Science and Values in Natural Resource Decision Making

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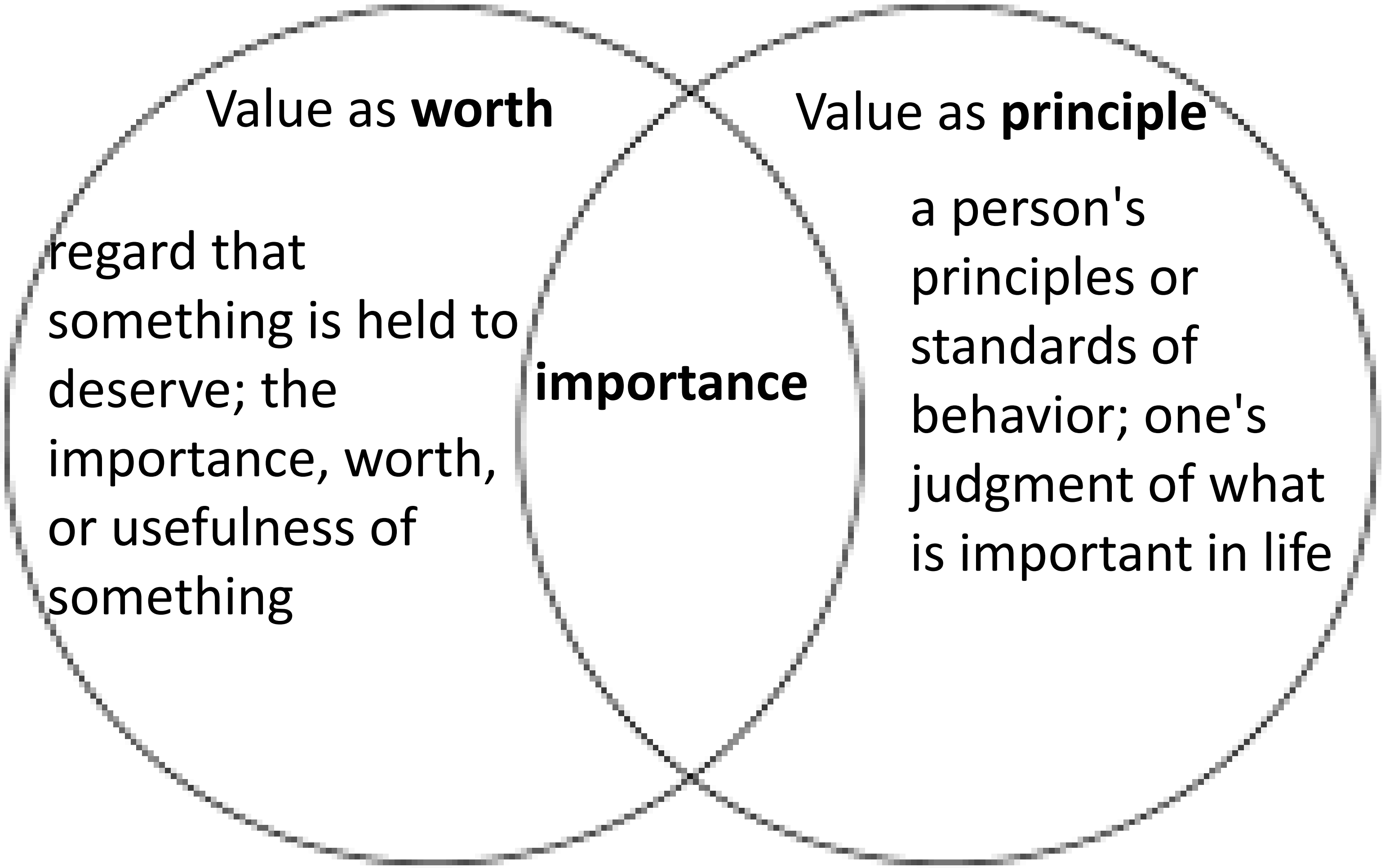


Values in Science: Normative Science I

A *type of information* that is developed, presented, or interpreted based on an assumed, usually unstated, preference (i.e., value) for a particular policy or class of policies.

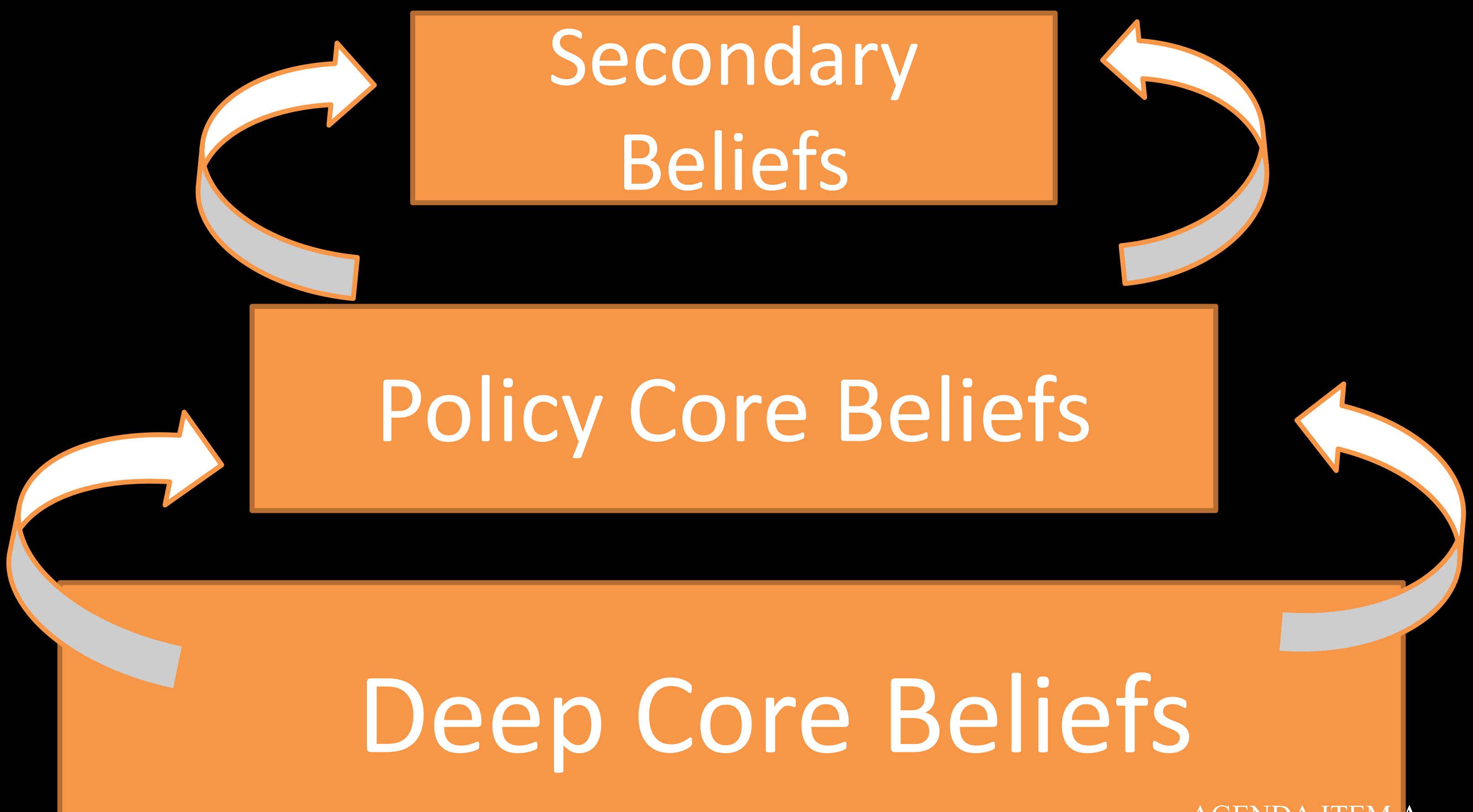
Examples:

- pristine ecosystems are preferable to human altered ones
- native species are better than nonnative species
- more biodiversity is preferable to less biodiversity.

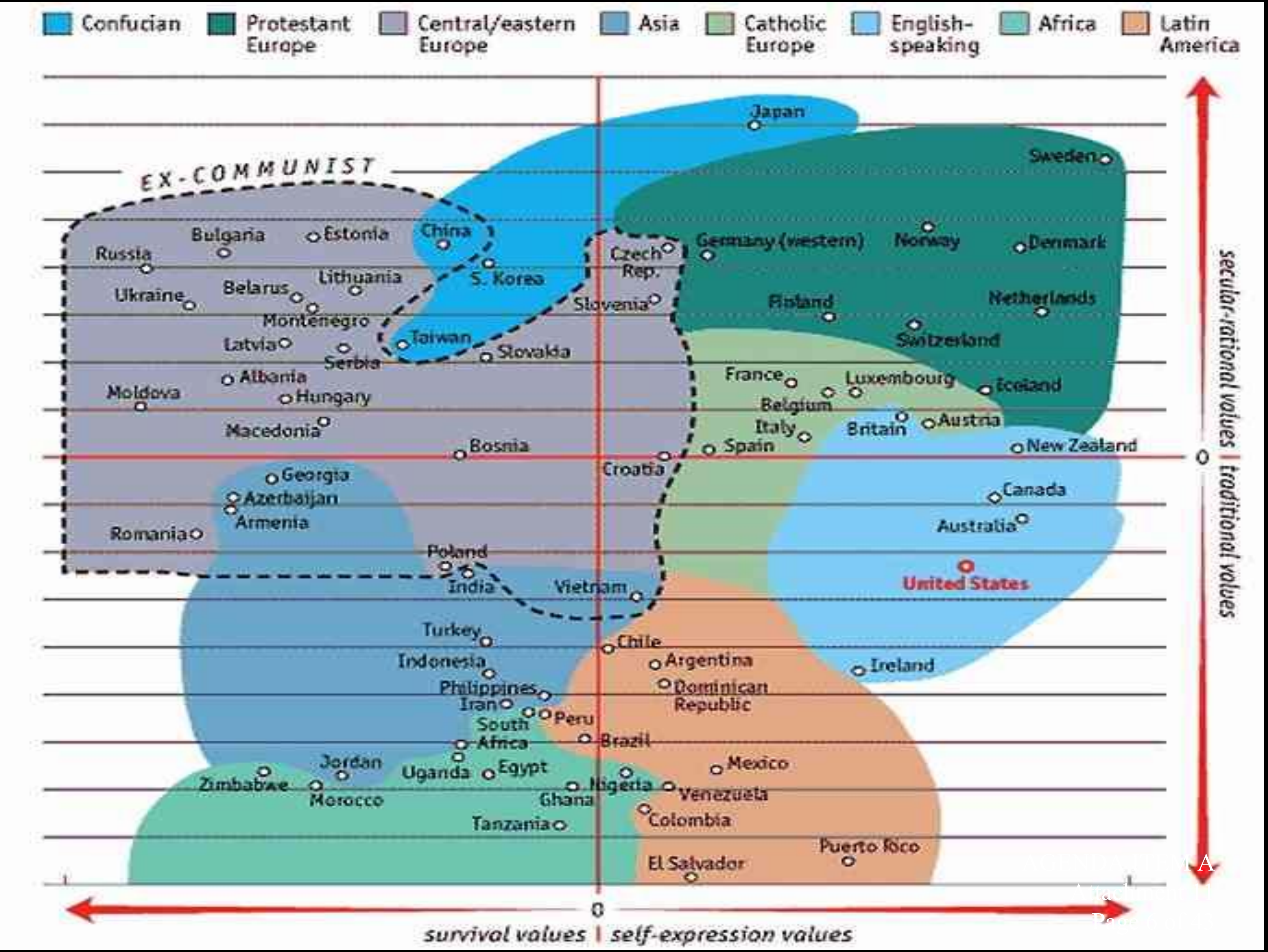
Values in Science: Normative Science II

A *form of inquiry*, typically involving a community of inquiry and its accumulated body of provisional knowledge, that seeks to discover good ways of achieving recognized aims, ends, goals, objectives, or purposes

Beliefs and Values in Policy



Deep Core Beliefs



Policy Core Beliefs

- Whose welfare counts
- Relative authority of government and markets
- Proper roles of general public, civil servants, experts in policy development
- Relative seriousness and causes of policy problems

Secondary Beliefs

- Relatively narrow in scope – focused on specific issue
- Often about rules and operating procedures
- Specific programs, specific locales, specific procedures
- Changing requires less evidence and usually more open to negotiation

Complex Systems Redux

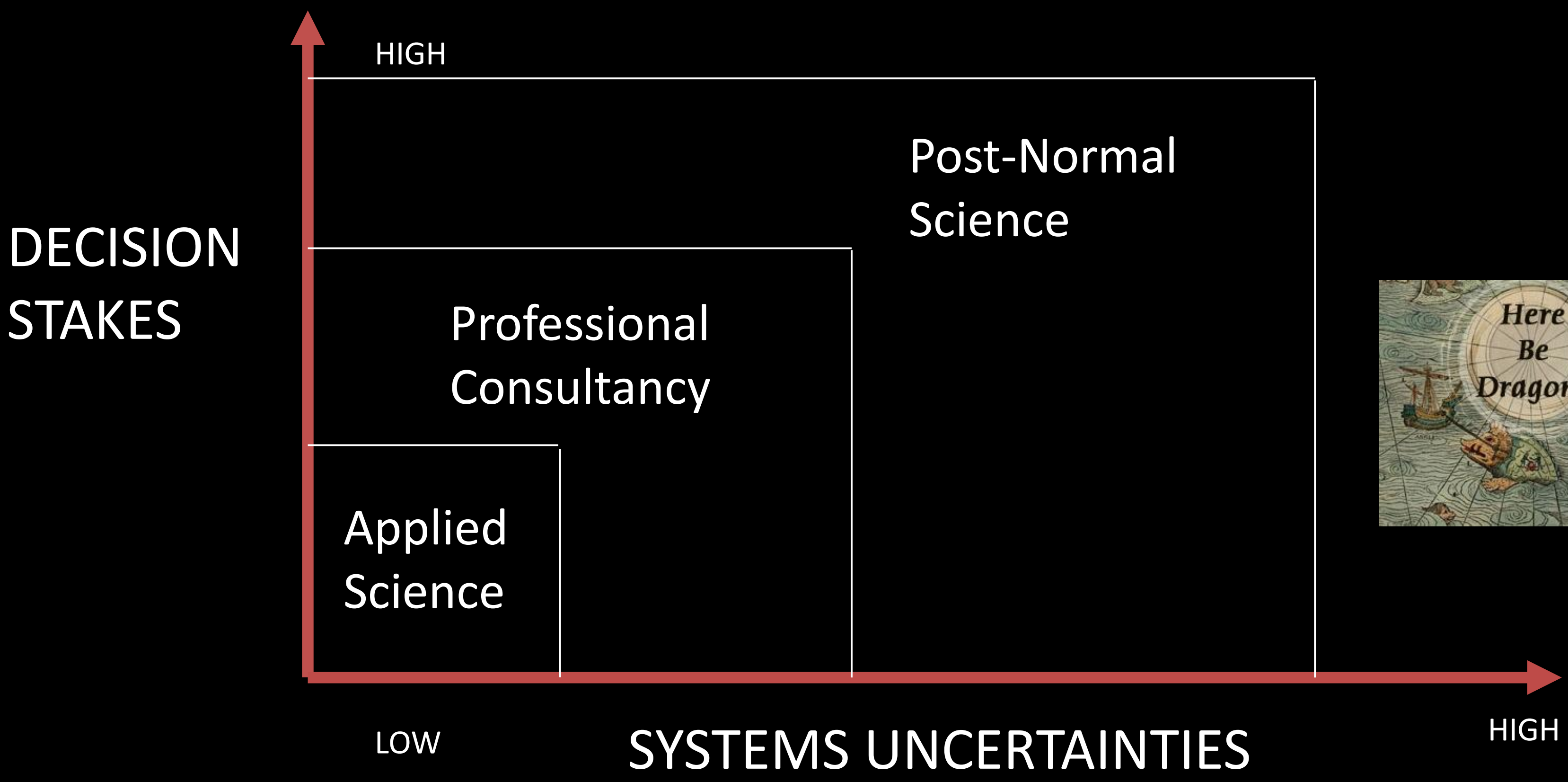
- Significant and irreducible uncertainties of various sorts
- Self organizing with operating states that can radically shift
- Emergent properties that are more than the sum of the parts
- Multiple legitimate perspectives: choices are driven by values embedded in the social systems in which science is being done

Environmental Policy in Conditions of Uncertainty

- Normality challenged: can routine science provide adequate knowledge base for policy decisions?

- Environmental issues: uncertain facts, values in dispute, stakes high, and decisions urgent

Sciences for Wicked Problems



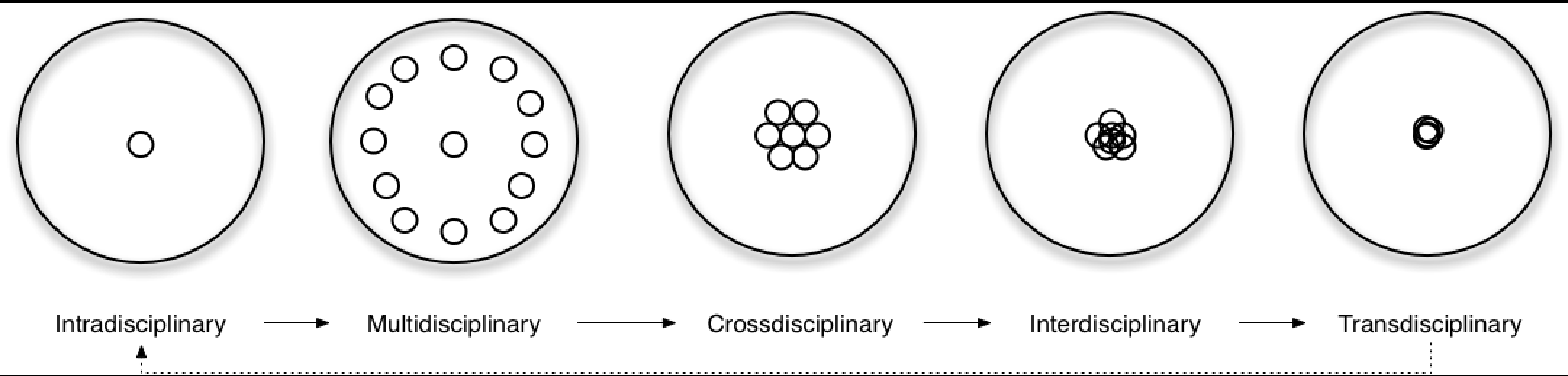
Characteristics of Post-Normal Science

- Decision needed before scientific evidence available
- Need for transparency, robustness, and uncertainty management
- Goal is usable knowledge
- Use of extended peer community to include local knowledge and expertise

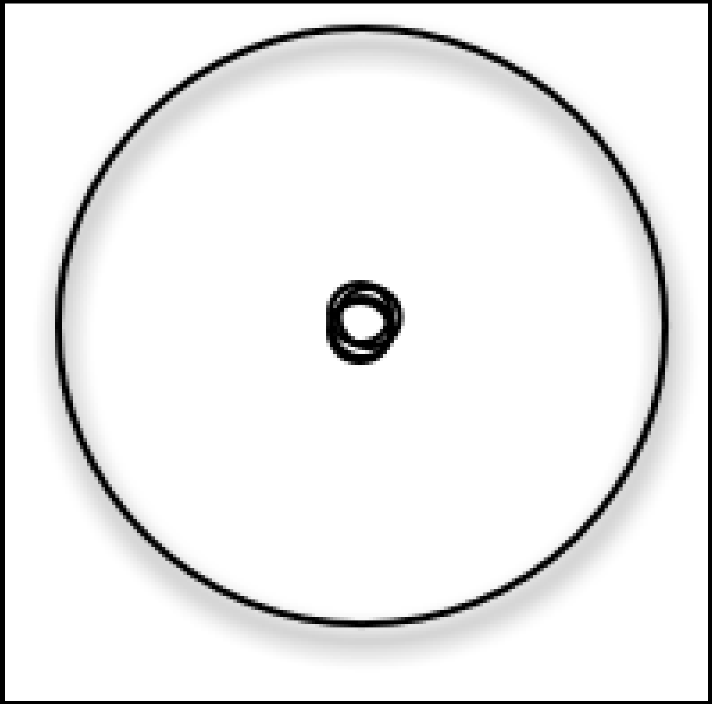
Approaches to Post-Normal Science

1. Multi-/Inter-/Trans-Disciplinary Science
2. Clumsy Solutions
3. Co-production

1. Multi-/Inter-/Trans-Disciplinary Approaches

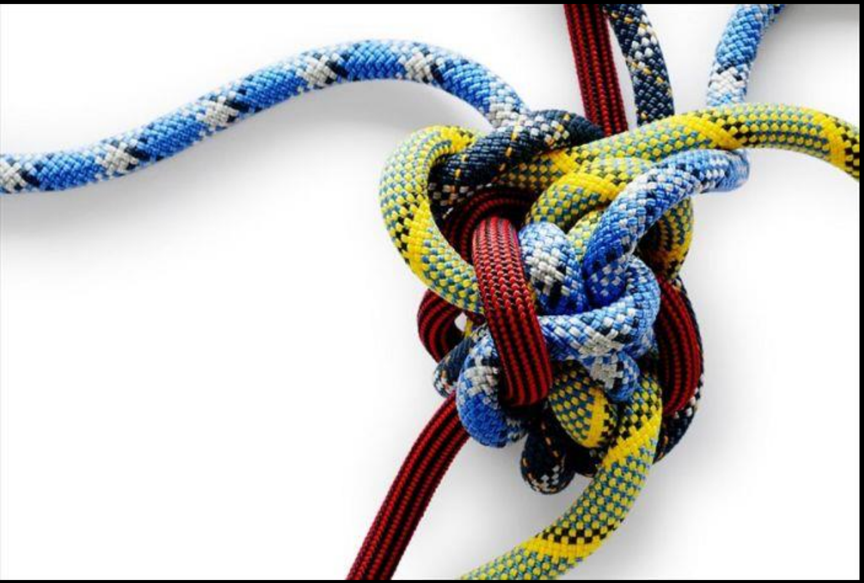


Transdisciplinary

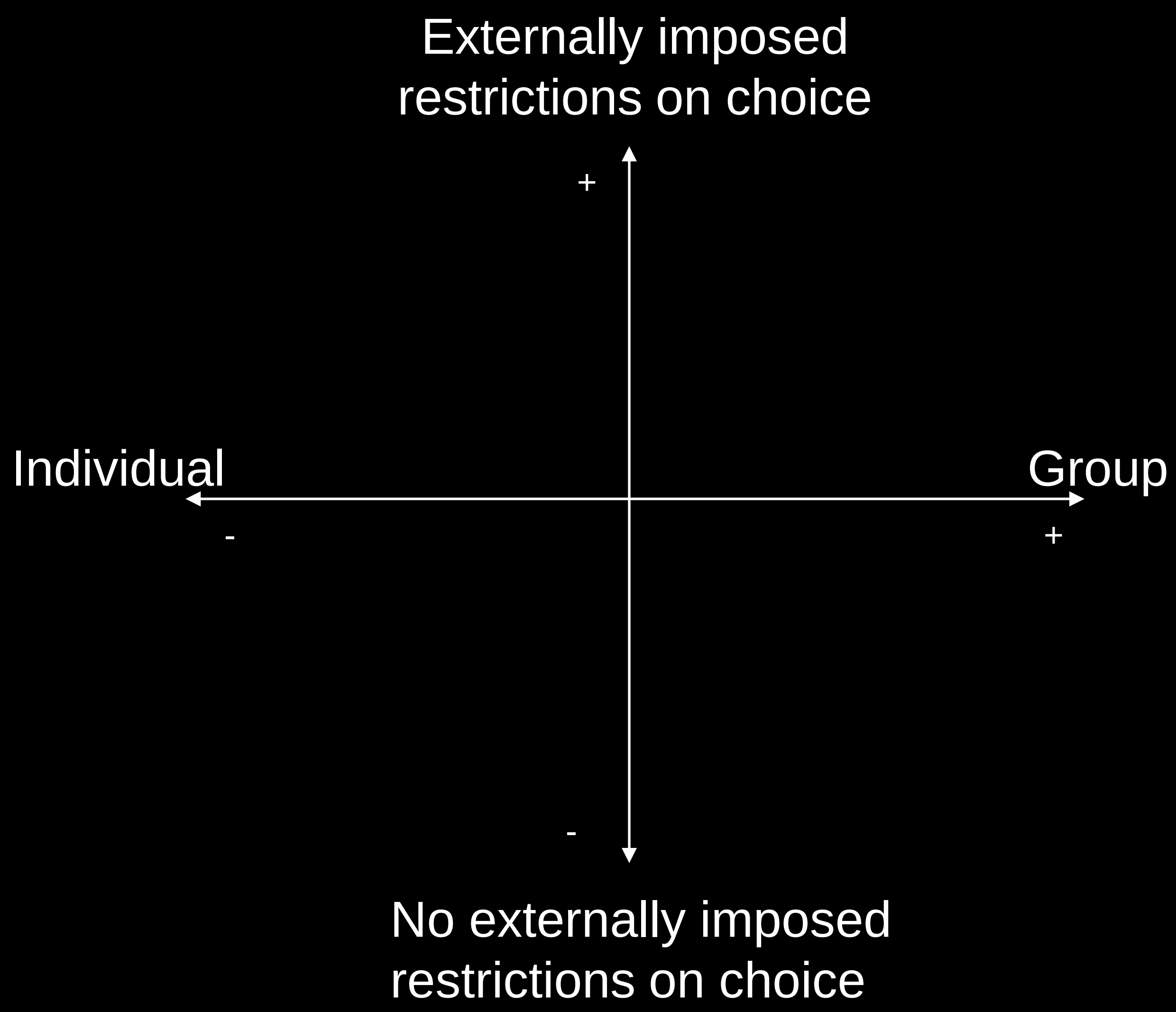


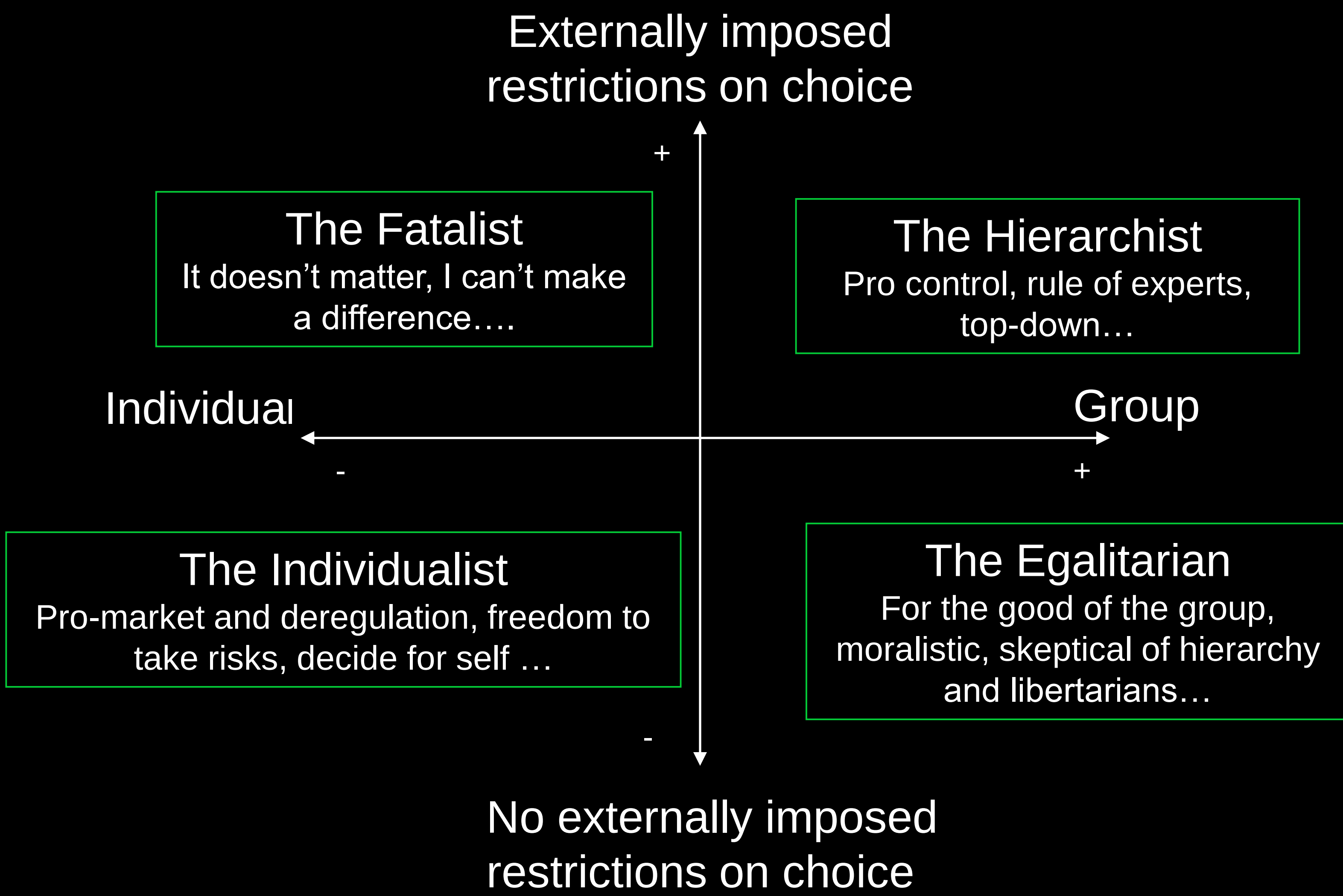
- Transcends disciplinary boundaries
- Combines interdisciplinarity with participation of extended peers
- Involves non-academic participants as equal players
- Searches for solutions to wicked problems
- Relates all disciplinary knowledge into a coherent whole

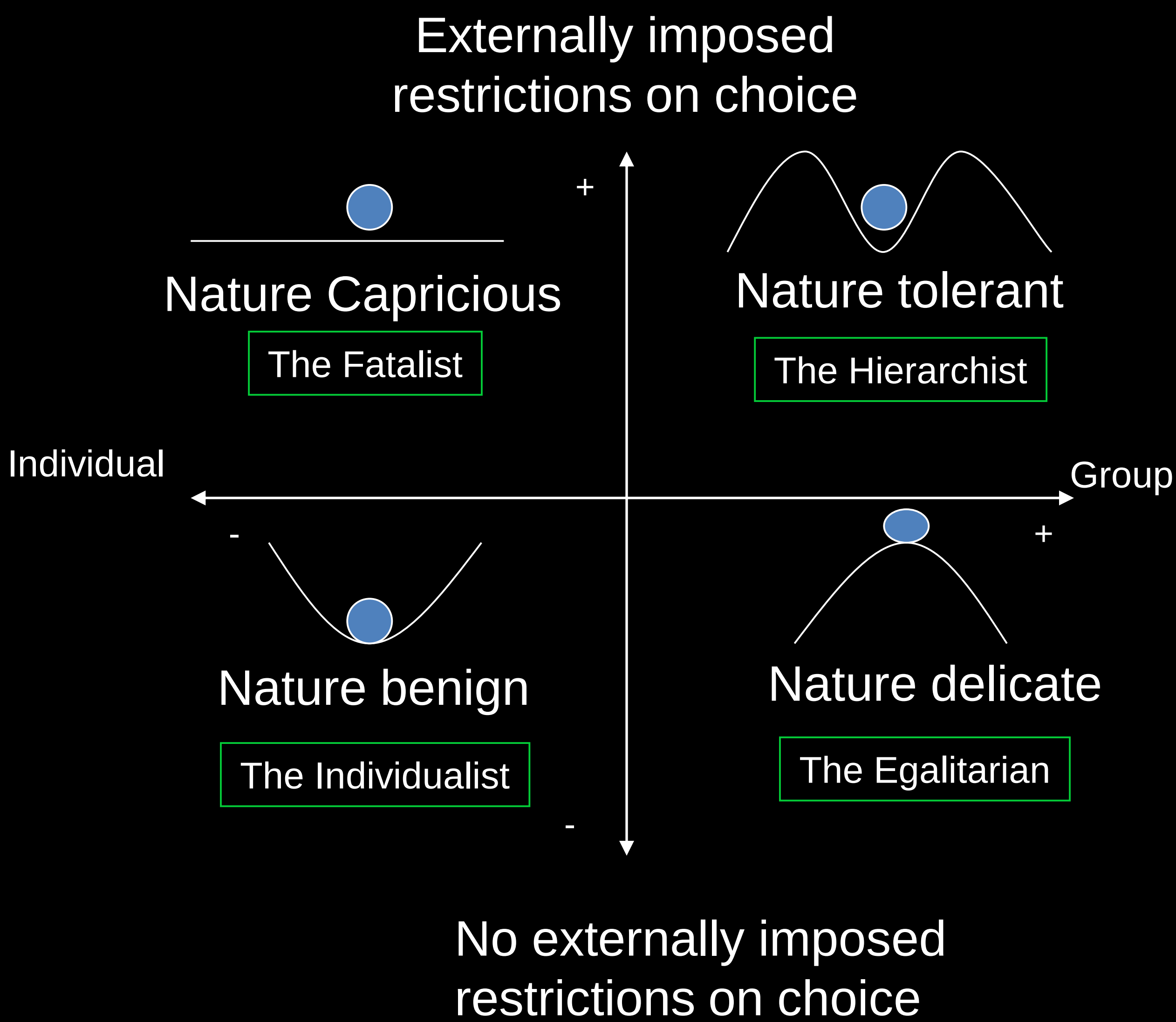
2. Clumsy Solutions - Cultural Theory



- Different ways of perceiving the world
- Partial knowledge about different solutions
- Elegant solutions: raise opposition and delay action
- Clumsy solutions: address different ways of knowing
- Additional messiness: allowing extended peer group involvement


Externally imposed restrictions on choice
+
Individual
Group
-
+
-
No externally imposed restrictions on choice


Externally imposed restrictions on choice
+
The Fatalist
It doesn't matter, I can't make a difference….
The Hierarchist
Pro control, rule of experts, top-down…
Individual
Group
-
+
The Individualist
Pro-market and deregulation, freedom to take risks, decide for self …
The Egalitarian
For the good of the group, moralistic, skeptical of hierarchy and libertarians…
-
No externally imposed restrictions on choice


Externally imposed
restrictions on choice
+
Nature Capricious
The Fatalist
Nature tolerant
The Hierarchist
Individual
Group
-
+
Nature benign
The Individualist
Nature delicate
The Egalitarian
-
No externally imposed
restrictions on choice

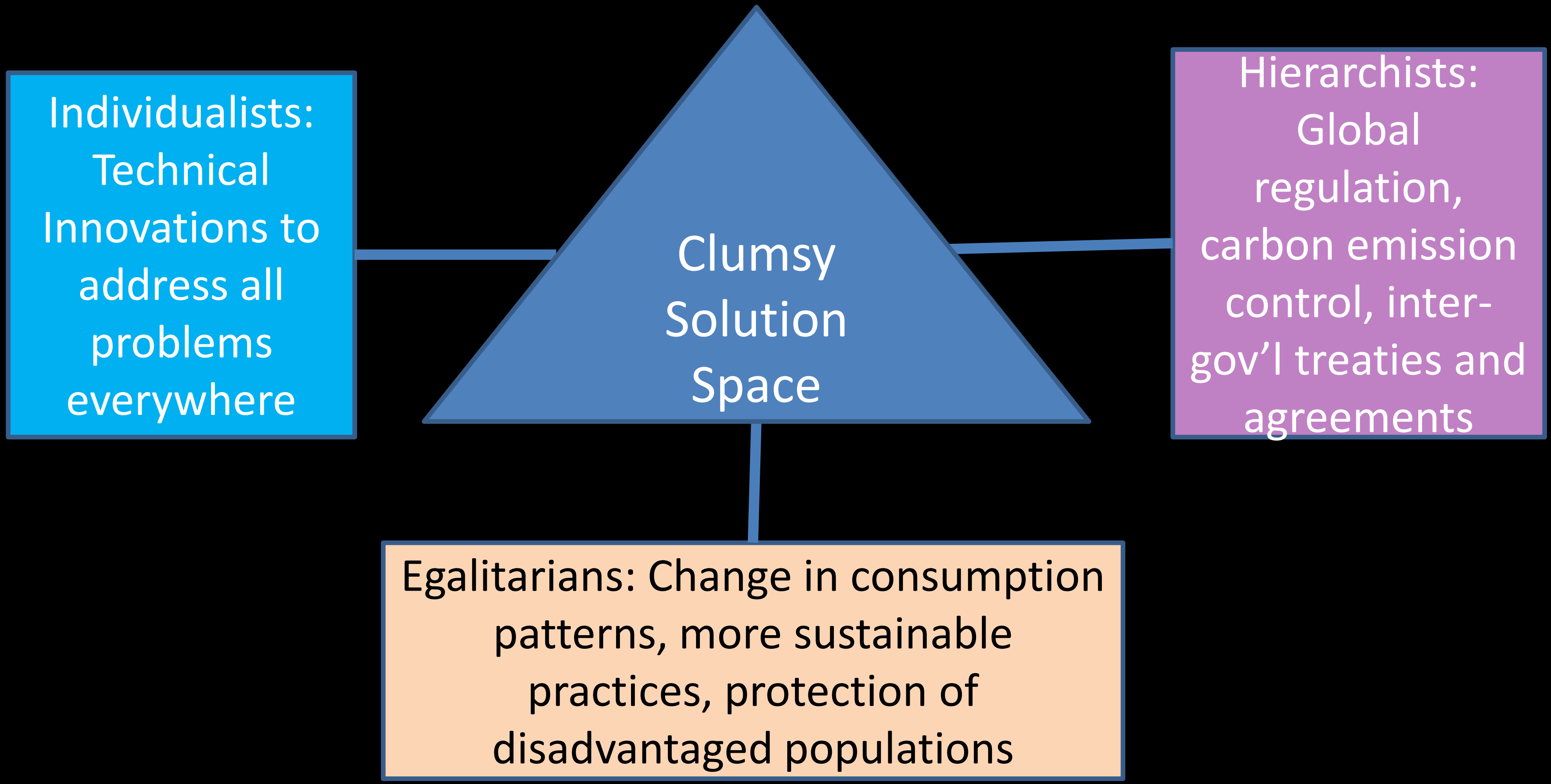
Clumsy Solutions Example

- Otay Water District, City of San Juan Capistrano Water District, and Irvine Ranch Water District
- Conservation rate structure: funds all current operations by a base rate, sectors are allocated conservation use targets
- Those using more than the target are assessed sharply escalating fees for water

Clumsy Solutions for Water Shortages

- Egalitarian: each household is allocated the same fixed allowance for human consumption
- Hierarchical: allowance varies by lot size and by month to allow for seasonal variation. Data about own and others water use.
- Individualist: strategy protects the customer's freedom of choice to use as much water as can be afforded.

Clumsy Solutions for Climate Change?



3. Co-Production of Knowledge

- Scientists, managers, policy makers, land owners, and other interested parties
  - Frame problems
  - Identify acceptable methods/sources of evidence
  - Interpret data within local contexts
  - Develop workable solutions

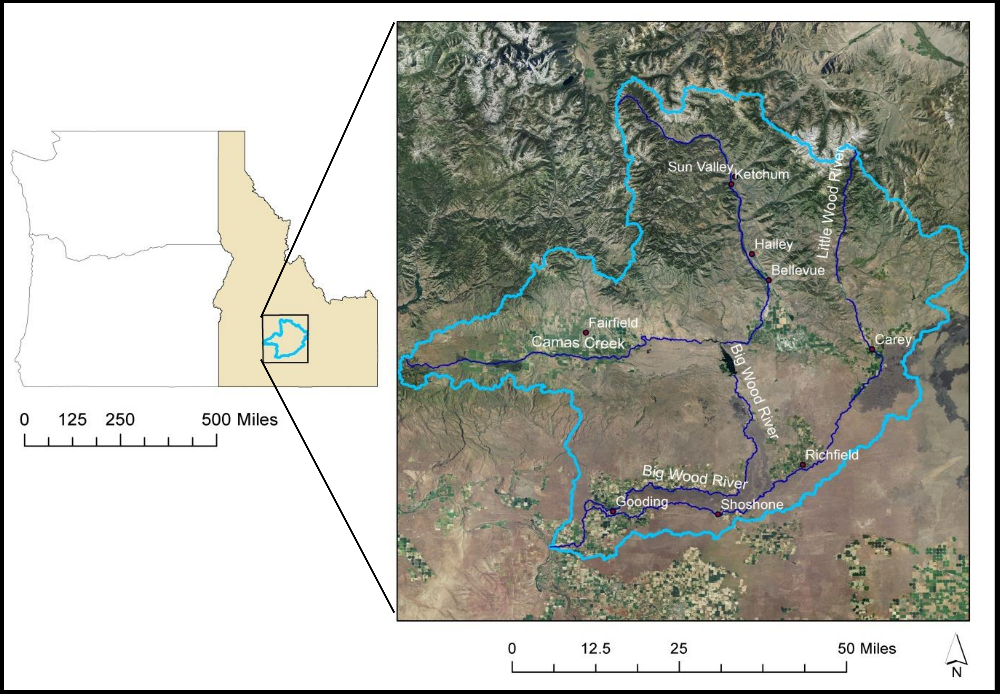
- Disseminate information, data, and best practices to create usable knowledge

Co-Design and Co-Production of Knowledge

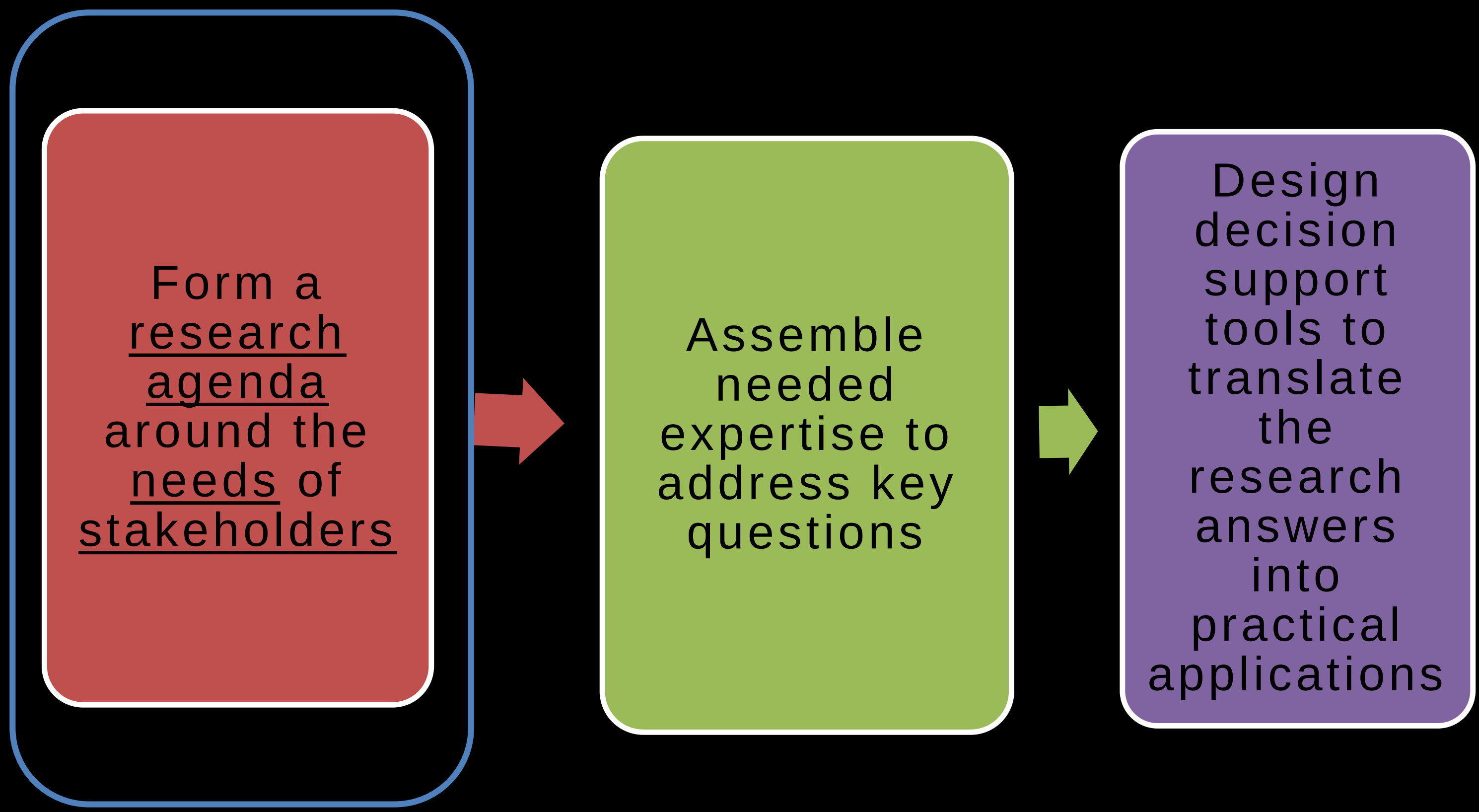
Source: Cowell et al, 2013

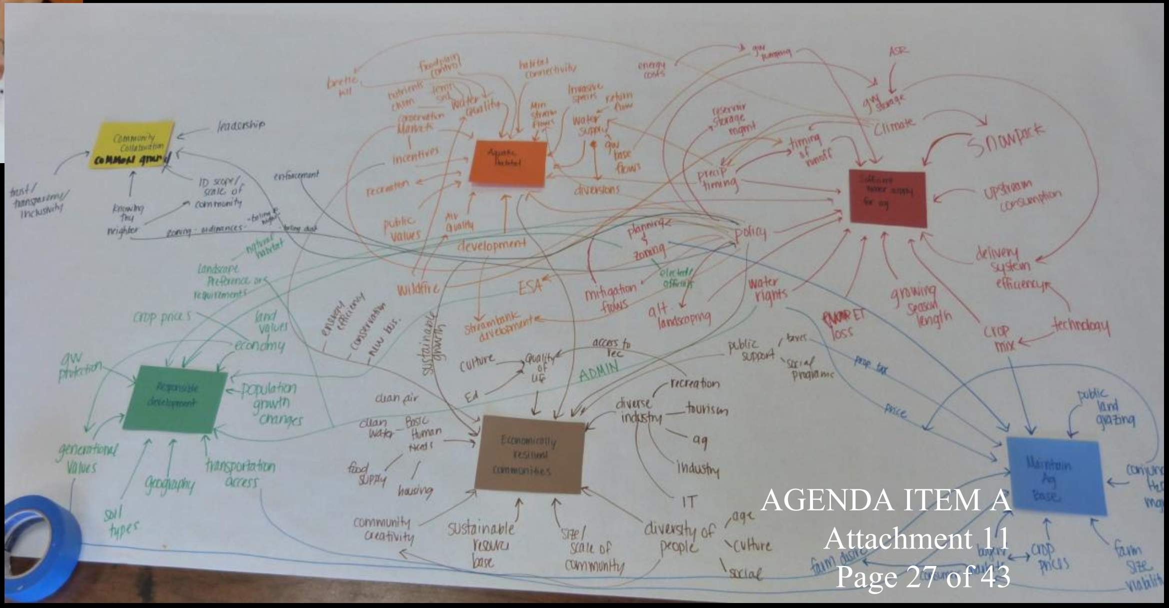
Example: Knowledge to Action Network in Idaho

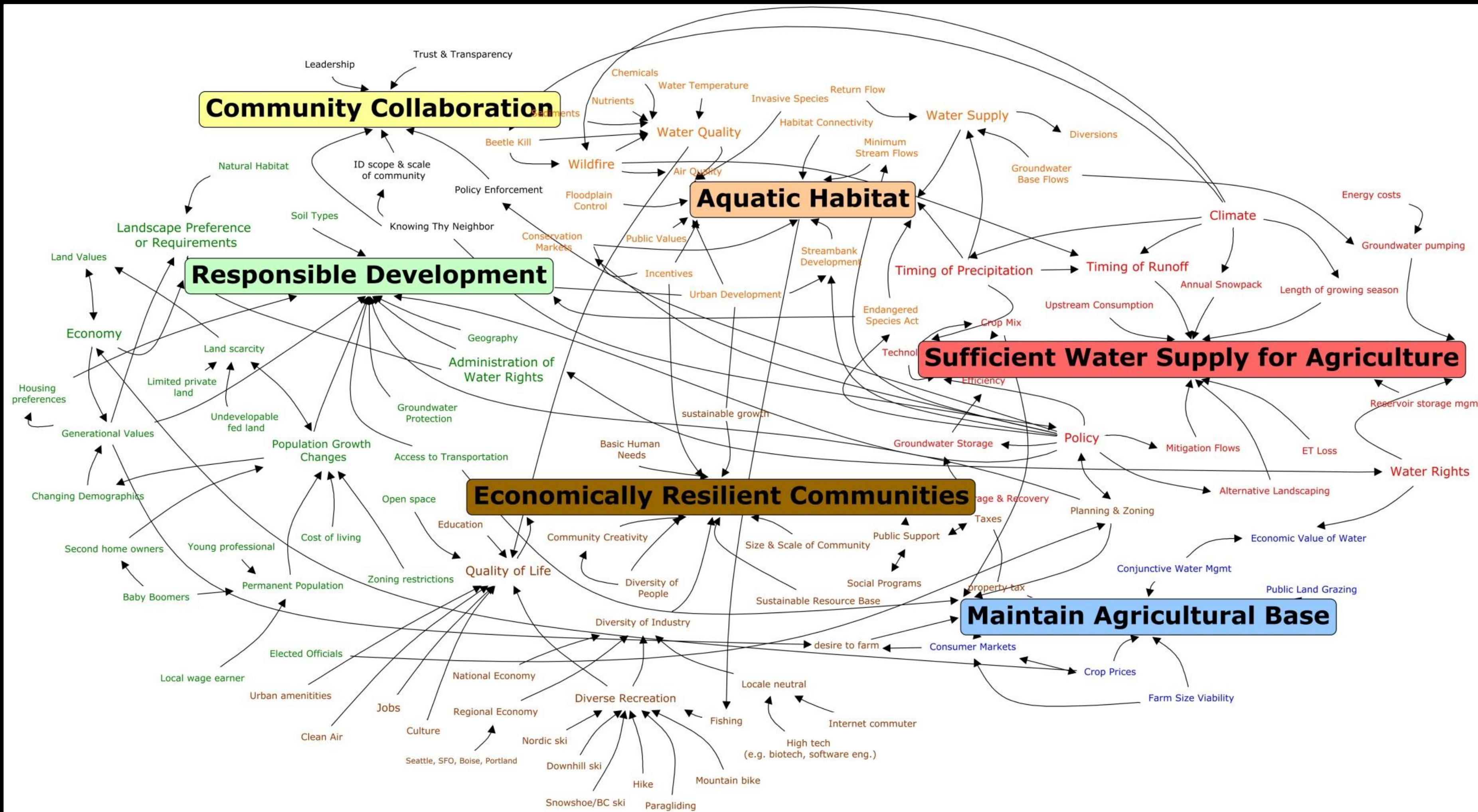
Irrigators, canal operators, extension folks work with OSU scientists and facilitators to model likely impacts and adaptation strategies in Big Wood Basin



Step 1: Forming a Research Agenda






Community Collaboration
Responsible Development
Aquatic Habitat
Sufficient Water Supply for Agriculture
Economically Resilient Communities
Maintain Agricultural Base
Leadership
Trust & Transparency
Chemicals
Water Temperature
Nutrients
Invasive Species
Return Flow
Water Supply
Diversions
Water Quality
Habitat Connectivity
Beetle Kill
Minimum Stream Flows
Groundwater Base Flows
Wildfire
Air Quality
Natural Habitat
ID scope & scale of community
Policy Enforcement
Floodplain Control
Energy costs
Climate
Groundwater pumping
Soil Types
Knowing Thy Neighbor
Landscape Preference or Requirements
Conservation Markets
Public Values
Streambank Development
Timing of Precipitation
Timing of Runoff
Land Values
Incentives
Urban Development
Annual Snowpack
Length of growing season
Endangered Species Act
Upstream Consumption
Crop Mix
Economy
Land scarcity
Geography
Administration of Water Rights
Housing preferences
Limited private land
Undevelopable fed land
Groundwater Protection
sustainable growth
Efficiency
Reservoir storage mgmt
Generational Values
Population Growth Changes
Access to Transportation
Basic Human Needs
Groundwater Storage
Policy
Mitigation Flows
ET Loss
Water Rights
Changing Demographics
Open space
Alternative Landscaping
Planning & Zoning
Education
Taxes
Second home owners
Young professional
Cost of living
Community Creativity
Size & Scale of Community
Public Support
Economic Value of Water
Quality of Life
Conjunctive Water Mgmt
Permanent Population
Zoning restrictions
Diversity of People
Social Programs
property tax
Public Land Grazing
Baby Boomers
Sustainable Resource Base
Diversity of Industry
Elected Officials
desire to farm
Consumer Markets
Local wage earner
National Economy
Crop Prices
Urban amenitities
Locale neutral
Jobs
Diverse Recreation
Farm Size Viability
Regional Economy
Fishing
Internet commuter
Clean Air
Culture
Nordic ski
High tech
(e.g. biotech, software eng.)
Seattle, SFO, Boise, Portland
Downhill ski
Hike
Mountain bike
Snowshoe/BC ski
Paragliding

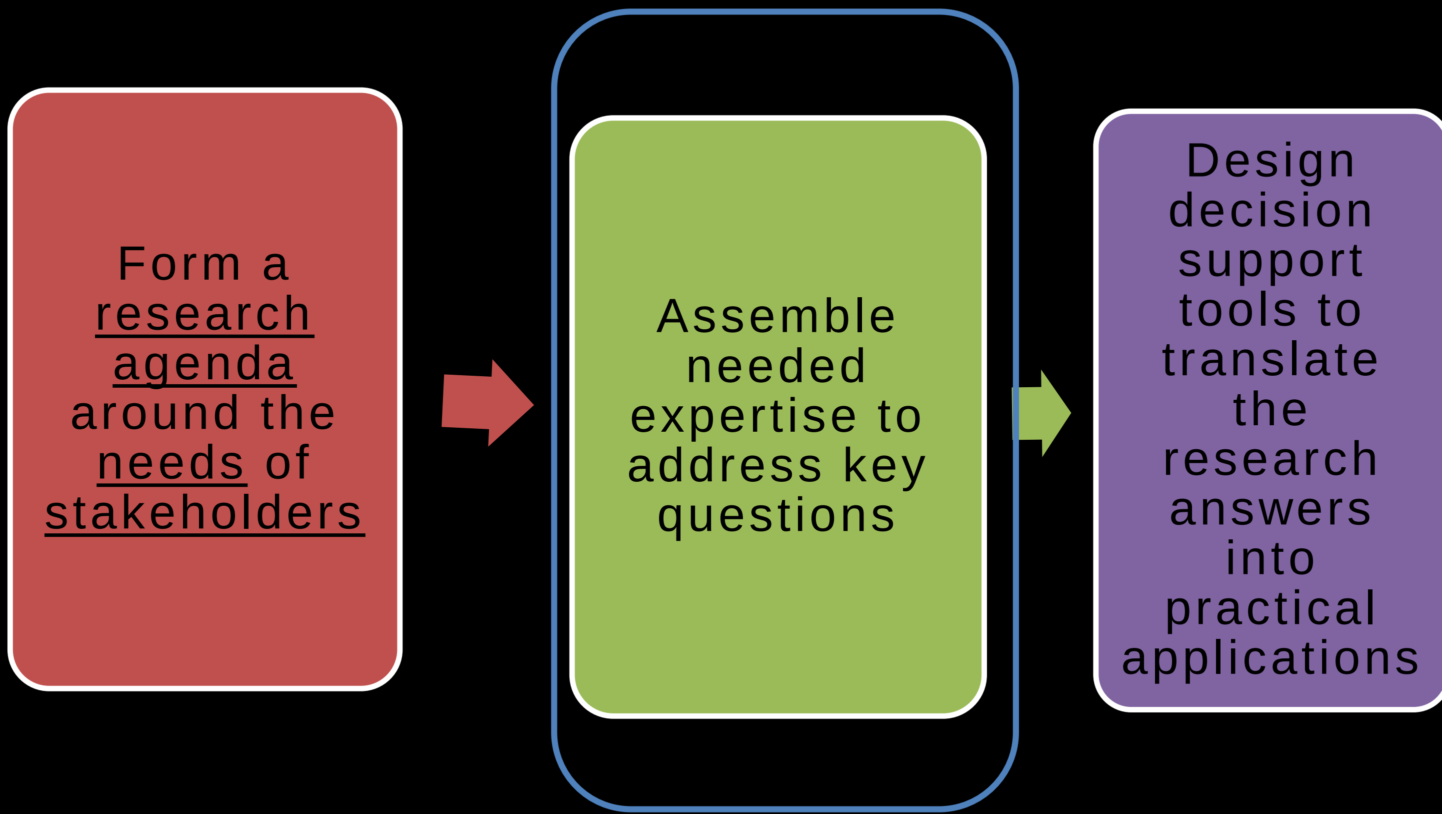
Research Questions

- How are drivers of change, both biophysical and human, likely to affect the quantity and timing of water for agriculture, fish habitat, and municipal uses in the Big Wood Basin?

- Where and when is water scarcity most likely to occur in the Big Wood Basin under projected climatic conditions?

- What policies and strategies would be most effective for achieving the desired endpoints for the basin?

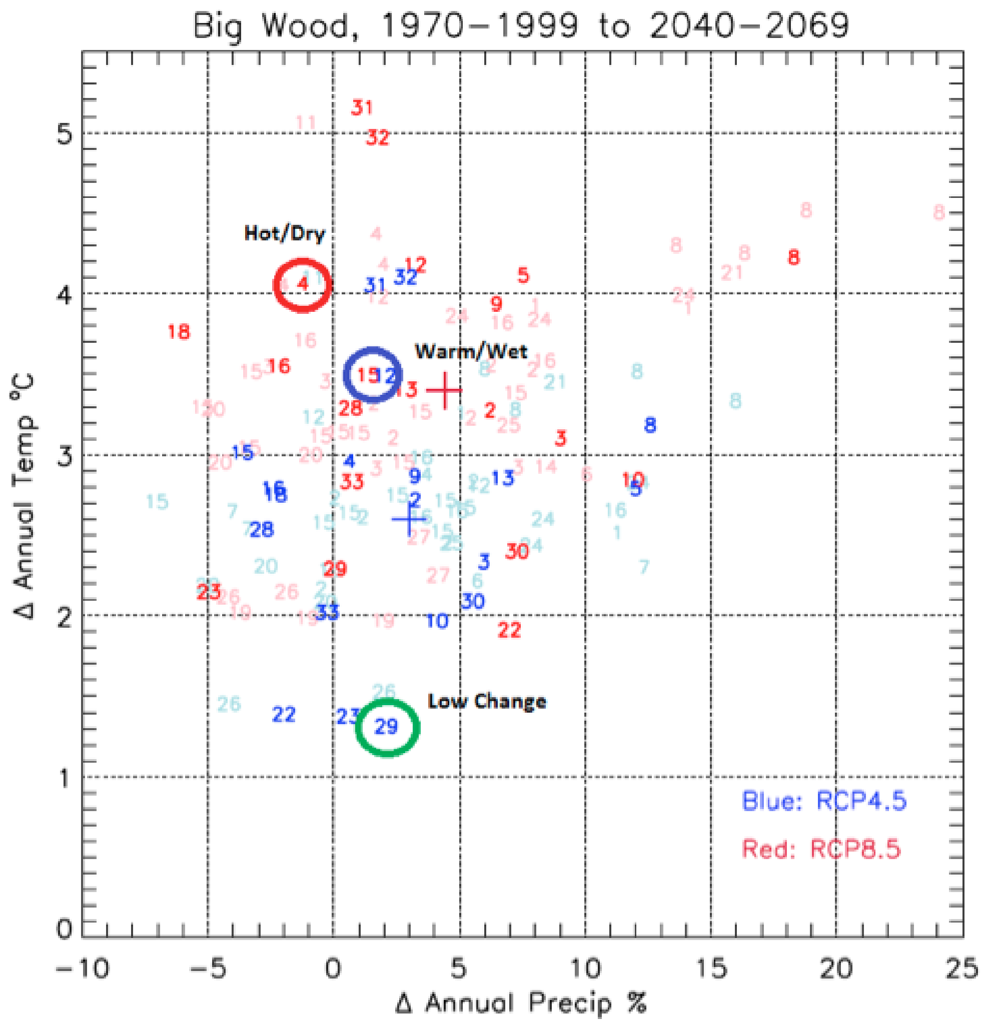
2. Getting the Needed Information



Assembling Expertise

- Are the right people in the room? Who is missing?
- Gathering relevant data from agencies and individuals
- Webinar Series for basin-specific information
  - Climate modeling
  - Adaptation to climate change
  - Groundwater

Big Wood Climate Model Selection



1. CESM1–CAM5
2. CCSM4
3. CNRM–CM5
4. HadGEM2–ES
5. HadGEM2–CC
6. CMCC–CM
7. EC–EARTH
8. CanESM2
9. IPSL–CM5A–MR
10. bcc–csm1–1–m
11. HadGEM2–AO
12. MIROC5
13. NorESM1–M
14. CMCC–CMS
15. CSIRO–Mk3–6–0
16. IPSL–CM5A–LR
17. MPI–ESM–MR
18. BNU–ESM
19. FIO–ESM
20. MPI–ESM–LR
21. GFDL–CM3
22. MRI–CGCM3
23. inmcm4
24. FGOALS–s2
25. FGOALS–g2
26. GISS–E2–R
27. GISS–E2–H
28. bcc–csm1–1
29. GFDL–ESM2M
30. GFDL–ESM2G
31. MIROC–ESM–CHEM
32. MIROC–ESM
33. IPSL–CM5B–LR

Δ Temperature, °C

	RCP4.5	RCP8.5
Max.	4.1	5.1
75%	2.9	4.1
Mean	2.6	3.4
25%	2.1	2.8
Min.	1.3	1.9

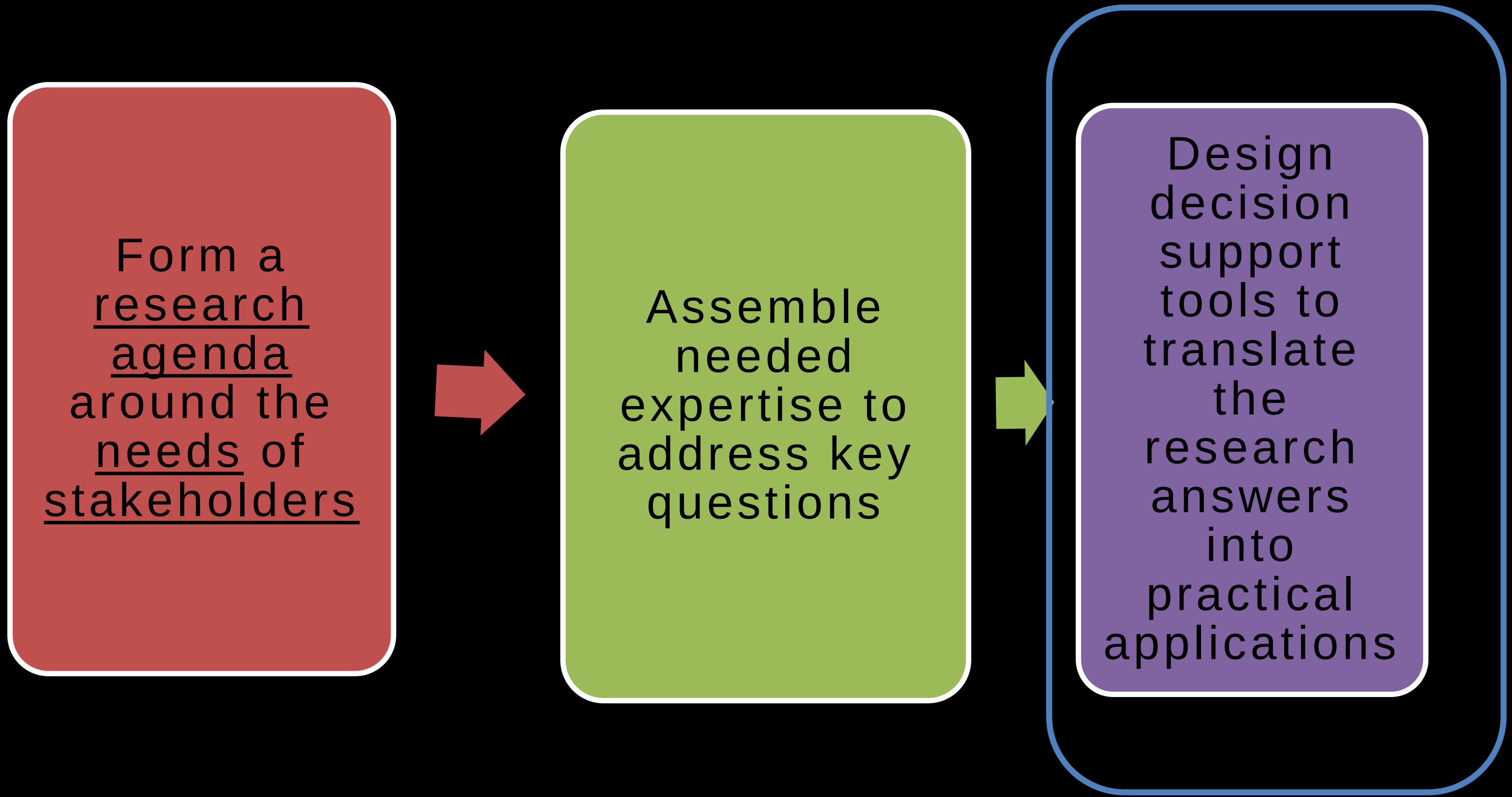
Δ Precipitation, %

	RCP4.5	RCP8.5
Max.	12.1	18.3
75%	5.8	7.1
Mean	3.0	4.4
25%	−0.20	0.20
Min.	−2.8	−6.1

Where models had multiple ensemble members, ensembles were averaged prior to calculating statistics in the table above.

Key:
Dark color = MACA available
Light color = MACA not available
Models ranked by performance index
"+" = mean of RCP

Step 3: Creating tools to answer questions

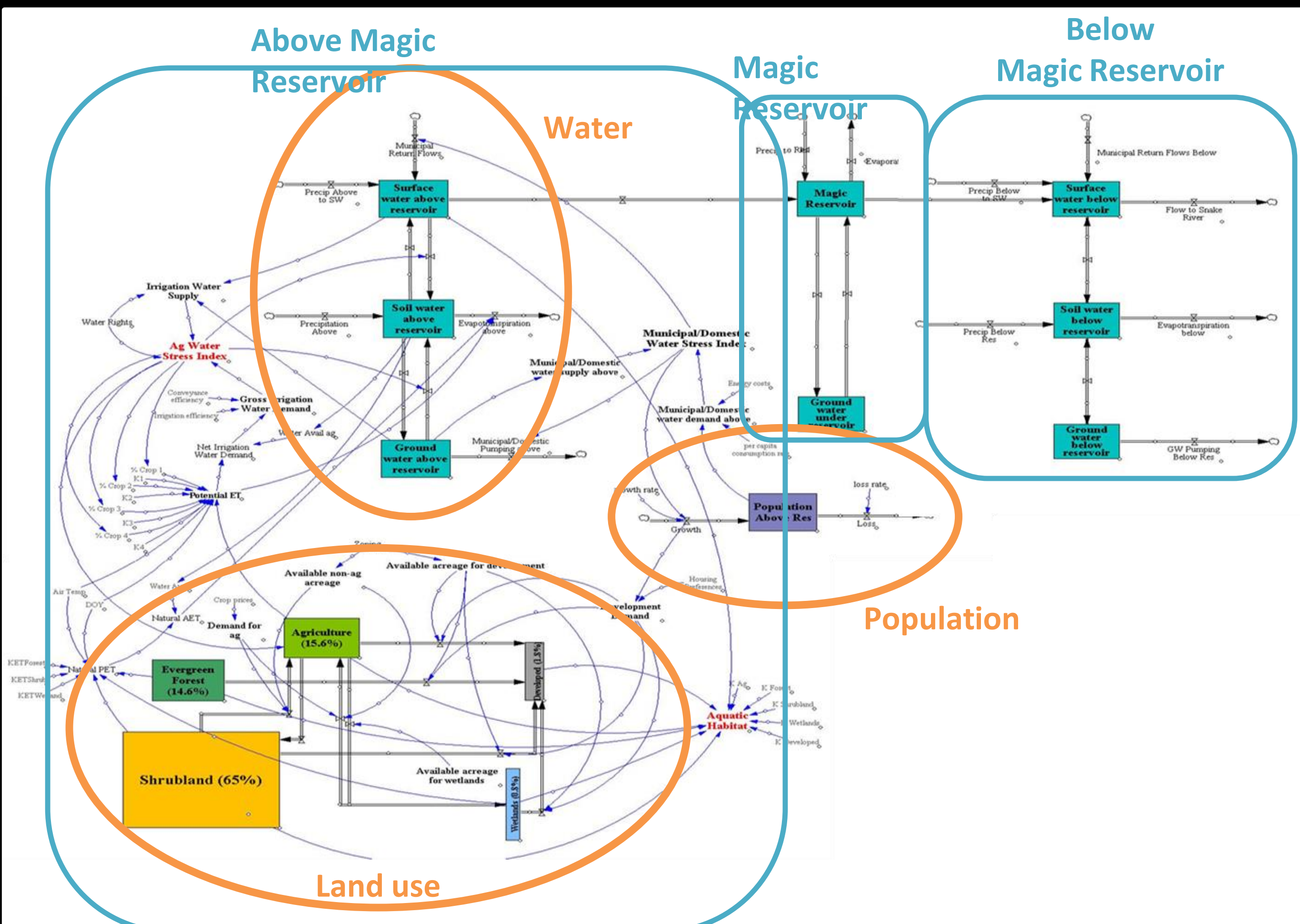


Understanding Impacts of Change in Big Wood Basin

2 Methods Proposed:

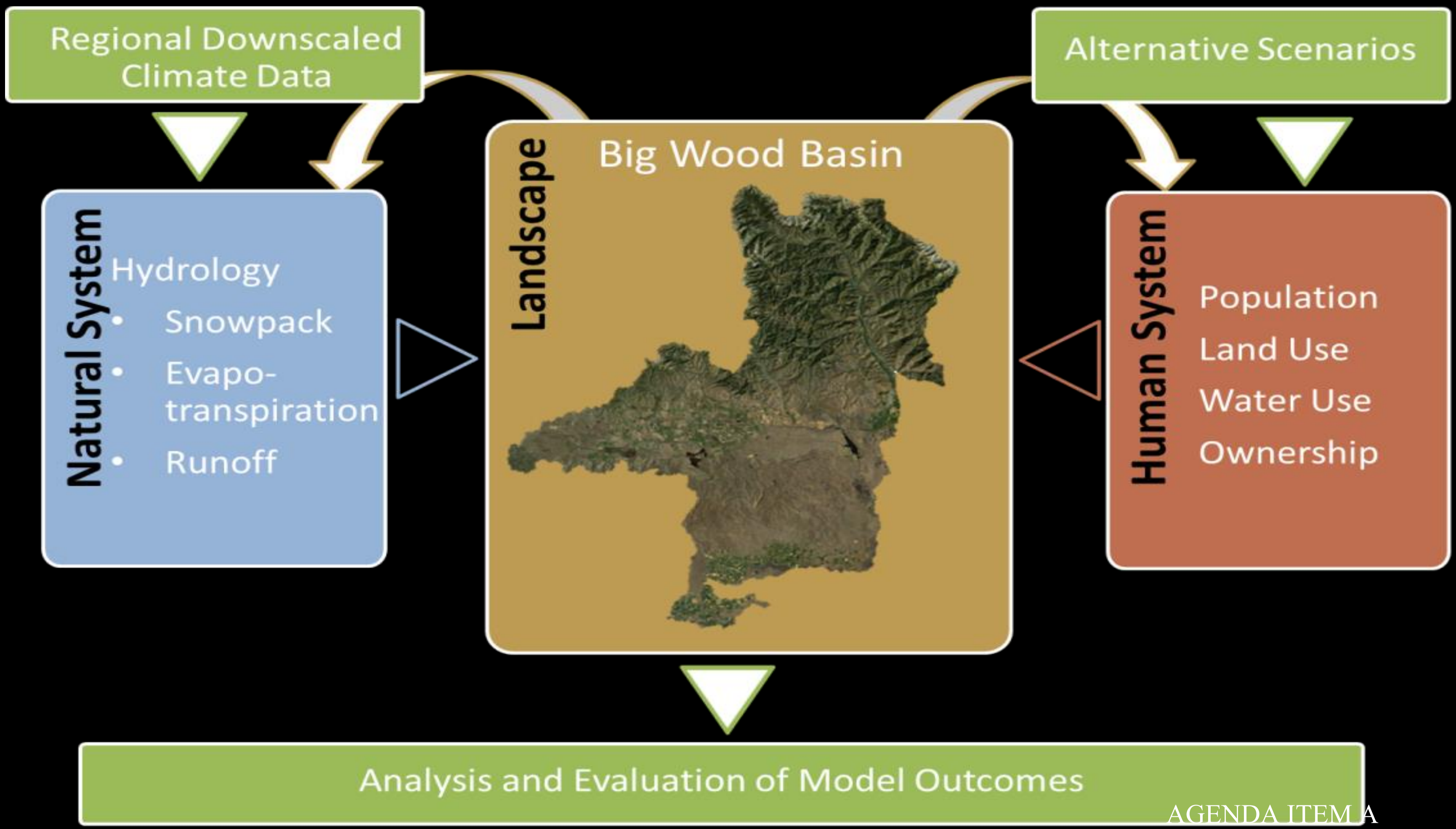
- System Dynamics Model
- Envision – a spatially explicit modeling process

Modeling Water Use
with Systems Dynamics Model

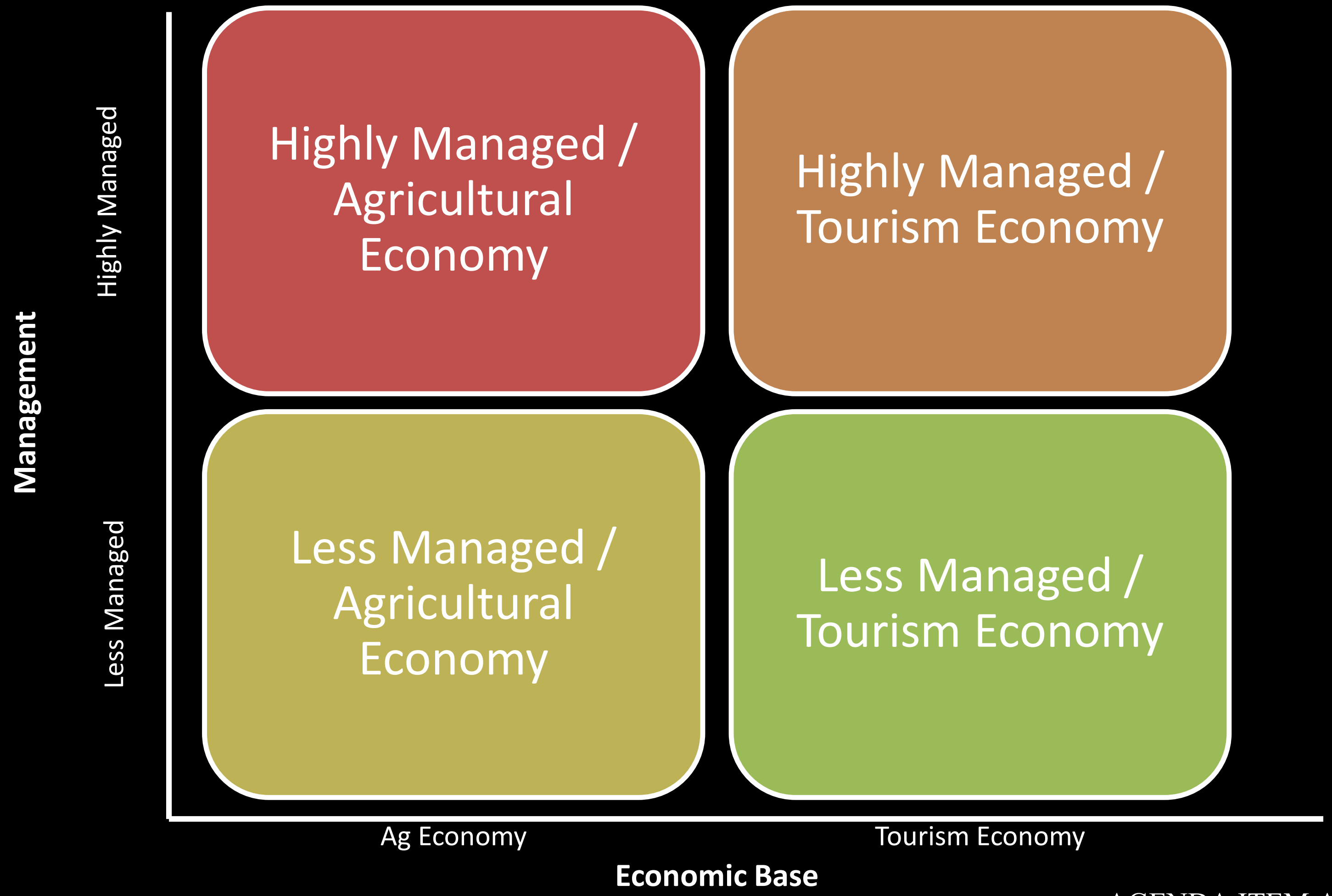


Didn’t address the complexity of the system or answer our questions

Shift to spatially-explicit, agent-based alternative futures modeling platform



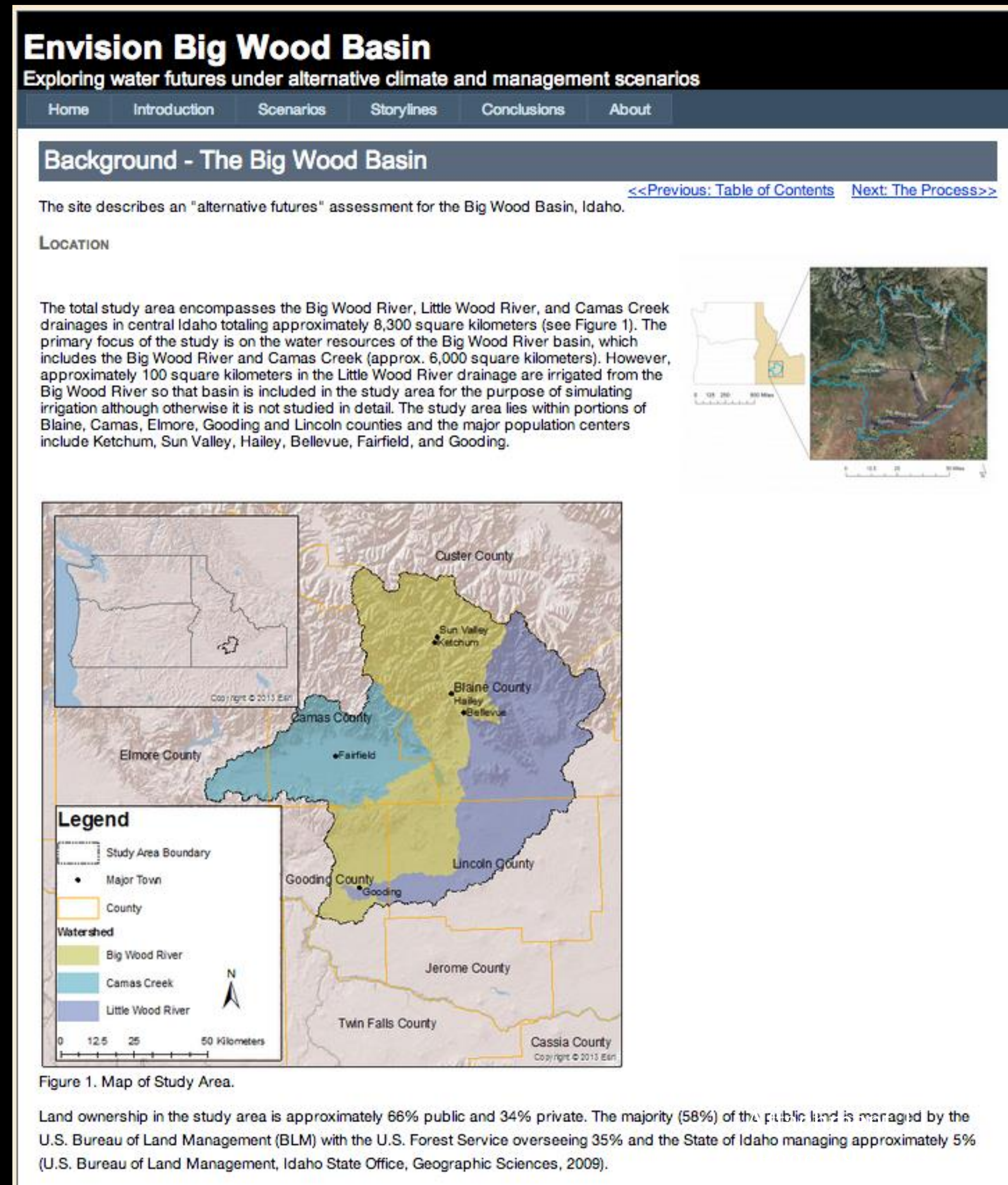
Alternative Scenarios: Economic base and management approach



12 Alternative Scenarios: economic base, management approach, climate scenario

Result: Too much information

Identify which *Storylines* matter to participants
- Temperature
- Snowpack
- Water Demand


Envision Big Wood Basin

Exploring water futures under alternative climate and management scenarios

Home | Introduction | Scenarios | Storylines | Conclusions | About

Background - The Big Wood Basin

<<Previous: Table of Contents Next: The Process>>

The site describes an "alternative futures" assessment for the Big Wood Basin, Idaho.

LOCATION

The total study area encompasses the Big Wood River, Little Wood River, and Camas Creek drainages in central Idaho totaling approximately 8,300 square kilometers (see Figure 1). The primary focus of the study is on the water resources of the Big Wood River basin, which includes the Big Wood River and Camas Creek (approx. 6,000 square kilometers). However, approximately 100 square kilometers in the Little Wood River drainage are irrigated from the Big Wood River so that basin is included in the study area for the purpose of simulating irrigation although otherwise it is not studied in detail. The study area lies within portions of Blaine, Camas, Elmore, Gooding and Lincoln counties and the major population centers include Ketchum, Sun Valley, Hailey, Bellevue, Fairfield, and Gooding.

Figure 1. Map of Study Area.

Land ownership in the study area is approximately 66% public and 34% private. The majority (58%) of the public land is managed by the U.S. Bureau of Land Management (BLM) with the U.S. Forest Service overseeing 35% and the State of Idaho managing approximately 5% (U.S. Bureau of Land Management, Idaho State Office, Geographic Sciences, 2009).

Create Storylines

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Home | Introduction | Scenarios | Storylines | Conclusions | About

Storyline - Snowpack

<<Previous: Precipitation   Next: SWE Maps>>

Take Home Message

Snow in the Big Wood Basin is an important storage mechanism satisfying late spring and summer water demand lower in the basin. The climate models show clear trends in the **timing** of snow, with more of a mixed story regarding the **amount** of snow expected into the future. In general, the amount of snow tends to continue the current downward trend, but there is some decade variation in this. These impacts of reduced (and earlier) snow are addressed later on in this storyline.

Key Findings

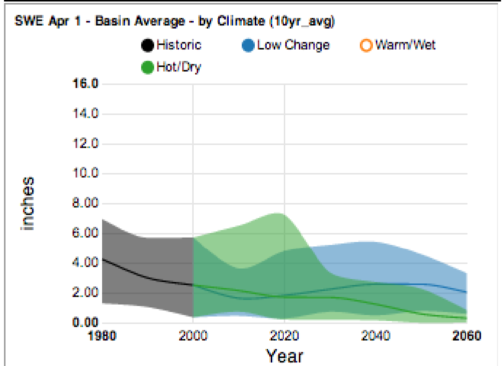
- Snowpack has declined over the last 30 years.
- It is difficult to identify a consistent future trend in the volume of peak snowpack across the scenarios.
- However, all scenarios suggest a change in the timing of the peak seasonal snow (historically found near April 1) which may occur up to 6 weeks earlier.
- High elevation snowpack, where most of the basin's snow occurs, will be most impacted.

Background

Snow is critical to the area, because it represents water **storage** in the system, similar to a reservoir and supports winter recreation. Loss of snowpack implies loss of that storage capacity, which is either gone or requires replacement in the form of man-made reservoirs. We show both the amount of snow, and the timing of the snow, to capture this storyline. Snowpack is expressed here as "**Snow Water Equivalents**", or **SWE** - the amount of water contained in snow - and is sensitive to changes in both temperature and timing of precipitation.

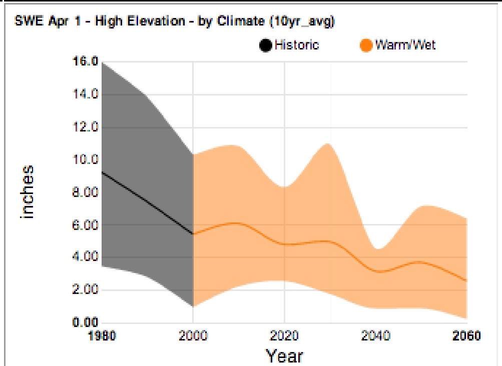
The Data

The following chart shows a summary of the basin average snow (SWE) on April 1 for the entire Big Wood Basin.



Filter: [ ] reset Shortcuts: ablm abmm tblm tbmm
Low Change Warm/Wet Hot/Dry

The chart below shows similar data, but only for the high elevation (> 6500ft) areas in the basin, for each of the climate scenarios.



Filter: warm reset Shortcuts: ablm abmm tblm tbmm
Low Change Warm/Wet Hot/Dry

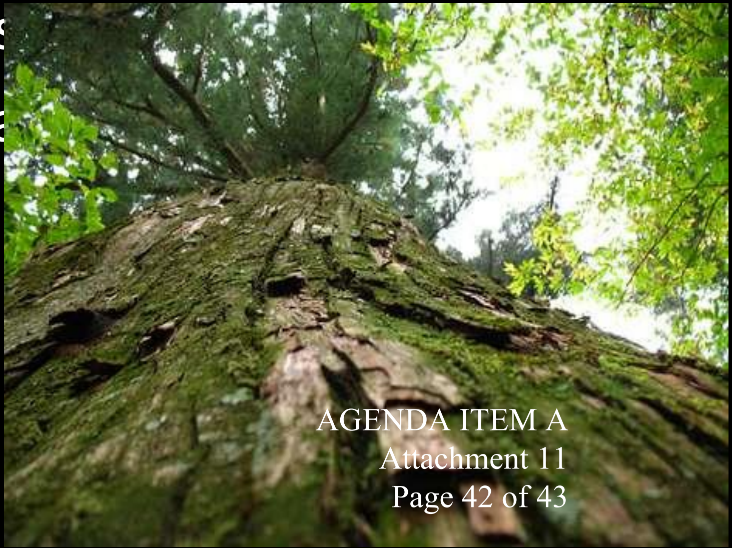
- Take home message (non-academic)
- Key features/points
- Background/context
- Data (display and sources

Lessons Learned

- Participatory projects take lots of time
- Local expertise and data increase legitimacy of results and solutions
- Conversations avoid arguments about what/when/if/who to blame
- Lots to learn about understanding and communicating complicated information

Decision Making for Wicked Problems

- Extended peer communities: all who have desire to participate in resolution of problem
- Participation through citizen juries, focus groups, consensus conferences, watershed councils, knowledge to action networks
- Awareness of different ways of seeing the world
- Increased collaboration to improve system knowledge and generate clumsy solutions
- Collaborative solutions have moral force a political influence



ANY CLUMSY OR WICKED QUESTIONS?