CLIMATE CHANGE INFORMATION FOR LONG-TERM WATER SUPPLY PLANNING

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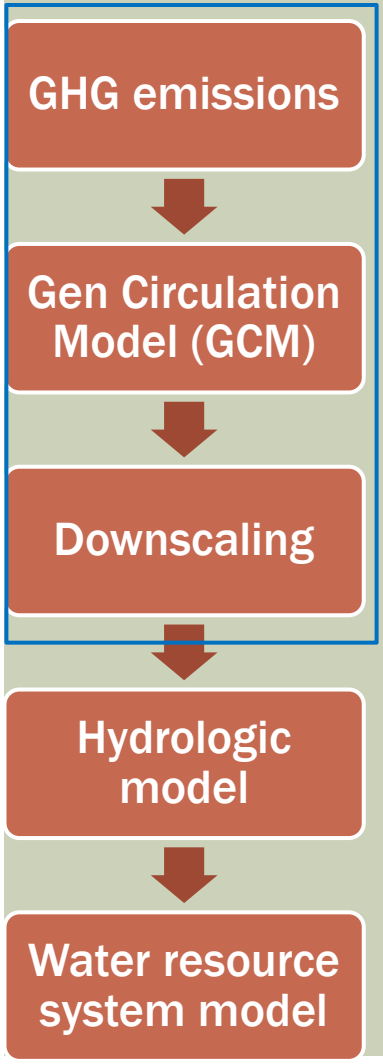
TOP-DOWN CLIMATE ASSESSMENTS

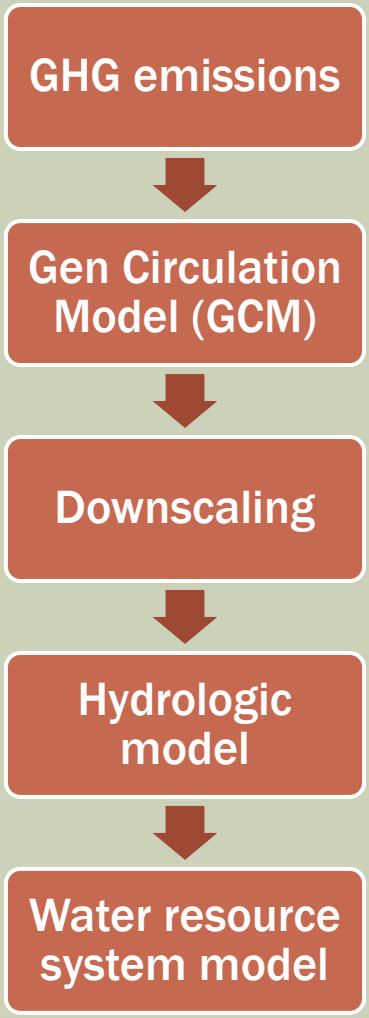


Conventional way: Begin with the climate change projections from General Circulation Models (GCMs)

Use of projections involves many choices and assumptions

- How many GCMs?
- Which models?
- Statistical or Dynamic Downscaling
- Assess skill?
- Correct for biases?
- If yes, what scale, variables, techniques?

GCM-DRIVEN CLIMATE ASSESSMENTS



Use of projections involves many choices and assumptions which

- affect the output, add uncertainty
- affect interpretation of output
- are often debated; are hence subjective

Focus on the projections and characterization of uncertainty

Focus rarely on the system under study

Result: Limited actual usability for decision making

OBJECTIVE

1. Decision-centric climate assessments

2. Approach proposed for Orange Water and Sewer Authority (OWASA)

DECISION-CENTRIC APPROACHES

OR

BOTTOM-UP/ VULNERABILITY-BASED/BOTTOM-UP MEETS TOP-DOWN

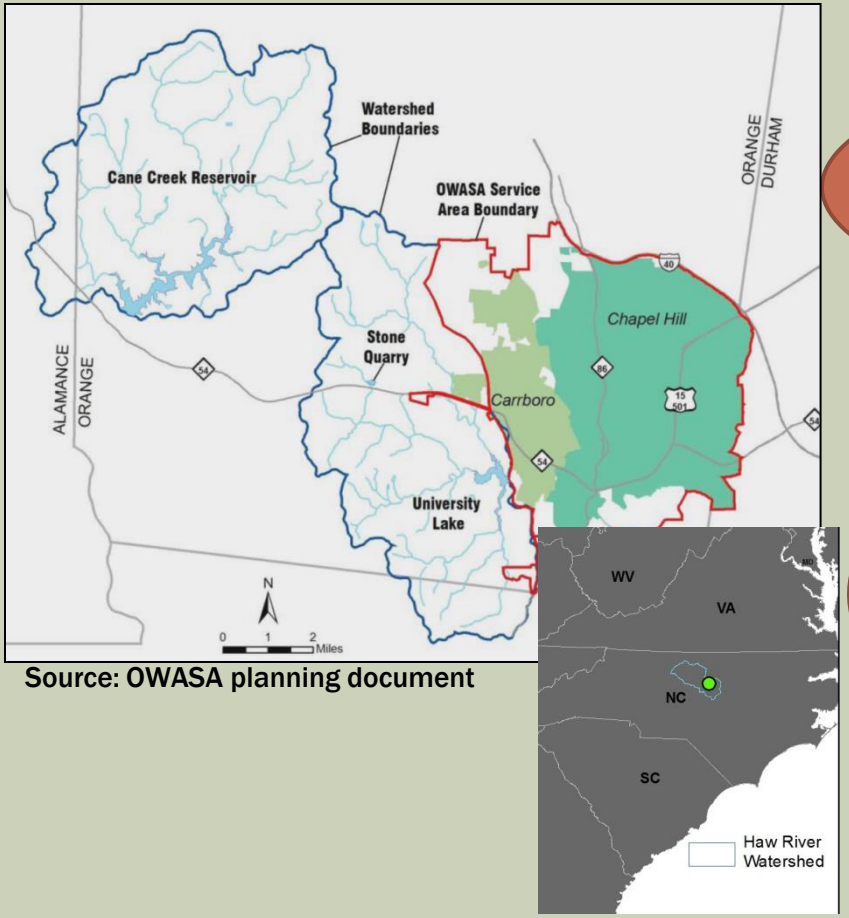
Several different methodological approaches

KEY CHARACTERISTICS

- Begin with the decision-making context; requires communication with resource managers
- Assess vulnerability, i.e. failure to perform as expected
- Projections are used BUT focus on identifying actions that are robust and/or adaptive
  - Direct appraisal of decisions/ policies
  - Indirect

ORANGE WATER AND SEWER AUTHORITY (OWASA)

Long-range (50 years) planning update in 2015-2016



Source: OWASA planning document

"Can and should we apply downscaled modeling results to inform our plans and investments?"

"Our immediate concern is the effect [of climate change] on firm yield of water sources through the next 50-yr planning period"

ASSESSING IMPLICATIONS OF CLIMATE CHANGE ON WATER SUPPLY

Decision Scaling

by C. Brown and colleagues (2011, 2012)

1. Context, stressors, metrics of performance, thresholds
2. Climate conditions that pose problems (critical)
3. Plausibility of critical conditions

Raw water supply

Dependability in the long-term

Firm Yield

maximum quantity of water that can be supplied throughout the most extreme drought event observed

Annual Reliability =

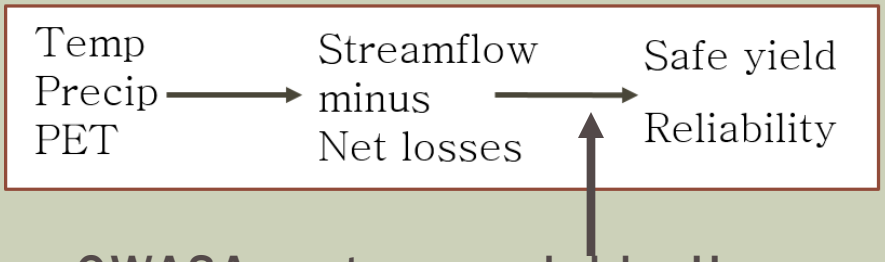
$$\frac{\text{No. of years demand is met*}}{\text{Total no. of years}}$$

Thresholds: TBD

WHAT IS THE SYSTEM RESPONSE TO CHANGES IN CLIMATE?

1. Stressors, metrics, thresholds
2. **Climate conditions that pose problems (critical)**
3. Plausibility of critical conditions

A. MODEL OF SYSTEM RESPONSE TO CLIMATE



- **OWASA system model by Hazen & Sawyer**
- **Monthly interval**

Key climate variables that explain system performance?

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A. MODEL SYSTEM RESPONSE TO CLIMATE

B. STRESS TEST

Vary climate variables parametrically/ stochastically for a wide range

Similar to a systematic sensitivity test

No climate change projections used so far

WHAT CLIMATE CHANGES POSE PROBLEMS?

1. Stressors, metrics of performance, thresholds
2. **Climate conditions that pose problems (critical)**
3. Plausibility of critical conditions

No climate change projections used so far

A. **MODEL SYSTEM RESPONSE TO CLIMATE**
B. **STRESS TEST**
C. **CRITICAL CLIMATE CONDITIONS**

Identify climate conditions where **decision-relevant thresholds** are crossed

For example, when are projected demands for future not met?

For example, when is the planned capacity expansion not enough?

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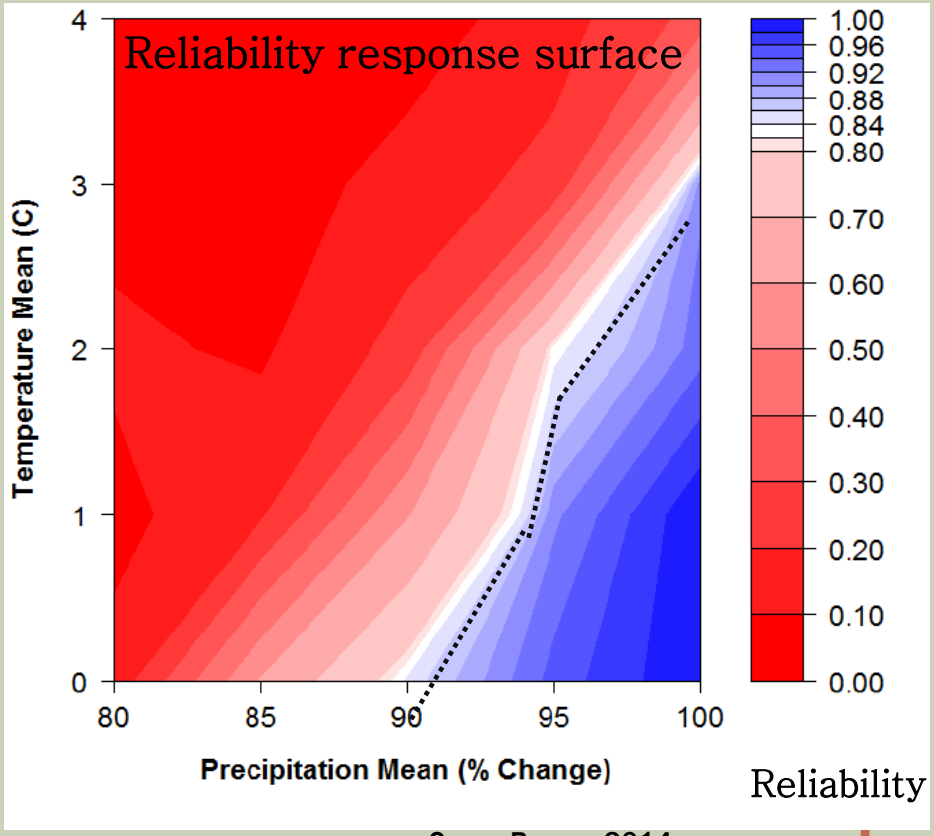

Casey Brown, 2014

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Figure from: http://www.water.ca.gov/climatechange/docs/Decision%20Scaling%20Approach-%20Dr.%20Casey%20Brown.pdf

WHAT DO FUTURE PROJECTIONS SAY?

1. Stressors, metrics of performance
2. Climate conditions that pose problems (critical)
3. **Plausibility of critical climate conditions**

- Full set of models (**ensemble**) available through the latest CMIP-IPCC effort
- Multiple scenarios of radiative forcings
- FIRST, how well do climate models simulate key variables?

  e.g., persistent dryness for Safe Yield

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Relative likelihood of threshold exceedance

- Summarizing model spread
- No. of model projections that cause Safe Yield & Reliability to exceed thresholds

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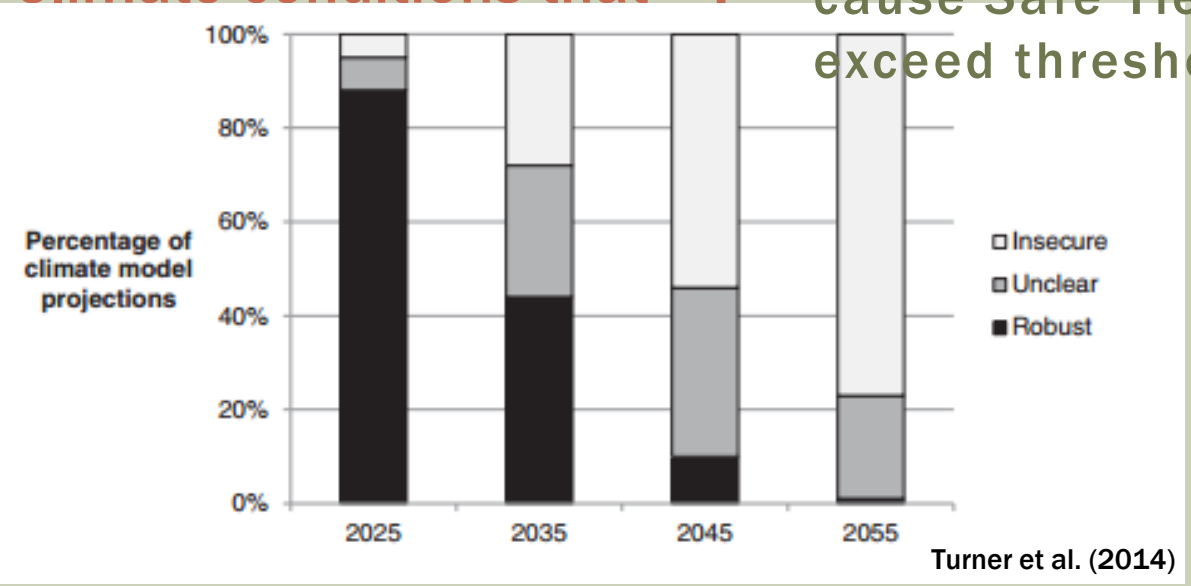

Turner et al. (2014)

Turner, S. W., Marlow, D., Ekström, M., Rhodes, B. G., Kularathna, U., & Jeffrey, P. J. (2014). Linking climate projections to performance: A yield-based decision scaling assessment of a large urban water resources system. *WRR. 50*(4), 3553-3567.

HOW MUCH DO PROCESSING DECISIONS MATTER?

1. Stressors, metrics of performance
2. Climate conditions that pose problems (critical)
3. Plausibility of critical climate conditions

COMPARING MULTIPLE ENSEMBLES

- Discard poorly performing models
- Choice of downscaled datasets
- Discard highly dependent models

Not much, if threshold exceedance does not change significantly

RECAP

This approach allows me to:

- NOT: ~~How will the raw water supply change under future climate?~~
  At what point does the change in water supply matter (*thresholds*)?
- How much does the climate need to change (*stress testing*)?
- Identify what aspects of climate do we need to get right (*modeling and stress testing*)?
- What is the plausibility of problematic climate conditions?
  - Does this answer change with different choices in processing climate projections
- Uncertainty in future conditions framed in terms of its relevance to OWASA's planning

Acknowledgements

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QUESTIONS???