Robust Adaptation to Climate Change

A Decision Tree for Water Planning

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Partners: Patrick Ray, Luis Garcia, Diego Rodriguez, Marcus Wijnen, many others
Integrated Basin Planning under Uncertainty

• “When we try to pick out anything by itself we find that it is bound fast by a thousand invisible cords that cannot be broken, to everything in the universe.” Muir (1869)

• “All solutions are provisional and local.” Briscoe (2014)

• “Everyone has a plan until they get punched in the face” Mike Tyson (US Heavy Weight Boxer) via Briscoe.
What is a Water Planner to do?

- Investments in the water sector are potentially significantly impacted by climate change
- Assessment of climate change risks is required
- Climate change may cause the project goals to not be met
- Unclear how to use climate information to aid decisions

*A standard process for Project Evaluation for Climate Risk is needed!*
Risk or Opportunity?

• Instead of focusing on *risk*, there is an opportunity for developing *robust projects*

• **Approaches available** that lead to projects that are more robust to climate change and other uncertainties

• Also helpful in addressing *contrasting objectives* of constituencies

• **Guidance** needed to navigate these approaches
Uncertainty Management
(de Neufville et al., 2004)

Climatic outcome (e.g., rainfall, production)

Risk Management

Opportunity

Probability density

Crisis

Hardship

Forefitted Opportunity

Hansen, pers. comm.
Why is this difficult?

• How will the science improve decisions?

• Usual mode of engagement: Prediction - centric
  • Science reduces the uncertainty affecting the decision
  • E.g., Science: the most likely future condition is A
    • Decision – under Future A, Option 1 is my best choice

• Mode of engagement under climate change
  • Science characterizes uncertainty (may increase)
  • E.g., Science: here is a wide range of possible futures, and we’re not sure they delimit the true range
    • Decision – um …
Now What?
The Decision Tree for Climate Risk

• Guidance for conducting Climate Risk Assessment for water infrastructure

• Designed to screen first and increase analysis only if required

• Bottom up = Project focused
**Decision-centric Climate Science**

“Decision Scaling”, Brown and Wilby, 2012 (EOS)

1. Stakeholder defined Risks
2. Identify Climate Hazards “Stress Test”
3. Evaluate climate informed risk scenarios

GCM Projections

How do investments respond to changing climate conditions?
What are non-climate factors that are also important?
At what level of change makes an investment fail?
A “Checklist” Approach

- Straightforward to implement
- Defensible process – passes the board
- Hierarchy of effort
  - Screening level vs detailed assessment
- Adds value to the process
  - More robust to uncertainty
  - Builds consensus among constituencies
Decision Tree Step 4: Climate Risk Management

- Stakeholder Engagement
- Trade-off Analysis
- Adaptation Alternatives
- Model and Data Preparation
- Stress Test
- Climate Vulnerability Report
DECISION SCALING

Stage 4 Examples
Decision Scaling Project Sites

- Great Lakes of North America
- Kosi River Basin, Nepal
- Indus River Basin, Pakistan
- Niger River Basin
- Colorado Springs Water Supply
- Northeast US Water Supply (NYC, Boston, Providence, Hartford, Springfield)
- California Department of Water Resources
- Texas Water Supply (Fort Hood)
- Southeast US (Appalachicola-Chattahoochee-Flint)
Climate Stress Test

Climate/Weather Generator

Hydrologic Model

Wat. Res. Model

Observed climate data (at a location)
Statistical climate parameters
Generated sequence of weather

Climate Vulnerability

Robust
Colorado Springs (USAFA): Future Conditions
Colorado Springs (USAFA) Water Assessment
Assessment of Climate Risks to the Niger Basin Investment Program

- Investment plan of $8 billion over next 20 years
- Team: Brown, Yonas Ghile, Ken Hunu, Amal Talbi, N. Harshadeep, Tony Garvey, Johan Grijsen, Aondover Tarhule, Hrishi Patel
SDAP development of the Niger River Basin

- Taussa Dam
- Fomi Dam
- Kandadji Dam
- Kainji/Jebba Dams
The future is uncertain …
Wet Season Rice

Irrigation Sensitivity - Wet Season Rice

Charts:
- SA - Baseline
- SA - 10%
- FO-TA-KD
- FO-TA-KD - 10%

X Axis = Run off change (%)
Y Axis = Average irrigation (ha)
Models agree on low risk!

West Africa

Performance Threshold
Conclusion

• Planners need guidance on how to plan for the uncertainties associated with climate change

• Decision Tree designed as straightforward and defensible process for assessing climate risks

• Informed by but not driven by climate model projections

• Climate Informed Decision Analysis can leads to plans that are robust to climate (and other) uncertainties

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Further Reading