ADB

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Basins Adapting to Climate Change – Approaches to Managing Uncertainty

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Uncertainty and its Souces

- Scenario assumptions
  - drivers of change (population, technology, …)
  - corresponding emissions trajectories
- Atmospheric sensitivity to GHG
- GCM specification (models vs reality)
- Initial conditions
- Regional climate (downscaling)
- Regional impacts (sectoral models)
- Shocks (volcanic eruptions, …)

Uncertainty we can quantify

Uncertainty we can anticipate

Total range of uncertainty (unknown)

Strategies for Managing Uncertainty

- ***Resilient Strategies:*** **use measures that provide reasonable adaptation over a wide range of future conditions (including present)**
- ***Adaptive (Iterative) Strategies:*** **use measures that can be adjusted, corrected and modified as new information becomes available**
- ***Decision-Scaling:*** **determine vulnerability independent of likelihood; assess *plausibility***
- ***Precautionary Strategies:*** **use measures that minimize the maximum harm (minimize risks of severe, low-probability scenarios)**

Resilient Strategies

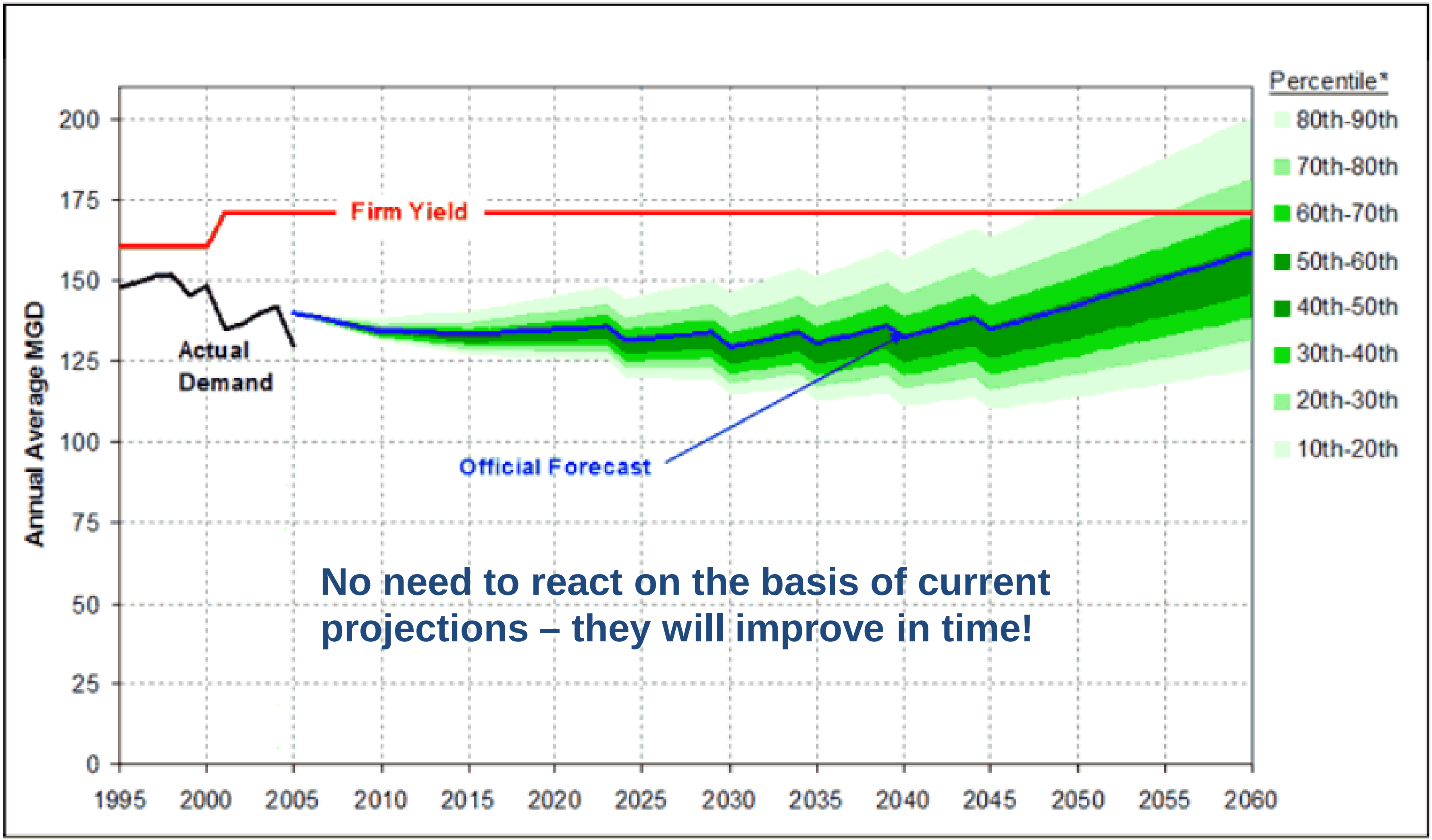
- ***No-regrets Strategies***: generate net benefits independent of how, or whether climate change occurs (but benefits might be greater under CC!)
- ***Low Regrets strategies***: for which climate change readiness can be introduced at low costs
- ***Win-win strategies***: provide net benefits in other areas or sectors while also reducing vulnerability to climate change
- ***Robust strategies***: can be demonstrated to perform *acceptably well* under a wide range of conditions – e.g. less specialization, more *diversification*

Resilient Strategies in the Water Sector

Adaptation Measure	Regrets	Cost	Technical Difficulty
Supply Side:			
Diversification of sources	Low	High	Medium
Construct additional storage	Medium-High	High	Medium
Watershed management, source protection	Win-Win	Low	Low
Advanced water treatment (recycling, desal)	Low	High	Medium
Reduce non-revenue water	Low	Medium	Medium
Demand Side:			
Metering	Low	Low-Medium	Medium
Low-use appliances	Low	Medium	Medium
Consumer behavior change	Low	Low	Low

Source: World Bank (2006)

Incremental Strategy: Seattle Water Supply



No need to react on the basis of current projections – they will improve in time!

Source: Paul Fleming, C40 Conference on Climate Change,Tokyo, Oct. 22, 2008

Decision Scaling: Irrigation in the Brantas

- 85,000 Ha irrigated area, 2-3 crops per year, reservoir supply
- Hypothetical temperature changes of +1, +2, +3, +4 °C
- Hypothetical rainfall changes of 0%, -5% (annual)
- Changes in runoff estimated using climatic water balance

Aridity Index:

$$\phi = \frac{ET_0}{P}$$

(ratio of potential annual evapo-transpiration to annual precipitation)

Turc-Pike equation:

$$\frac{E}{P} = F(\phi) = \frac{1}{\sqrt{1 + \left(\frac{1}{\phi}\right)^2}}$$

(describes actual evapo-transpiration as a function of the AI)

Annual runoff:

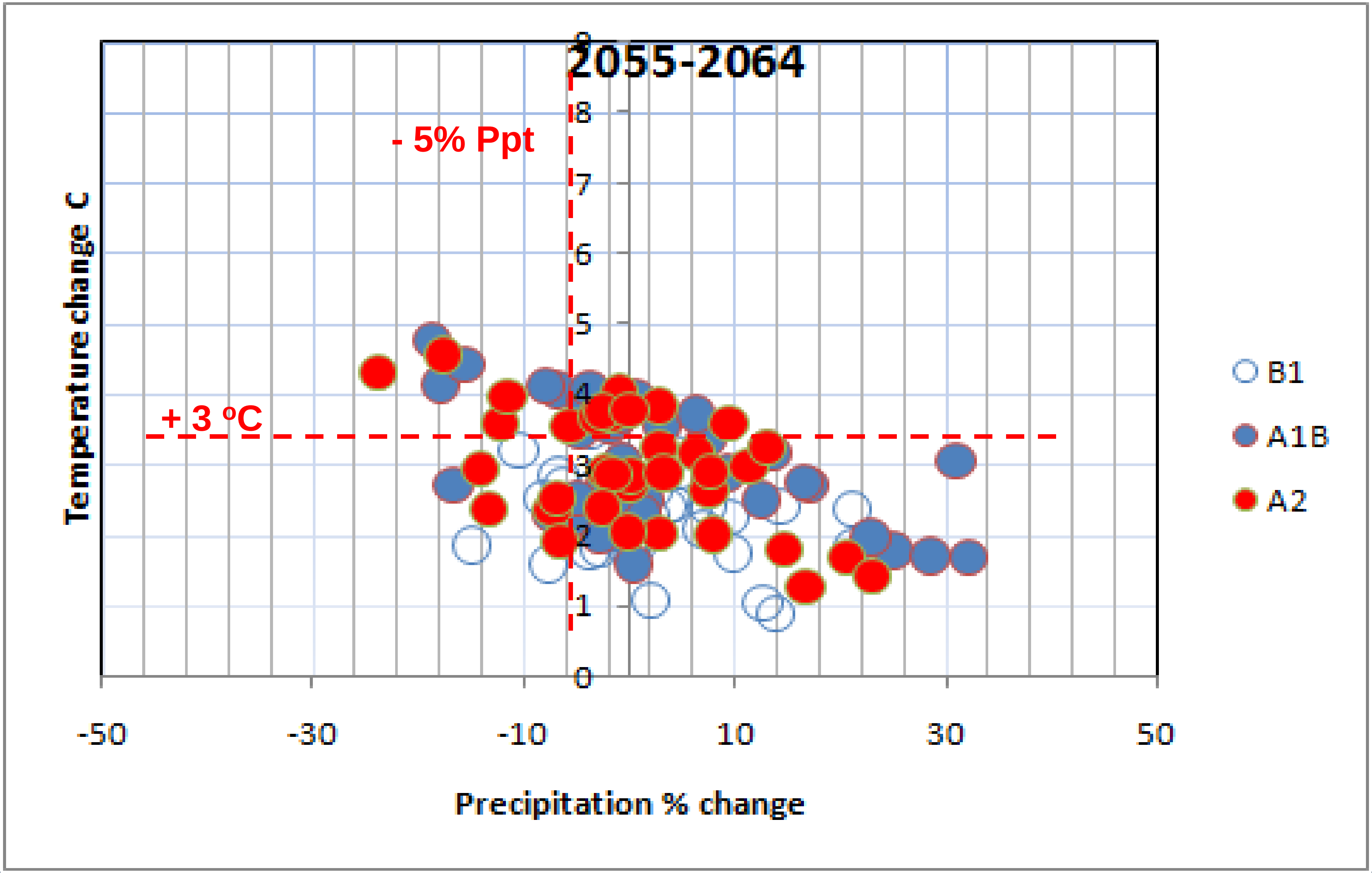
$$Q = P - E$$

(runoff is annual precipitation less annual actual evapo-transpiration)

Results of Sensitivity Analysis

	Changes in:			Reliability of Irrigation by Season		
Temperature	Rainfall	Runoff	Ir. Demand	Season 1	Season 2	Season 3
Baseline				96.3%	100.0%	89.0%
+1 Deg. C	0.0%	-1.8%	2.6%	96.3%	100.0%	81.7%
+2 Deg. C	0.0%	-3.6%	5.1%	95.4%	100.0%	75.2%
+3 deg. C	0.0%	-5.5%	7.5%	88.1%	99.1%	74.3%
+4 Deg.C	0.0%	-7.4%	10.0%	86.2%	99.1%	67.0%
+1 Deg. C	-5.0%	-10.7%	6.0%	84.4%	99.1%	67.9%
+2 Deg. C	-5.0%	-12.5%	8.4%	83.5%	96.3%	59.6%
+3 deg. C	-5.0%	-14.4%	10.9%	74.3%	95.4%	51.4%
+4 Deg.C	-5.0%	-16.2%	13.5%	73.4%	91.7%	39.4%

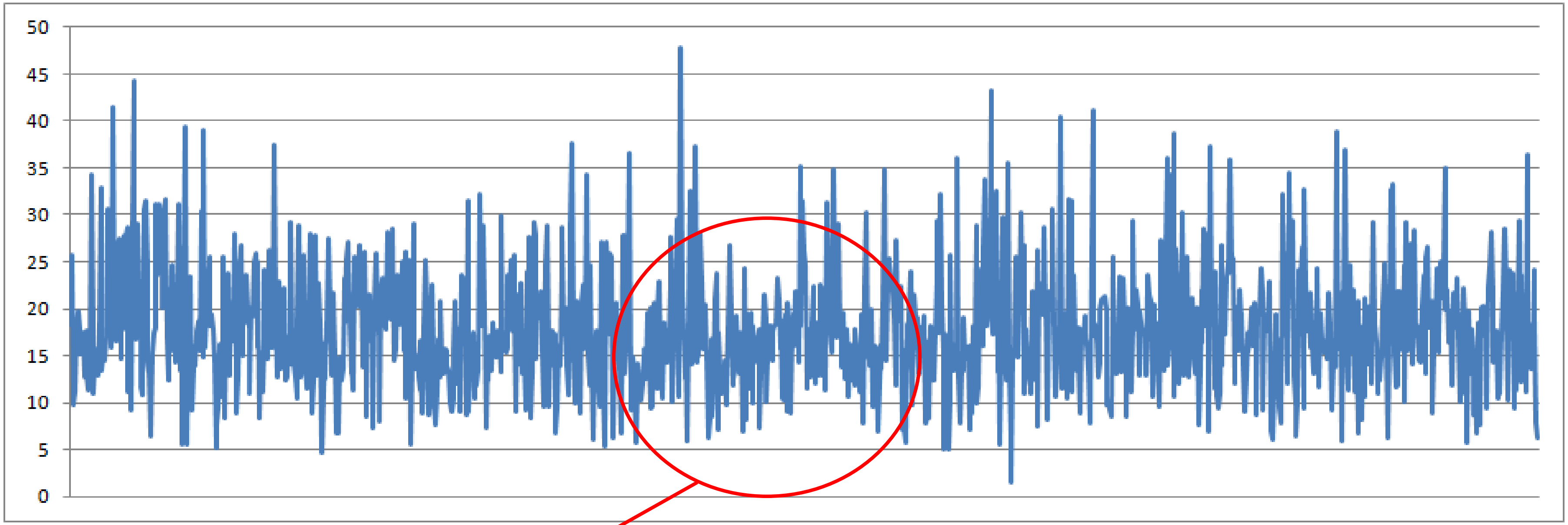
Assessing Plausibility of Difficult Scenarios



112 Projections, Statistically Downscaled CMIP3

Precautionary Strategy: Preparing for Drought

- It is important to know "how bad things can get"
- Models may not be able to provide realistic time series
- Paleo-climate reconstruction used to plan for extreme drought



1,000 years of reconstructed flows on the Sacramento River, California USA

Use decades of lowest reconstructed historical flow as severe drought scenario

Critical Thresholds

Thresholds present special challenges to adaptation, since conditions for resilient strategies can be violated:

- Points of dramatic or qualitative system change
- Irreversibility
- Unpredictability

Examples of critical thresholds include:

- Freezing point of water
- Minimum Day/Night temperatures - rice yields
- Minimum Night temperatures - human survival
- Temperature thresholds for disease vectors (e.g. anopheles mosquito - malaria parasite)
- Critical flood flows for levee-protected infrastructure

Thanks for your attention!

Questions?