Scenario Planning for Climate Change Adaptation Decision Making

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Using Scenarios to Consider Uncertainty

Decision Makers

Use scenarios for long-term planning

- Often not considered as 'scenarios'
- Often restricted in their options (e.g., specified population growth rates, water usage, 'official futures')
- Can face difficulty getting constituent support

Modelers/Scientists

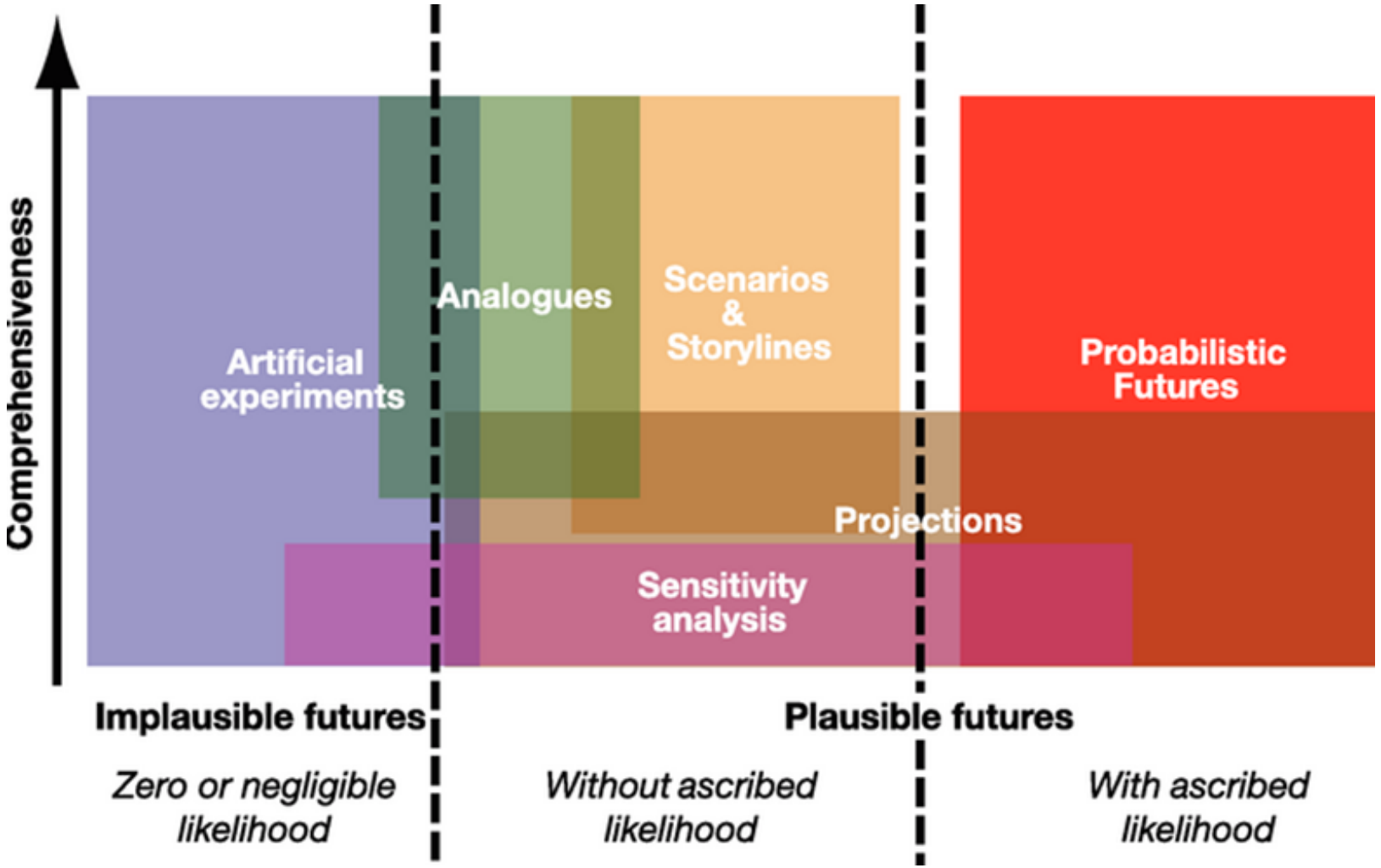
Use scenarios from research perspective

- Primarily to test models: baseline, +/-
- Often limited in options: disciplinary focus

Scenario Typology Template

Purpose
Participants
System definition
Scenario planning method used
Information inputs used in scenario development
Main steps in the process
Engagement and communication strategies
Uncertainties addressed, and how
Types of outputs
Applications of, and outlets for, scenario outputs

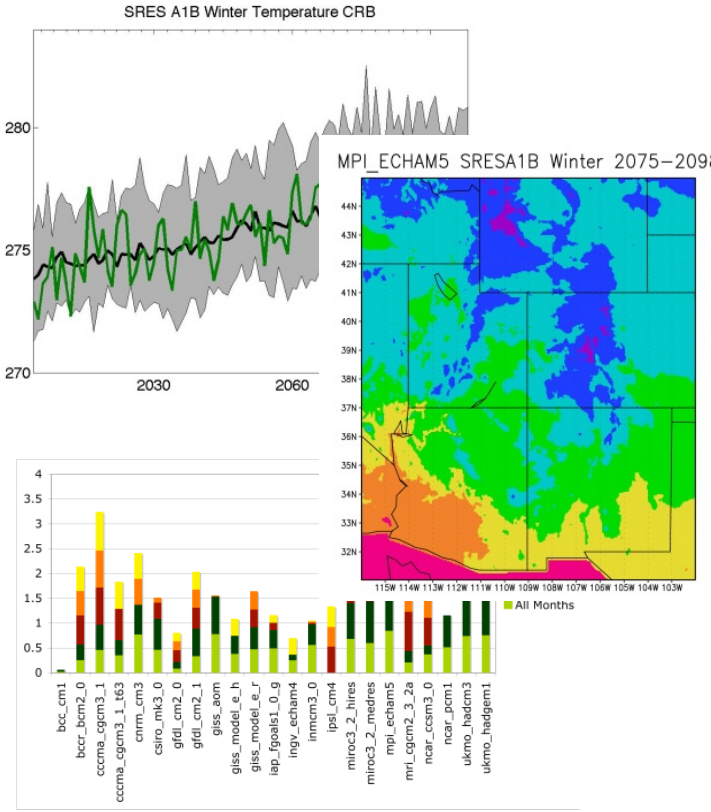
Ways of Seeing the Future



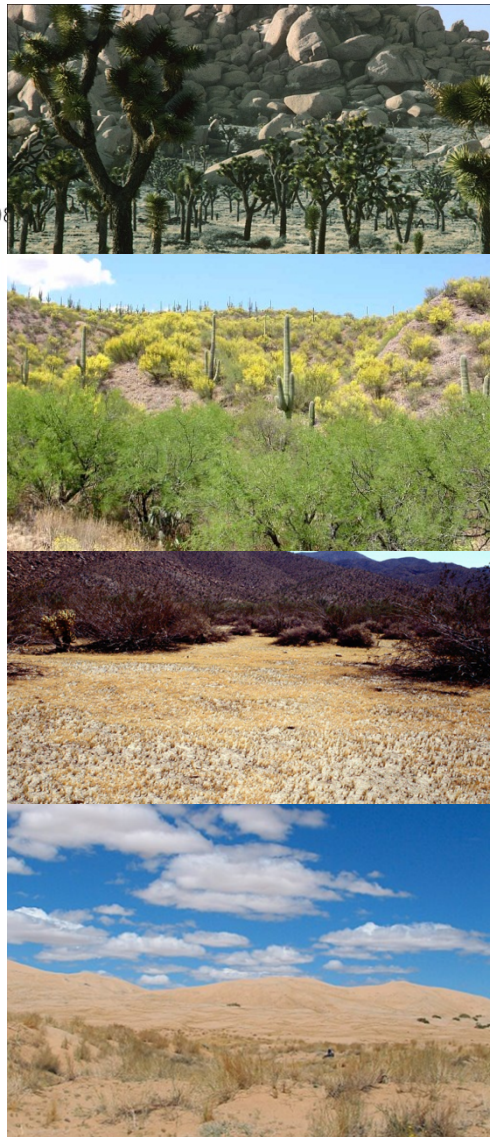
Looking at scenario futures from the perspective of plausibility rather than probability.
Source: Carter et al., 2007 (IPCC AR4, p. 145).

Different Approaches to Uncertainty and Scenarios

Characterizing Uncertainty

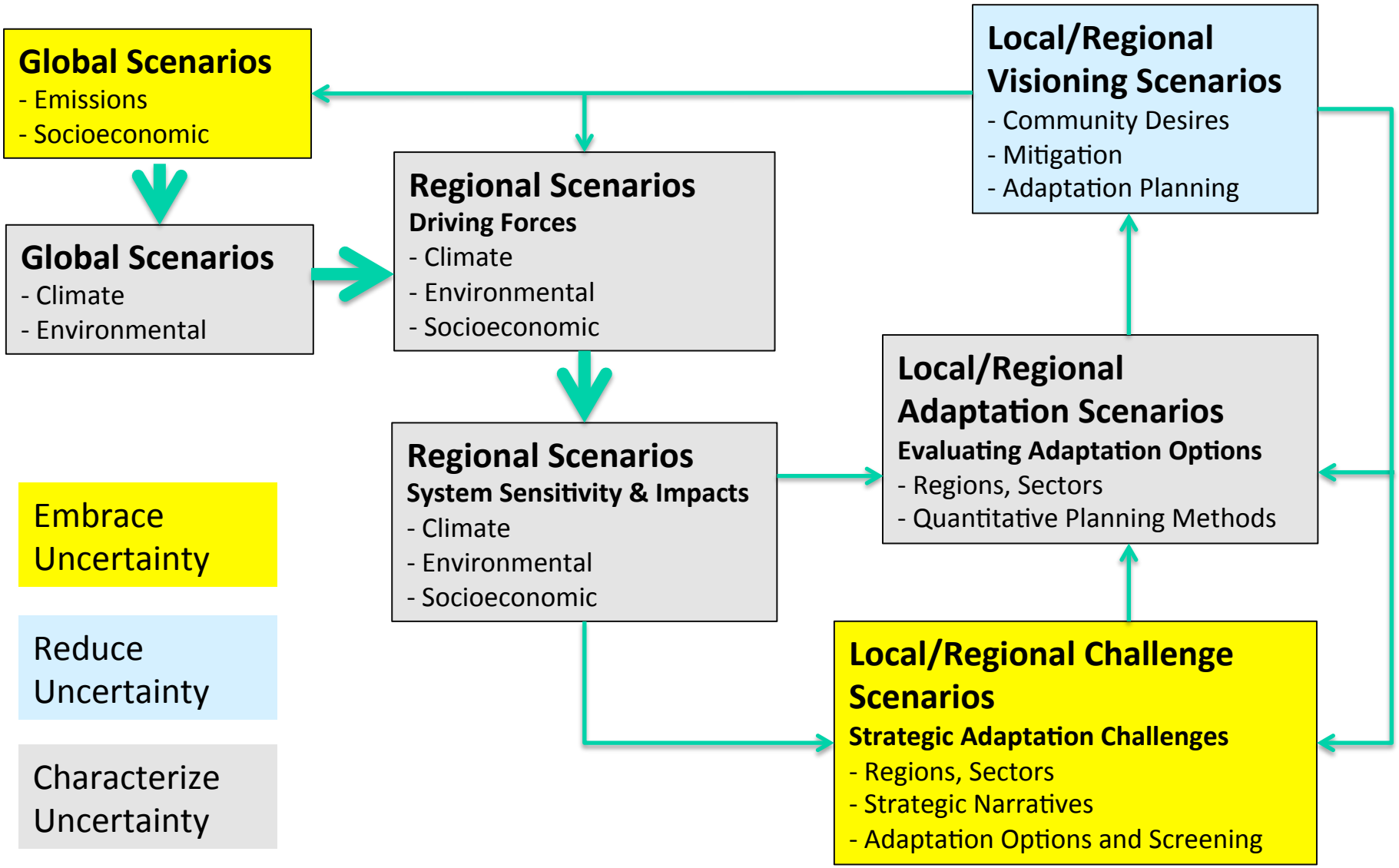


Embracing Uncertainty



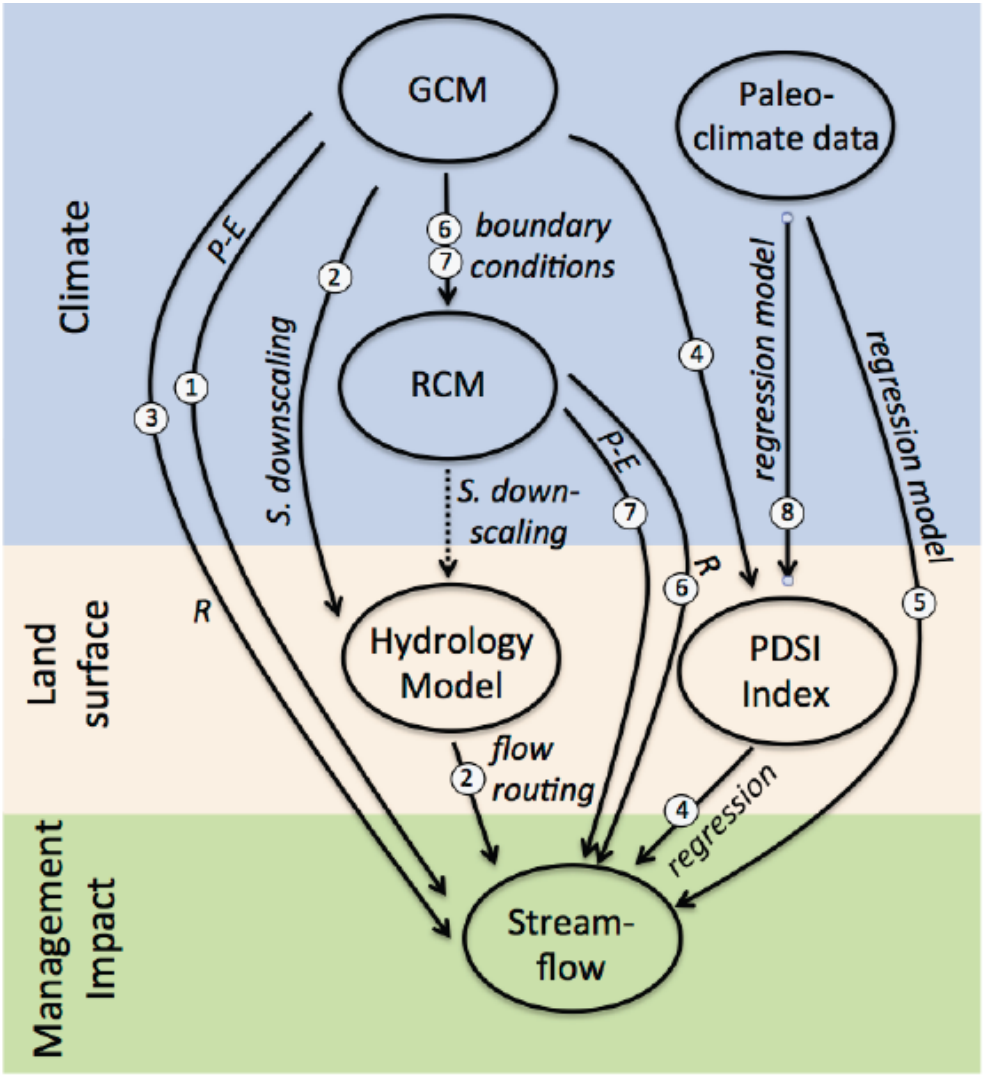
Reducing Uncertainty

Ecology of Scenarios



Geneology of Projections

- Dates
- Scales
- Base data
- Models and versions
- Methods of bias adjustment & downscaling
- Which GCM projections
- Underlying assumptions



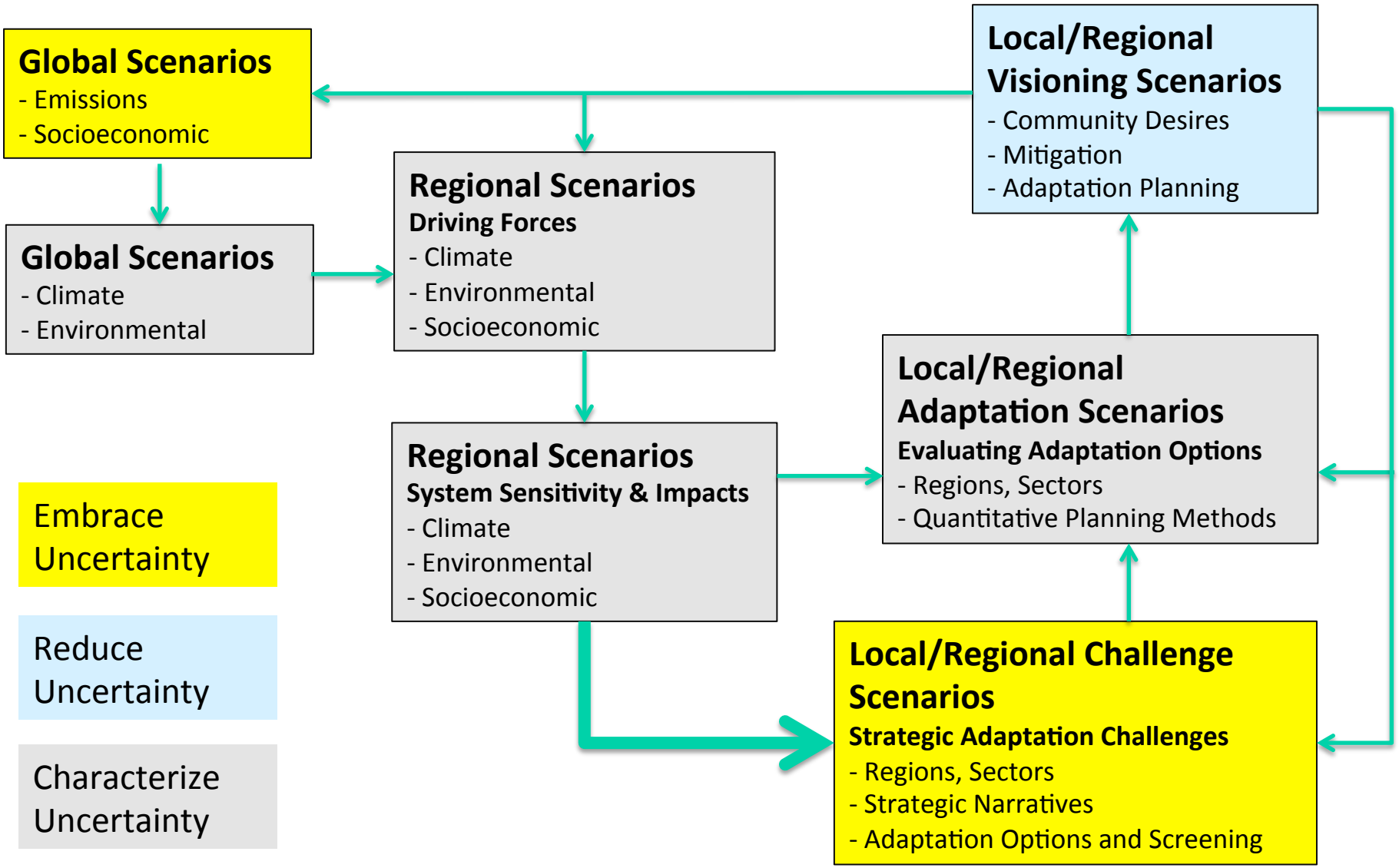
Studies using various approaches:

1. Seager et al. 2007
2. Christensen et al. 2004; Christensen and Lettenmaier, 2007; USBR 2011
3. Milly et al. 2005
4. Hoerling and Eischeid, 2007
5. Woodhouse et al. 2006; McCabe and Wolock 2008; USBR 2011
6. Gao et al. 2011; Rasmussen et al. 2011
7. Gao et al. 2012
8. Cook et al. 2004

Abbreviations:
GCM – Global Climate Model
RCM – Regional Climate Model
PDSI – Palmer Drought Severity Index
P – Precipitation
T – Temperature
R – Runoff
E – Evaporation
S. Downscaling – statistical downscaling (studies above use BCSD)

Reconciling Colorado River Flow Projections Project: Vano et al., BAMS, 2014

Ecology of Scenarios



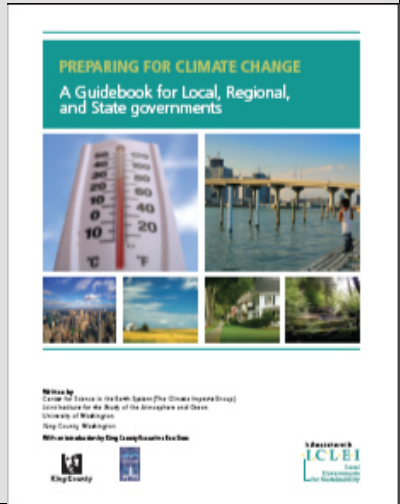
External Drivers, System Impacts

SUMMARY OF PROJECTED CLIMATE CHANGES FOR JOSHUA TREE

Climate Variable	General Change Expected	Specific Change Expected & Reference Period	Size of Expected Change Compared to Recent Changes	Seasonal Patterns of Change	Confidence	Source & Context
Temperature	Increase	2050: +2 +/- 0.6°C 2100: +3.1+/- 1.1°C	Large	More pronounced in summer and early fall	>99.9% *Virtually certain*	Abatzoglou and Brown*
Precipitation	No Change / Decrease	2050: 0 +/- 2% 2100: -2.5 +/- 2.5%	Similar	More pronounced in winter and spring	Spring 99% Other seasons non-significant	Abatzoglou and Brown*
Relative Humidity	Decrease					
Wind Speed	Increase					
Extreme Events: Temperature	Warm Events Increase / Co Events Decre					
Extreme Events: Precipitation	Decrease/Inc					

SECTORS AND POTENTIAL IMPACTS TO JOSHUA TREE

Sector	Sub-Sector	Impacts
Natural Resources	**Hydrology & Water Resources**	**·Increase in extreme runoff and flooding (especially in winter); decrease in total snowpack; decrease in soil moisture[1]; limited surface and groundwater availability[2]** **·Water shortage, decrease in water quality** **·Link between high precipitation events and increase in invasive species to increase in fire size and spread.** **·Decrease in overall precipitation could lead to drought conditions. This could help eliminate the threat of invasive sp**
	Aquatic Ecosystems	**·Nitrogen eutrophication; increas summer; warmer stream temps;**
	Vegetation	**·Changes in phenology and geogr season)[2]** **·Increased invasive species** **·Stand-replacing fires result in lo could take hundreds of years for**
	Wildlife	**·Changes in phenology, migratio** **·Threatened desert tortoise**
	Disturbance (fire, pests, pathogens, avalanche)	**·Fire: Increase in length of fire se non-native invasive grasses provi** **·Pest/Pathogen: increased winter**



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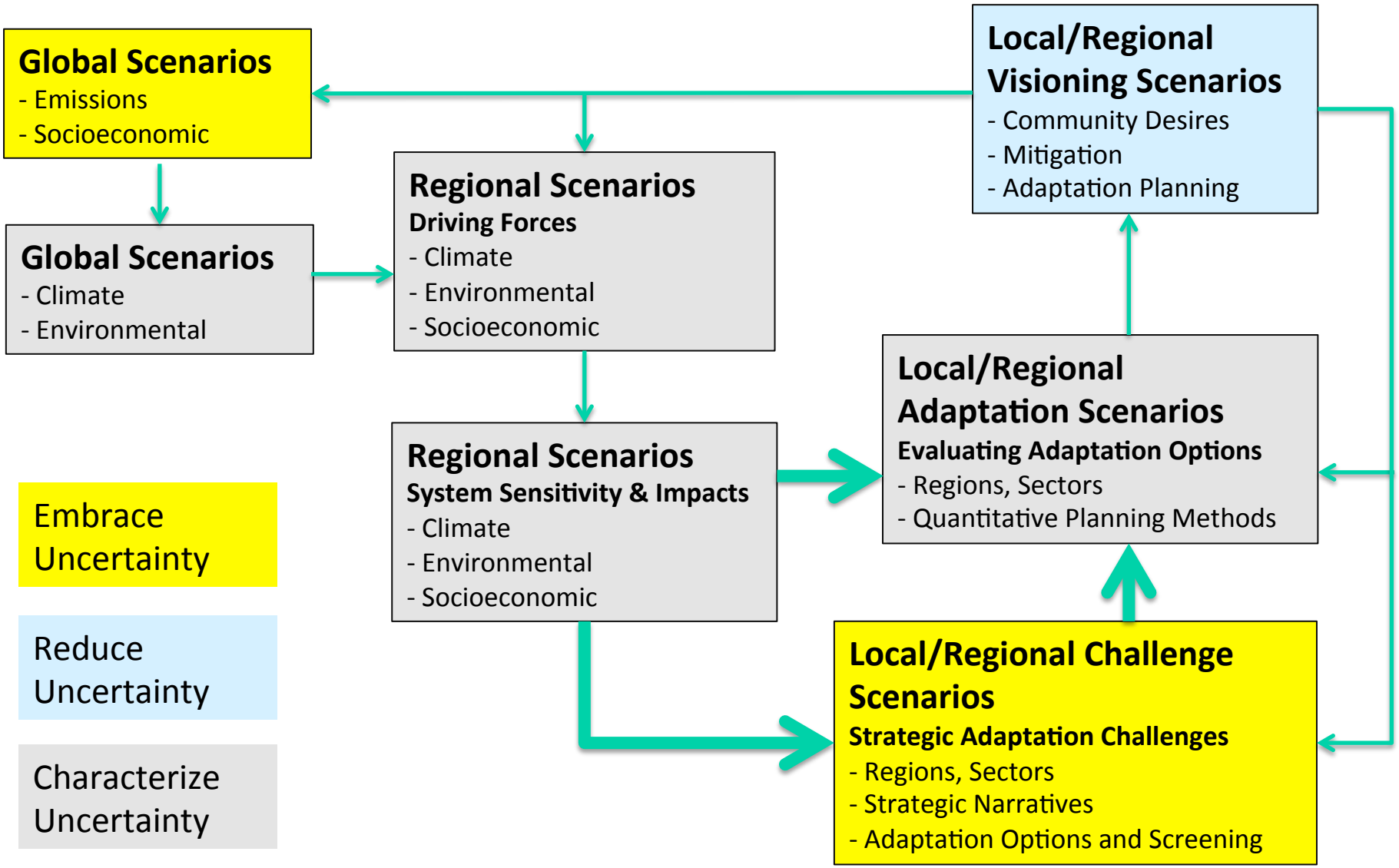
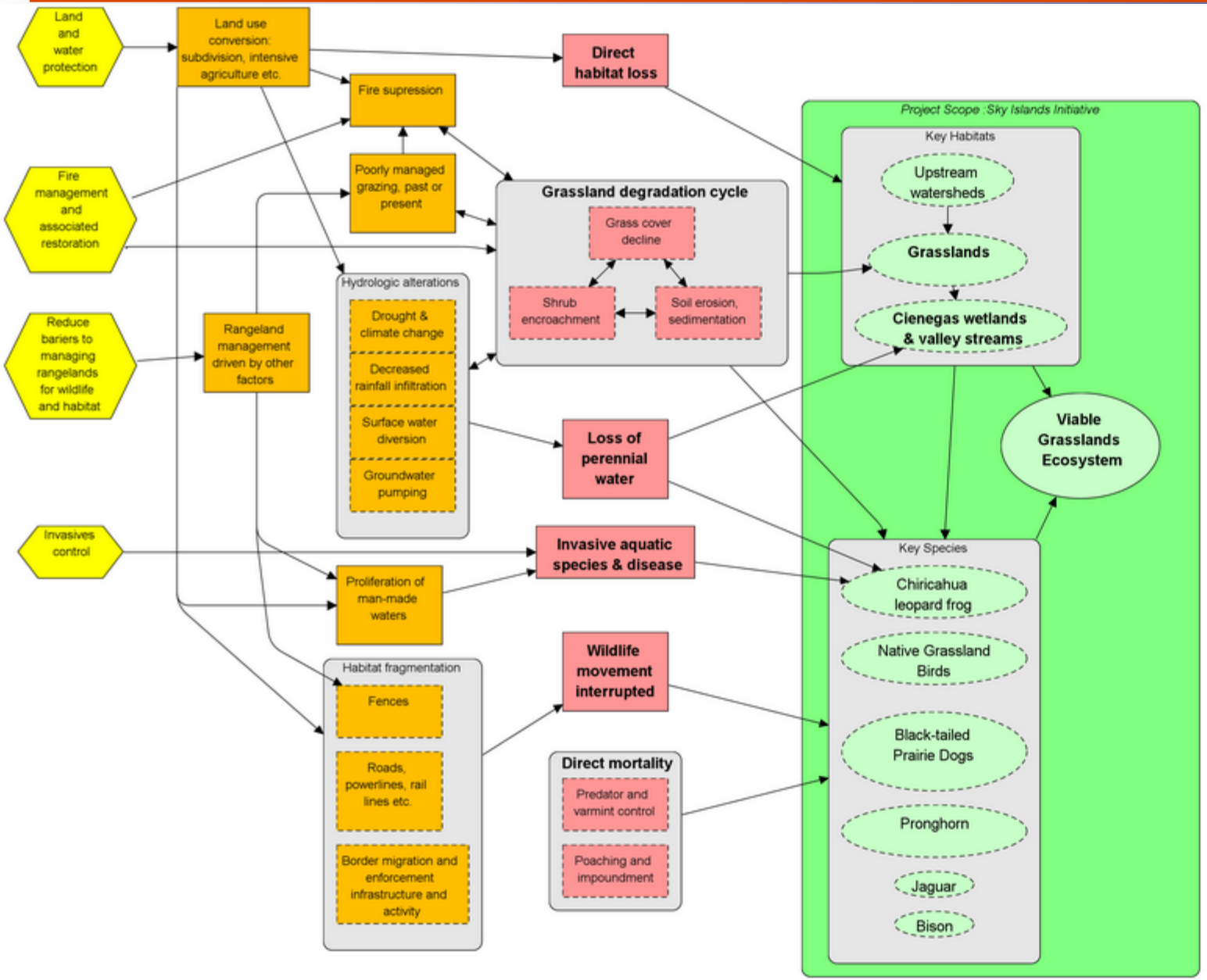


Conceptual Maps



From NFWF, Sky Island Alliance, 2012

Integrating Adaptation Options with Planning

Identify options: Millar's 5Rs+ 1

Organize options

- Simple decision tree
- Scenario decision points, indicators

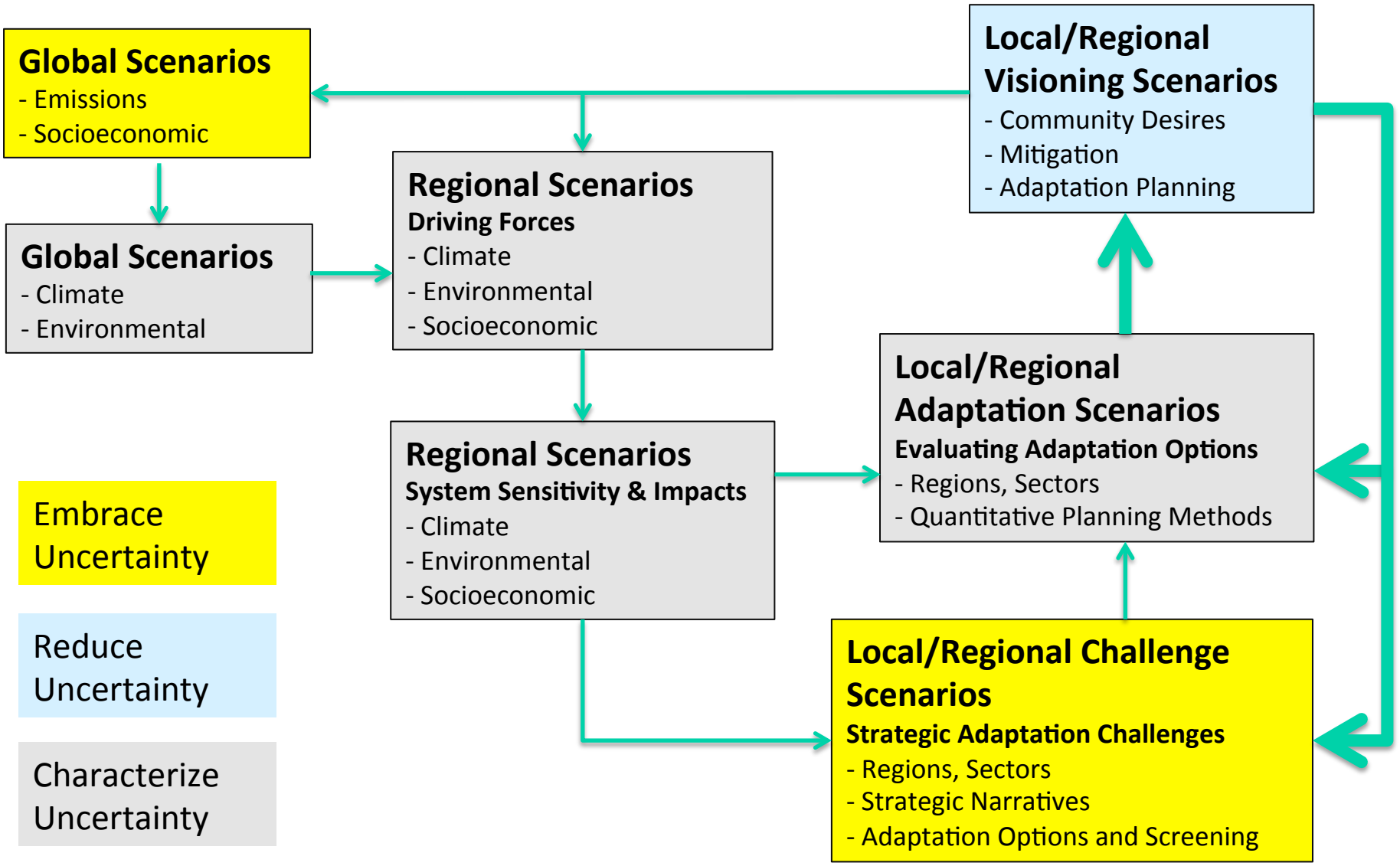
Evaluate options

- 'No regrets' options
- Significant change in direction
- 'Hard' choices

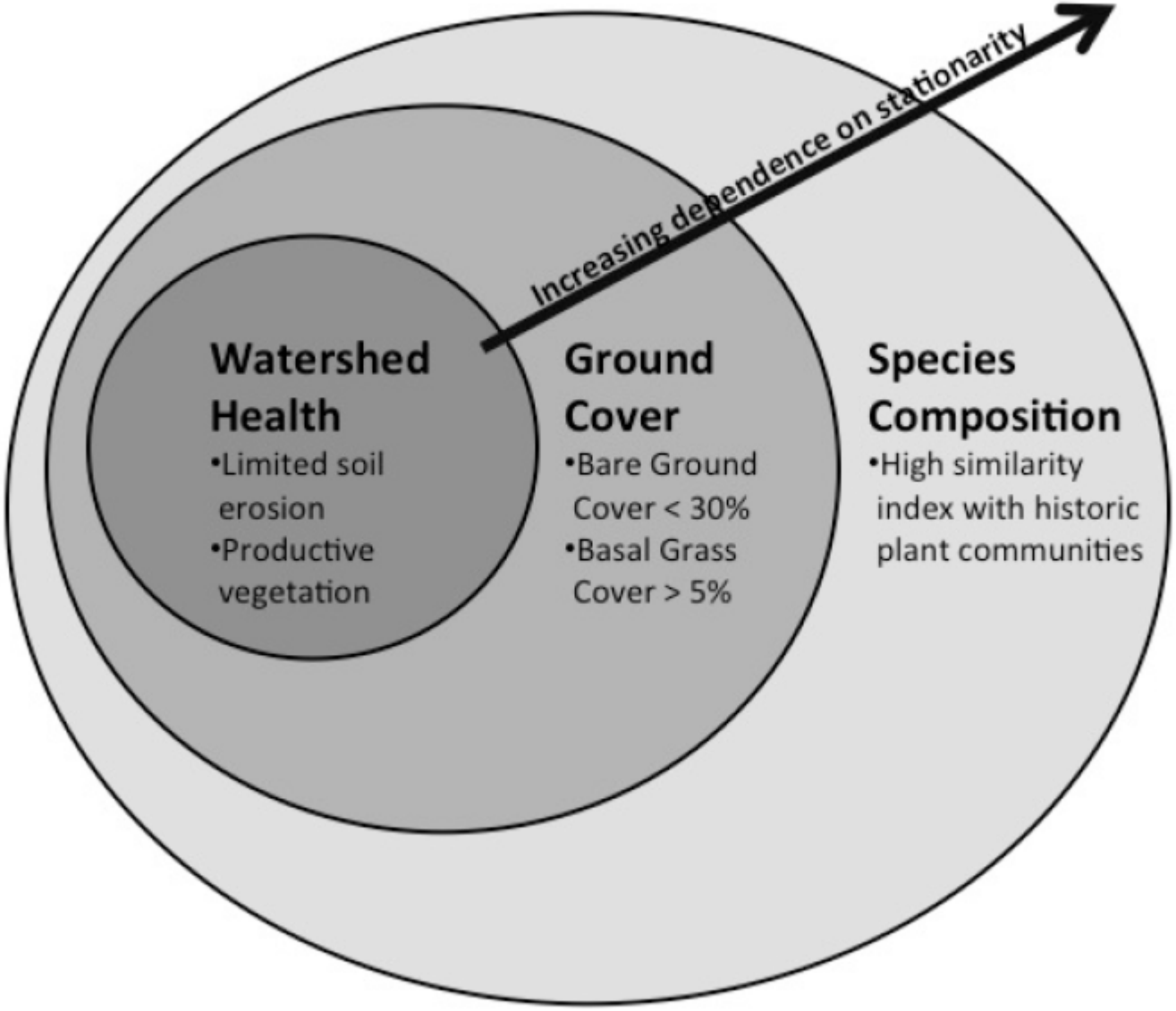
Operationalize options

- Leading indicators
- Disaggregated steps
- Timelines and calendars

Ecology of Scenarios

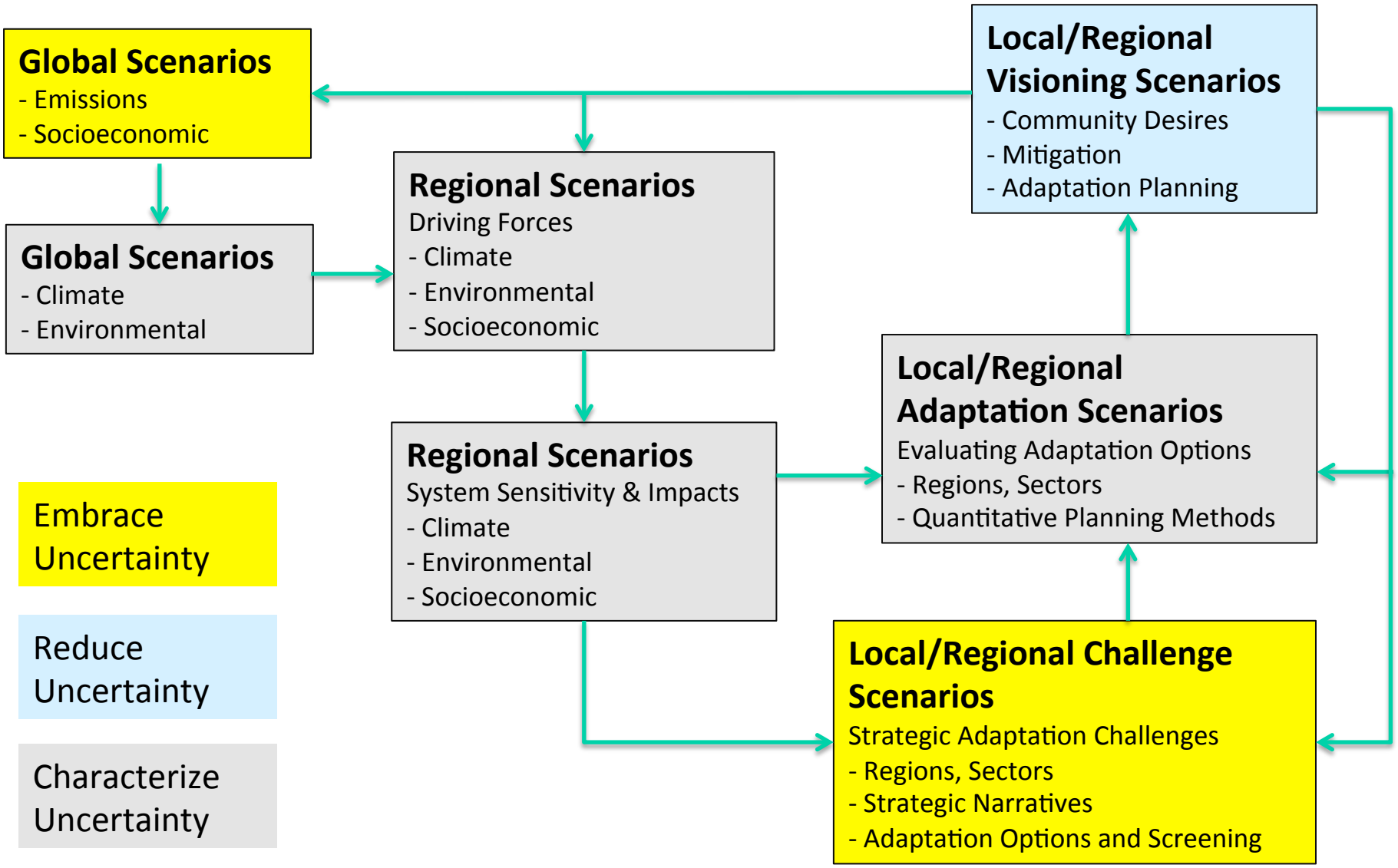


Nested Objectives

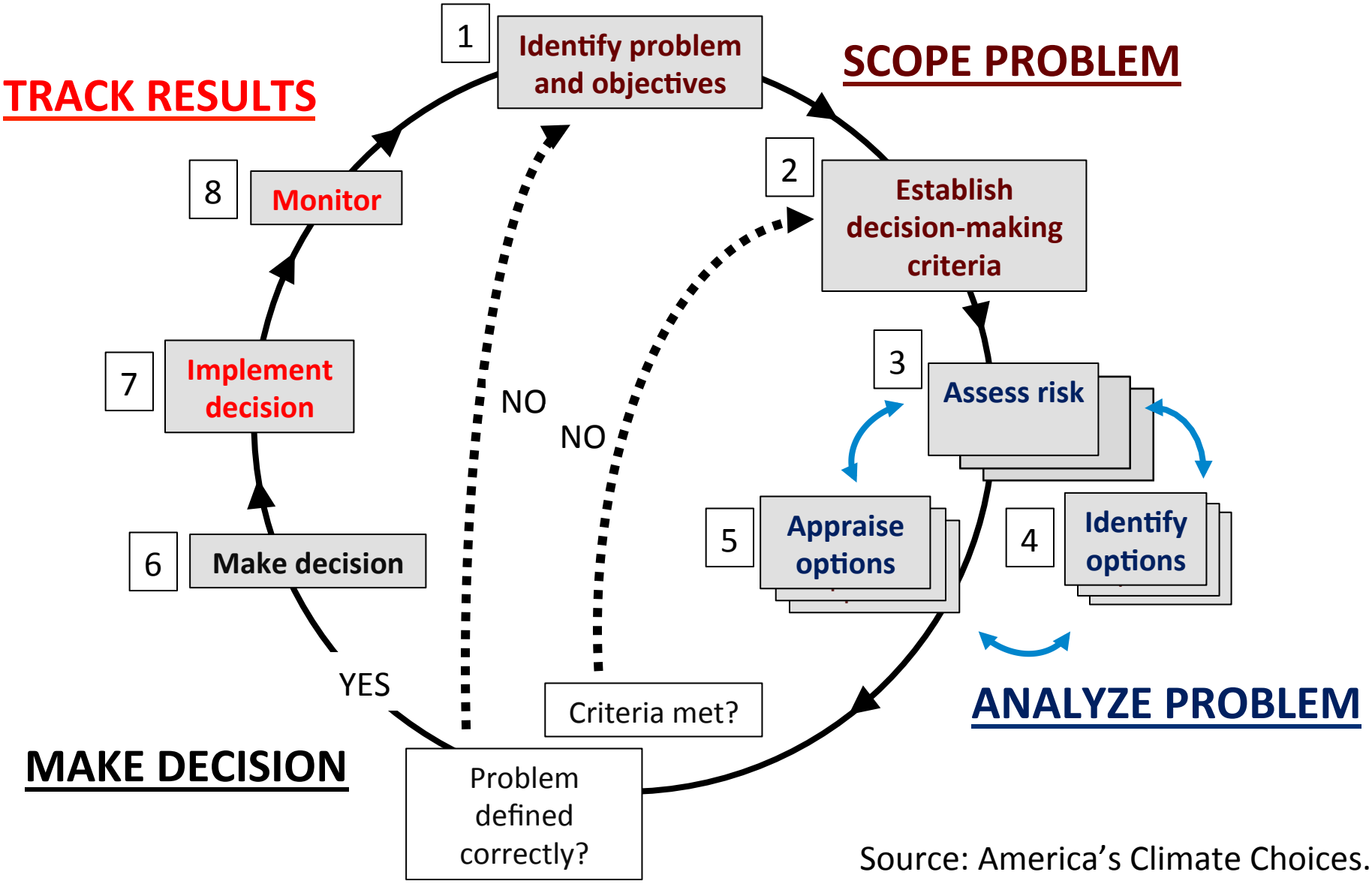


From Caves et al., Ecology and Society, in press

Ecology of Scenarios



Iterative Risk Management Framework



Source: America's Climate Choices. National Research Council, 2010.

Use of Scenario Planning

- Insight! -- Outreach
- Bring insight to ongoing processes: stakeholder discussions, modeling studies, vulnerability assessments, agency planning, business development

- Evaluate existing plans.
- Evaluate extant adaptation options: robust, no regrets

- Innovate new adaptation options: stops 

, bridges
- Develop portfolios of options: time-varying, weighted