The nexus of science and resource management: Re-visiting adaptive management and decision environments

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Adaptive management: Learning by doing

• Policies aimed at facilitating complex innovation will need to be as learning-based and as flexible as the innovation process
• Cognizant of nature’s time scales
• Scales of change are not easy to separate
• Rate of innovation vs. nature of innovation
Elements of adaptive management

- Recognition of scientific and management complexity and uncertainty
- Directive and/or need for action
- Implement management actions to address resource problems as experiments
- Monitor and evaluate effects of action/experiments (what works, what does not)
- Develop integrated models for ecosystem interactions, legal and cultural requirements etc.
- Develop experiments in a participatory process involving a key parties
A pathetic track record for implementation of adaptive management:

- Successful
- Modeling failure
- Implementation failure
Subset

- Colorado River Grand Canyon
- Columbia River System
- Everglades
- CALFED
- Rio Grande
Benefits of controlling seasonality hydrology

- Conveyance of flood waters
- Storage for power and irrigation
- Predictable navigation opportunity
- Enhanced recreational uses

AM Needs

- Sufficient water resources for experimentation
- Resilience identified/understood in key ecosystem components
- Flexibility among stakeholders?
- Room for political negotiations?
Everglades Scale Issues

-1/2 Wetlands Lost

-Water Allocation among land uses of agriculture, urban and conservation

Subsystem Scale Issues

-Wading Bird Foraging

-Endangered Species (Wood Stork, Panther)

-Landscape Scale Issues

-Changes due to water management

Regional scale issues climate

Biotic changes due to:

-Nutrient Enrichment

-Altered Hydrology

-Altered Disturbance Regime
The birds saw it differently: seasonal drying concentrated the goodies
Colorado River Flow
Departures from Average

Annual Colorado River flow at Lees Ferry, AZ.
Departure from 9 Year Moving Average.

Climatic Influences
ENSO, PDO
Southwest Monsoon
Land Surface Feedbacks
Extreme Events
Observed Winter Temperature for the Southwest US
Issues in the Grand Canyon

Dam Construction
- Loss of sediment input
- Lower flows
- Temperature changes
- Trophy fishery

Endangered species
- Exotics

Hydropower, Recreation, Over-allocation
We can now build some really impressive looking models

Water management regime

- Flow
- Turbidity
- Temperature
- Benthic algae
- Riparian vegetation
- Detritus
- Aquatic insects
- Terrestrial insects
- Exotic fishes
- Native fishes
- Water birds
- Cowbird
- Sparrows etc.
- Peregrine falcon

Water management regime
These models look right when compared to available data.
Cross-scale water management issues: Linear-comprehensive vs. adaptive management

- Indeterminate
- Long-term
- Decade
- Year
- Seasonal
- Monthly
- Daily
- Hourly

Household-municipal-county

State

Regional

National

Global
Managing Uncertainty:

Where is the uncertainty?

Problem Domain

- science
- organizational
- community
- political

- adequate theory
- multiple hypotheses & congruent management actions.
- tractability (complexity)
- confronting models w/data
- independence/ rigor
- novelty
Managing Uncertainty:

Where is it?

Problem Domain

- science
- organizational
- community
- political

- expressions of power
- multiple equilibria
- paths not taken
- NONE are scale invariant
- stability of institutions
- novelty of approaches
- role of epistemic groups
- multiple discourses
- juggling domains
Flexibility and risk management remain underlying concepts.

Broad range of potential outcomes (growth, energy demand, NOT “most likely” etc.)

By 2000 the Columbia River Basin managers were no longer using the term “adaptive management”
Well-defined standards or procedures for confronting uncertainty in AM are lacking

• “Acceptable risk” is poorly defined
• Experiments are visibly gambles, and public decisions are not supposed to be
• Admission of uncertainty is too often seen as weakness, therefore assume that investment in small research or engineering solutions will do the job
• No clear definition of risk management authority and responsibility
  “Flexibility” can be a dodge for difficult decisions
Usefulness of projections in AM

- Are the findings & understandings at the level to be usable?
- **Early-warning:**
  - Do they convey the uncertainty needed for hedging strategies?
  - Do they tell us how to hedge better against [remaining] uncertainty?
AM problems: Limited ability to experiment
“war” of competing models and projections

Actors, resistors, decision makers
- “Adaptive management” models have become mediating tools in the dialog among actors, resistors, decision-makers
  - i.e. not necessarily a “consensus builder” but highlights potential tension and exposes perceptions of risk and uncertainty

  e.g. water leasing vs. permanent transfers
Problem framing: water managers and researchers

- Goals
- Critical issue identification
- Time frames
- Basis for decisions
- Expectations
- Product characteristics
- Nature of “use”
The Known, Unknown, and the Unknownable

- Most managers do not believe that climate change scenarios should elicit a change in resources planning.
- E.g. most water utilities believe that they can withstand a repeat of past drought patterns given current infrastructure and water policy: criticality, capacity, credibility
- Know-how, know-what, know-where, know-when,
• Choice/desirability of outcome is influenced by many factors beyond probabilities and payoffs (see also “comparative ignorance hypothesis” Fox and Tversky 1995)

Meta-uncertainty-Researchers do not always know how unsure they are or what is needed to be known
Envisioning the future: What can these experiences provide for scenario development?

- Concrete examples and representative events
- Use easily recalled supporting evidence
- Ask people to project themselves into the situation (explain outcomes, situation etc.)
- Plausibility (also implausibility)
- Prior experience and beliefs
- Document situation in which scenarios are presented and discussed
Additional criteria for scenario “validity”

- Purpose of the scenario
- Criteria the scenario must meet to be declared acceptable for use
- The context in which the scenario is to be used
Different value frames in forecast applications: Distributional and procedural issues

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<tr>
<th>Technical frame</th>
<th>Application frame</th>
<th>Procedural frame</th>
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<td>Quality</td>
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<td>Expert</td>
<td>Consultative</td>
<td>Co-production</td>
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Option Space

$O_0$ Ignore the “Problem”

$O_1 \ O_2 \ O_3 \ O_4 \ O_5$

$O_6 \ O_7$

Just Plain Stupid Options

$O_{12} \ O_{13} \ O_{14}$

Uncertainty-Hedging Options

$O_8 \ O_9 \ O_{10} \ O_{11}$

Science-Confident Options
Alternatives assessments

- Fixed policy/practice
- "Trial & Error" – random choice of new practices
  - Nobody does this
- AM as implementing new, provisionally optimal practices on the basis of feedback
- AM as implementing & varying policies in order to learn –
  - Could be optimal, but not necessarily
- Adaptive governance
Opportunities for “win-win” situations and rule changes may exist. Changes are extremely difficult to implement

- Criticality
- Credibility
- Capacity
- Communication