“Right now I think the wisest strategy is to diversify among your mattresses.”
• Two Very Different Discussions
  – One mostly focused on questions of “what”
    • What can we do to assist decision makers?
    • Answer: need Donald Rumsfield to rescue us
      – Knowns, Knowable Unknowns, Unknowable Unknowns
  – One mostly focused on the question of “how “
    • How do we do we provide better information?
    • Answer: some kind of ‘connector’ organization
• I’ve combined into one set of slides
Purpose of the Workshop from Website

1. Match questions being asked by decision-makers with answers that can currently be supplied by available modeling tools;

2. Identify/define questions being asked by decision-makers that cannot be answered by currently available modeling tools;

3. Take a first step toward identifying gaps that might be closed by (improvement in/development of additional) high resolution models; and

4. Identify alternative strategies might be needed to supplement decision support needs across different timescales.

First Group added this to the mix:

0. What climate related decisions do decision-makers face? What data drives these decisions?
0. What climate related decisions do decision-makers face? What data/information drives these decisions?

- **Long term capital decisions**
  - Conveyance, storage, desal, etc
  - May be tied to changes in extremes
  - When do we cross a threshold that requires structural solution?

- **Changes to Operations**
  - Some effected quickly (e.g. no outdoor watering), some slowly (reservoir ops with legal impediments)
  - ‘Uncontrolled Spill’ like a crime these days
  - Changes in means may apply to these changes...

- **Changes in User Practices and Behavior**
  - Conservation
  - Also see Feedback Loop in Social Change

- **Changes in Water Portfolio**
  - Conjunctive Use, Institutional Coordination, Banking, Sharing, etc...

- **Possible Feedback Loop:** climate caused social change could impact economy, thus impact all of the above.
  - E.g. Let’s tear down a dam

- **Uncertainty:** is it real, or an artifact of models?

- **Knowns and Unknowns** – can we categorize as:
  - Knowns, Unknowable Unknowns, Knowable Unknowns

- **Timeframe of Decisions**
  - 30 to 40 years but lead time plus life of investments can mean these are 175 Year Decisions

- **Need collaborative process with scientists and water managers**
  - No need for water managers to pursue modeling independently
  - Scientists and water managers are thinking about the same things.

- **Observations are a disaster...**
  - Can’t calibrate or verify models with bad observations
1. Match questions being asked by decision-makers with answers that can currently be supplied by available modeling tools;

- Don’t care how much warmer; do care how much a buffer we have…
  - Buffer includes anything and everything we can think of…
- Engineers need temp, precip, runoff, demand response at suitable time/space scales
- Thresholds
  - Should modelers provide probabilities for questions asked by managers, or should modelers provide the best projection,
    - First is easier to do by modelers, second may be more useful
    - Engineers want a clear outcome from models
- Temperatures
  - We know it will be 2C warmer, just don’t know exactly when. Is this actionable? Can this help us with snow related questions?
- Sea Level
  - Similarly, sea level rise of 2 feet is a given, just don’t know exacly when.
- Intensification
  - All models predict some form of this, but our ability to quantify is limited.
2. Identify/define questions being asked by decision-makers that cannot be answered by currently available modeling tools;

- **Vulnerability**
  - Consequences * Probability is understood
  - We know the consequences, but not the probabilities
  - Engineers design for failure, but DM’s won’t tell public this

- **Robustness of PDFs**
  - Current EIS questions – people are making answers up in response to a need
  - Fake a PDF for Decision Makers – Don’t Ask – Don’t Tell
    - Tacit Understanding Between Engineers and Decision Makers
  - Lots of PDFs available, just don’t know how much to trust
  - Climate Modeler: “We still don’t have robust PDFs. I hope decision makers are not using these PDFS!”
  - DM’s don’t want Probabilities, they want Possibilities – Mulroy
    - DM’s can willfully ignore lesser probabilities if they imply politically tough decisions
    - DMs need to game out future with possibilities

- **Absence of ‘Risk Tolerance’ Analysis**
  - What is the risk sensitivity of utilities?

- **Ability of current models to adequately describe new natural variability**

- **Precip Questions**
  - Do difficult science questions get put off in favor of doing new science? e.g. convective precipitation

- **‘Upscaling’ idea**
  - Could we use general model tendencies (e.g. CA’s mediterranean climate changes to arid desert) to our benefit?

- **Floods**
  - No Way to get 3-hour precip from GCMs.
  - Climate Science is a miserable failure on timescale of hours to days. Flood events very much the key to re-operations and yet this is a huge gap.
  - May be helped by increased resolution
3. Take a first step toward identifying gaps that might be closed by (improvement in/development of additional) high resolution models.

- What do higher res models get us?
  - Weather models have always improved with increased resolution
  - High Elevation Areas are a big target with big potential gains
  - Flat areas not as promising
  - We get better depiction of extremes
  - Any chance to mix high/low resolution in models?
  - High Resolution is the easiest thing to fix right now compared to other problems

- Apparent failures from higher resolution efforts
  - Newer high res models are not as well developed as older, lower res
  - Correct parameterizations are difficult, but not best use of scientist time

- What would we do differently with higher resolution?
- Sensitivity Analyses with Historical Data Might be just as useful as higher resolution model output
  - Could be more confident with results
4. Identify alternative strategies might be needed to supplement decision support needs across different timescales.

- Need better connector/boundary organizations
  - Possibly RISA-like, possibly IRI-like
    - No RISA is perfect right now
  - Can’t be monolithic
    - ‘Nobody wants someone else telling them what their vulnerability is.’
  - Must be intelligent interface
  - How do we help smaller utilities in the West?

- “The big elephant for water managers is to what degree should water managers be concerned that current science questions are not relevant to water management?”
  - Need to commission water management science?
  - Answer: No need for Water Managers to pursue climate modeling science independently – same questions are being asked by both groups
Closing Thoughts

- Is old model of risk (water provider bears/hides risk from everyone else) too expensive and too stupid for the 21st century?
  - Speaking of False Certainty, we already have it...
  - R. I. P. ‘Firm Yield’ Concept
- Can ‘insurance’ (i.e. sharing risk) increase reliability?
- Can we really afford to insure against biggest potential drops?
  - Isn’t this a question for society as a whole?
  - Rethink water use?
- Can we deal with -20% through efficiency in many places?
- Can we move to ‘adaptive management’ and be more intelligent in investments and operations?
‘You go first’...who’s going to be the fall guy or gal?