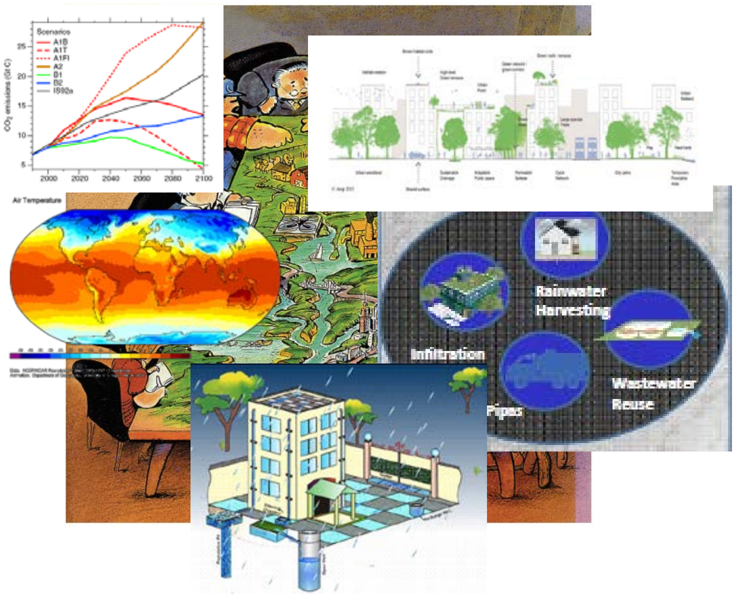
California Water Supply



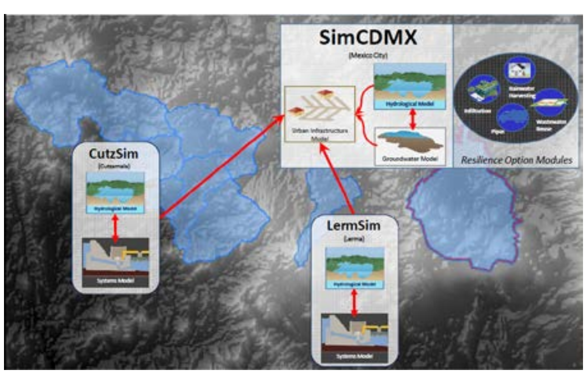


Resilience by Design

1 **Define Resilience and Scope**



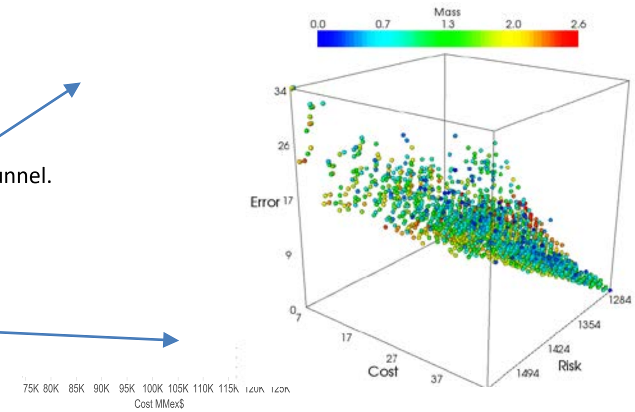
2 **Collaborative Modeling**



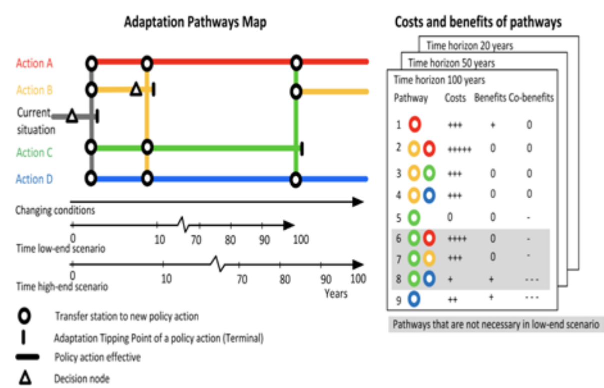
3 **Data Analytics discovers optimal resilience investment portfolio**

Enlargement of the Bosque-Colorines tunnel.

Construction of Temascaltepec

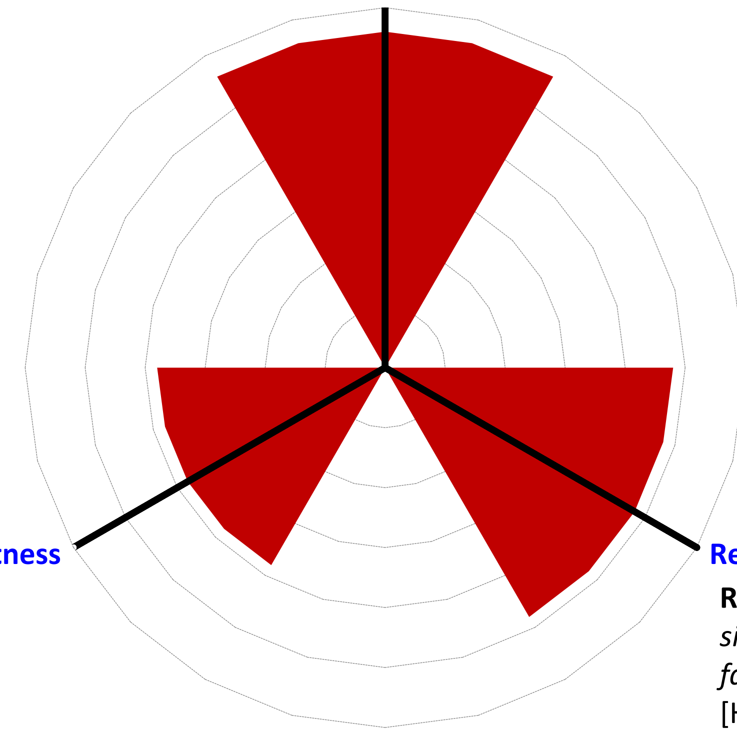


4 **Design Water Security and Resilience Plan Implementation**



Resilience Evaluation

Opciones que mejoren el desempeño, robustez y resiliencia



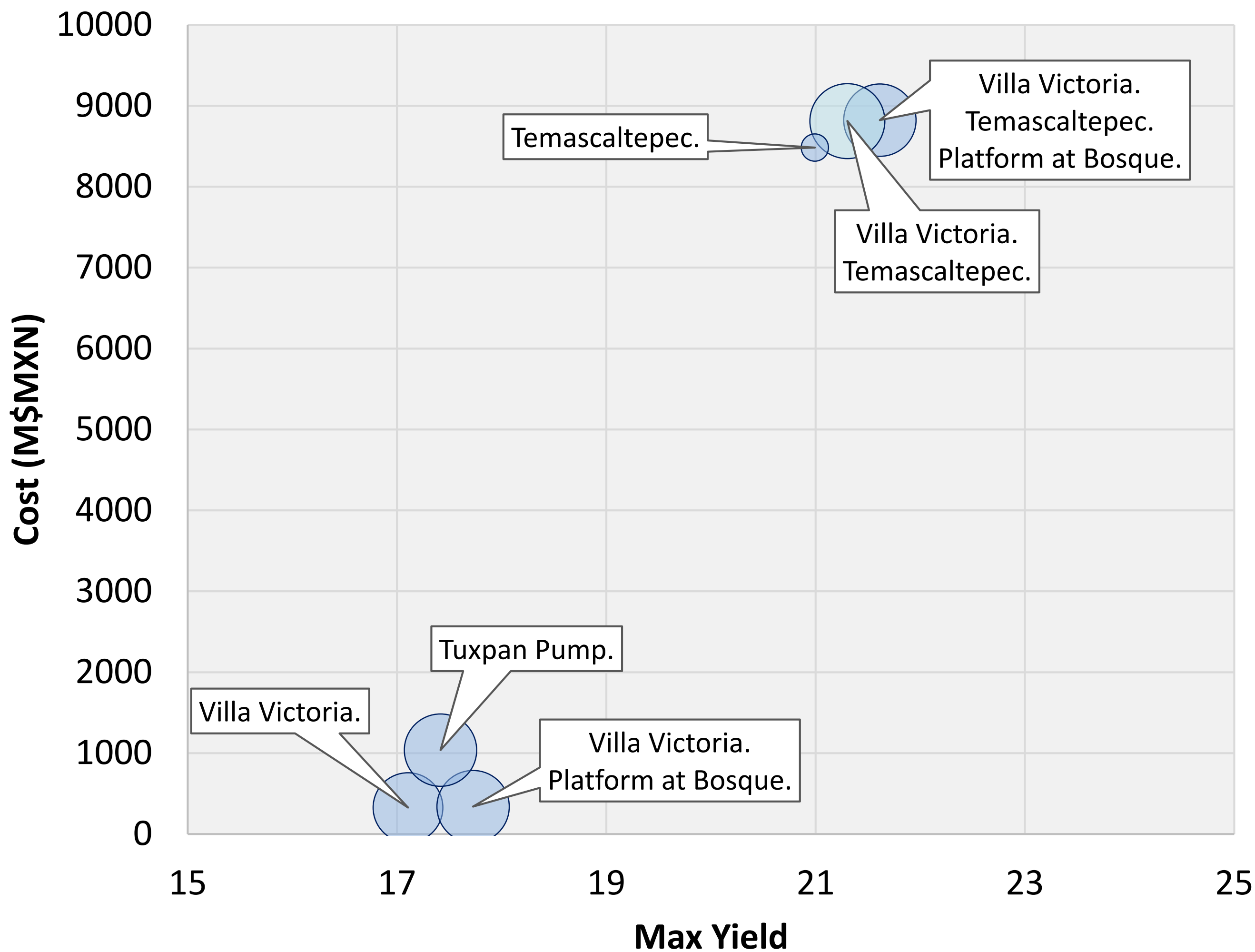
Promedio de desempeño – *el servicio esperado del sistema*

Robustez – *el cambio o disrupción que es necesario para transformar el mantenimiento de un sistema de una series de procesos y estructuras a un numero de procesos y estructuras diferentes*
[Holling 1973]

Resiliencia – *que tan rápido un sistema se recupera de una falla una vez la falla ocurrió*
[Hashimoto et. al 1983]

Resilience Evaluation

Circle Size = Resilience



Conclusion

- Cities are key players in Basin Freshwater Resilience, and City resilience is dependent on Basin Resilience

- There's a significant and important opportunity to re-engineer water investment

- Performance-based resilience as basis of optimized investment design