Scenario Planning for Climate Change Adaptation Decision Making: The State of the Art

Workshop Report

March 31-April 1, 2015
University of Arizona, Tucson, Arizona
hosted by the Center for Climate Adaptation Science and Solutions

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I. Introduction

This report summarizes the activities and outcomes of the March 31-April 1, 2015 workshop, "Scenario Planning for Climate Change Adaptation Decision Making: The State of the Art" at the University of Arizona. This workshop was focused on understanding alternative approaches to scenario planning, lessons learned in using them, and ways of extending and combining the approaches that are currently in use.

Decision-makers and managers are increasingly being asked to make decisions in the context of uncertainty, with climate change adding new sources of complexity. We've observed that scenario planning is being used as means of providing managers with insights into options for responding appropriately to change in the near and long term. The increasing use of scenario planning prompts some questions, such as:

- What is the state-of-the-art in scenario development?
- How can uncertainty within scenarios be communicated effectively to stakeholders and what types of scenarios are appropriate and beneficial to pursue in a given context?
- In using scenario planning methods: What works where, when, and why?
- How can the effectiveness and utility of scenario planning processes be enhanced?

The workshop explored lessons learned in applications of specific scenario planning techniques as well as connections between the different methods that have emerged, with respect to how they frame uncertainty and how they function in a decision support context. We also discussed several alternative science-based approaches and modes of engaging stakeholders in scenario planning, while promoting scholarly work to assess the state of the art.

The workshop was designed to address the following topics:

- To what extent is scenario planning the answer to the challenge of decision-making in the context of a changing and uncertain future?
- What is needed to move scenario planning forward in various contexts?
- How can what is learned be better integrated into organizations, programs, and agencies?
- How can we best provide a broader understanding of methods, their respective value, and their appropriateness to particular decisions or problems encountered by prospective users of scenario planning methods?
- What other resources are needed to improve scenario planning processes?

Among the motivations and objectives for workshop were to:

- Gain a better collective understanding of scenario planning methods, the value of various methods, and the suitability of various methods to different types of decisions or problems
- Clarify theoretical and practical issues about methods
- Demonstrate, through case studies and discussion, the methods and processes that are used and useful
- Articulate the characteristics of each method and derive a typology of scenario planning methods for use by scenario planning practitioners, researchers, and potential users of scenario planning. The proposed typology will include assessment of synergies between methods and information flows from method to method, from those that characterize uncertainty (e.g., originating from climate models) to those that embrace uncertainty.
- Describe their application to decision making, including experiments and mixing methods
- Work toward providing practitioners with a broader toolkit of scenario methods and techniques for decision makers and improve connections with local and regional planners

- Produce a co-authored paper on the state of using scenarios in climate adaptation planning. The proposed audience for the paper includes climate science translators, adaptation practitioners, scenario planning practitioners, and scholars of climate change adaptation
- Identify research, institutional, and resource needs to improve the information available and the flow of information across methods in specific applications
- Contribute to curriculum and training opportunities broadly.

I.b. Definitions

Prior to the workshop, the planning committee developed definitions for important concepts to be discussed (see Appendix C). In general, scenarios are plausible descriptions of the future used to envision unpredictable future conditions. They range from verbal descriptions of future circumstances (often called 'narratives' or 'storylines') to complex quantitative representations of socioeconomic, climate, or environmental conditions. Some scenarios combine both narrative and quantitative aspects.

Scenarios are not predictions or forecasts. Typically they are used when uncertainties are so substantial that they cannot be assessed using standard probability methods. When applied in climate change research, scenarios help to evaluate uncertainty about human contributions to climate change, the response of the Earth system to human activities, the impacts of a range of future climates, and the implications of different mitigation and adaptation measures.

For our purposes at the workshop, we grouped scenarios into several broad categories by their primary use, including (1) scenarios for helping groups to plan goals and strategies, (2) scenarios used to coordinate research, and (3) those that integrate planning and climate research. Scenarios for participatory adaptation planning, as described in may projects and case studies that will be discussed at the workshop, often combine both visioning and information from climate-related research.

We provided a few definitions to participants, mostly to remind them of the need to use a 'modifier' in front of the word 'scenario' to be clear about what type of scenario you are referring to because there are so many different kinds that miscommunication frequently occurs when using the word scenario. In addition, the 'outputs' of one scenario activity can be seen by someone else as 'inputs' to another, and without stating clearly what type of scenario we're each talking about, confusion could have mounted quickly.

I.c. Case studies – (PowerPoints for these are available on the project website, at http://ccass.arizona.edu/spworkshop):

NPS Climate Change Response Program (embracing uncertainty) (Hartmann, Star, Welling):
The traditional NPS approach was to follow a preferred alternative future for 15 to 20 years and pursue that outcome. NPS is beginning to use a series of plausible futures in its Climate Change Response Program and has initiated a set of workshops to assist landscape adaptation efforts and other responses. Under guidance of the Global Business Network, NPS has focused on educating staff and partners on utility of climate change scenario planning (Weeks, Malone and Welling 2011; NPS 2013).

Structured scenario planning/ Future Mapping/participatory scenario creation (visioning, management) (Hornbach, Mason) – This approach seeks the least-risk course of action roadmaps, using highly prepared meetings with all participants interviewed in advance, and scenarios divided into end states (outcome at planning horizon) and events that must occur or not occur to lead to that outcome. (Mason et al. 2014)

Adaptation for Conservation Targets (ACT) (develop actions, break paralysis) – piloted by the Southwest Climate Change Initiative (SWCCI) at workshops in four southwestern U.S. landscapes. The workshops fostered cross-jurisdictional and multidisciplinary dialogue on climate change through participation of scientists and managers in assessing climate change effects, discussing the implications of those effects for

determining management goals and activities, and cultivating opportunities for regional coordination on adaptation of management plans (Cross et al. 2012).

Land use and transportation planning (A. Sussman) – Through a pilot project and partnership with the FHA and US DOT Volpe Center, the New Mexico Mid-Region Council of Governments incorporated scenario planning and climate change analysis into its long-range transportation planning process for the Albuquerque area. The resulting policy document, *Futures 2040 Metropolitan Transportation Plan* (2015), identifies regional challenges ranging from congestion patterns, growth policy, and natural resource pressures, and analyzes how encouraging development in key centers and corridors results in a the region that is more resilient to climate change and produces less GHG emissions.

Decision scaling or thresholds approaches (C. Brown) – risk analysis and management process designed for use in water resources planning and management under climate change. Brown has used decision scaling to incorporate climate information, in a process whereby information related to climate projections is tailored for use in a decision-analytic framework, as in in the International Upper Great Lakes Study (Brown et al 2011; Moody and Brown 2012).

Visualization of qualitative scenarios and visioning processes (S. Sheppard) – Sheppard has used a conceptual framework to generate alternative, coherent, holistic climate change scenarios and visualizations at the local scale, based on quantitative and qualitative information, in collaboration with local stakeholders and scientists.. It provides a template for a process to integrate emission scenarios with mitigation and adaptation strategies, and link local manifestations of impacts and responses with global climate change scenarios. (Sheppard et al. 2011)

Discussion sessions in the workshop addressed framing the issues, along with inputs and outputs; the planning process, applications, connecting approaches, and mixing methods; a typology of approaches (discussion was initially guided by attached chart); and outputs, including guidance, scholarly articles, and future workshops. See workshop agenda (next section) for motivating questions for each discussion session.

I.d. Participants

The participants for this workshop were nominated by the organizing committee based on their experience with the use of scenario planning techniques. The list of participants and their affiliations can be found in Appendix A.

Organizing Committee
The following people planned the workshop and served as facilitators during the event:
Mary Black, University of Arizona, CCASS
Gregg Garfin, University of Arizona, CCASS
Holly Hartmann, Independent Consultant
Kathy Jacobs, University of Arizona, CCASS
Richard Moss, Pacific Northwest National Labs and University of Maryland
Erika Rowland, Wildlife Conservation Society

I.e. Funding

Funding for this workshop came from the Technology and Research Initiative Fund (TRIF) provided through the Institute of the Environment.

II. Outcomes

The discussion and conclusions from this workshop have been summarized in several ways, and products are still being developed related to this event. An EOS article has already been published (https://eos.org/meeting-reports/advancing-scenario-planning-for-climate-decision-making); this workshop report provides an overall summary of the event; a scholarly article by Richard Moss inspired by this workshop is being developed, focused mostly on the importance of participatory processes in climate science; and one more peer-reviewed article and possibly a guidebook/brochure are still anticipated.

Short Summary of Workshop Outcomes

The benefits of Scenario Planning include:

- Thinking across scales and domains, connecting to people in places and livelihoods, nesting
- Can connect to strategic planning, operational planning, long-term planning
- New knowledge when you think at multiple scales, ability to cross sectors
- Potential for connecting to IPCC and global emissions scenarios/RCP's
- The Adaptation and Mitigation Framework of IPCC is impoverished…scenario planning provides an alternative

Alternative Frames for Scenario Planning:

- Resources vs complexity – need to focus on the high complexity low resources intersection because this is where the challenges are
- Modularity and recombination…mixed methods and flexible applications are needed, preferably allowing for dissection of the components of processes and the capacity to recombine them, e.g., a "building block" or modular approach
- Divergent and convergent exercises – a source of confusion and discomfort with the process. Some participatory processes are designed to bring a diverse group of people to a common conclusion; however, resilience is a divergent process that requires building of capacity as well as converging on a conclusion.
- There are multiple ways of communicating and engaging – modeling, storylines, visualization (pictures) – the successful ones all tell stories
- There is a false dichotomy between qualitative and quantitative approaches; between scenarios and modeling, between short-term and long-term approaches, and between normative (start where you are) vs. exploratory (starting with end-sate in mind) vs. observational (see where you go approaches. Components of all of these can be combined into new techniques.

Barriers and opportunities – negative forcing with crisis vs positive forcing with incentives, vs. thresholds of opportunity – there are a lot of places to enter processes from a facilitation and analysis perspective.

Observations of Participants

1. Scenario planning includes unique opportunity to build social capacity that supports adaptation, e.g. Adirondacks, Western N Carolina, Tucson Water…(Hypothesis: process builds social adaptive capacity – what are the metrics or evidence? Is there a way of mining the Adirondack process? And other case studies?

2. Typology (see Appendix D) – if it is a useful way to organize case studies, could we add to it issues about documenting adaptive capacity, institutional capacity…e.g., changes in the Park Services and Tucson Water?

3. Connections between scenario planning and decision-making – and structured decision-making. If planning is married in the right way to a good scenario process… it could be more useful.
What characteristics need to be present for a decision process to "work"? As opposed to the characteristics that determine what is a good decision…?

4. Ways to connect different methods to an iterative risk management cycle – where do scenarios fit in the cycle, scoping, analysis, prioritization?

5. Ecology of Scenarios – could be a separate thought paper…mapping different methodologies and how they are connected.

6. Uncertainty and confidence – in a process like scenario planning, these themes interact in a fruitful and creative way – in a scenario planning process, considering the full range of uncertainties if it done well it leads to higher confidence among the participants….

7. Legitimacy of scenario planning processes in different applications – eg an integrative scenario process is not enough to overcome all of the issues of exclusion…

8. Evaluation and metrics – need for monitoring and feedback – monitoring itself is not a goal – but a framework for learning – need to be thinking about it as a dynamic assessment activity…

III. Workshop Agenda

Tuesday, March 31, 2015

8:30—9:00 CONTINENTAL BREAKFAST

9:00—10:00

Session 1 — Overview (plenary): housekeeping, brief participant introductions, purpose of meeting, agenda, definitions, introduction to the concept of a typology/taxonomy of scenario methods. What scenarios are being generated? What are the issues? What are the decision contexts in which they are used? What mental models lead to more robust outcomes? How can we advance the utility of scenario planning processes and effectiveness and applications in a variety of contexts? Are there opportunities to further expand the utility of scenario planning through curriculum development and training efforts? (Gregg Garfin; Holly Hartmann)

10:00-10:30

Session 2 — Setting the Stage (plenary): (Richard Moss)

10:30—10:45 BREAK

10:45—11:4**5**

Session 3, pt.1 — Case Studies (plenary): discussion of the scenario approaches that are being used by practitioners, drawing on a cross section of sectors, scales, and time horizons. Six 10-minute presentations with transition time/brief clarifications between, followed by a one hour discussion (Gregg Garfin, facilitator)

- National Park Service method (embrace uncertainty) (Holly Hartmann, Jonathan Star, Leigh Welling)
- Structured scenario planning (visioning, management) (Dave Mason, Kathy Hornbach, and colleagues)
- Adaptation for Conservation Targets (ACT) (develop actions, break paralysis) (Erika Rowland)
- Land use and transportation planning (Aaron Sussman)
- Decision scaling or thresholds approaches (Casey Brown via GotoMeeting)
- Visualization (Steve Sheppard via GotoMeeting)

11:45—12:45 LUNCH (provided, non-working, networking)

12:45—2:15 **Session 3, pt.2 — Case Studies** (cont.)

2:15—2:45 BREAK

2:45—5:00

Session 4 — Framing, Inputs and Outputs for Scenario Development (plenary, Jacobs, facilitator) [Begin discussions of a framework that makes sense, using inputs from the day]

- **Framing Questions**: 1) how to set expectations for scenario planning for practitioners; 2) how to help stakeholders define the problem/issues to address; 3) how to identify the important drivers of change; 4) how to choose between different scenario planning approaches; 5) ways to approach uncertainty, 6) how to agree on assumptions and facilitation techniques
- **Inputs to a scenario planning process:** exploring the broad context of relevant past and future conditions, examine how practitioners develop baselines (observations and data) and projections (expectations about the future, including climate, socioeconomics, land use, sea level, modeling, etc.), focusing on the challenges of integration, assumptions, practical considerations about data availability

- **Outputs:** discuss how the flows of information generated in scenario planning processes can most easily be used in decision processes and flow into other contexts and outcomes..

6:30 CCASS-HOSTED DINNER at Old Pueblo Grille, 60 N. Alvernon Way. We'll arrange carpooling
for those who need transportation.

Wednesday, April 1, 2015

8:00 – 8:30 CONTINENTAL BREAKFAST

8:30—9:00 **Session 5 -- Revisit Day 1 and Schedule for Day 2**

9:00—10:45 Marshall Rooms 531 (2 groups), 549D

Session 6, pt. 1 — Process + Applications + Connections: breakout sessions -- groups of 10 working in parallel, with mixture of experience and organizations in each group, then plenary session for reporting back (Kathy Jacobs, Carrie Enquist, Holly Hartmann, facilitators)

- **Framing Questions:** 1) How can scenario activities be combined and designed to support a range of possible outcomes, including ways to integrate engagement and communication techniques with approaches that allow scientific analysis of alternative futures? 2) What are the barriers and opportunities in using scenario planning techniques in a planning or decision context; 3) which approaches work with which topics/challenges scales?
- **Process and Applications/Implementation:** techniques and applications of scenario methods, discussion of mixed-method and nesting approaches, putting participant-defined futures in general context. How do you engage people in using scenario methods?
- **Connections:** examination of the connections between scenario-based approaches and existing planning efforts, mixed methods, deliberation, communication and decision-making frameworks (more bottom-up and applied; approaches for working across sectors; holistic; cross-cutting)

10:45—11:15 BREAK

11:15—12:15 **Session 6, pt. 2 — Process + Applications + Connections: Plenary session,** reporting back (Hartmann, facilitator)

12:15—1:00 LUNCH (provided)

1:00—2:15 **Breakout sessions -- Marshall Rooms 531, 539, 549D ONLY HAVE 539 FROM 12:30-2**

Session 7, pt. 1 —Typology, Guidance, and Promoting Innovation of Scenarios -- Rapid-fire brainstorming for an hour in breakout sessions about opportunities for innovation, barriers to overcome, etc. then 20-minutes to create summary of discussion for plenary): state-of-the-art with respect to the array and intersection of scenario methods, elements of good practice and good fit? How can scaling up/nesting/innovation be achieved, guidance/guidelines? Where are various processes best used? How can the flow of information be improved? What other resources are needed to improve the flow of information? (Will use **draft typology chart**, **information flow diagram from Hartmann, and "Ways of Characterizing the Future" graphic** as a starting place for discussion, provided to participants as attachments to the white paper) (Erika Rowland, Richard Moss, Gregg Garfin, facilitators)

2:15—2:30 BREAK

2:30—4:00

Session 7, pt. 2 – Typology, etc. (plenary) Breakouts report back, with facilitated discussion of thoughts regarding an informed selection of scenario approaches for specific applications, needs, goals, working across sectors, etc. (Enquist, facilitator)

4:00—5:00

Session 8 — Next Steps (plenary): discussion of workshop outputs, preparation for the National Adaptation Forum, input to the NCA Sustained Assessment. How do we turn this into practical guidance, and is it appropriate to do so? (Garfin, facilitator)

5:00 Adjourn

IV. Summary Notes from Meeting Sessions

Session 1 - Notes
Gregg Garfin – Introductory Remarks
Scenario planning is used in a wide range of contexts, water supply planning, urban planning, etc… many are related to climate change, which is the focal point of this workshop. Different methods have different characteristics…

Our motivation for pulling this together – there is a lot going on using these methods, and there are a lot of discussions of which methods are best for which applications… so taking the pulse here… and trying to establish a path forward

Our questions were articulated in a white paper – what is the state of the art in using scenarios, how is uncertainty characterized and communicated, what works and what doesn't, how can we enhance the effectiveness? What is needed to move forward, how can outcomes be better integrated into programs, organizations and agencies. How can we provide guidance?

Goals – better understanding of methods, theory and applications; assessment of characteristics, resource needs; outputs – typology as a tool for part of the conversations, one or more publications.

Strawman typology for discussion – purpose, participants, system definition, method used, info inputs, main steps, engagement and communication strategies, uncertainties, outputs, applications for outputs

Critical timing – there is a lot of discussion about this topic with Water Utility Climate Alliance, a lot of confusion about what scenario planning is…

Introductions of participants: these are initial thoughts of participants about scenario planning, what it is and how it can be or is being used:

- It is a creative way of thinking
- It is a tool in business applications
- In running an R&D shop, it is a way to frame research questions, help people use them for anticipatory way to help people get the info they need for decisionmaking
- In the context of a network of higher education, can help with resilience planning
- It facilitates adaptation planning in a climate context, particularly in natural resources and biodiversity conservation
- Question: How to do coordination across scenario planning efforts to help stakeholders?
- Can be integrated into long-range transportation efforts, development patterns and land use configurations that are more resilient
- Scenarios to explore uncertainty with professional policy makers with water managers and cities
- Climate change adaptation on SW military facilities; used fairly informal scenarios as a way of generating discussion… and interested in other ways to use scenarios.
- Long-term management of Colorado River and uncertainty
- Try not to use scenarios up front – rather, in the context of climate risks to water worldwide, try to rethink in terms of vulnerability and recombine
- Using climate change focused scenario planning for long term landscape planning and design, collaborative water management
- Climate adaptation planning for wildlife management
- Climate change adaptation coordination for the NPS – developing guidance for planners on integration of climate into stewardship responsibilities.

- Application of scenarios at larger scales – tool for integrating decision making on a landscape scale
- Bringing complex research quality models to stakeholders in ways that would be useful for them
- How to implement certain aspects with stakeholders and decision-makers integrating different methods and applying what comes out of them into a portfolio of options
- Connecting science and policy in exploratory scenarios, exploring impacts to Colorado River water supply availability
- Scenario planning for a wide spectrum of activities, water resources applications, for Albuquerque etc.
- Scenarios as a tool for bridging science and policy – National Climate Assessment – bringing it into the process
- Scenario planning for water resources – profoundly useful as a way to talk about the range of possible futures, working with non-professional decision-makers, good for engaging… how to frame things in an understandable way
- Making the bridge between uncertainty and decision-making, State of Florida, DOT –
- Landscape scale applications, context of climate change, SWCSC
- Similar to reaction to the internet – what is the internet going to do to your business? Climate change is like that – what is it going to do to your business or your NGO
- Plant physiology and landscape ecology – visualization tools, how to provide a way of thinking about future distribution of forests, eg forest forecast.org to visualize rates of change, also military landscape level views, data, visualization and computational techniques
- Liberating us from a linear predictive framework… more than one way to do scenario planning – this workshop is being used to unpack this idea – used differently by academics than practitioners
- EPA's integrated landscape tools – landscape level climate adaptation planning –
- Developing models to forecast how forests will respond to climate change…how we can increase resilience
- Small regional conservation organization, Sky Island Alliance, regional adaptation planning with natural resource planning – on the ground adaptation planning, landscape conservation design.
- Scenarios in the context of planning and community engagement in climate change, integration of mapping and visual media

Agenda description – stage setting:
How scenario planning methods either do or don't fit in the typology, guidance on how to use methods, Research needs and gaps, next steps… moving forward collectively or individually in developing outputs

Definitions of scenarios – they are a tool for long-term planning; narratives of alternatives in which decisions may be played out, coherent, internally consistent and plausible; not predictions or foreccasts, generally not about arriving at a most likely future.

Holly Hartmann
There are other typologies out there – but we need to frame the discussion so we can make sense of it.

Decision makers have used scenarios for a long time, but they have different ways of working with scenarios than modelers do; it can take a year or more to get all parties to the same language. Use the word scenario with modifier to make sure that we know what we are talking about – and don't confuse each other.

The white paper… includes a typology with various categories that can be used to distinguish between approaches – the typology can change as part of the discussions

Can explore the kinds of uncertainties, the outputs, the information inputs and outputs, etc

Pros and Cons and lessons learned/strengths weaknesses is a category that needs to be added to the typology.

Ways of seeing the future graphic (from Richard – see his powerpoint) – including consideration of both plausible and implausible futures, a lot of interest in this slide but it isn't perfect.

Analogues are a scenario of the past – space for time exchanges also
Ecology of scenarios – how do these approaches relate to each other (see Holly's powerpoint)
Three categories:

1) Ways of characterizing uncertainty – integrated modeling, downscaling, etc
2) Embracing uncertainty – focusing explicitly on components of uncertainty – to put boundaries around them – a range of possible futures…
3) Reducing uncertainty – including social uncertainty – scenarios being used to increase the acceptability of certain decisions, eg land use planning, etc, trying to build support for a shared vision… federal highway transportation authority has a good guidebook on this…

The ecology has different components at different scales, global, regional and local, whether it is about emissions or socioeconomic scenarios that can feed into regional climate projections and sensitivity studies. Within the local and regional scenarios there is less of a literature than at the global to regional flow.

In the USBR Basin Study – there were different approaches/assumptions for coming up with estimates of future Colorado River supplies – each approach produced different outputs, decision makers and stakeholders came up with a lot of different numbers based on a range of approaches and assumptions…

Re Table – from Climate Impacts Group (see Hartman slides)
Narratives are in the embracing uncertainty – drivers and impacts category
Helps to structure the information
Regional scenarios to local adaptation options is another flow
Adaptation conservation target approach as an information flow across different scales and disciplines

Organizing options
Decision tree, decision points, indicators,
Evaluate options
No regrets, significant change in direction, new objectives, retreat
Operationalize options
Leading indicators and trigger points, or incrementally operationalized
Disaggregated steps
Timelines and calendars

Local and Regional Visioning – Common visions, community values – from the bottom up – realignment or nested objectives – moving down the hierarchy to a reduced expectation outcome

One objective of the workshop is how to go across these approaches to connect these ideas together… the stakeholders want one way to do things, we want to help people get something done that makes progress… so they can see how it fits in the broader picture. Scenarios are a tool for managing risk in an iterative way – scenario work helps them scope their problems, analyze them, make decisions, track and monitor implementation – where does it all fit?

Points in the decision process can be added to the typology… the NPS approach has scenario planning within the steps of their own decision process.

Session 2 – Setting the Stage

Richard Moss

Need to reflect on the sweet spots – what we learn from the global top down scenarios in ways that can be related to the bottom up approaches

Billion dollar weather-climate disasters graphic (see Richard's slides) – SE has real issues – this is not just an artifact of climate change, these expensive events are a consequence of where we are placing things, in areas that are at risk

Scenarios are not just about the climate, they are about socioeconomics, environmental justice, infrastructure decisions – global approaches can't reflect on the differences between poor and wealthy communities, the top down scenario doesn't work at all in that application…

The combination of scenario approaches allows this integration of climate and social systems/impacts to be analyzed.

Motivated by making better decisions – more useful information for making decisions –

Some of the decisions that people were already making are really adaptation decisions – now they have to consider climate change in addition.

Factors of success in planning for a non-stationary climate – recent GAO climate change report says the factors include: weather related crises that spurred action, using available info, access to local expertise, considering climate impacts within existing planning processes, e.g., existing standards such as National Institute of Building Sciences – set the standards to incorporate climate changes, return periods of extreme events etc.).

Scenario planning – a way to identify goals and possible ways of achieving them

Dessai and Hulme inverted triangles graphic – bottom up (local) vs top down (global) processes (see Richard's slides)

It is broadly consistent with Holly's ecology of scenarios – it is the interplay of these kinds of scenarios that is of interest.

Have to avoid starting with the uncertainty caveat, this causes stakeholders to lose interest.

NOAA RISAs, LCCs, etc., are a local source of info that they are more likely to trust than a national expert.

Need data mining of data we already have in a more effective way – keyed to particular thresholds

Important to keep in mind what is enabling people to move forward…

Re: Different ways to characterize the future graphic – see Richard's slides - some of the storylines have gotten too detailed in the IPCC process, so detailed that people think they are "likely" outcomes…

The more detail there is the more believable people think the scenarios are…so an alternative approach was developed: Shared Socioeconomic Pathways – now they start with GHG concentrations (radiative forcing) and work in both directions – towards the socioeconomic futures that are consistent with these concentrations – breaking the perception that there is one socioeconomic future associated with each climate future. Also, can work back to emissions from these levels. Want a framework that allows different approaches…a goal seeking mode…

There was such a focus historically on emissions that it constrained the research process for IPCC…

Using the representative concentration pathways (RCPs) – four different levels of climate forcing, from highest to lowest levels…are now used.

This is an inversion of the previous thought process-- instead of driving down from emissions, starting with the concentrations of GHGs is a dramatic alternative to standard thought processes.

This allows a look at the intersection of mitigation and adaptation – e.g., big international process has five different storylines that can be represented along different pathways – sustainability = SSP1 (similar to B1);

High pop, regional rivalry = SSP3 (previously A2). Storylines and tons of data that underlie all this are available. None *assume* additional climate policy.

Overarching questions – how do changes in climate and society affect impacts and well being, etc.

The radiative forcings that come out of the models…in some cases it is physically impossible to get to the highest emissions levels… and without climate policy it is not possible to get to the lowest forcing levels in some of the shared pathways…

SSP data will be available on a website, which gives sophisticated users access to a huge amount of information.

Scenarios for the NCA3 – used existing literature, high and low climate scenarios (A2 and B1) using global and regional models, SRES, older climate model runs, downscaled climate data, population and land cover ICLUS (EPA) work on population and land use (Theobald).

New contributions from NCA3: 8 regional climate histories and projections prepared for the regions, based on observations, with climate process research and model outputs that were keyed to the interests in the region. In addition, Sea Level Rise scenarios – based on projected changes in global mean sea level… these had an enormous range .2 to 2 meters… based on a risk management approach, rather than an arbitrarily truncated range. You need to decide which part of the range to pick based on your level of risk averseness…and the time period of concern. This is a major innovation.

NCA3 Scenario Planning pilot – Purpose was to enable communities engaged in their own planning process to explore implications of climate change and test how this method could be supported by NCA
Gave them "best chance you will get" and the "big problems, low capacity" approaches – national conditions provide a context for what you might be able to achieve at a local level…

Participants (author teams) were asked to explore adaptation strategies at two ends of the spectrum – a "worst case" and a "best case" scenario without depending only on technologies for the challenging scenario, with results to be brought into the adaptation chapter… there was very limited response to this request and more work needs to be done to see whether participatory scenario planning can make a significant contribution to future assessments.

How to get use of scenario planning to become more common? Need to know the state of the art of scenario planning, how can more widespread use be encouraged, which aspect of top-down scenarios are useful and which need to be improved… these are things that can be changed… more tailored to specific decisions.

Some consideration is needed here in the connections between the top-down and bottom up approaches.

Why such different approaches for NCA3? – the big push on risk framing was to give them a bad case and think about how to manage that outcome… through adaptation.
You don't want to think about the mass of the probability distribution – you need to think about the "bad tail" – low probability high consequence outcomes if you want to manage risk…

A portfolio of options can meet both… if you can find the actions to embrace then that is empowering.
No regrets vs significant change in direction is a very different thought process… include criteria, identify sources that are hard to choose to do because of system, and consider professional risk…eg the risk of being wrong.
The two option version (worst and best) represents a continuum of possibilities in between…

Session 3: Case Studies

Leigh Welling
NPS began working with participatory techniques in 2007; 19 workshops, 29 case examples completed
Has explored lots of techniques and applications
Context – meeting the mission of NPS under climate change – requires new tools due to an unprecedented levels of challenge.

The purpose is to enable park managers to consider trends and account for surprise, facilitate conversations, stretch thinking and empower action; consider what is known and what is uncertain and what is most consequential.

This allows rehearsing/discussing options, proactive on what-if scenarios. They have been training others to facilitate complex conversations. Outcomes include a more literate workforce that has an improved capacity to deal with uncertainty. Park planners and managers are the main audience of these activities.
Four NOAA RISAs, three CSCs, 90 parks, 100 partner organizations have been engaged, and they have used quantitative and qualitative approaches.

Engaging stakeholders who are affected, knowledge holders, curious and creative ideas to challenge conventional thinking – are all criteria for success of this process.

Scanarios are used for a variety of reasons - as inputs to park planning, financial contingencies, action plans, as a platform for training and capacity building; for resource stewardship planning, and informing decision-making, e.g., wildlife management and fire management.

Process methods: Core methodology is a nested matrix – classic two by two framework; e.g. Assatigue example – Parched Ponies, ASIS Sand Bar, Drowning Island scenarios – each "storyline" is named.
Then developed 16 nested scenarios – e.g., Social Concern/Leadership; Sea Level Rise, Storms, etc.
Alternative methods that were useful with management teams – are a least change approach – good way to connect with management teams… card-based, two sided cards that represent climatic and socio political uncertainties… inductive.

Scenarios are used to generate actions and to test decision options.
Isle Royale – scenarios were: no intervention; augment wolves; managed relocation; restore pre-European conditions.

Why are participatory scenarios valuable – they allow people to get into a conversation, get past mental roadblocks, pick apart complex issues. The Park Service wants to get to action quickly, and scenarios resist that. Many scientists favored the 2X2 approach where the managers disliked the two by two discussion because they wanted to go directly to solutions and understand the complexity of their own systems.

Scenario discussions allow important issues to emerge… provide balance in conversation – but are less useful in identifying exactly what actions to take.

3 viewpoints – scenarios as **products**, as **process** and scenario thinking as **"scenaric thinking"**

ADK – Dave Mason, Kathy Hornbach,
Structured Scenario Planning
Adirondacks case – building a 25 year all inclusive strategy for the region, half private and half public, 100 towns, 130,000 residents… starting with a highly polarized environment.

Common Ground Alliance Core Team was the client.

Mason/Hornbach conducted 150 interviews – leading to an option "kit" that includes alternative future conditions; 515 people attended the workshops. The purpose was to improve the regional conversation, it was informally linked to an economic development planning competition.

This method is called FutureMapping
In the workshops there was a lot of agreement on vision and priorities; leading to a roadmap, hundreds of aligned efforts now, sustained effort – there is now a lot of economic development money as part of this effort.

Write kit – Wild Park – Usable Park, Sustainable – etc end point ideas come from interviews or classic research
Goals – develop the mental model of the people in the group at the time – not a coherent experience at the beginning – reveals the need for them to learn; if they are senior managers it is hard for them to let go of their commitments.

Then you give teams an outcome, and you pick a series of decisions (events) that must have gotten you there. Real action comes from the monitoring system a couple of years later –

Work behind the scenes – ranking of the scenarios – most to least desirable… most and least attainable…Usually it is hard to get to the desirable outcomes.

Intentionally incomplete futures are provided – have to engage people in how it fits together and what events have to take place to get to that outcome. Also ran follow up meetings.
Lessons – a lot can be accomplished around mental models even if you don't control the resources, but alignment across groups gives leaders comfort…need to interview widely to create the option "kit."
End states have to connect to how people think –
Workshop attendees can edit, add and delete events, but can reuse the endstate framework in other similar exercises
ADKfutures.net – public monitoring tool – matching up real world news with events

Steven Sheppard

Visualization (presented remotely)

Local climate change visioning, focused on bringing scenarios to decision-makers and practitioners in ways they can relate to. Participation and engagement is a major objective – scenario building, data/model integration, 3D and 4D visualizations. E.g. Snowpack animation – used with communities in the Vancouver area. This approach converts a graph into a clear mental picture. Land use, local climate change drivers and impacts can be displayed.

Sea level rise impacts in the community – with adaptation options displayed, e.g., the effect of dikes– a range of possibilities in a landscape that they know well, exposing them to future thinking.
More radical options include floating houses, etc.
Evaluations showed this was an effective approach – e.g., before the exercise 23% felt that the impacts of climate change are serious now; afterwards 46% thought that the impacts are serious now; qualitative evidence of being empowered.

Also evaluated support for mitigation policies and similar outcomes, and have done some longitudinal work – no real detection on policy but the managers felt positive about the tool.

Kimberly visioning – GIS based modeling of pests, flooding, etc. options embedded in an actual adaptation plan, about a third were adopted, several built.

Later version of a delta project – hold the line with dikes… visualization with a flood breach and dike breach situation…

He is a little frustrated that the methods have not been widely adopted in planning. Now going to high schools with an educational video game… built on the scenario setup – futuredelta2
Start in 2100 with the outcome of the business as usual scenario, then go back to where we are and discuss what you have to do differently to get there… community outreach on alternative futures…

Guidance manual, book on Visualizing Climate Change…

Erika Rowland,
Adaptation for Conservation Targets, ACT
Participatory Adaptation Planning approach focused on adaptation conservation targets, lowland boreal wetlands, Yellowstone River, etc. This is a place-based, target-focused approach…first applied in the SW with a pilot effort - Wildlife Conservation Society has applied it broadly.

Project partners – always about engaging regionally relevant groups, very participatory, including info providers, resource agencies, practitioners. The purpose is considering what to do to achieve conservation goals in light of climate change.

Process grew from existing frameworks – bringing it into existing planning processes, adaptive management; focusing on particular conservation features that you would pick at the outset. Need to acknowledge the importance of people's mental model – come with a strawman, give people an opportunity to weigh in;
Use both conceptual models and scenarios of climate change to think about impacts on targets, management intervention points, brainstorming a suite of actions, etc

Came to the workshops with scenarios already developed based on expert input, 20th century climate records, impacts in the region. Info from global and regional models….
Two day workshops – hard to think through more than 2.
Graphical conceptual models – often previously developed and tinker with them in the workshops.

They consider climate drivers, but not other drivers of change (to keep it simple).
Brainstorm management interventions – intervene, eg to manually remove saplings, prescribed fires, herbicide control, prescribed fires and herbicides in combo.

The positives – given that the process in application for less than a decade…
Improving understanding of potential impacts, demonstrating a framework for developing adaptation actions, allows consideration of specific management action for implementation, a catalyst for overcoming uncertainty based paralysis, providing a launching point for adaptation planning across jurisdictions…

The challenges – limited number of targets of interest to participants can be covered at once. Relies on climate as a driver, this is limiting, conceptual models may be limiting for considering broader impacts, intervention points and management options, aims for near- term actions that address future change for a fixed time period rather than a longer term approach; early applications, better for exploring options than making decisions…
No one group was going to take any one option and implement it on the ground….

Casey Brown – (Presented remotely - Patrick Ray was present)
Decision-Scaling (or "Scenario Planning Meets the Stress Test") – a small number of discrete scenarios often don't match well with the real world…how to use climate information in a bottom up way without being overwhelmed by the uncertainty ? (This is a systems analysis approach)

Objective is getting past the "predict then act" approach that goes towards a single most likely future.

Challenge is incorporating poorly characterized uncertainty – should we make our plans so that they do well under historical climate conditions or future: Decisions that they make are high stakes decisions, eg need a predict then repeat mode because the impacts could be very different than what they expect.

Approach is decision scaling – bottom up approach – stakeholder defined risks; climate stress test (carefully structured sensitivity analysis that leads to scenarios); evaluate climate-informed risk scenarios.
Example of a climate stress test –vary precipitation and temperature and find out what is problematic for the water supply system under a risk analysis – now know what you are vulnerable to.

Climate stress test – water resources systems analysis – stochastic weather generator that samples climate conditions that would break the system – through a hydrologic model and systems model – climate response model, how it performs over a wide range of changes…

Decision scaling is an alternative to downscaling, tailor the climate information around the risks
Exhaustive exploration of future conditions, allows ability to identify and select robust strategies, from this scenarios emerge. Understand the sensitivity of the system to climate change vs understanding the sensitivity to climate change projections themselves so not dependent on the projections.

Colorado Springs utilities – Monte Carlo outcomes – testing performance of the system relative to a wide range of climate changes, including reductions in precipitation and increase in temp – shows the reliability of system… in this case, it can handle a lot of climate change beyond what is expected. But also interested in knowing whether can meet future demand, this causes a dramatic change in reliability.

Then bring in specific projections of temp or precip and can show that on the graph – can see quickly that there is a high probability of problems… in the context of demand growth.
Future probabilities – key point here is that if you are using a large ensemble of GCMs that are equally likely that is a big problem… a lot of correlations between models – the range from models is much smaller than the full range of uncertainty. Important for stakeholders to understand.

Evaluating new hydropower in Nepal under climate and nonclimate uncertainties – electricity prices, lifetime, capital cost, discount rate and differences in precipitation. In this case climate change posed no risk to the proposed developments…it is not one of the key factors, economics are more important….

Current approaches to planning are not well adapted, but climate projections not credible variables of most interest, scenario planning explores a limited set of futures. Decision scaling combines scenario planning and decision analysis. Currently exploring SERDP and world bank applications.

Question: From an ecological point of view, are you incorporating forest change in water supply futures? This is a critical potential impact on water supply. Fire events have been considered, but changes in forests not part of the analysis so far. Any time you work with a water utility there are a limited number of things they can consider, have to simplify.

Stress test can consider climate factors and nonclimate factors. Often they are looking to test specific climate impacts, suggest alternative variables, e.g., demands. Talk about what can go wrong, sample across a range… try not to limit the range up front. There are 3000 different futures in the Nepal analysis – in CS big model, have to be more selective.

Aaron Sussman
Land use and Transportation Planning
Incorporating climate information into existing planning processes in New Mexico, planning for a 50% increase in population expected by 2040 in Albuquerque.
Partnership with FHWA and US DOT to incorporate climate change into regional planning process –

Federal land management agencies, metro planning stakeholders, natural resource agencies, water utility authority, with no previous experience in scenario planning. Working to integrate climate related analysis into planning efforts, droughts, wildfires, flooding, water availability,

Considering whether development patterns make them more or less resilient to climate impacts and then incorporating that into the Metro Transportation Plan – MR COG. This is a long-range transportation plan, 20 plus years, updated every 4 years, considering alternative development patterns that result in smaller regional footprint, improved mobility, reduced dependency on single occupancy vehicles, greater resiliency, lower emissions

Started with identifying regional challenges; #1 concern was water. They then incorporated these into scenario concepts – stories about ways of developing, two workshops on preliminary scenarios that were analyzed via evaluation, then evaluation and preferred scenario. They used some standard land use and travel models with inputs based on different land use options.

Principles led to a preferred scenario – Increase attractiveness around activity centers and transit nodes, some changes in infrastructure. Measured findings include reductions in vehicle miles, commute times, new land developed, emissions, residential water consumption, reduced fire risk. A "lower level of deterioration" by emphasizing development in core locations you are minimizing development in areas of greater risk…
Pros – MTP is a built-in forecasting approach, can be linked to policy decisions; market based tools (incentivizing movement towards center rather than discouraging elsewhere).
Cons – constrained by existing policy environment and agencies; market tools not utilized to force growth in areas where it is most beneficial – hard to get the kind of structural changes that might be required may need more dramatic change

Interesting in spatial analysis as an outcome, creating an inventory of existing infrastructure and what is at risk now and over time, analysis requires understanding of changing conditions and impacts to natural features…

Questions:
Increasing density is one way to reduce vehicle miles;
Sketch planning tools can force growth into particular areas to help with the visualization component;
How could life cycle considerations of existing infrastructure be built into this plan…?

Session 4 — Framing, Inputs and Outputs for Scenario Development
Discussion

We have discussed a wide range of approaches: One approach focused on generating qualitative scenarios for natural resources management; another is a process of future mapping informed by events projected by participants and pathways to futures; a third process looked towards opening a conversation to break paralysis in natural resources; a fourth was visualization; a fifth approach was scenarios derived from data through a stress test; and finally the regional transportation planning approach.

The idea of not needing advanced modeling of climate in order to talk about the future is being used in Phoenix – eg looking at different flows in the rivers, starting with the outcome of the change rather than talking about climate drivers explicitly; looking at impacts of extreme storms without knowing specifically what the climate future is; a lot of "what if" based on paleo record. This is a scenario approach that has not been specifically described in the case studies.

This way you can go a bit past the bounds of the existing models – you don't have to get into the argument of what is going to happen, whether it is climate change related – focus on possible futures rather than climate per se. Still need to link these possible futures…and to monitoring to see where we need more work…
"Events" work (FutureMapping) is helping with this, focusing on what the stakeholders care about…

Informed sensitivity is another approach used by CH2MHill – changes in a climate sequence, can plug in specific climate changes for analysis. Question whether water resources as an issue is uniquely positioned – it is probably easier to identify the threshold values where there are triggers in the system… Much trickier to use others like fire.

Difficulty in identifying what you care about with when you have stakeholders coming from different perspectives on the same resources – this is a key barrier – testing the mental models
In the interviews, they need to recognize their own ideas - give them their version of the future and ask what it would take to become real…

In the Adirondacks competing camps had radically different concepts – so the future mapping is the right answer if it is really messy (complex) situation – this is a good approach. In this situation there was no quantitative model that could be used for this… it didn't matter if there was a right answer… just a good way to have a conversation.

There is no right answer in any of these techniques – the degree of being able to apply quantitative models is related to the number of perspectives… The underlying skill set is in helping people grapple with a problem – structure the conversation according to the shape of the problem. Quantitative modeling is not always an important component – finding common ground was a major part of the Adirondack effort – Common Ground group only talked about what they agreed on…which is not always a way to solve problems.

End states are pushed out to the extreme – the teams have to make the strongest possible case for their own end state – to really think about all the implications, gets the elephants in the room. This kind of role playing helps people's ideas converge, because they have worked through the implications together.

Scenarios they emerge from sources of differences in conceptions of the world, not just differences in outcomes or data. They don't just reflect uncertainty they reflect key differences in perception and training.

Re: Quantitative model of the Brahmaputra river (Casey Brown), scale or interest domains control. There is a false dichotomy between quantitative and qualitative solutions – people always trying to get a better handle on a problem… with groups who are coming to it from a different place… a good process needs both…or multiple… components/approaches. Quantification doesn't get you closer to a decision – public opinion, budget, policy also are controlling; scenarios are a way to get people think broadly – but then they have to narrow down/focus on specific issues in order to make a decision.

The analysis piece is where people are doing the quantification – but we need to make the decision more concrete so it can be better implemented… and avoid misplaced investment.

Tucson Water was very reliant on engineering models prior to the CAP delivery problem in the early 1990's – this was a perfect storm issue with everything going wrong at once – and nobody wanted that outcome but it happened anyway. An unanticipated consequence of switching from groundwater to surface water was huge physical disruption of the water supply system. When the strategic planning process came around 10 years later… they didn't want to make the same mistake twice… they wanted a way of looking at the future that was more adaptive and broader, more possible futures, not hardwired to a particular solution. After the conceptual envelope was broadened they got more specific in the analysis.

Scenario planning may be most valuable when combined with other decision tools – Structured decision-making addresses many of these issues. Scenario planning allows for divergent thinking and thinking outside of the box. SDM helps you converge again.. this idea of diverging prior to converging is an important theme across the scenario planning approaches.

The combination of tools can be very valuable…all contextual
We don't need quantitative analysis to look at extremes – don't need to use the whole train of models to get there…. Can use very simple scenarios to get there, though may need more extreme extremes to fully frame risks.

To prepare for most challenging scenario have to get going now – preserving options involves having to buy land now for a future reservoir for example. There are options that will no longer be available in the future that will be foreclosed if not protected.

We are not all looking at the same thing, some are planning processes, tools etc..
Different aspects of each of these approaches are useful in different circumstances.

Need to explore further the integration of tools – managers put more credibility in numbers than exists there… needs to be documented… must always caveat lack of certainty in quantitative findings…

Use of scenarios is something that is normal within a planning process – which method is the best method depends where you are in a planning process…

History of science is rife with collective wrongness – there are collective delusions that can be dangerous. It is really valuable to have a divergent phase of planning processes that provides a safe space to "identify elephants," then go to the necessary convergence afterwards… Depends what kind of problem you are trying to solve – a scenario approach is an early warning system to tell you you are wrong… with an engineering solution need to know that you are wrong early in the game or there are serious consequences.

Managers and decision-makers want to know whether they can make the decision easier, which is not the same thing as making a better decision…. This is a powerful decision… Depending who your decision maker is, they may not want to hear many futures… but the flexibility of having many futures means you can keep your job longer.

Stories are an important part of exploring the future, but there needs to be bounding and steering towards best available information – robustness as opposed to optimization – this can be quantified…

Projections – if you think about the conceptual models, the quantitative approach is an "end goal" but it is more useful in a diagnostic sense – looking for surprises, multiple approaches coming to the same answer.

The cone of uncertainty – is more useful than a single projection – it gives you some wiggle room.
Don't need a quantitative solution for everything, the cone can be defined based on specific climate projections

One of the benefits of quantification – poll around the room – how do you test and evaluate your scenarios to figure out which ones work… what does "work" mean? How to figure out the metrics for evaluation… value of the scenarios – you can come up with a conceptual envelope that talks about the future possibilities – then you have a cone, and you can look at what combinations of actions, what sequence of actions gives you the biggest bang for the buck…
Not necessarily an optimal answer, just a sense of what to concentrate on. Can lead to initial adaptive actions to consider in your quantitative analysis.

The metrics have to be relevant to decision makers… All of the scenario processes have expansions and contractions – generally the ones that quantify the metrics more than those that use quality only…

Underlying themes in the conversation- importance of basic decision science – characteristics of good decision-making include: Appropriate framing, broad identification of alternatives, identification of

preferences, logical reasoning, and a commitment to act. We are talking about using scenarios for different components of this process – linking the quantification to the decision – need clearly defined options to select from to do analysis…

Versatility of scenarios is a blessing and a curse…WUCA (Water Utility Climate Alliance)– people tend to start slow with scenarios and plausibility – then they want to know more about acute conditions which leads to robust decision making, more quantitative need metrics…

How do you know when scenarios are useful – you need a set of them – bounding the cone of plausibility – need a set of scenarios that are divergent and relevant… the way we can tell if they are useful is whether they get used… the more successful ones get talked about – this can help future decision processes – also a success if the scenarios show up in planning documents – or if we can go back two years later to see what was created, and with some updates they are useful…

Need to appreciate that there is an absurd amount of information out there, this can actually be a disincentive to good decision-making.
Ranking, ordering thinking can come from qualitative analysis….

Are there cases where people are actually implementing decisions that have come out of scenario planning - White paper of WUCA…gives examples.

Concern on the infrastructure side – most agencies design based on professional societies' standards – don't move those folks except in a quantitative way – can't just design on the basis of a theoretical "future climate" have to convince the third party who is a credible authority… e.g. Is Arctic amplification a real thing, and how is that going to affect my roof loading designs…?

World bank – concept note – risk assessment framework for places –don't want to spend a lot of time assessing climate risks if they aren't the most important risks… do a sensitivity analysis –if other risks are a bigger deal… parallel coordinate plot – how sensitive is it to design life. Net present value of the investment…

Huge range of net present value – climate change generally leads to a conclusion that it is a win to invest in the dam (Pakistan)… very sensitive to price of hydropower, discount rate, etc…

Inputs to a scenario planning process

One way to develop the inputs for scenarios is do interviews, asking the clients themselves for anything that is relevant, existing current plans, literature searches; some people have special expertise and when they are interviewed they provide important insights, also need breadth across the organization…one person in an organization is not usually enough. Especially for private companies, going to the librarian is a good approach… interview with outside experts, customers. Check with professional networks for info too.

There are many different classes of input – economic, biological, political, etc… usually there is a focus in each process. The process, if successful, opens up a series of alternative realities for the future. Common to all is making sure the inputs incorporate a broad diversity of alternative states. Another component with the private sector is suppliers, etc. If your purpose is to look at the future state of the climate, there are a lot of different approaches… e.g., time for space techniques. Environmental history is another way to mine the literature for alternative states that can enrich the future – looking for analogues.

There is power in observational records and experience that tell you the world is changing… Models don't convey confidence about this the same way that observations do…Evidence of change. Personal perspective is

critical. "An ounce of observation is worth a pound of modeling" per Kelly Redmond (DRI). Tree Ring records have had a big impact. This recast the conversation for water management – the gateway drug for managers: "Paleobacon."
Inputs and the role of webinars – they work well in establishing a foundation – very constrained and focused, very useful. Focused questions, readings, used as a foundation for future work, etc. helps with discovery of what people are running away from. NCA reports also very helpful… including the confidence components... focusing on the less certain things takes the pressure off the more certain things…

Make sure to keep the traditional approach to planning for comparison purposes – people understand that approach. Keep the scenarios very similar to avoid confusion –

How to embed a local focus within a broader context of socioeconomic change and environmental and land use change, what sorts of information about broader context are useful… ? Info about the changes in relative importance of different economic activities and sectors is really important, eg the 5 Cs in AZ (cotton, copper, etc) are no longer very relevant. Changes in transportation and markets, demographic changes… understanding the big drivers of the past as well as the drivers of the future is important in planning. May want to bring in experts like the state demographer to brief people…specific to an area. Regional economists, etc…

Comment about paleo as an entry drug – transparency and accessibility of data and tools – importance of bringing people to a level where they have capacity to engage.

Identifying your scenario team is important, there are multiple roles, eg: steering, leading, facilitating, experts who can help the client understand some things they don't already know… Stakeholder engagement – bringing in someone who has been at a unit for a long time as a participant.. eg the chief of maintenance in a location, can provide priceless insight. Institutional knowledge is critical.

Scope of the effort needs to be clear from the beginning – eg in the study of benefits and costs of hydropower in Nepal, not considering feedback effects – eg alternative energy choices – do you clarify what you are **not** doing…? These issues are much more complex than they appear.

Taking global trends and processes and understanding how they play out at the local level is really hard
How do you incorporate climate adaptation into land use and transportation decisions? Comes back to simplifying the inputs and clarifying the questions… setting aside things that you can't handle. Looking at how interventions affect/relate to larger trends… comprehension in terms of storytelling –

One starting place is the goals of the organization, finding places where they can better achieve those goals with the possibility of actually changing them. Can't start out with idea of changing goals (that might result in pushback)… but that may be an outcome of the conversation after they understand multiple possible futures. There needs to be an explicit conversation about goals.

What happens when you don't have the right team in place, an adaptive pool of people who can help…especially if the issues morph during the conversation? How to have that capacity available…
The inputs depend on the problem scope and scale… size of the problem, size of the group, understanding the question well… and setting the bounds of the problem… helps you understand the external factors today. There is a bias related to future expectations – may need to reframe questions.

Big issue now with NPS – what is the spectrum between inputs that are extensive, customized and expensive – vs. limited and synthesized….and cheaper? You can't get all the experts, so how can you shortcut to get good enough inputs to make progress? – NPS nested scenarios included a decision to customize every climate scenario but not the socioeconomic scenarios – used one standard matrix; A practical approach to use is off the shelf info for some components of the analysis.

Higher education Is now working on a resilience framing (through Second Nature) – thinking of using scenario planning to build the social capital components through the scenario process – starting from a place of knowing where they are and what they want and then adding the climate components and adaptation options. Education institutions are in a slightly different category… but in some ways they are similar to other institutions.

Organizing these thoughts – in an iterative risk management cycle, where do the scenarios connect? There is an aspect of scoping, mental mapping; what are the big questions and issues; decision scaling is about drivers and that is a different set of inputs than if you are analyzing the drivers or creating a plan. Very different inputs and approaches than if you are doing it as part of a science implementation program.

Outputs from Scenario Processes

Working with a lot of agencies, the outputs need to be identified before the inputs are selected… a lot of focus has been on changing what is happening on the ground, pulling in experts as needed –
Understanding how your audience processes and receives information is critical, eg model output is almost never acceptable as an actionable outcome. It is different depending on the culture of the organization…
Capacity of individual clients need to be considered.

Shared mental models allow alignment of the group – if the scenarios offer different directions for the organization… if done well they will understand the most important actions and changes that need to happen and a set of signposts or milestones towards success. What kinds of resources are needed to get to outcomes – an implementation plan… if that is what clients want? In high tech companies…they align around intended outcomes.

Outputs include: streams generated, briefings for the organizations to get higher level support, Documentation of the process and what is learned. A complete record of the meeting is another output.
Detailed process documentation is important and can be very valuable…for multiple reasons, e.g., transparency and to remember what was done… data produced for the process can be an output in itself.
What were we thinking, limitations and constraints.

Utilities are obsessive in general – laying out no regrets strategies before the tipping point can be a helpful foundation for future actions… especially if there is a trigger point in the meantime, pre-positioned thinking for future decisions, rethink is much quicker.

Scenarios themselves are an output that is really valuable as are derivative products, eg public outreach documents. Evidence of utility of a scenario process is a manager that keeps the scenario description on the wall – though output is often that more work is needed.

New partnerships are an important outcome of scenario processes… qualitative relationships and changed attitudes/perceptions/world views are also outcomes.

Experiences in NPS: how much detail needs to be preserved from these efforts? some reports are very cryptic. In many ways the degree of documentation is a decision of the team and the client – a long report vs something people will read is the tradeoff. Pointing to sources of information that are not formally reported is one way to summarize.

Individual parks handle outputs differently – eg Sequoia KC has worked with outputs of their scenario exercises extensively. How much of the outputs in any process can be designed to be inputs to the next part of the process? How often is there a need to revisit assumptions etc.? How to organize the documentation in a more useful way, translate it for wider understanding and use? Technology can be a big help in curation…
The challenge is there is so much information and a need for translation if anyone is to find it useful.
The participants should agree on when they intend to revisit the outcomes again…

The pace of global change will not allow people to walk away from this conversation for long.
In FutureMapping we build event paths for each scenario that goes to an end state, this is an output, a basis for a monitoring system. We build an ongoing library of outputs from previous groups… some can be used again.

Combining understanding of process with input information that has proven useful in the past is an important part of improving the process…
Looking at other people's methods – a community of practice around these techniques, an analysis of what is useful…can also be helpful.
Working with a science communications group – how simple can or should you make information – are we insulting them or confusing them?

Biggest output from some processes is the assumptions that were identified and challenged that were made about the system.. eg the depiction of what demand for water looks like. Denver has a buildout calculation – but if Denver builds up (higher rise buildings) rather than staying at current densities, what does that mean? Huge gap between supply and demand, regional demand, wildfire, watershed, climate change are a number of additional challenges not previously considered.
Considering the alternative mode of development changed philosophies on everything.

Day 2
Session 5: Revisit Day 1
The group reconsidered the agenda and decided to stay in plenary discussion rather than breaking into small groups.

Themes emerging from the first day included:

- Timing of inclusion in the decision process of scenario activity is of interest.
- Tension between specificity and inclusivity – relates to the convergence and divergence approaches
- Trust is the fundamental component of success, this is well documented
- Choosing techniques needs to focus on amending our own methods to their needs
- May need a completely different approach for each group – when you are experienced you essentially riff off of your knowledge and Mix and Match to suit the application – this is actually standard practice
- Choosing and structuring a scenario process is more of an art than a science
- Openness vs structure of the process – law of two feet – people should come or go based on how well the process is defined… eg the Adirondack process is the right approach at the right time… there has to be a relationship in the early stages with the people engaged to bring them back for more
- There are some really basic scenario methods and ways to link them but a lot of variety in options, new experiments that lead to better ways of getting to outcomes.
- A taxonomy does appear to be needed – but it is not so much a matter of discrete approaches, but more modular features… A classification may not work well since there is a lot of similarity in techniques.
- Also – is scenario planning a continuing dialogue or an event? followup and monitoring is really important to find out whether there are outcomes… changes in attitude, actions, etc…
- Can start without an intention for an outcome, but there likely ARE outcomes and they might not be what you expect
- Modeling as a tool doesn't engage people – they either believe it or don't
- Scenarios DO need data – if you have a data rich environment – need to figure out how to combine the tools of modeling with the process of scenario planning
- Scenario planning can be EITHER an event or a process… scenaric thinking is where we are trying to move ourselves and managers.
- A lot depends on the type of organization that you are dealing with, eg a utility is focused on outcomes, not attitude adjustment/definition… Scenario planning can be incorporated into the mission

and function of a utility – without a champion, it goes away. Trying to maintain continuity and institutionalize it is very difficult… So driven by individuals… and support of leaders.

- Divergence-convergence is an important framing issue/learning point as is the false dichotomy between quantitative and qualitative approaches…

We usually do this scenario work on behalf of stakeholders, but there are three major considerations – learning about method and technique, learning/disciplinary science related to the science needs, and National Assessment implications – we can gain insights that may be of use to others in the sector who are grappling with similar problems. If we can find a way to reflect the learning in something larger there are more benefits to action.

Challenges include the balance between learning and action – broad value of learning up front is a hard sell This technique uses science but is actually art – which makes it hard to institutionalize. Need to think through overcoming that hurdle. Is this similar to adaptive management? Getting the money and the commitment at the beginning for monitoring gives the group permission to be wrong..

Importance of ex poste assessment – we are looking for commitment from participants to be prepared in advance as well as a commitment to following up from the beginning… common to end with the workshop and the report… but there is a need for followup…

Session 6: Process and Applications and Connections

Framing Questions: 1) Combinations

Scenario planning for scoping, prioritization, engagement, etc. Given limited time and resources, how do we get the most out of the effort? The 2X2 method causes divergence (framing alternatives), whereas the future mapping approach may cause convergence. The modular approach is an appealing idea – if you can break down the approaches into discrete modules and understand the criteria for applications in particular circumstances, they can be recombined in new ways for new applications. You have a framing you can use for picking the methods at different scales.

The next module depends on the shape of the problem and the client… the events may take them to action, it is hard to know what the end point of the effort is while it is ongoing. There may not need to be an explicit decision about what the next step is during the process itself.

FutureMapping includes a toolkit of approaches, often using cards and dots – but thinking about structuring a way for the group to move through the problem. A systematic look at the problem and alternative paths towards a process is needed. In long term planning it is a different set of tools than if it is a short term decision. Is the scenario planning an end in itself or is it a tool towards an outcome?

For long term planning – start with being open to the divergence of ideas, big brainstorming, then focus on a couple of main ideas, then in a systematic way develop narratives that are grounded in something real, eg what are the long-term drivers of change in the region, then go big again, looking at the options in an unconstrained way, then focus down to public health issues in a crisis situation… what is doable , realistic?
Denver - All of the supply and demand ideas that were feasible were considered… then decided what balance of options to consider – pros and cons of the supply and demand options and how they relate to alternative economic scenarios, suggested alternative plans for each of the scenarios. There were not common solutions across the scenarios, so this required more analysis. Tested how flexible and adaptive can we be… starting over to work on a policy statement now.

Hierarchical decision-making (eg in corporations, governments). If there is a nesting of decisions up a hierarchy, the relationship of the decisions to the hierarchy is not always clear to the participants…higher ups may be setting the boundary conditions for the conversation. Approach may require being tailored to the

expectations of higher ups. Different methods may work at higher vs lower levels of the chain of command… What actually works is that the business units can feed up into the ideas of the upper level, need to accommodate these expectations… Depending on where you start in the hierarchy, may use different approaches to bring people in. It may be a lot cheaper to start at the top.

At NPS biologists and scientists were asked to pull together the science on the way to getting to the managers, an introduction to scenario planning… using preliminary scenarios that are already developed… to start the conversation.

Bureau of Reclamation – started with a lot of iterative conversations, not explicitly started as a scenario planning conversation. Initially a lot of work getting buy in on the process with each stakeholder group, multiple trips up and down the chain. What are the questions, how can we get to answers, etc… on defining problems and challenges in the system – how to address the challenges based on people's underlying assumptions – how to get them past these underlying biases?

Framing Questions 2) Barriers

Connections between alternative futures might be tenuous… a single strategy that works across all options is hard to come up with. No low regrets or low risk options are a good starting place. E.g., for water management, buy land for a reservoir but if you don't need it, could still sell the land… so a low regrets option without stranded assets.

Last task for teams is how the solutions can fit together, perhaps solutions are phased in over time in response to triggers. Time and willingness of client to spend time, budget limitations are barriers; deciding whether a small number of people take a large amount of time to get to an outcome vs a large amount of people for a smaller amount of time at the same cost.

A barrier is mindset – it can be very difficult to get people to step out of their existing mindset. One solution is to do the process internally. External facilitators may be a problem rather than a solution (especially if they don't understand the culture of the organization(s).

General challenge – people who want a "most likely" perspective, hard to change their mindset and encourage them to accept multiple futures or a range of possible futures.

Opportunities can come from profound failure; when all the rules are up in the air, an industry transition point, a business model starts to break… the expected future becomes undesirable, that is a motivation to change the trajectory. This is what happened at Tucson Water.

Framing 3) Opportunities
Three categories of opportunities: 1) negative forcing in decisions and the way you make them, or crises that actually happen; 2) positive – opportunity to save money, enhance quality of life; 3) opportunity thresholds, eg technology opens up a whole new arena. Viewing scenarios as a way to change the way you make decisions; federal policy and leadership allows or expects this kind of activity.

DOD up top is out in front on climate change, but at individual facilities are not all on board – different parts of the federal government are more and less hierarchical, and more or less open to considering alternative futures that include climate changes.

Better to do long range planning when you are not in a crisis – decision making under stress is not the best way to do this. When leadership changes in an organization is an opportunity as well. Tough to link today's decisions to some future scenario – how to illustrate those links is a barrier, eg how do the day to day decisions lead to one future or another.

Irreversibility of a decision is also a barrier to decision-making… robust decision-making is still the focus but there may need to be risks taken.

Should we be matching specific techniques with specific kinds of decisions/topics/scales?

We should go through the case studies and look at the modules within them and where they might fit in a stepwise scenario process. There may be some decisions that are more linked to some approaches or scales, or kinds of participants or specific expected outcomes than others. BR[1] large scale on the supply side, demand side used different scale (smaller).

Public vs private, institutional participants may require different scenario approaches.
Difference in scale – can also mean temporal differences as well – long and short term processes, different techniques?
Businesses – old consulting proposals (from Dave and Kathy) provide a map of steps and costs that were associated with different approaches… as well as timelines…

Mixing techniques – ACT and 2X2combo? Participant vertigo and lurching between ideas can be a problem… the audience often doesn't get it, eg advisory committees and boards having to deal with a lot of methods and voices. Need to be cautious.
The ACT process laid a foundation of logic chains from a driver to a result… see less of it with 2X2?

Managers are interested in learning about scenarios and how they are created, and might be interested in pre-cooked scenarios, to avoid the fatigue of actually creating them. Many want to just move on, and get to the actions. Scenarios are a tool… people aren't very patient with the development process and can be irritable.

Need to resist this perspective that one or two scenarios are enough. Not enough exploration of uncertainty will be included – the purpose of scenarios is to embrace uncertainty. If the second future is different enough from the first this is less of a problem.

Need to let people examine and localize scenarios even if they are imported from elsewhere.
Scenario fatigue is a serious challenge, but if the internal group did all the work it made it easier for the upper management. Good to have a mix of practitioners and scientists with the managers.
How to engage them in using scenarios – convince them to come in the first place?
Incentive to actually participate – one way is to have leadership tell them they have to come…There are always people who don't get the importance of this. The preliminary survey interview approach helps people think they are helping to create a process, and then tying it directly to their own needs as you design the process will rope them in. A function of the core group is as builders of trust. If you get one person who is a leader and trusted you can get other people there. Keeping them there is another story. Peer to peer conversations are important.

Leadership wanting engagement is an important part of getting people to the table.Having people understand that if they aren't there the decision will be made without them. But if you are doing research there is less incentive for people to be part of the process.

A public workshop for free to allow them to experience the process can help convince people to engage. Often it is word of mouth among participants who have been part of previous successful scenario planning experiments that bring people in. Adirondack process was public – and they held 14 workshops instead of the original 1. People came because it became clear that decisions were going to be made as a result.

Sometimes you get only a few people to a workshop, but you can have groundtruthing conversations between workshops.

Even if there is not a decision to be made, if they feel there is a real outcome, they are likely to want to engage. If they are invested in the topic that matters to them.

Framing 4): Connections: Linkages between scales or cases –
A lot of the methods do link up – could use decision scaling to identify drivers of uncertainty, or for analyzing options against the vulnerability space. Depends where you are in the process. In the corporate world, if the outcomes are linked to the budget, strategic planning, etc already ongoing then integrating scenarios works well.

NPS – inculcate scenario planning into existing planning processes… still working on ways to make this fit into existing planning processes. It is now used in "alternatives generation" for NEPA analysis.

How do you carry four futures forward? Look for low regrets that support them all, plan the infrastructure program to support a wider range of options for the future. Then the financial managers can move in – the planning process itself becomes more flexible. Explanations in foundation documents in the past were set for long periods of time, now planning is much more flexible.

If the world is changing, we don't want to start with a blank sheet, we want to set the stage for experiments that make sense if the world turns in that direction, preparing for multiple future options.

Ecological Services in FWS – had a hard time bringing scenarios into regulatory documents, but they used the scenarios in the strategic plan, and then that started affecting the regulatory components. Agencies don't want to go out on a limb – they want "permission" to act – and there are all kinds of complexities – they want authoritative information that they can use, eg official standards.

Incremental smaller things can reinforce the process… e.g. connecting the scenario activity with ongoing processes so it doesn't seem separate. Integrate with components of planning processes that are already institutionalized – eg analyzing resilience of systems, just another tool… Don't need a separate framework. Emergency management and table top scenarios are another example.
Connecting across sectors – different agencies, missions, etc.? After the scenario framework is set – you can take the framework out for discussion to other organizations – how can you align your organizations strategy to that outcome?

Games – literal board games with cards were used in Nepal and DC – cards with roles for sectors… beans are how you win…shows how the decision-makers in the sectors have to work together to get the most beans… icebreaker at workshop. But sometimes the games can actually be insulting – need to be sensitive to the audience.

Mainstreaming climate adaptation and scenario planning – in WUCA often not successful outside of long term water supply planning. Need more research on ways to dive into and test these processes. Up against institutional barriers on how to proceed. One game is to assume a fixed water supply, how to do the tradeoffs between sectors to decide who gets the water that we do have in a shortage? Good for role playing.

Need peer to peer conversations – a manager in the same room with the staff is likely to limit people's input, have breakout groups that are peer to peer? Need to avoid having someone's voice unheard. Structures that prevent people from dominating – or being unwilling to talk. Have to be prepared to reconfigure groups during the day… might start with a lot of diversity – it is very disarming – no one has the right answer. In a brainstorming mode people should feel safe with ideas… perhaps later in the conversation – people with similar experiences and insights need to talk to each other. How to internalize the process. Water is an engineering dominated field. Few are prepared to engage in these complex conversations.

Parking lot topics:
Evaluation, research/data needs, training students, next generation managers and researchers, institutionalizing the process, vulnerability assessment is different from understanding response options, when they should be done separately or linked

If you start with vulnerability assessment the outcome is very different from where you want to be in 20 years. Is it important to start there… rather than starting with visions of the future? Vulnerability helps as a good starting place for getting people's attention. Can also use VA as a way to screen options…
Need to start where the people are and what they want to talk about. Ultimate approach might be negotiated – the vulnerability analysis may be a way to expand the pie – eg connect the fire risk into other arenas like water and energy to help develop options.

There is a cost to doing assessment – where can I rule out where I clearly have no vulnerability… separating the response from the vulnerability assessment. Maybe at the institutional level you can combine these ideas but not at higher levels.

Dominated solutions – a deterministic solution may be dominated by the stochastic set…linear thinking doesn't get to maximum benefit> encourage considering a range of uncertainty.

Where you think about the current vs the present – you are in a specific context now, so you are making assumptions about your future vulnerability. Things are not that simple, you may need to iterate to get between where you want to be and where you are now. It doesn't make the decisions easier it makes them better…. Can continue to iterate over time as there is more information (adaptive management).

At what point in the divergent-convergent model do you make a decision to focus on specific outcomes… need a lot more smaller scale approaches that are cheap. Some of these efforts are gigantic and expensive. As a first cut can do a simpler approach… including generic top level scenarios, like climate outcomes in 2030, what are the adaptation options.

Might be helpful to have a first cut of scenario planning guidance and a deeper dive guidance for experienced practitioners. Transferability is one way of making things cheaper, and having think tanks develop a standard set of products that can be beneficial across applications.

Some levels of vulnerability assessment can be "first cut" and help with framing the rest of the effort and setting priorities, with the expectation of revisiting later. Then you can repurpose the original assessment. VA is very trendy right now for feds, NGOs were there about 5 years ago. VA is not an end in itself. A Mobius strip – can be really frustrating.

No one in federal circles thinks VA is an end goal? People are struggling to figure out what is the proper order of activities.

<u>Institutionalizing Scenario Thinking.</u>.
What is the role of policy or expectations, eg being climate ready. This is beyond the institution itself – being climate ready is about a whole community.
Mainstreaming as an assumption rather than an exception. Similar to the issue of integrating and embracing conservation.
How to move to dynamic thinking without causing dysfunction. If the state required integrated water management would this force this outcome?
Embedding or institutionalizing – the solution is that this is a campaign, need to win people over. We always look at the supply side, but we need to spend more time on the demand for information.
This issue is far beyond the scenario planning integration issue… it is about embracing change… and a faster pace of change.

Outreach with any employee to work on climate issues to help them access the information –BOR.
This is a way to empower people. There are some models in the conservation community – supply and demand approach to adaptive management – starting with Kai Lee's book. Ecosystem based management and fisheries started bringing these ideas to the table. Campaign +

Hard and soft institutionalization – building climate in, but not explicit that it is just about climate change; culture-related, give them a concept and a language to embrace change → change mindset
Institutionalizing decision making in context of change, if the change is negative → a tough sell; if we frame in terms of the future we want, then it's easier to get there; SP is a tool for positive framing.

Session 7, pt. 1 —Typology, Guidance, and Promoting Innovation of Scenarios
Is there a place where there is a good fit for certain practices.. commonalities, and connections?
Two buckets – the quantitative scenarios and the narrative/contextual version. The GBN/NPS and Future Mapping are major categories of methods..

There is a need for qualitative and quantitative components to fit together better. Under what circumstances does it make sense for modules to work together and under which circumstances not? The typology does need to be comprehensive but there are multiple dimensions of all of this, which is an occupational hazard. New frame: Think about 2X2 – resources available for project (low to high) (vertical); outcomes simple/to outcomes complex process (degree of complexity).
The really interesting quadrant is low resources and high complexity – this is where innovation is really important. As detail increases there is a higher likelihood of being wrong. Complexity of the process, eg lots of different parties, increases the challenge.

Look at each of the quadrants in this matrix and give advice? In the upper right more monitoring is possible (more resources, more process). The consequence of the decision is also a component of this – risk is another dimension beyond complexity that could be part of one of these matrices. Another is the importance of inclusion – eg a diverse group that needs to engage in the solution.

Scale issues, nesting – how does this fit in these frames? At some regional scale may have capacity from RISAs etc to build the climate futures. Already have rich description, economic development info,
Reusability adds value – groups can see how their perspective relates to others… and what comes out of various workshops. If there is a canonical set of options, can develop a drop down menu… and this will be more efficient.

An additional value of the prepopulated scenarios is consistency across landscapes…it is imperative to work at larger scales across land management units. If there is a small set of extremely useful scenarios, can check back on the idea of sharing across units and how to improve as well as saving money and time.

A research idea – need to have more adaptation options, what works, building a library of options and research needs. Monitoring data need to be compiled in order to assess the utility of options – may need to do adaptation experiments based on information that we already have, improve those and expand understanding.

There is a role for some simulation model to understand behavior before you have as much data as you want.
Forest inventory analysis plots already exist – and they can be used to assess certain questions.
If you can make the argument for monitoring – we do have a lot of programs in place right now, but our questions are bigger and broader and they are not designed to be integrated. Design-based approach, eg global grid – need to match questions to data availability. There are lots of investments in monitoring and yet there is no effort to make them work together. Need to see the value of multiple groups connecting across a broad platform so that similarities in data can be identified…

DOI is looking at landscape level mitigation strategies – need open source data, seamless across institutions, colocation, metadata – currently not accessible. This is an ongoing challenge.

There are people from the research side who are working on connecting data sets and getting them to talk to each other but FIA frustrating. Ecological informatics is very hot. It is frustrating to have to go through statistical gyrations to get to the outcomes rather than working together up front.

The LCCs and CSCs are good entities to tackle this problem, but will be a long time for solutions – within Desert LCC, information sharing, etc. We have an inadequate array of monitoring – there are ways to solve for some of this through informatics. There are some questions for which the data simply don't exist. Can facilitate conversations at regional scales to make at least regional improvements. Need to look for opportunities to advise and intervene.

Consistency is not as important as coherence…and this is more doable – e.g., through metadata. Even the reporting framework for GHG is insufficient for making dynamic progress – moving from a reporting to a dynamic assessment framework would make a big difference. Requires a framework/platform that contributes to a dynamic assessment.
Role of information – health care organizations are losing control of data – we are going to know more ourselves about our own health in the next ten years. There are a lot of data out there and we don't know what to do with it. Need a consumer report that puts the use of it into context as part of the metadata – has it been tested. The original utility of data has a lot to do with what it is appropriate to use it for.
The NCA3 traceable accounts are one example of a way to do this. But there is a ton of documentation of some data, overkill. Overload on documentation is a disincentive to upload as well.

Park Service INM nice interpretive guides – online. Want to capture as much as possible of the context of the data collection. Data that are being made public will be misused. At least if there are publications there is a peer review process, but data that are just uploaded are not reviewed. There are multiple issues here.

Can methods be nested in a way that promotes innovation… e.g. 2X2 connection with mental mapping? 2X2 focuses on endpoints… but mental mapping does the same thing with broader groups…to get to some of the same endpoints. Could explore different pathways to these outcomes. Dot and arrow exercise…dot where you are today, arrow where you expect the trajectory. People using this process find it is very revealing of shared mental maps.

Quick mental model – list 20 events, put a dot vote on what is likely and what is unlikely, this is a group mental model. Connection of 2X2 with the ACT approach – conceptual model/influence diagram… a key aspect is the leverage points, how you connect into the diagram, intervention options.

As the core team creates the prework – use the matrix model to identify the least change scenario (lower left) allows manager to move out of today. Then the manager starts to realize that a lot more change needs to be anticipated.

Structured decision-making – consequences table = objectives, criteria, alternatives…Then see if this changes in different climate conditions. At what point do objectives change?
Where does decision scaling fit in with the other techniques?

There is a lot that can be quantified – model development can also be participatory and result in buy in
Can actually incorporate some of the other techniques in the context of the model development.
Storytelling, visualization and modelling are all linked. How can we make sure that a "story" is actually modeled as a combination of variables? This is a big opportunity. These are all representations of reality… one is a picture, one is words, one is a model.

You can match parts of CMIP 5 as analogues of what you expect the world to look like.
Decision-making under deep uncertainty RAND… a possible way to engage this group? Starting a society… or a learning group… dynamic adaptive policy pathways – DAPP – subway map, with a key – talks you through decisions. On the key is qualitative info… qualitative presentation for framing a decision. Connects qualitative, quantitative and decision points. Really interesting approach, a brilliant way to connect the qualitative and quantitative approaches.

These are ways to level the conversation – how to get all of these approaches onto a parallel platform, comparable terms? A lot of opportunity for innovation… and synergies.

Next Steps:
Workshop outputs, preparation for the NAF, input to the NCA Sustained Process, Practical Guidance
Practical guidance – learning and sharing; not sure that an actual guidebook is in order but a lot of important lessons for practitioners – e.g., not about easier decisions, it is about better decisions; everyone has their own mental model, convergence divergence, etc.

- E.g. restoration guidance for springs – every one is different but we still may be able to help people approach this problem.
- There are some key chunks – what were the six big insights from this conversation? Information flows; why would people engage;
- Research gaps –eg evaluation, etc.
- Before jumping straight to guidance we should capture the main insights, guidance to whom and for what?
- Maybe a technical input to the National Climate Assessment as a goal…
- Frame the paper to make it different – a lot of scenario papers about how to. Let's target people already doing this work – to enhance current efforts – not starting from scratch (focusing on people who already understand scenarios). EG the Jonathan diagram, lower right hand quadrant…
- Real utility and urgency of using this tool… we need to move the needle… is there something that we can promote…
- A study from the National Academies of Science (BECS?) on this would be of interest – uses and limits of tools… next steps agencies could take… to bless an idea, but money is a problem
- The MIT Climate Co-Lab has lots of contests and fellows, social media – submit proposals about contributing to solutions… next year host a contest for advancing the state of scenario planning?
- Yale Communications group – Leiserowitz et al…a possible partner?
- ASAP and other professional societies – a letter or some proposals for continuing education training…
- Speakers Bureau idea-
- Also a peer reviewed paper, or white paper that can be shared as a group… Kathy H interested. We will send around some alternative ideas and ask for volunteers.
- What sorts of outputs you would like to see coming out of the national research program that would be useful for decision-making… USGCRP et al looking for input on how to make their science more useful and moving the National Assessment towards a more sustained activity.
- Do another meeting like this every other year.. planning for deep uncertainty – there may be enough to have a Scenarios conference with a broader group… an expectation that we will be in a different place in a couple years…
- Capacity building – how to grow the community and have more people with these skill sets… limiting factor is people who understand how to do this.
- Create a library of end states in advance and a template of how to run a meeting – this is a much simpler task and we could ramp up capacity to deliver workshops… other niches exist. Having the effort centered on a need that we identify – water, drought, climate change for the public – road show traveling group that allows these conversations to occur in different communities. A universe expander…

- National Conservation Training Center – piloted training 2 years ago – case studies, adaptation cycle, scenario planning training…use their model? Could we develop more sophisticated training on scenarios? The trainings are not static… introduce the techniques more broadly.
- Including scenario planning as a part of the National Assessment didn't actually take off. What could be done to advance applications in the National Assessment? There is a lot of development of NCA4 but they haven't been shared with the outside… INCA is focused on getting the next quadrennial report out but need to be strategic about scenario planning as an ongoing process rather than a pillar of the next synthesis report. Discussions of land use/land cover and socioeconomics have already started, but the participatory approach has not formally been discussed…. What do the stakeholder communities view as the role of the National Assessment? What do we need from the NCA? Authoritative science? Nesting and framing? The government doesn't want to stifle things at smaller scales… what should be the ongoing strategy?
- The NCA has become more about the process, this should help with dynamic assessment processes generally, could there be an onboarding package that would help them understand the value and role of this kind of work… timely delivery of guidance… and this is evolving…
- The sustained assessment special report laid out some of the questions that people want answered by the NCA. Some agencies may not be interested in supporting decisions directly…but moving forward the NCA does need to be decision relevant. To what extent is it in the NCA itself or as an outcome of the NCA. An open letter from this group could be powerful, especially if there is a request for information we could follow up.

Scenario Planning for Climate Change Adaptation Decision Making: The State of the Art
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Appendix B: **REFERENCES AND RECOMMENDED READING**

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Appendix C: DEFINITIONS

- **Bottom-up approaches**: analysis or scenario methods that begin with examination of the details of a system or decision that is of interest and then identifies general contextual trends or conditions that affect the system or decision.
- **Mixed-method approaches:** methods for scenario development that use elements of both a scenario planning approach, in which participants determine the purpose, substantive focus, and character of a scenario development effort, and other planning methods or scientifically derived scenarios, which can be used at points in the process to identify broader socioeconomic, climate, or other conditions that could affect relevant aspects of the future.
- **Top-down approaches:** methods that analyze general trends or properties of a system (e.g., global socioeconomic trends that give rise to emissions, then climate scenarios) to depict the broad context of future conditions which impact specific places, entities, or how decisions play out.
- **Uncertainty**: a description of the extent to which something is unknown. Uncertainty can arise because of a lack of information and/or disagreement about how to interpret the available information. It can also arise from ambiguous definitions, lack of understanding of underlying processes, errors in observations, lack of model skill, and other sources. Uncertainty can be represented both qualitatively (e.g., terms used by experts to describe the state of knowledge) or quantitatively (ranges of future variables as well as other statistical properties).

Visioning or planning-related definitions (including a few mixed methods approaches)

- **Exploratory scenario –** a scenario that is used to explore the implications of a possible future on predetermined goals and values (Holway et al. 2012) (references can be found in Appendix __).
- **Interactive and immersive visualization tools –** consist of a range of visual and spatial media derived from modeling, data, scenarios, and descriptive narratives used to contextualize and communicate climate change information in two and three dimensions at the local or regional level (Sheppard et al. 2011).
- **Mental model testing –** jointly building a group's explicit description of how things work or should be expected to work (based on their collective experience) so it can be discussed and compared to other scenarios.
- **Normative scenario** – a scenario used to help identify a desired future (Holway et al. 2012).
- **Participatory process –** a purposefully designed set of activities structured around framing (including clarifying objectives and identifying participants) and engagement of participants or stakeholders. This can include workshops and other means of engagement, including social media or use of technologies such as decision theaters. The outcomes can be varied, including a decision, a community plan, a report, films/audios, or other forms of knowledge sharing or exchange. (Derived from Moss et al. 2011).
- **Wind-tunneling –** after building the event or "endstate" scenarios (describing future conditions), the testing of alternative decisions for robustness. In this case, the scenarios are used for context.
- **Decision scaling**: "a new approach to using climate information within a decision making framework that links bottom-up, stochastic vulnerability analysis with top down use of GCM projections " (Brown et al. 2011a). Decision-scaling begins with a bottom-up analysis to identify a climate condition that impacts a decision and then uses sources of climate information such as GCMs to identify how often such conditions occur under different climate scenario.

Climate-science related definitions:

- **Socioeconomic scenarios**: narrative and/or quantitative descriptions of plausible patterns or pathways of demographic change (fertility, mortality, migration, and other factors that affect the size and location of human populations), economic development (patterns of trade, employment, economic development, etc.), technology (for energy, agriculture, water resources, etc., considering factors such as efficiency, fuel sources, and others), and institutions (types and effectiveness of governance

arrangements, patterns of association in civic organizations, etc.). These factors are important for understanding human contributions to climate change as well as the vulnerability or resilience of society. Historically, these scenarios have been developed to inform emissions scenarios.

- **Emissions scenarios:** descriptions of potential future emissions to the atmosphere of greenhouse gases and other radiatively important gases and particles that are used to explore the implications of alternative energy and technology futures and provide inputs to climate models (Moss et al. 2011).
- **Climate scenarios:** plausible representations of future climate conditions (temperature, precipitation, and other factors) produced using a variety of techniques including scaling of observed climate, spatial and temporal analogues in which climates from other locations or periods are used as example future conditions, extrapolation and expert judgment, and mathematical climate and Earth system models. All of these techniques continue to play a useful role in development of scenarios, with the appropriate choice of method depending on the intended use of the scenario (Moss et al. 2011).
- **Environmental scenario –** these **"**focus on changes in environmental conditions such as water availability and quality, sea level rise (incorporating geological and climate drivers), land cover and use, and air quality. Climate change can drive changes in these factors, or scenarios can represent independently caused variations. The potential impact of climate change and the effectiveness of adaptation options cannot be understood without examining interactions of changes in climate, environmental conditions, and human responses.."(Moss et al. 2011).
- **Climate model ensemble**: a group of climate model simulations that use the same assumptions. Large ensembles are used to generate information about natural climate variability and to characterize uncertainty from different sources, such as different initial conditions or model differences.