Methods and Approaches for Risk-Based Assessment and Communication: Climate Change and the U.S. Southwest

Gregg Garfin, The University of Arizona

Institute of the Environment

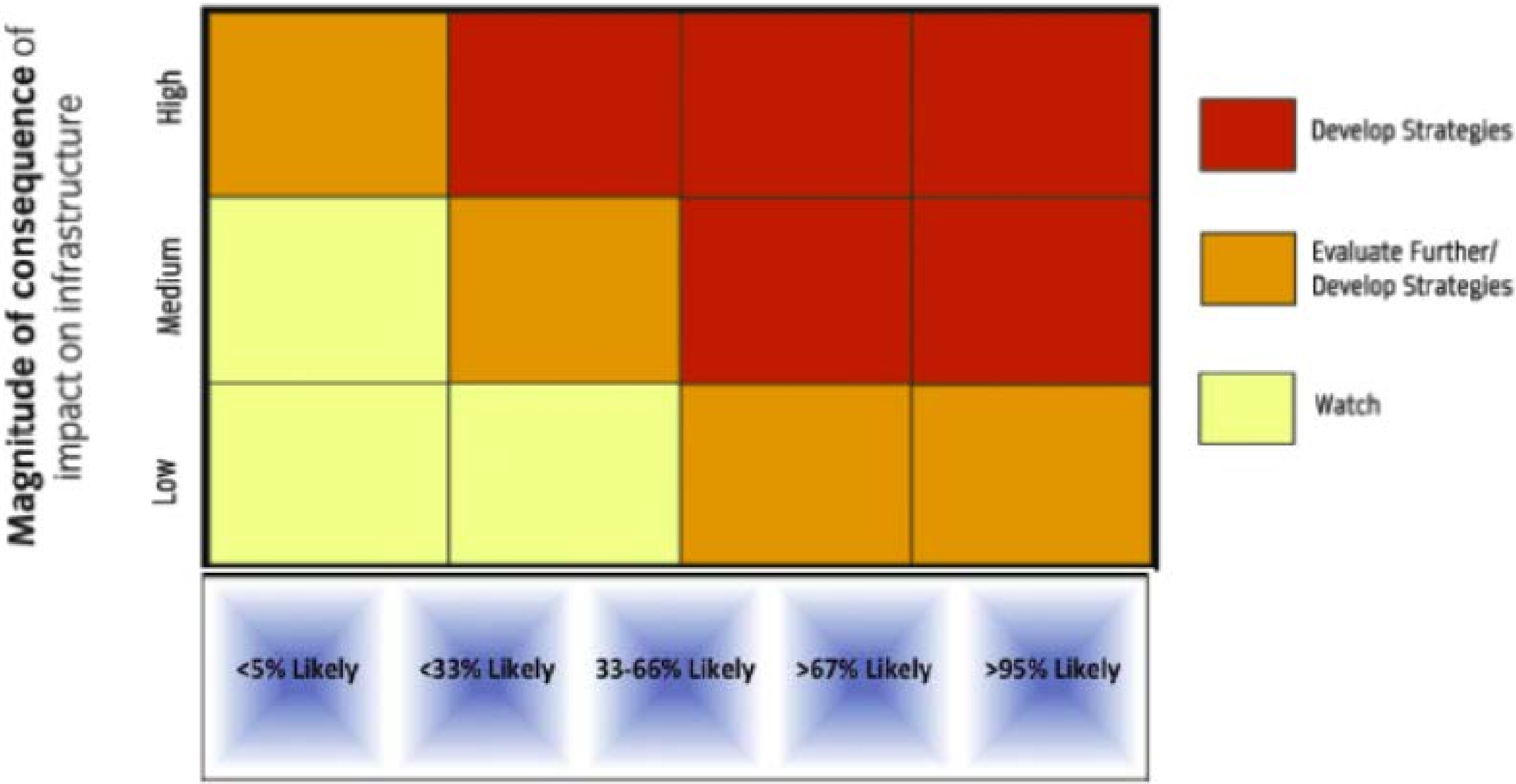
CLIMAS
Climate Assessment for the Southwest

COLLEGE OF AGRICULTURE & LIFE SCIENCES
School of
Natural Resources
& the Environment

COOPERATIVE EXTENSION
1914-2014
100
SMITH-LEVER ACT
EXTENDING KNOWLEDGE
CHANGING LIVES

Author Issues: NCA 3

- Time
- Resources
- Instructions
  - Evolving
- Traceable accounts
  - Uncertainty
  - Evidence
- Support for Authors
  - Using impact-likelihood matrix
  - Expert elicitation


Magnitude of consequence of impact on infrastructure
High
Medium
Low
Develop Strategies a
Evaluate Further/
Develop Strategies a
Watch
<5% Likely
<33% Likely
33-66% Likely
>67% Likely
>95% Likely

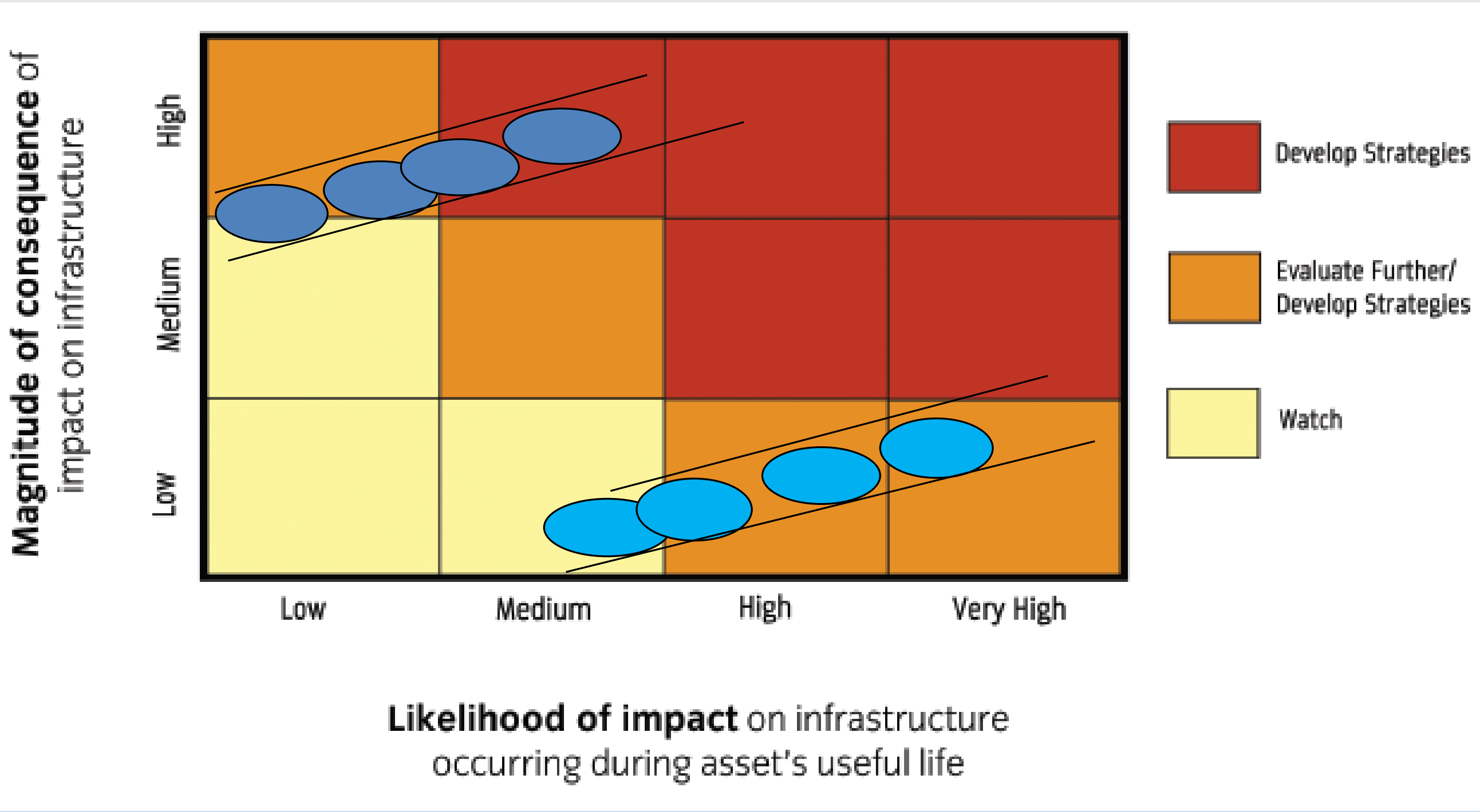
Example 1: Relevant Current and Future Climate Changes (from NPCC, 2010)

Depending on sea level rise futures that in turn depend on emissions trajectories that in turn depend on decisions taken in the near-term and beyond….

Flooding event	2020's	2050's	2080's
1/10 years	8-10 yrs	3-6 yrs	1-3 yrs
1/100 years	65-85 yrs	35-55 yrs	15-35 yrs

National Climate Assessment
U.S. Global Change Research Program

Tracking Flood Risk over Time



National Climate Assessment
U.S. Global Change Research Program

Traceable Account to NPCC (2010)

- Consequence:
  - Economic damage and some potential loss of life from published insured loss data; grows over time
  - The 100 year storm is a source of a *"key vulnerability"* because it meets magnitude and timing criteria; not reversible; expensive adaptation possible; important to economic sectors)
- Likelihood:
  - Judgments derived from published climate model predictions of SLR and associated effect on return times of storms

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Characteristics desired by users of NCA information:

- Accessible
- Useful
- Understandable
- Easily used as inputs to current decisions
- Easily used as inputs to decisions they are about to face
- Focused on individual hazards
- Articulating the possible consequences of particular choices on overall risks
- Certain
- Accurate
- Facilitates comparisons on alternative actions, past-present-future, tradeoffs

Reflect on the workshop themes of characterizing and communicating risk

- **Spatial scale**
  - Region-wide
- **Management scale**
  - Sector
- **Focus is mostly on changing exposure**
  - Sensitivity
  - Adaptive capacity
  - Non-climate risk

Recommendations: Authors

Culture of risk assessment

Recommendations: Authors

- **Integrated teams for risk assessment**
  - Cultivate integrated teams during the technical input phase
  - Risk-focused user workshops

- **Create institutions**
  - Community of assessment risk evaluators
  - Practitioner social learning about risk characterization and communication

Recommendations: Authors

- **Multiple author teams**
  - Vulnerability and impact
  - Risk and uncertainty
  - Expert assessment

Recommendations: Authors

Support for authors

Recommendations: Authors

- **Author support**
  - Time
    - Multiple author workshops
  - Method (not a suggestion) for evaluating importance, vulnerability, risk
    - Consistency is most important
  - Harvest risk-based analyses during sustained assessment

Recommendations: Authors

- **Research**
  - Conduct risk-based assessments
  - Risk-based mapping
  - Non-climate factors
    - Sensitivity
    - Adaptive capacity

Recommendations: Authors

Best practices

vs.

Consistent practices

ADAPTIVE CAPACITY

Factor Influencing Adaptive Capacity	Average Rank (s.d.)	Don't Know
Current level of awareness and understanding of climate change impacts	5.7 (2.7)	1
Current level of awareness and understanding of options to adapt to climate change	4.5 (2.6)	0
Current level of diversity of the forest economy	4.2 (3.0)	1
Degree of substitutability of non-timber forest resources	4.8 (2.9)	7
Cumulative effects of resource developments and other forces of change	5.1 (2.6)	1
Availability of informed, skilled, and trained personnel	4.6 (2.6)	2
Availability of scientific knowledge on climate change	6.1 (1.7)	1
Availability of local and traditional knowledge on climate change	5.5 (2.3)	2
Current level of investment in training, education, capacity building, knowledge exchange, technology transfer	4.1 (3.0)	1
Current allocation of investments in research and innovation	4.2 (2.8)	3
Current level of dialog among various decision-making agencies and stakeholders on adaptation	5.6 (2.8)	0
Current level of flexibility in forest management policies and practices	5.4 (3.2)	0
Current level of consideration of adaptation-related issues in forest management and planning	5.3 (2.6)	0
Availability of financial resources to adapt to climate change	3.9 (3.1)	3

Ogden and Innes, 2009 – Ecology and Society

Recommendations: Utility

User-centric process:

Discussion Support

Recommendations: Utility

- **Stakeholder / Decision-maker / User**
  - User-centric process
  - Involve the end user in assessment
    - Defining thresholds
    - Defining or branding scenarios
  - Risk-focused user workshops

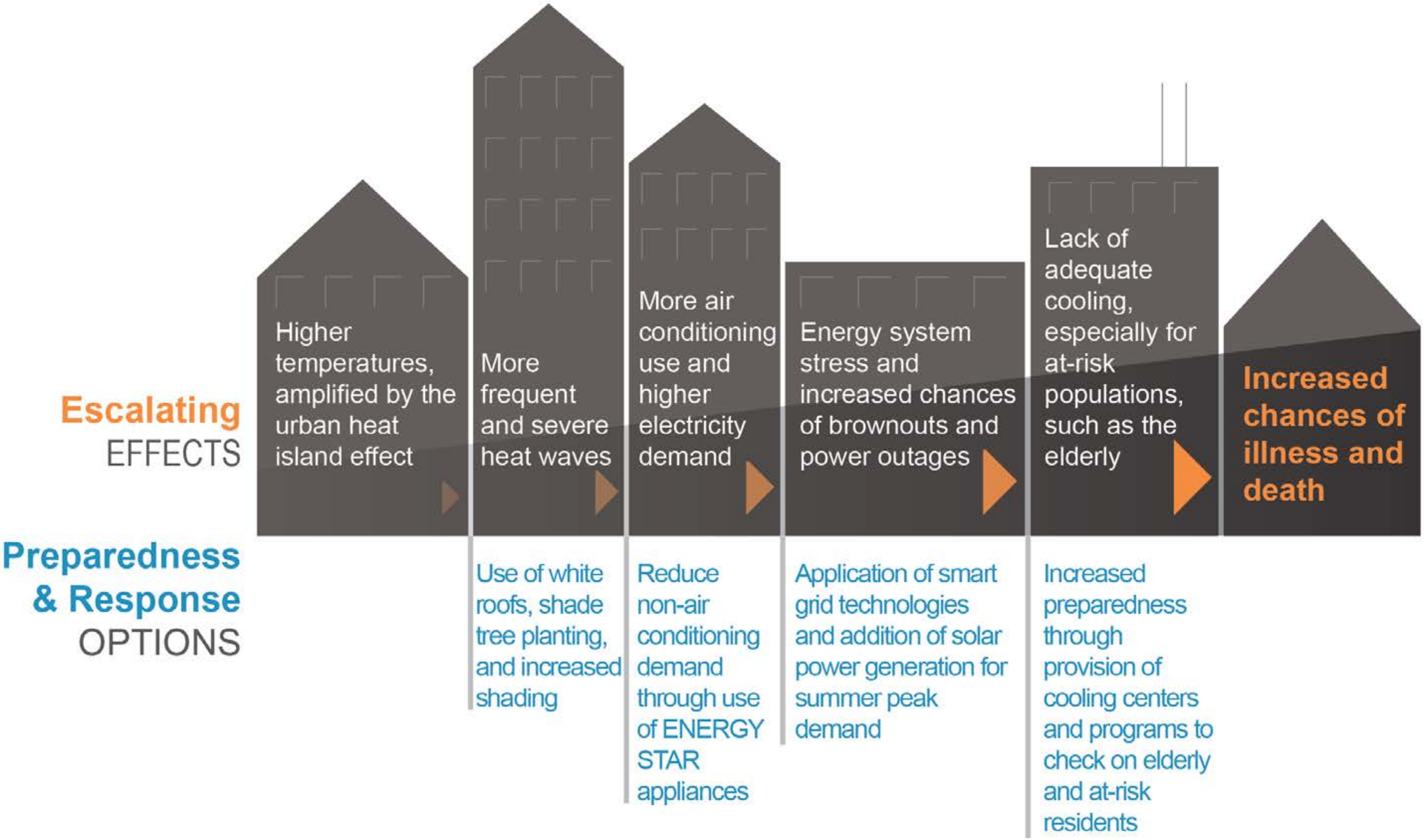
Recommendations: Utility

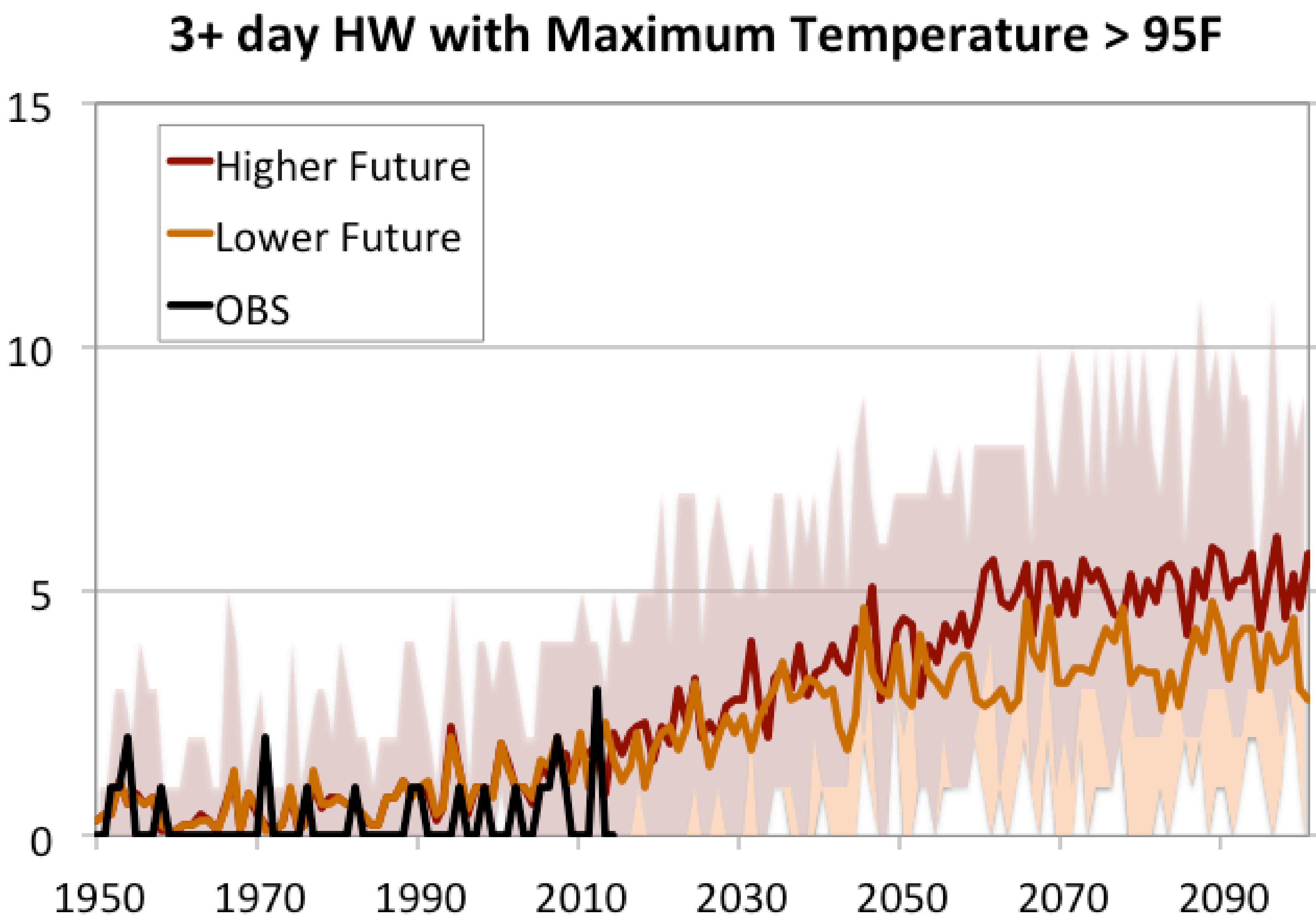
- **Framing**
  - Risk
    - Likelihood, Impact
  - Decision
    - Uncertainty
    - Impact
    - Values
  - Communication
    - Narrative

Recommendations: Utility

- Quantitative risk analysis: Research
- Qualitative risk analysis: Research

Urban Heat and Public Health





Katharine Hayhoe, Atmos Research

Branded Scenario

ARkStorm@Tahoe

Stakeholder perspectives on vulnerabilities and preparedness for an extreme storm event in the greater Lake Tahoe, Reno and Carson City region

- Christine M. Albano, University of California, Davis
- Dale A. Cox, Science Application for Risk Reduction, U.S. Geological Survey
- Michael D. Dettinger, National Research Program, U.S. Geological Survey and Scripps Institution of Oceanography
- Kevin D. Schaller, University of Nevada, Reno
- Toby L. Welborn, Nevada Water Science Center, U.S. Geological Survey
- Maureen I. McCarthy, Tahoe Science Consortium and University of Nevada, Reno

CNAP California Nevada Climate Applications Program

Southwest Climate Science Center

TSC Tahoe Science Consortium

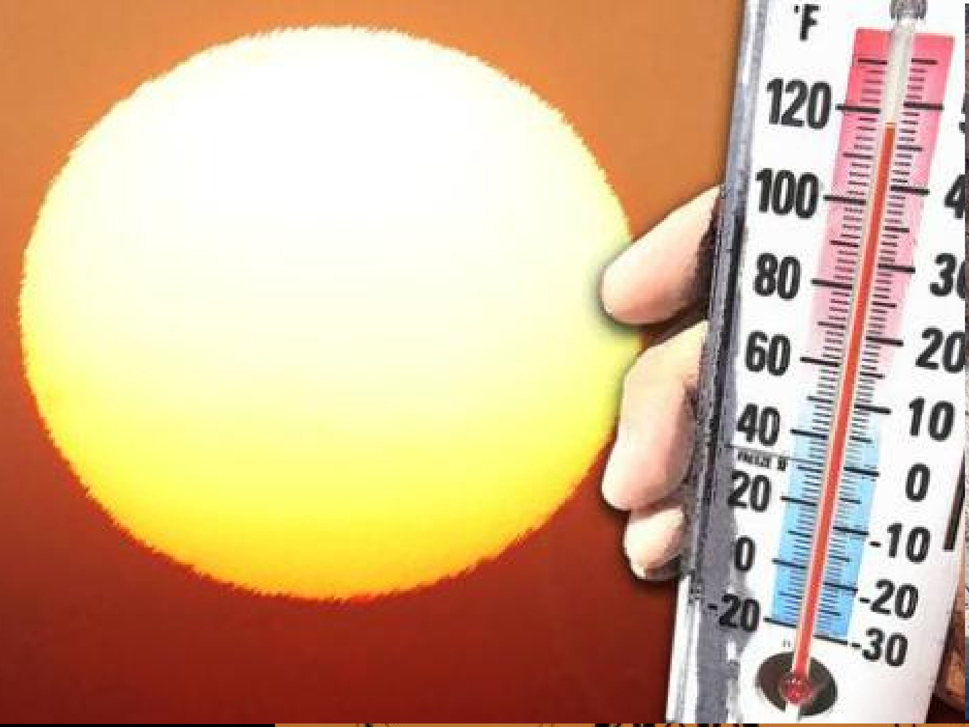
UC DAVIS UNIVERSITY OF CALIFORNIA

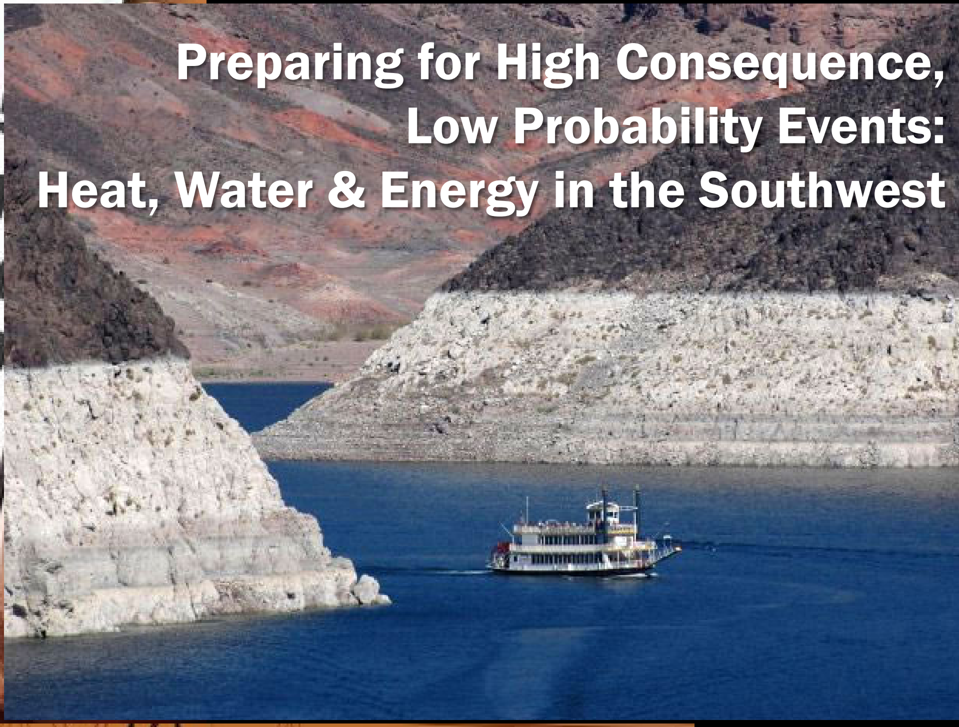
University of Nevada, Reno

USGS science for a changing world

Porter et al.
2011 - USGS

Preparing for High Consequence, Low Probability Events: Heat, Water & Energy in the Southwest





28 Sep 2015 - Hi-Low - Tucson, AZ

Drought

Decreased water supply reliability

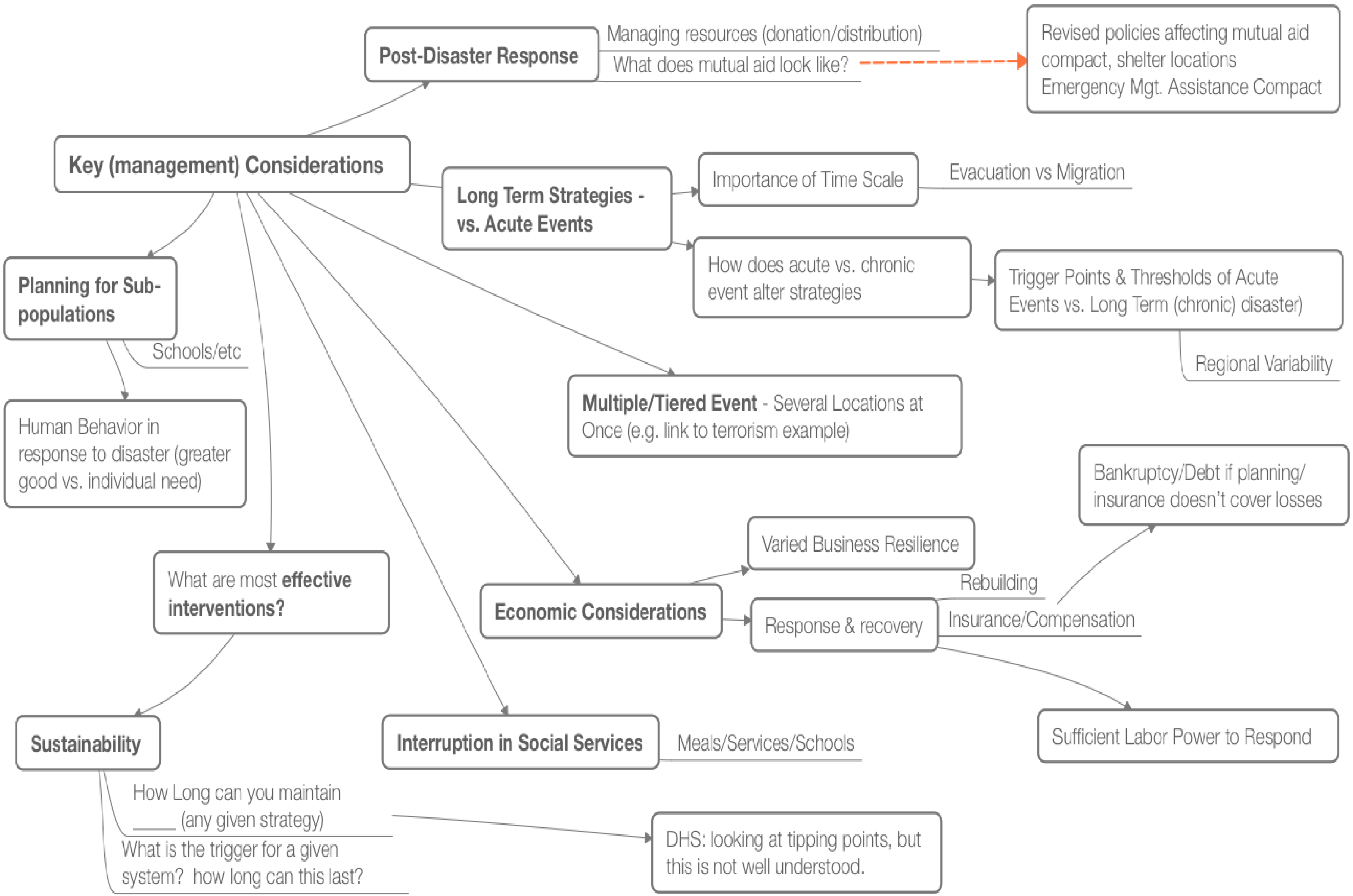
Local/regional heat wave

Increased energy demand

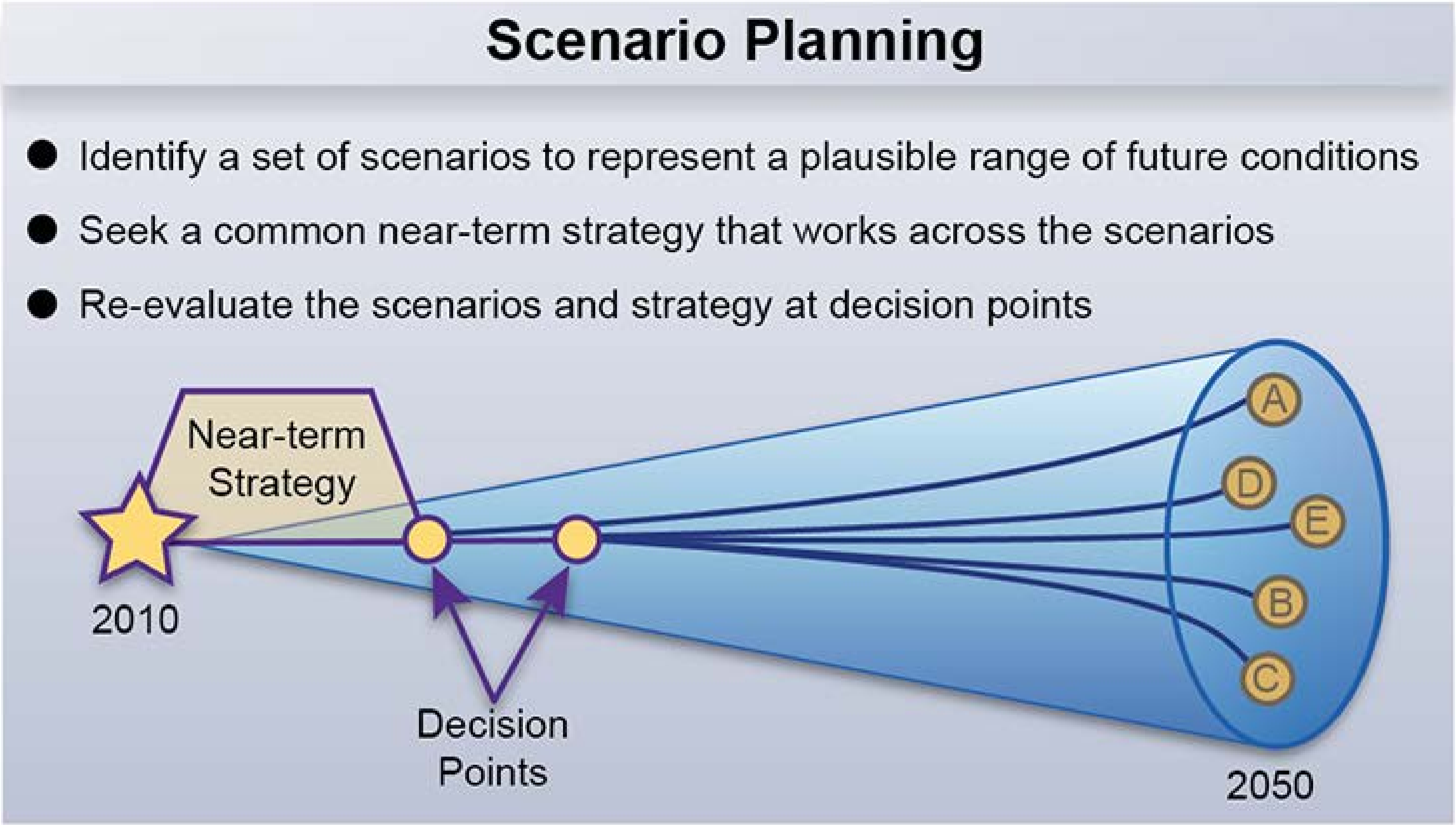
Power grid strain

Power outage

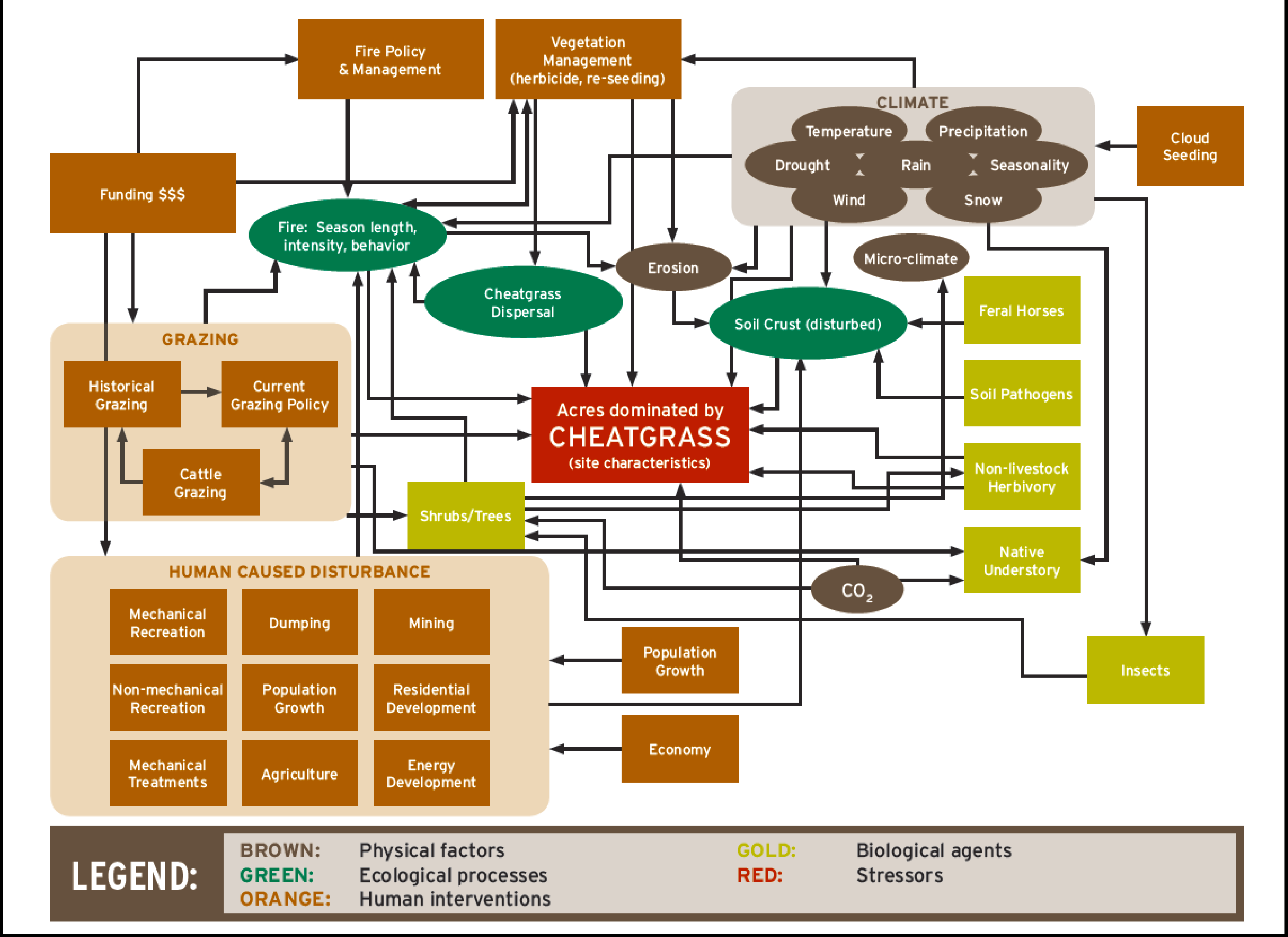
Impacts



Ben McMahan, University of Arizona, in Garfin et al. 2016

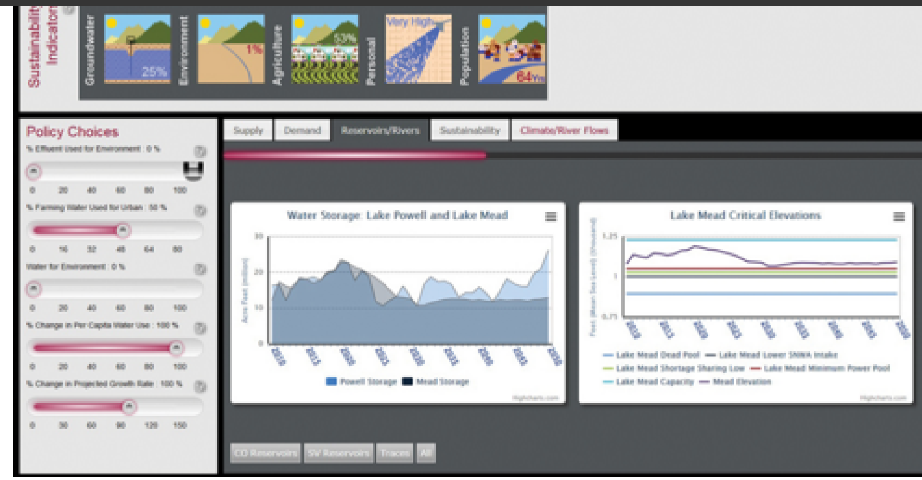


National Climate Assessment, 2014



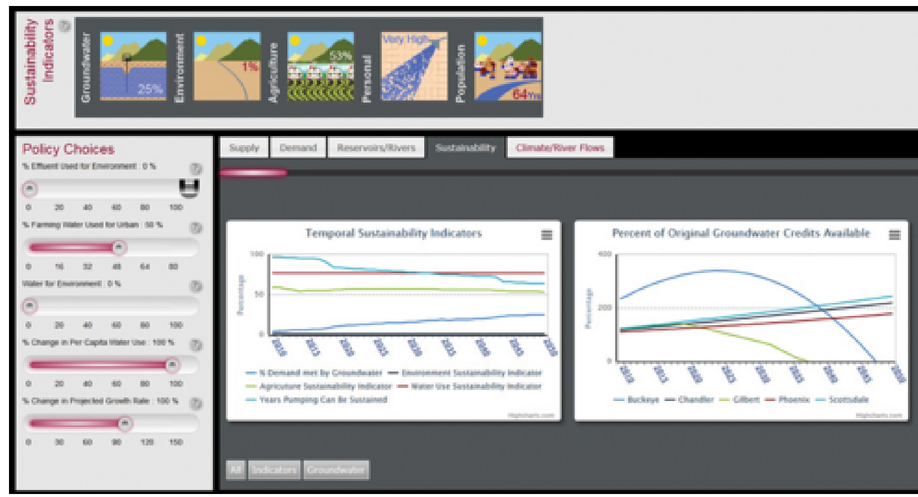
Wall et al. 2015 – Scenario Planning in the Great Basin Region

Water Supply – How much water is available, and where does it come from? The Phoenix Metropolitan Area receives its water from many sources including river water, groundwater and water reuse. Water supply is primarily influenced by climate.



Water Demand – Which communities use the most water per person? How much will those communities grow? Does that community have agriculture? How efficiently is water used? Water demand is primarily influenced by policy and population growth.

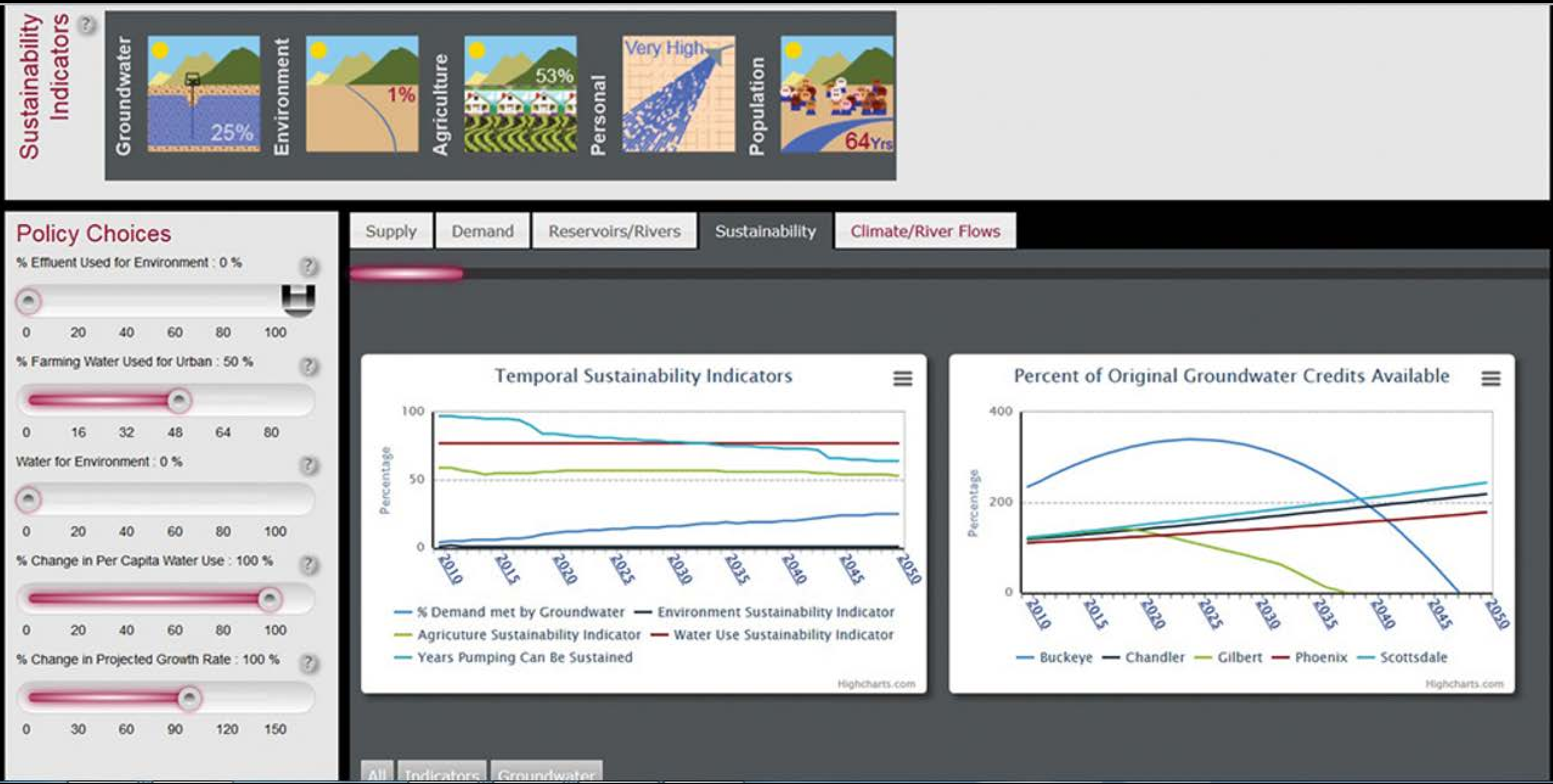
Climate Change – We cannot predict exactly how climate will affect water supply and demand in the future. What we can do is look at past patterns – decades with high flows, low flows or high variability from year to year – to understand best- and worst-case scenarios.



Population Growth – The population of Great Phoenix has been steadily growing for decades. Will it continue to grow at this pace, or will it grow faster or slower than predicted? WaterSim users can create best- and worst-case scenarios by changing this variable.

Supply, demand, climate, population, policy

https://sustainability.asu.edu/dcdc/watersim/



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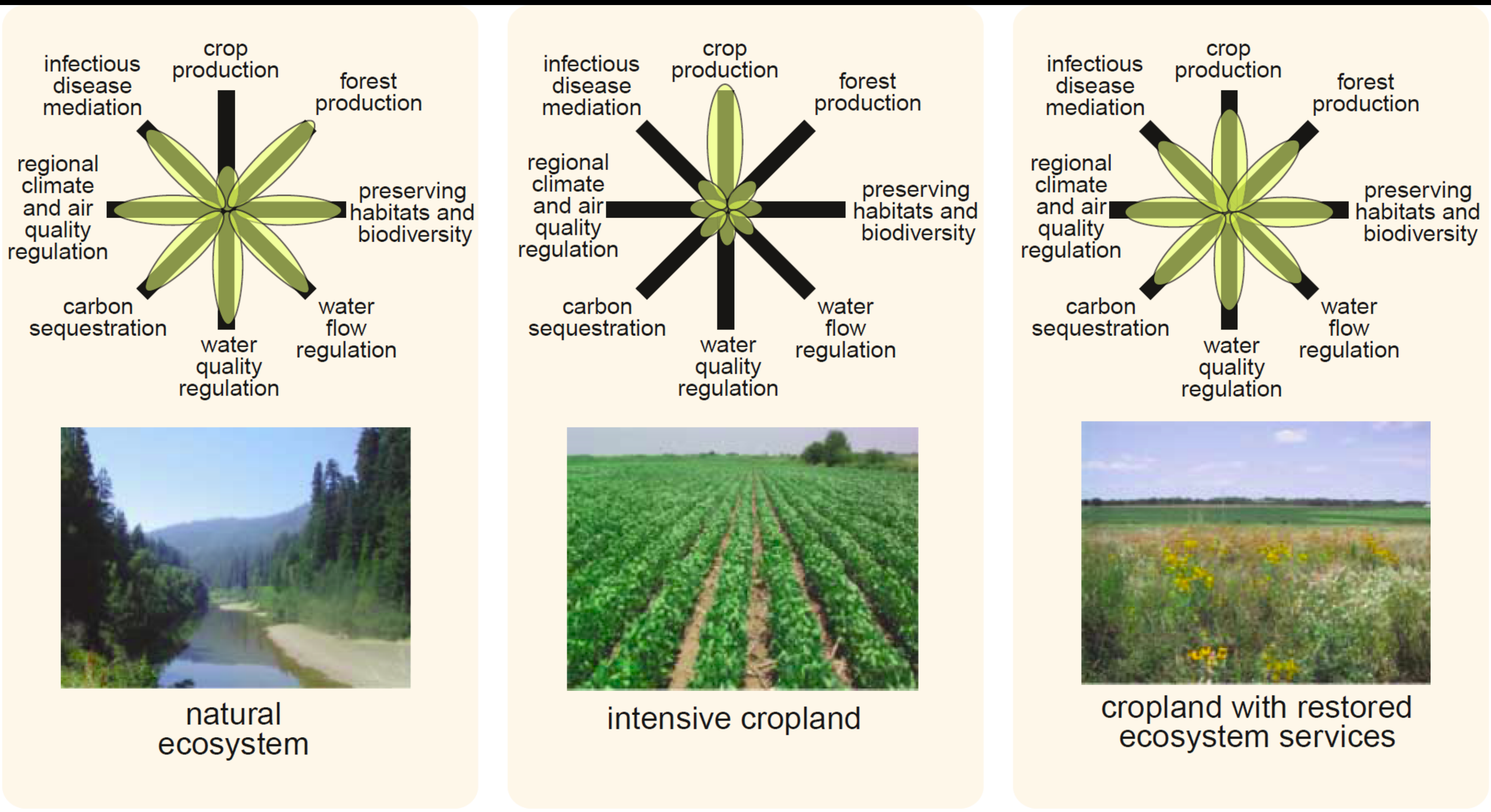
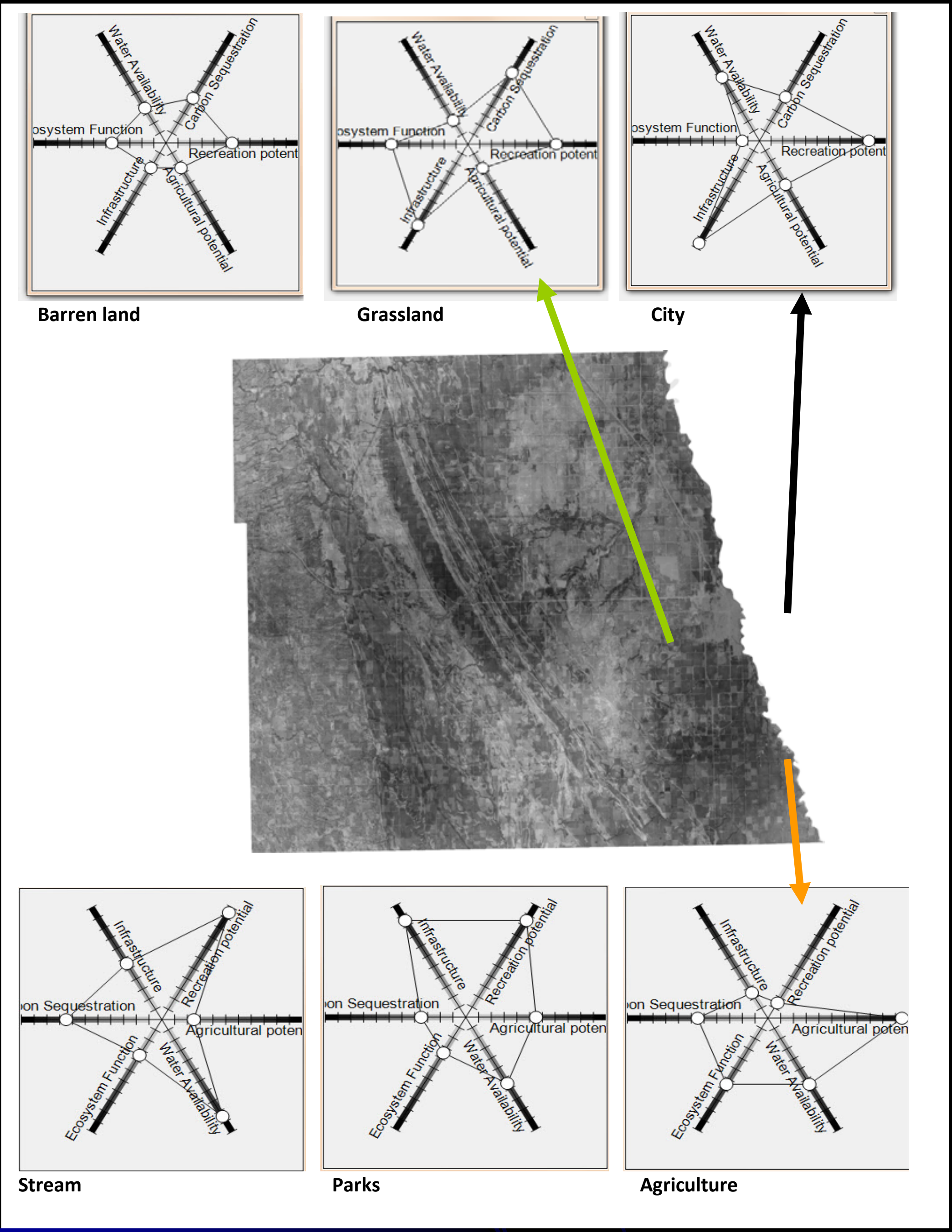


Foley et al. 2005 – Science 309: 570-574

Spider diagrams for selected land uses



Michael J. Hill, University of North Dakota

Scenario Paths for North Dakota

IPCC SRES	Global Warming	Energy	Agriculture	Matching MEA (?)	Conservation
A1F1 Rapid growth. Fossil intensive. Pop. peaks	High	Oil and coal expansion; wind and renewable expansion	Expanded growing seasons; food crises; food production priority	Adaptive Mosaic[1] Order from Strength	Further loss of grassland, wetland, biodiversity but with some site specific conservation
A2 Heterogeneous Fragmented Pop increases	Very high	Full oil and coal exploitation; slow development of renewable energy	Expanded growing seasons; food crises; food production priority	Adaptive Mosaic[1] Order from Strength	Further loss of grassland, wetland, biodiversity but with some site specific conservation
B1 Convergent Global Pop. peaks	Lower	Rapid development of renewable energy	Smaller expansion of growing season; significant biofuels; C trading; CRP; but high agricultural demand	Global orchestration	More multi-use land systems with wind, oil, grassland/wetland habitat, further farm bill incentives,
B2 Local solutions. Pop. increases	Moderate but increasing	Mix of fossil and renewable energy; ecosystem impacts considered	Slower expansion of growing seasons; farm bill incentives more effective	Adaptive mosaic Techno-garden	More multi-use land systems with wind, oil, grassland habitat, further farm bill incentives

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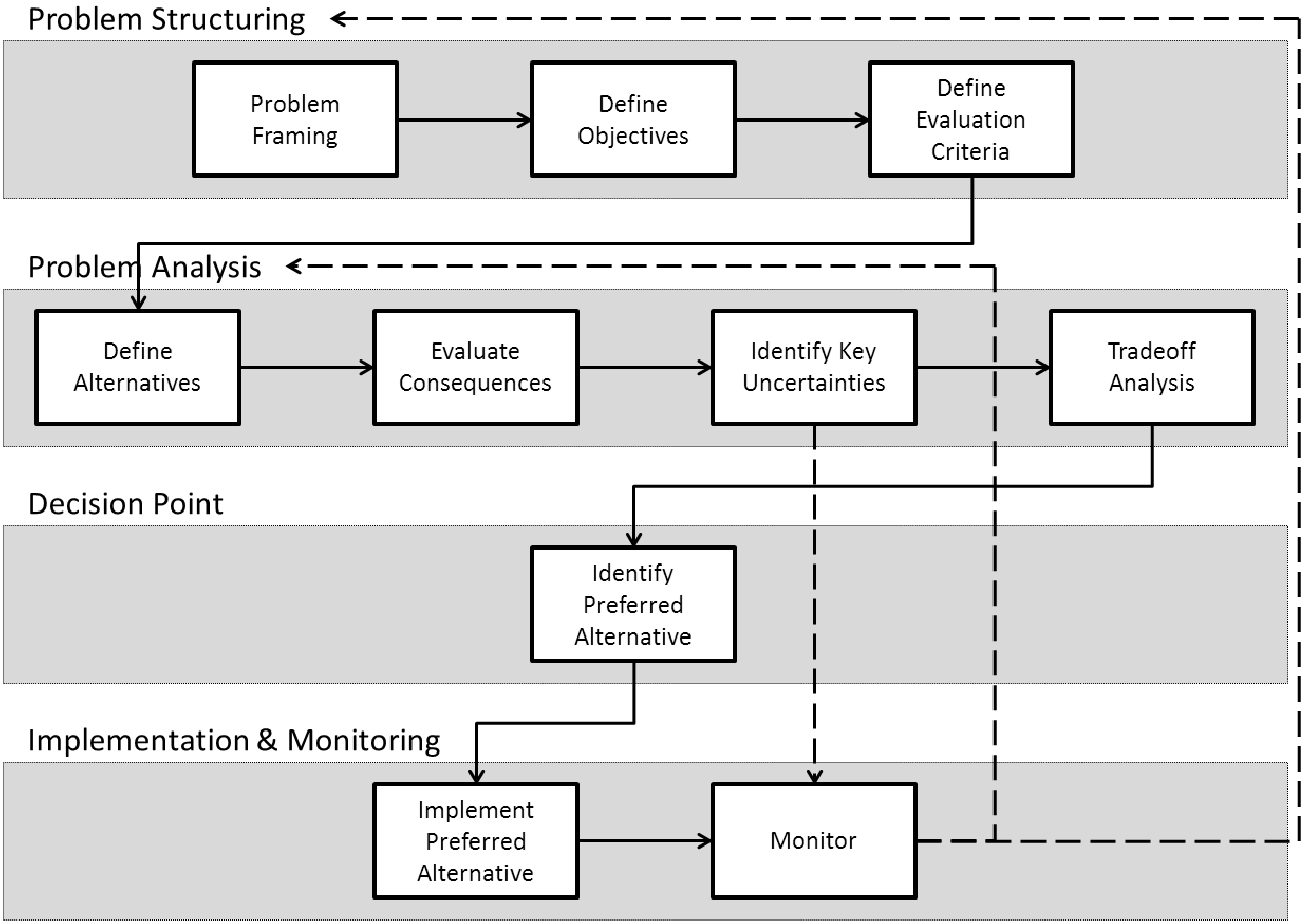
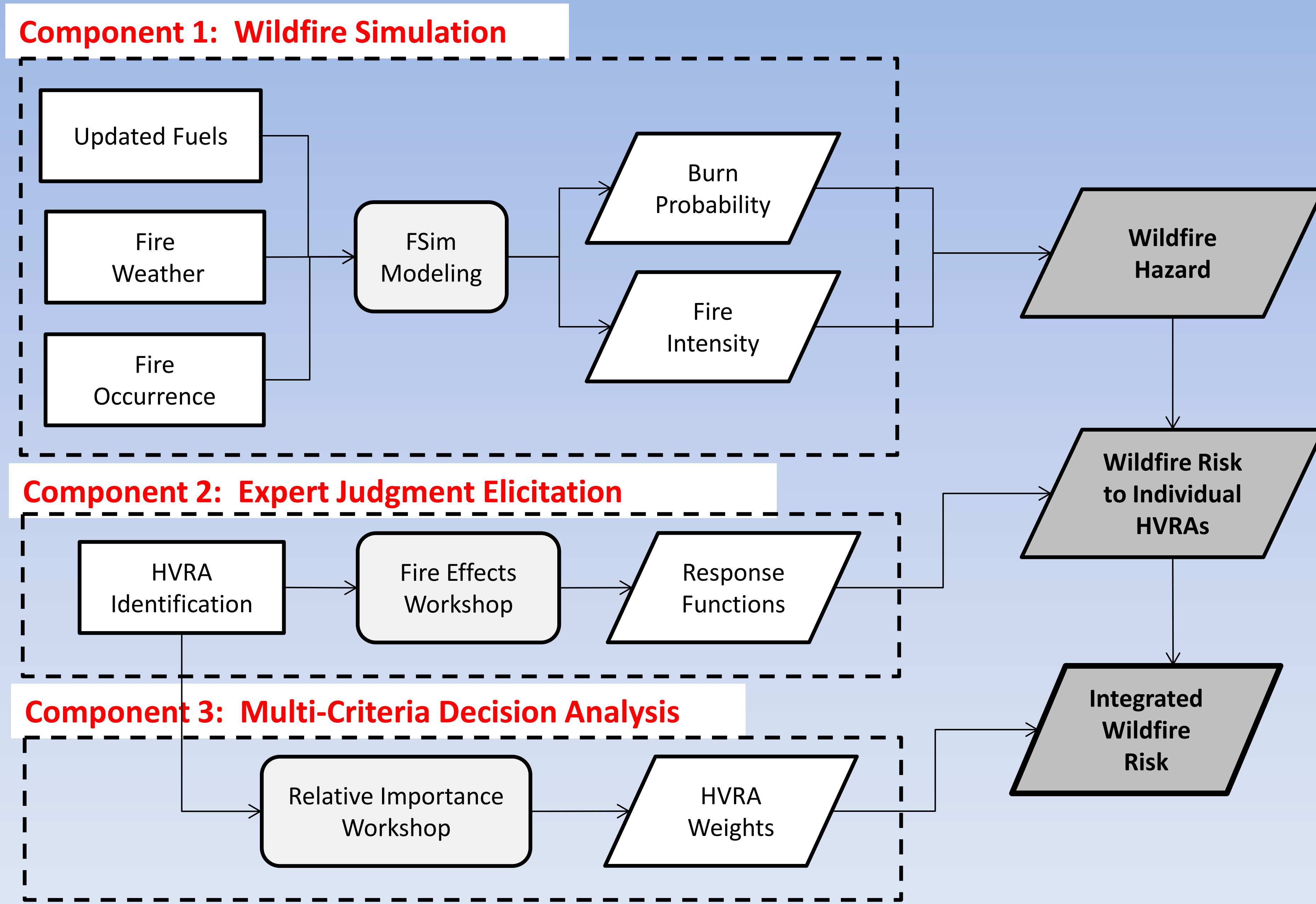
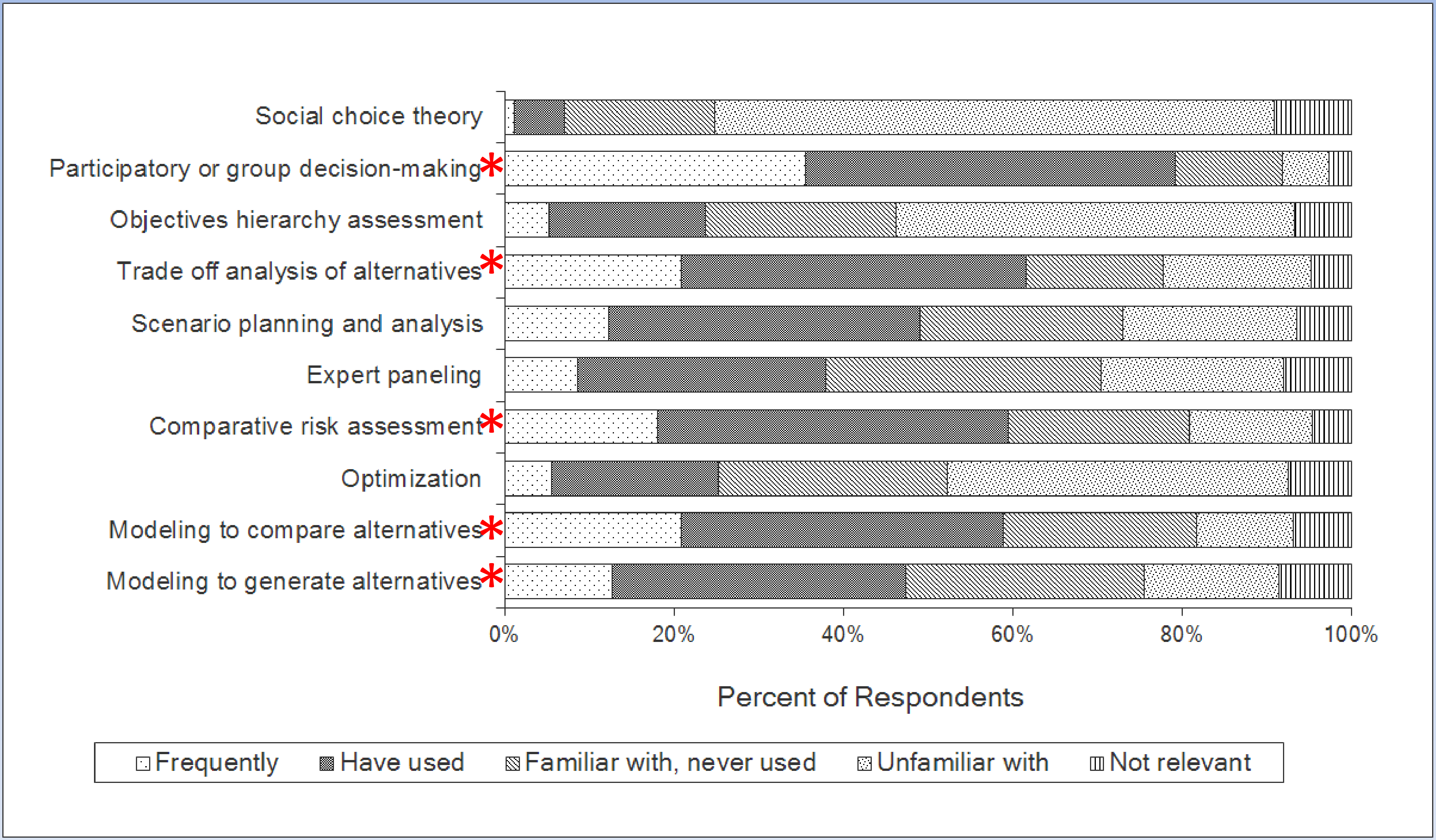


(Marcot) / Thompson et al., USDA-Forest Service – Structured Decision Making



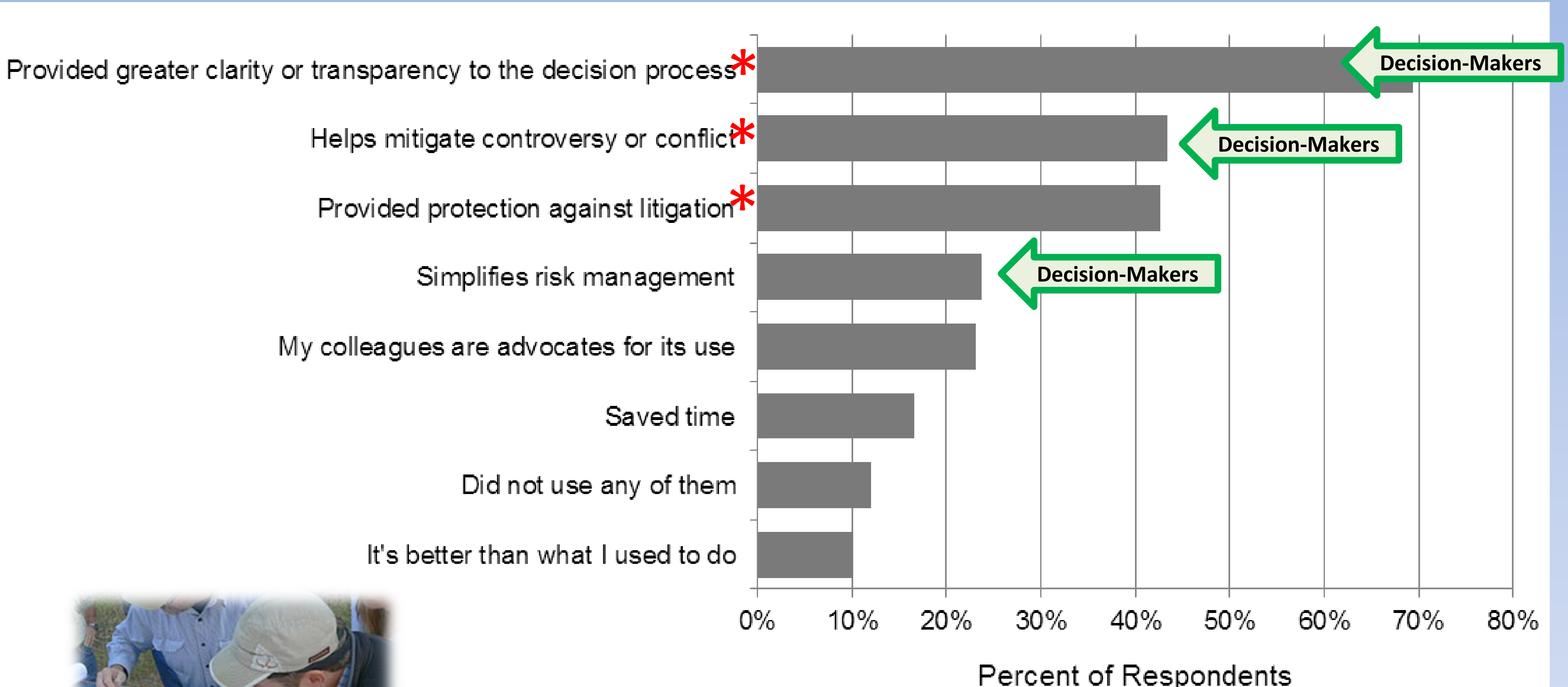
(Marcot) / Thompson et al., USDA-Forest Service – Structured Decision Making

How often do you use these decision-support *processes or methods?*



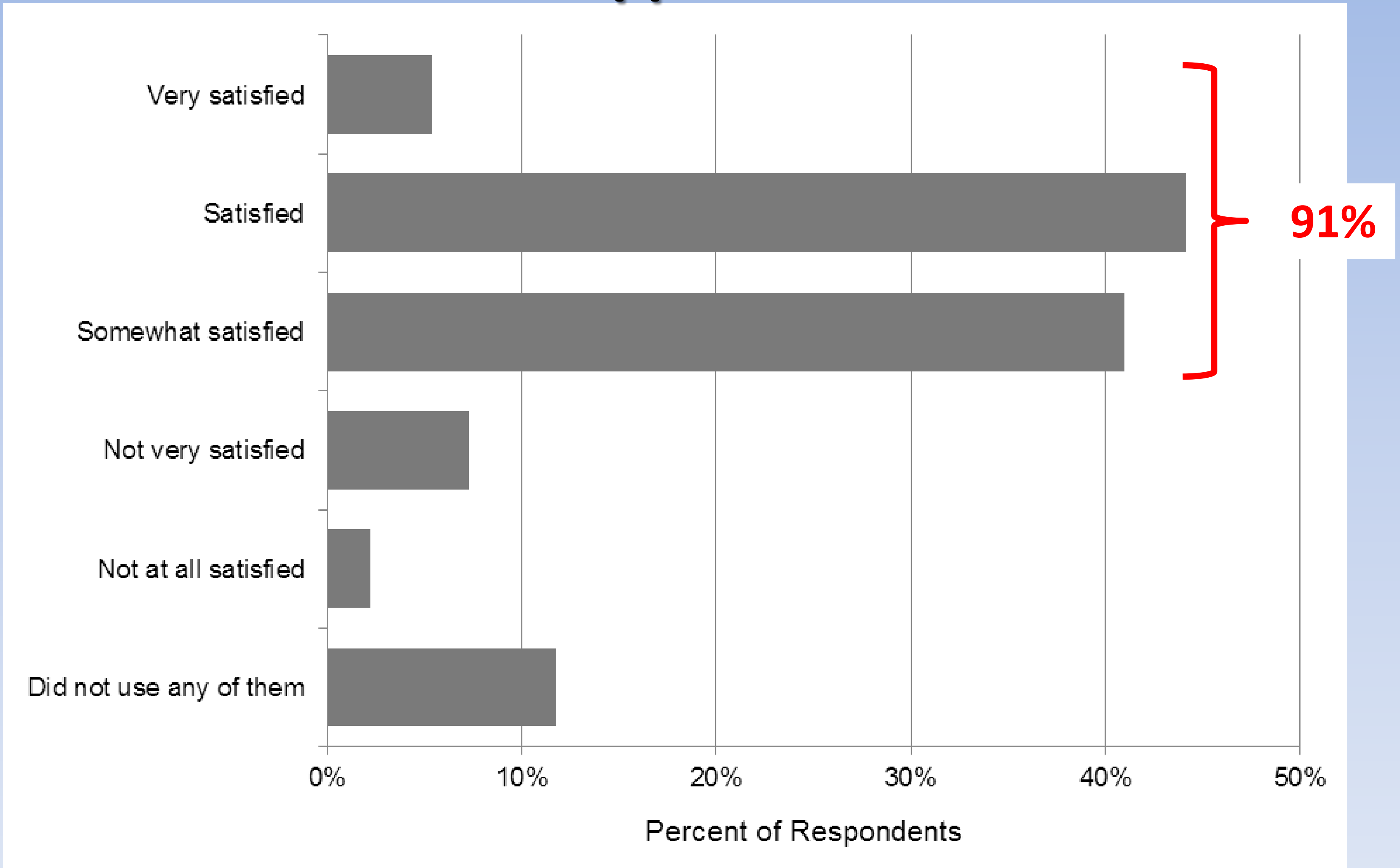
(Marcot) / Thompson et al., USDA-Forest Service – Structured Decision Making

Why did you use an SDM approach?



(X^2 = 29.49, df = 7, P < 0.001)

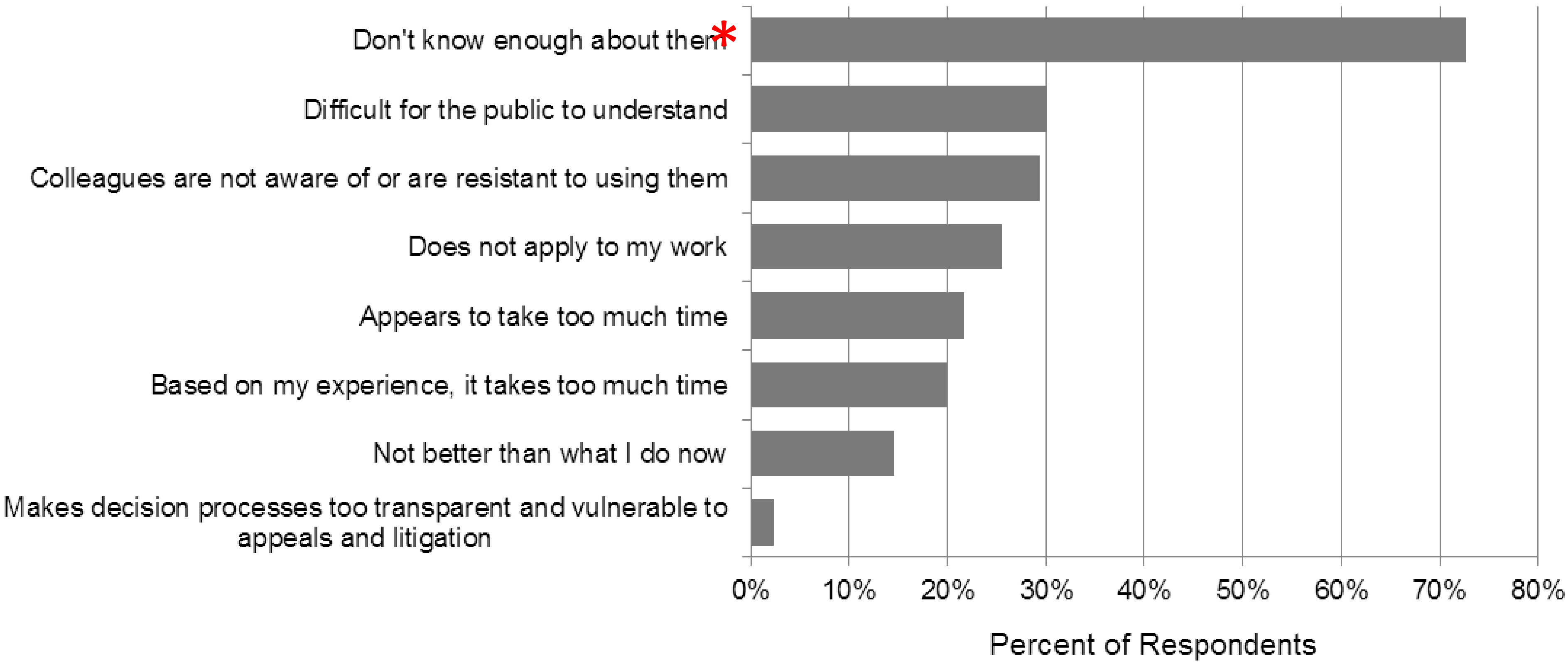
How satisfied were you with the outcome of using SDM approaches?



(X^2 = 15.71, df = 5, P = 0.01)

(Marcot) / Thompson et al., USDA-Forest Service – Structured Decision Making

What impedes you from using SDM approaches?



(X^2 = 17.01, df = 7, P = 0.02)

(Marcot) / Thompson et al., USDA-Forest Service – Structured Decision Making

Recommendations: Utility

Scale

Recommendations: Utility

- Utility for Decision-makers
  - Decision context specificity
  - Scale: illustrative for comparison
    - Region, state, city, community
    - i.e., case studies

- Foley, J. A., R. DeFries, G. P. Asner, C. Barford, G. Bonan, S. R. Carpenter, F. S. Chapin, M. T. Coe, G. C. Daily, H. K. Gibbs, J. H. Helkowski, T. Holloway, E. A. Howard, C. J. Kucharik, C. Monfreda, J. A. Patz, I. C. Prentice, N. Ramankutty and P. K. Snyder (2005). "Global Consequences of Land Use." Science **309**: 570-574.
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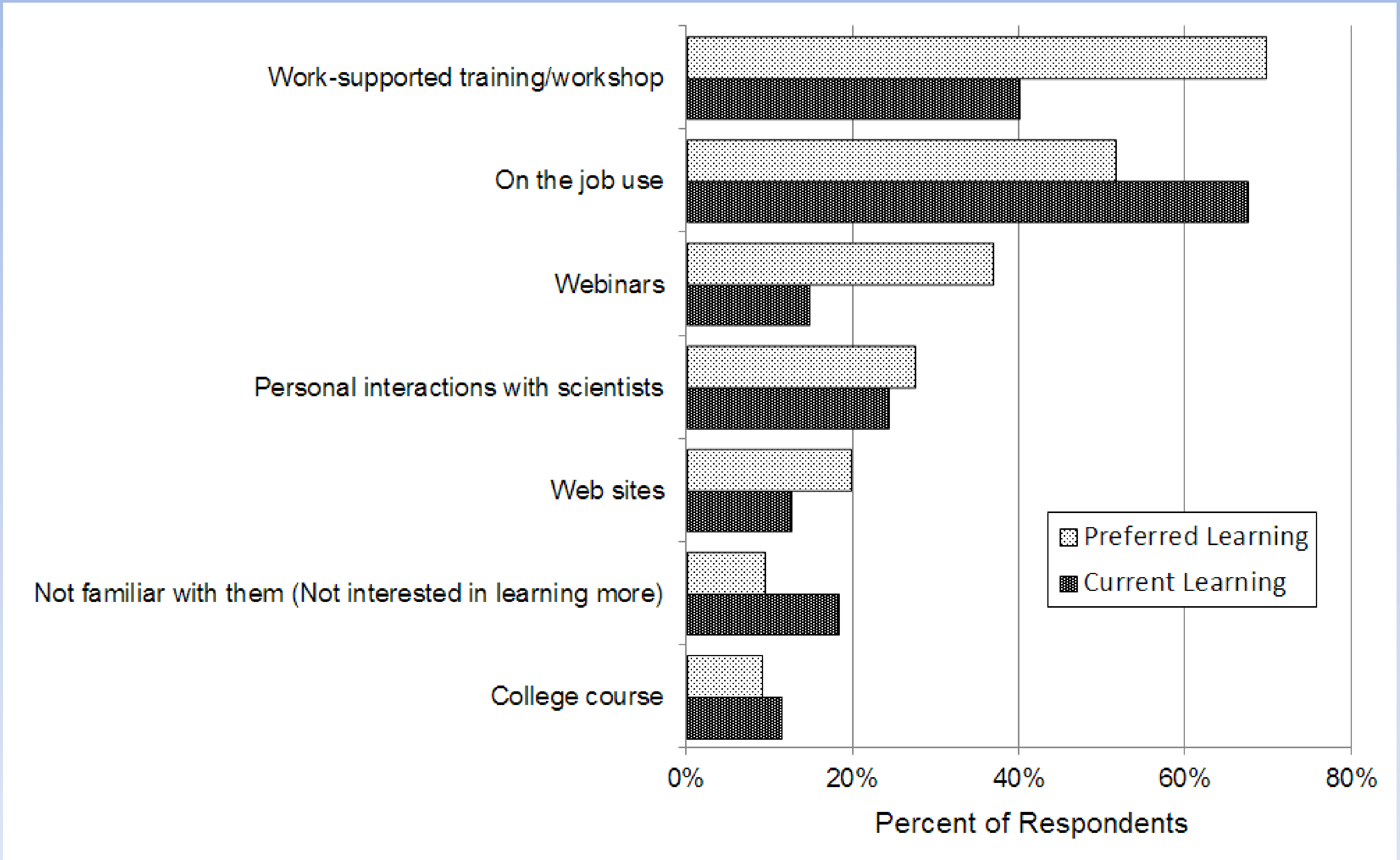
What are your current, and preferred, ways of learning about SDM approaches?



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