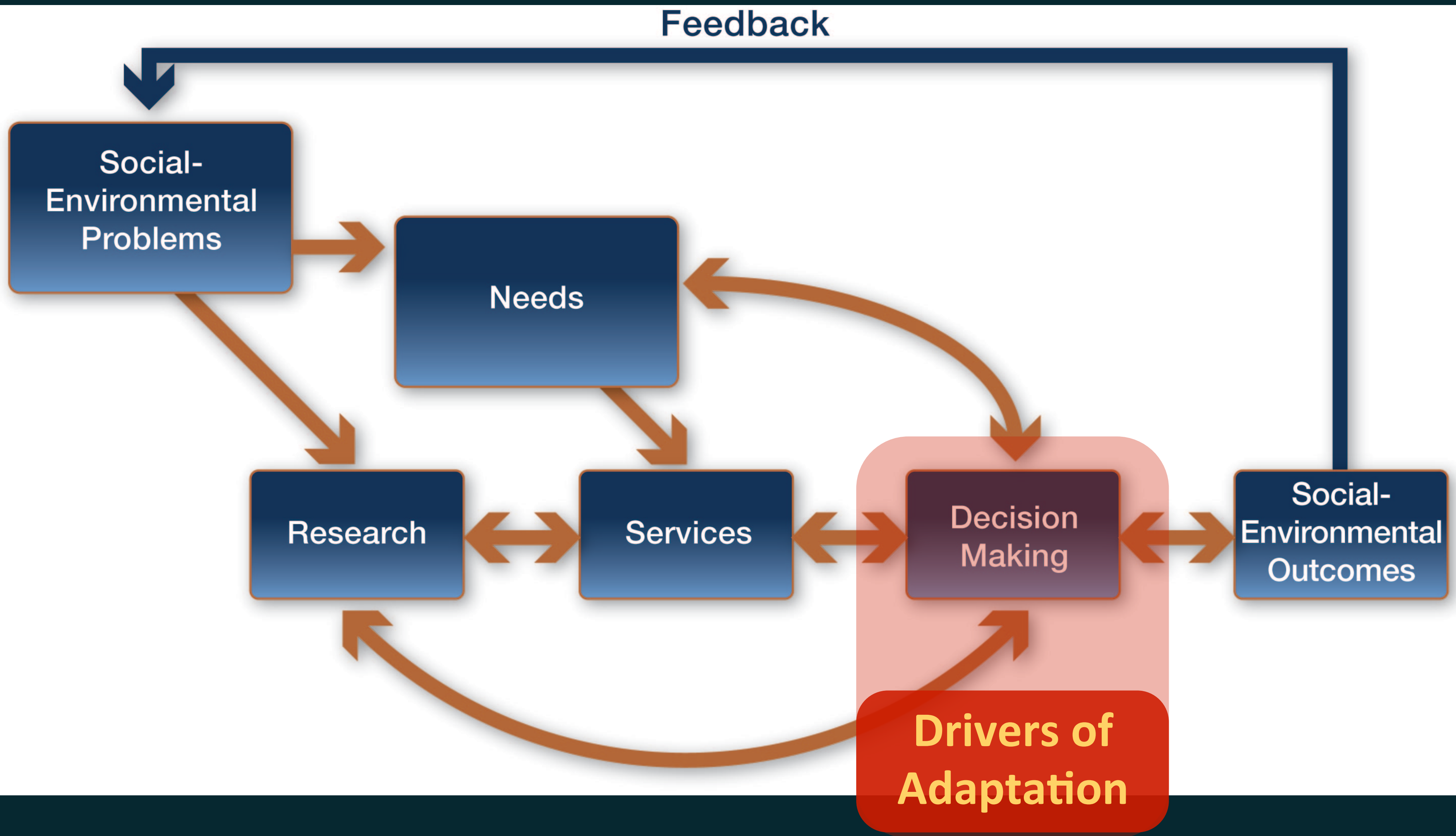
Ongoing and New Projects

Part 1


Feedback
Social-Environmental Problems
Needs
Research
Services
Decision Making
Social-Environmental Outcomes
Drivers of Adaptation

Drivers of Adaptation: Perceptions and responses to hazards by municipalities in Colorado, Wyoming and Utah

K. Andersson, L. Dilling

Purpose

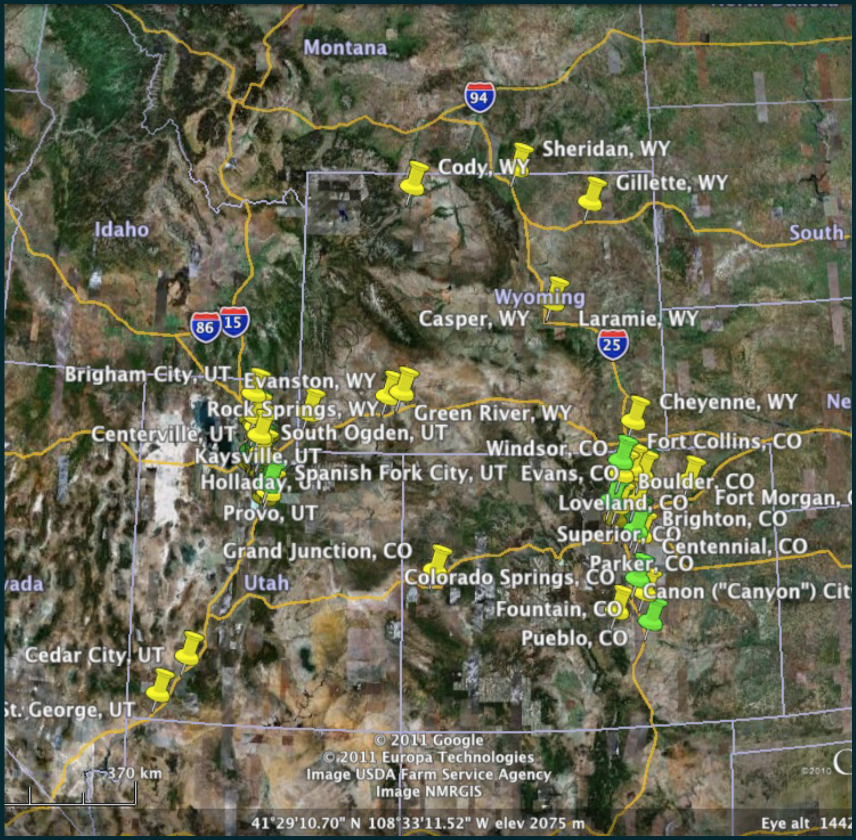
To understand what drives proactive community policy with respect to climate-related hazards

Research Question

Given a similar level of climate and weather-related exposure, why do some municipalities take action and others do not?

Research Design and Methods

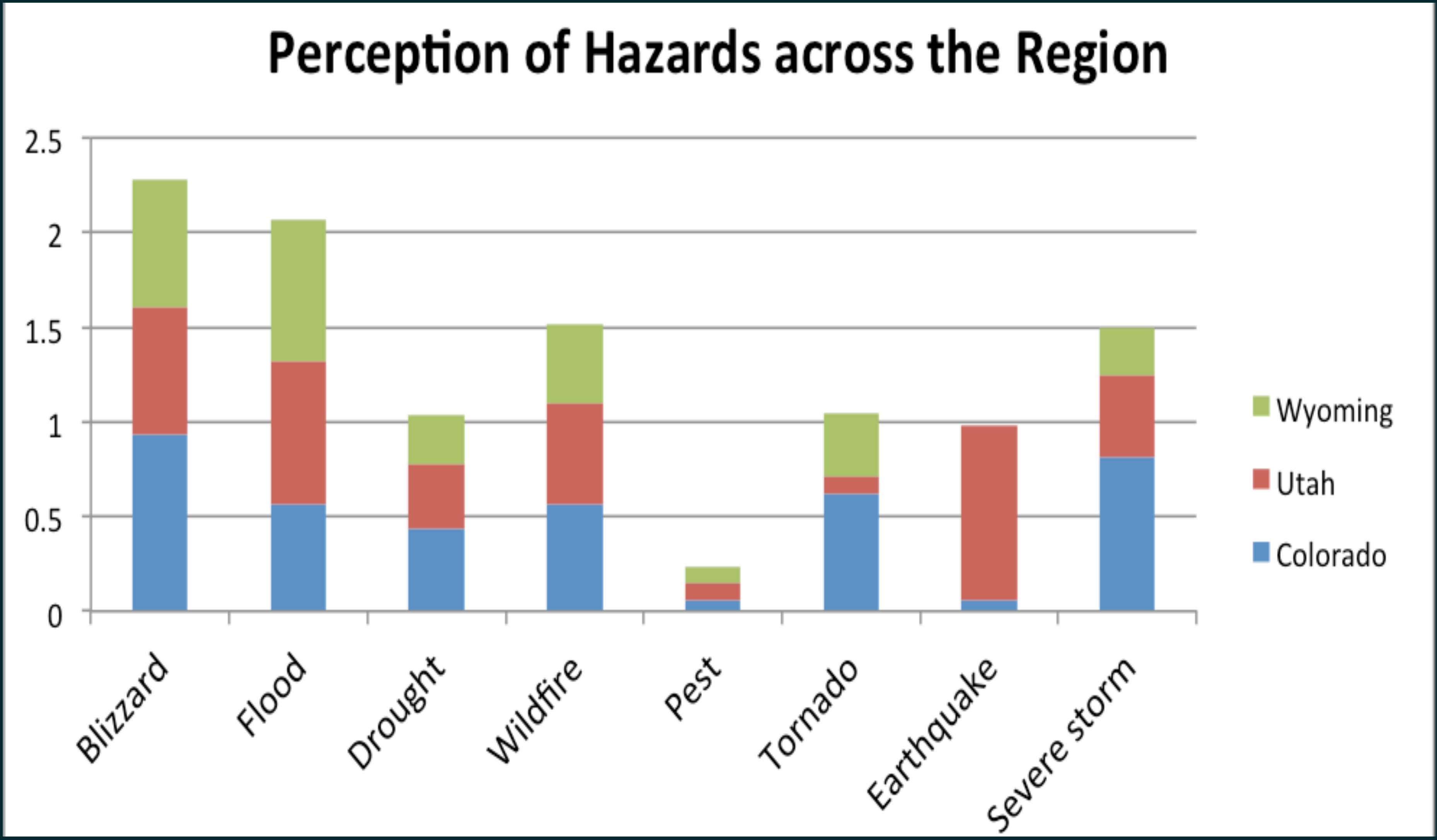
- Study Area: The U.S. states of Colorado, Wyoming and Colorado (our WWA RISA region)
- Unit of analysis: Municipal governments
- Selected 60 municipalities. All cities > 70K in population selected. Then a random selection of cities between 10K and 70K to obtain full sample of 60 cities.
- Second stage: Focus in on 3 comparative city pairs to formulate key hypotheses to test about the most important drivers
- Third stage: Test hypotheses with original 60 city data set



Suggested Measures of Adaptive Actions

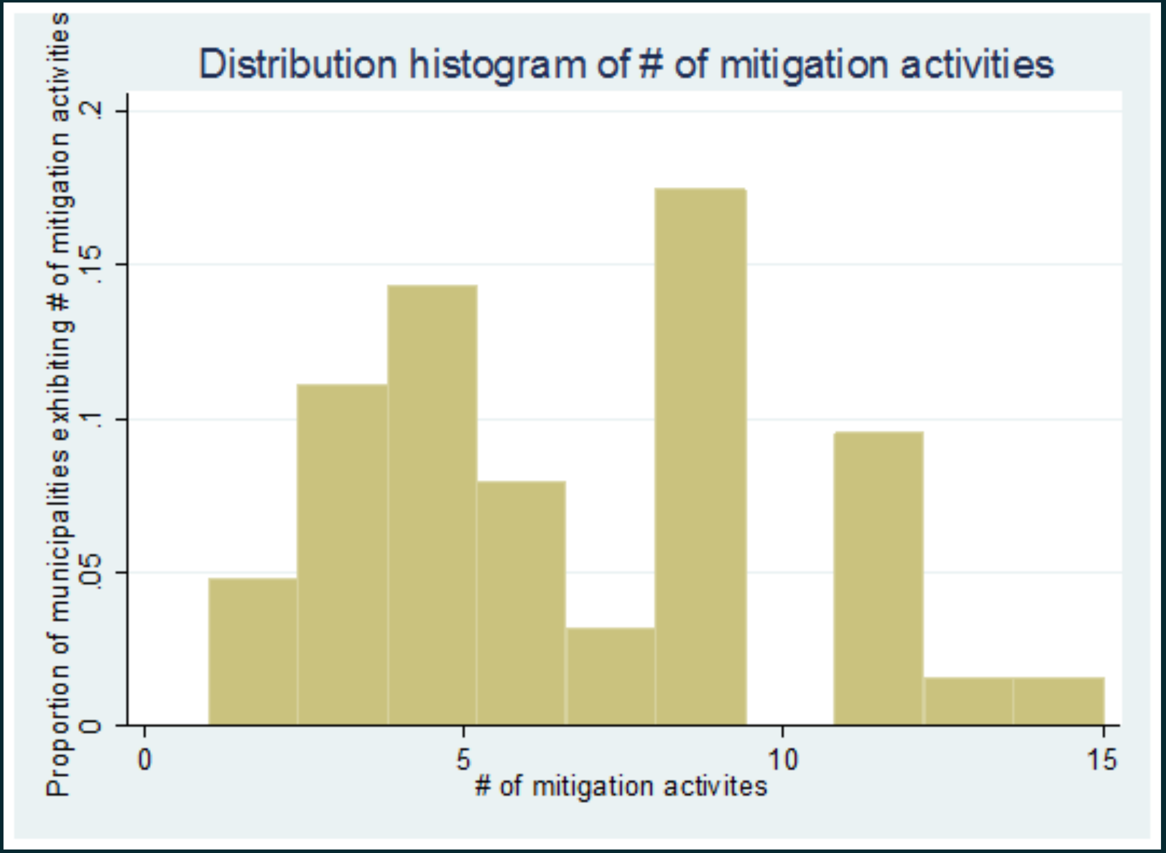
I. Ongoing mitigation/ risk reduction	II. Allocation of resources	III. Effort expended on emergency plan
Number of activities reported	Expanded departments	How recently was plan updated
Lessons learned from past hazards	Made new hires	How many staff-hours went into recent update
	Applied for new funding	How many people worked on recent update
	Acquired new technology or equipment	How many activities implemented from plan

Perception of serious hazards differs



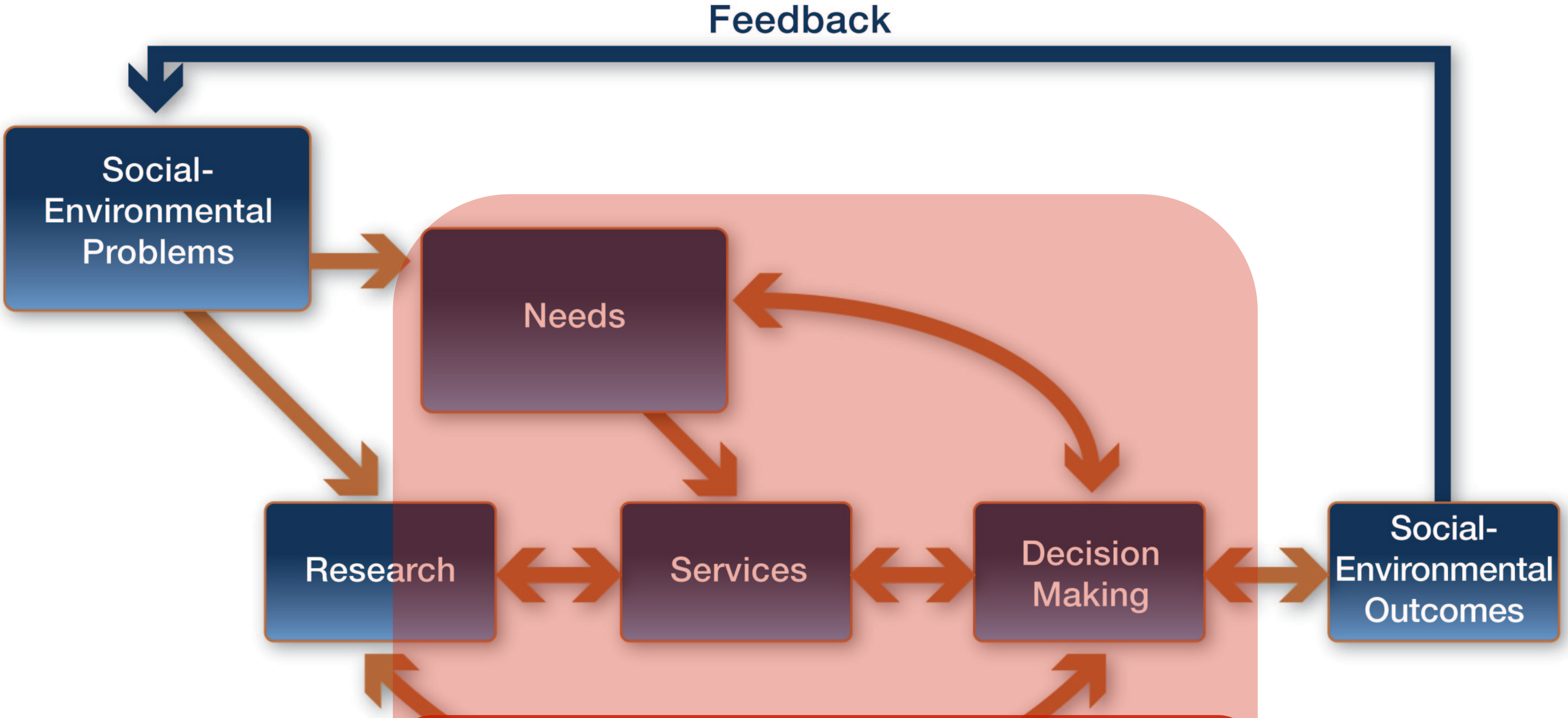
Measure I: Ongoing mitigation/risk reduction

- Considerable variation in responses across municipalities
- Considerable differences across states (Utah had significantly more activities than Colorado or Wyoming)



Other Measures

- Measure II: Allocation of Resources
  - Variation within states but not between states
  - Most measures not significant- only significant relationship was population and likelihood of making new hires
- Measure III:
  - State had strong influence on degree of confluence between municipal plan and county plan
  - High variation in both average time and human resource investment across municipalities



Analysis of Information Use by CBRFC Stakeholders

The Colorado Basin River Forecast Center and the Decision Making Process

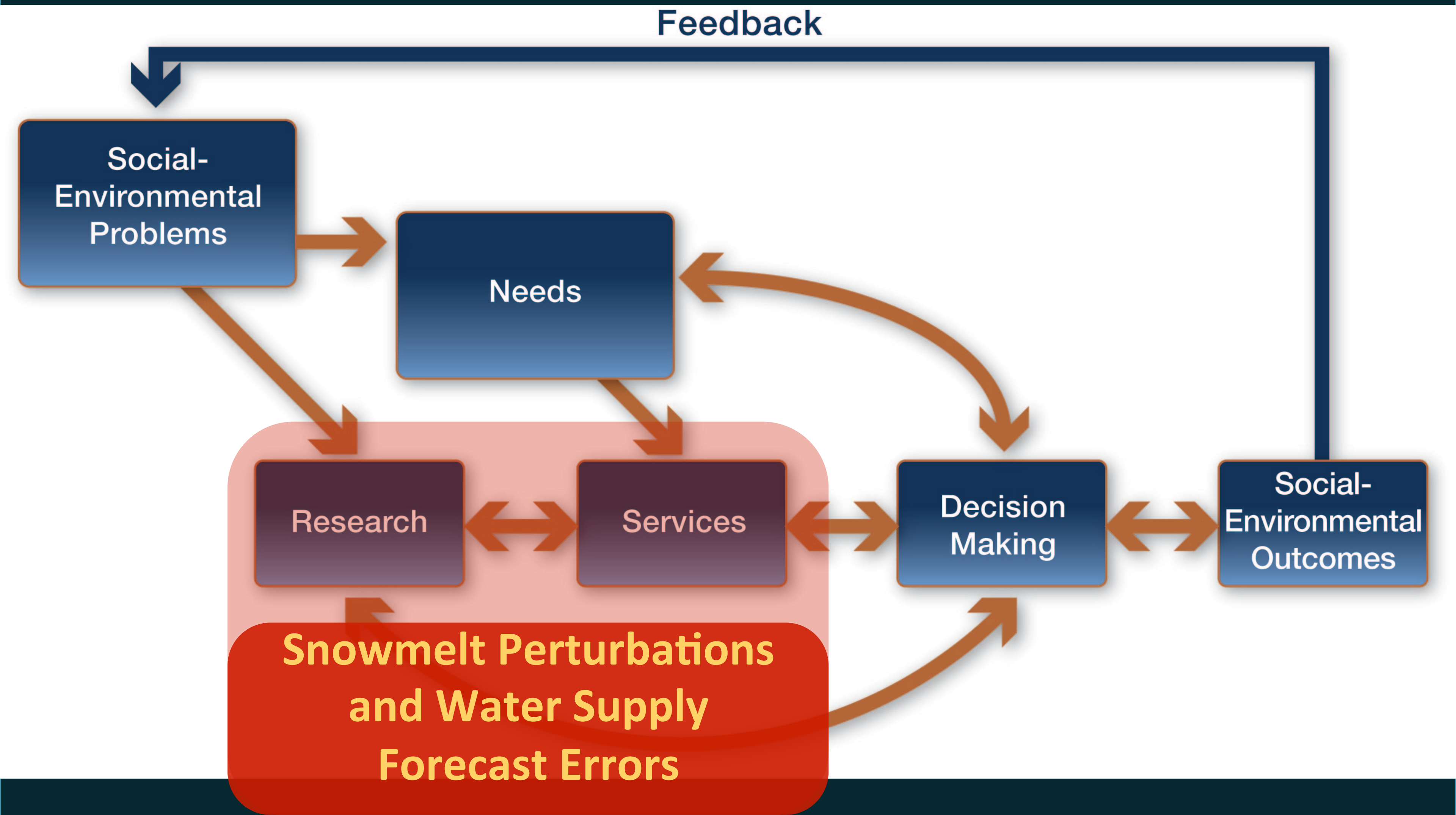
B. Klein and L. Dilling

NAS 2012 Report: "To accelerate the transition of new observational and prediction technologies into NWS hydrologic prediction activities, a clearer set of protocols and pathways for infusing research into operations is needed."

- Purpose:
  1. To understand how discoveries in snowmelt processes and forecasting can inform and translate into improved operational products for CBFRC
  2. To understand the decision needs, most important decision drivers and perceived vulnerabilities of CBFRC stakeholders

Approach and Progress

- Literature review on water managers' use of forecasts
  - Use tends to correlate with: higher capacity (size and personnel), surface water, perceived vulnerability from event experience, system flexibility and positive innovation experience
- Form linkages between snowmelt project, this project and CBFRC; ongoing study of CBFRC
- Conduct survey of CBFRC stakeholders


Feedback
Social-Environmental Problems
Needs
Research
Services
Decision Making
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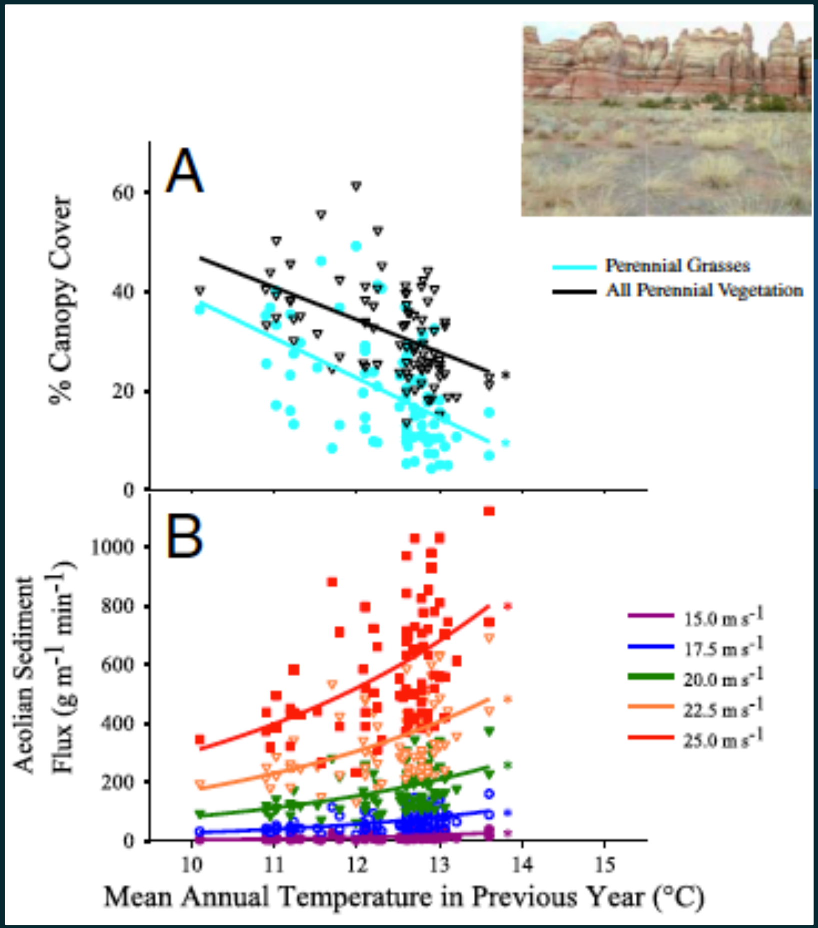
Snowmelt Perturbations and Water Supply Forecast Errors

Snow, Dust, Beetles, and Climate Change

J. Deems, N. Molotch, C. Wessman, J. Barsugli, K. Wolter, B. Livneh, T. Painter, B. Udall, J. Belnap, E. Gordon

Dust Emission Likely to Increase With Warming Climate



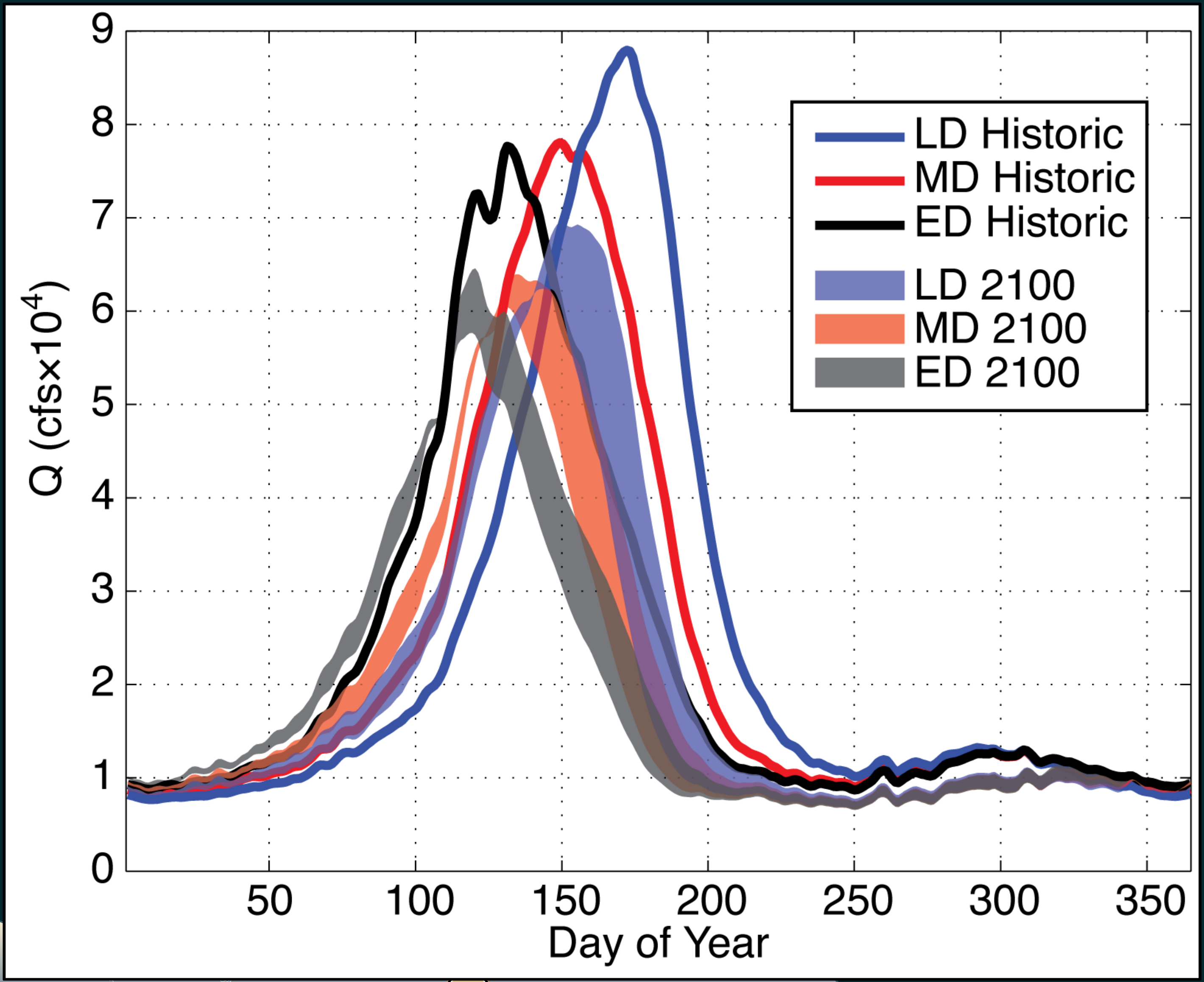
Munson et al. (*PNAS 2011*)

- ↑ temperature
- ↓ plant cover
- ↑ dust emission

How will warming temperatures & increased dust affect CO River runoff?

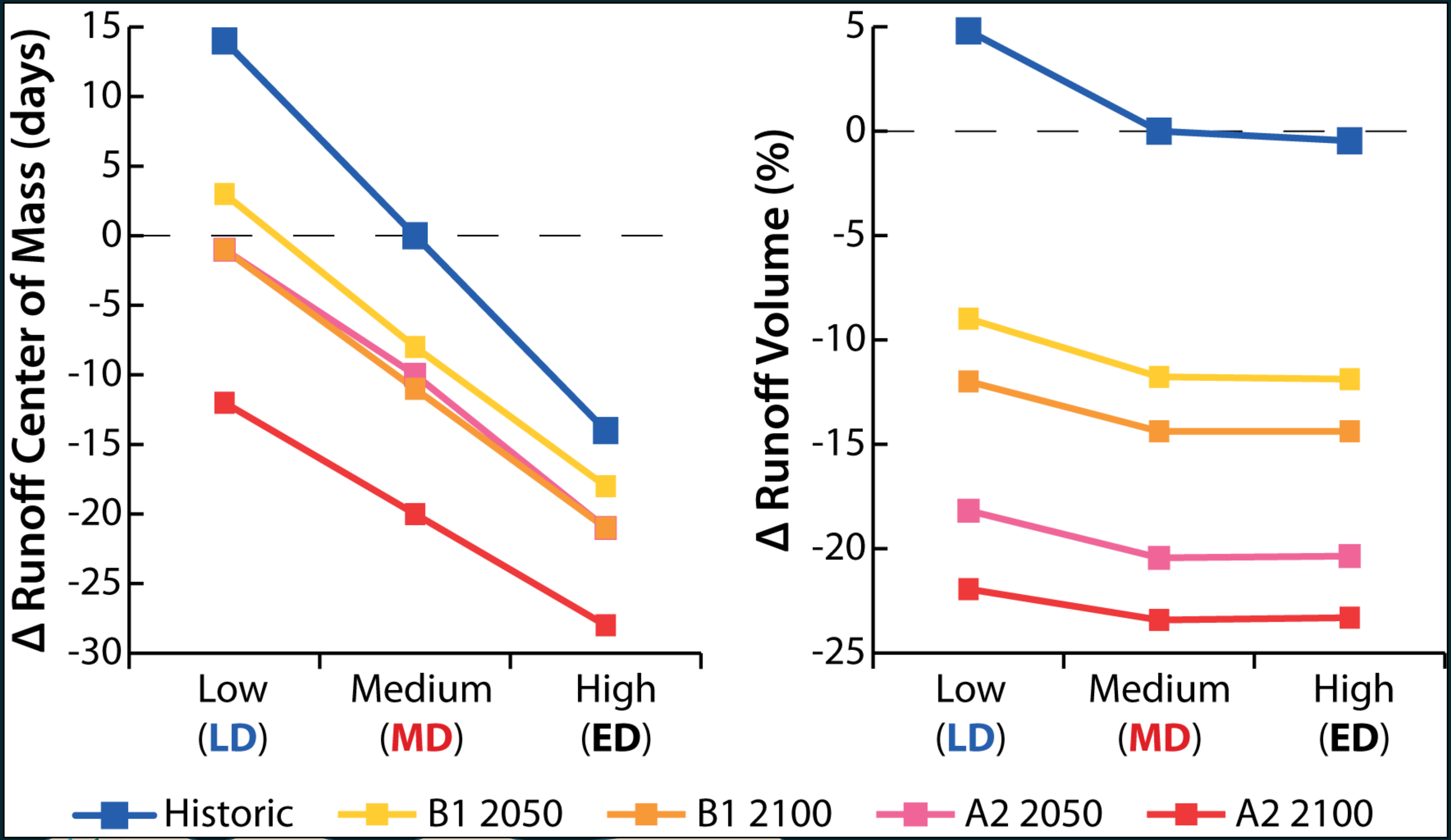
Corey Lawrence photo

More Dust & Warming = Earlier & Lower Runoff



from Deems *et al.* (*in prep*)

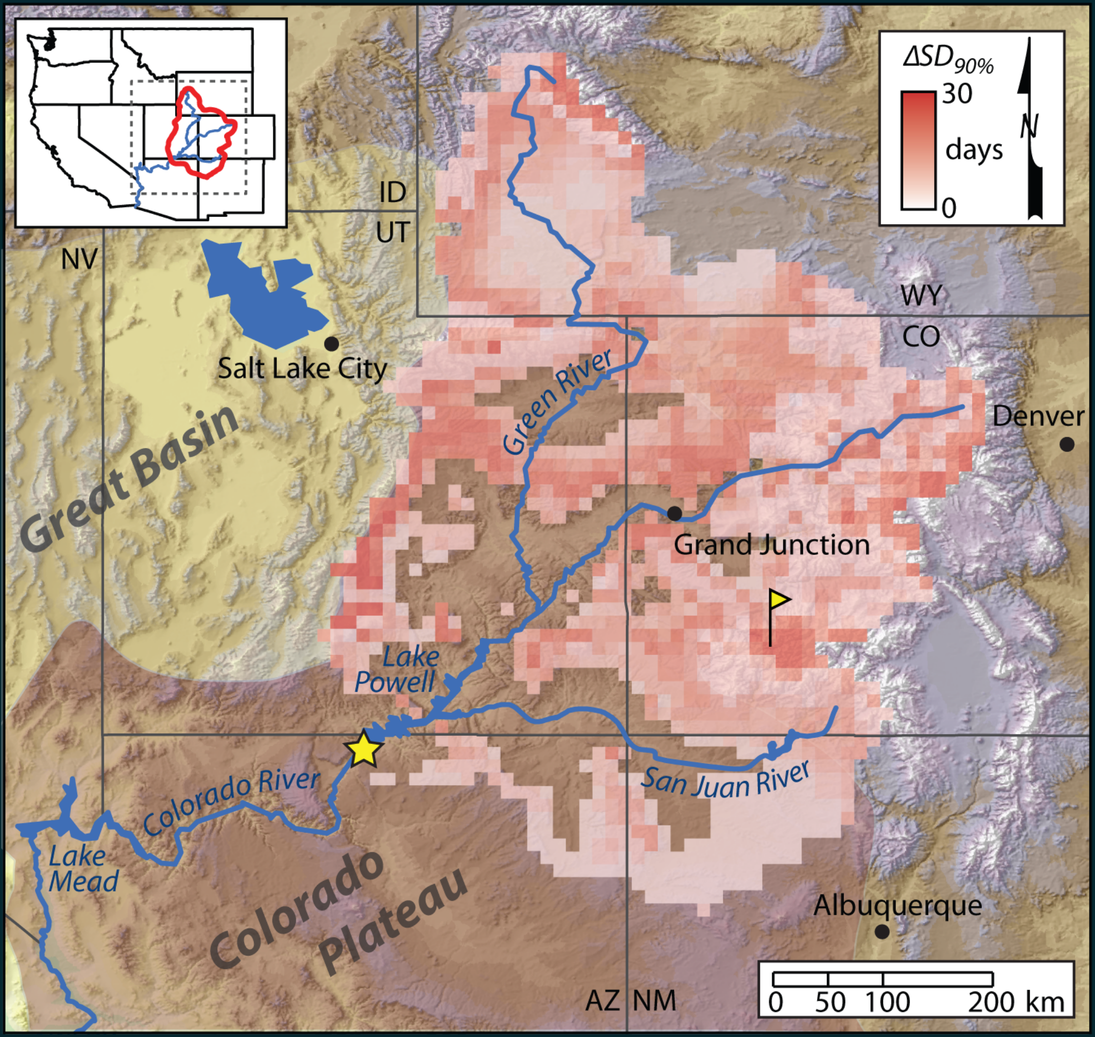
Runoff Sensitivity to Dust & Climate



from Deems *et al.* (*in prep*)

Dust Changes Melt-Out Dates Basin-Wide

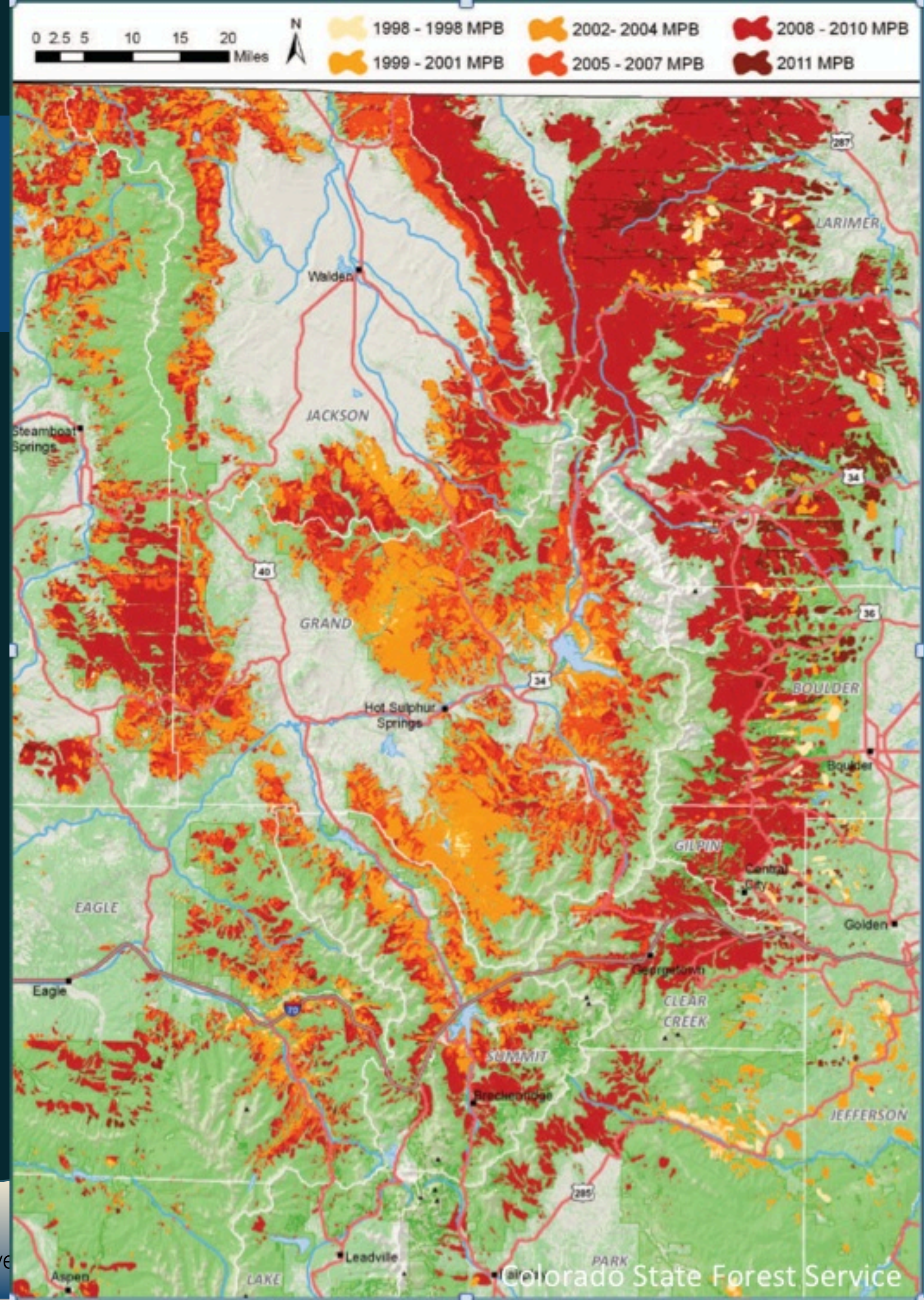
** Based on pre-2009 dust loading.*



Painter, Deems, *et al.*, *PNAS* (2010)

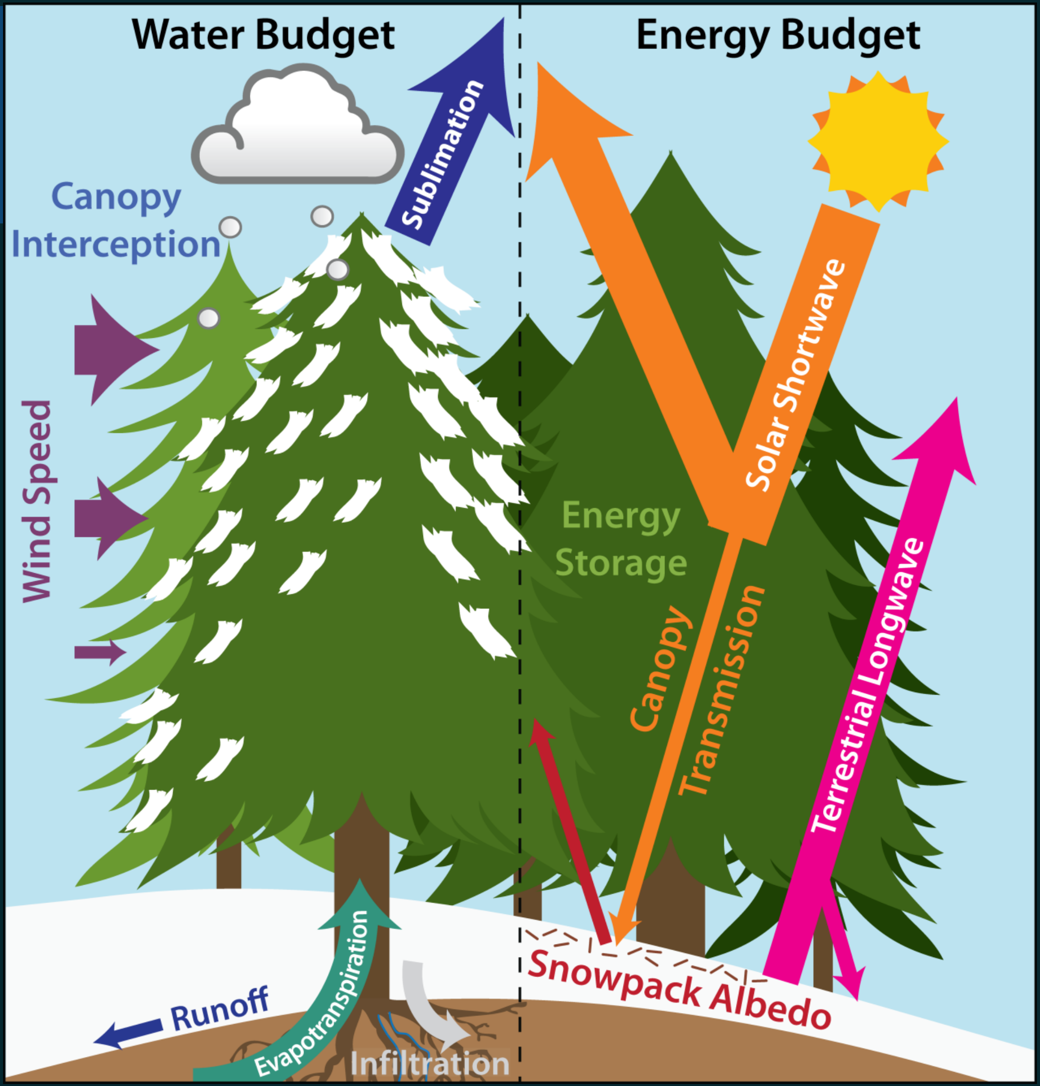
MPB Progression 1996-2011

- 4 million acres affected
- 400,000 new acres infested in 2010



Effects of Beetle Infestations

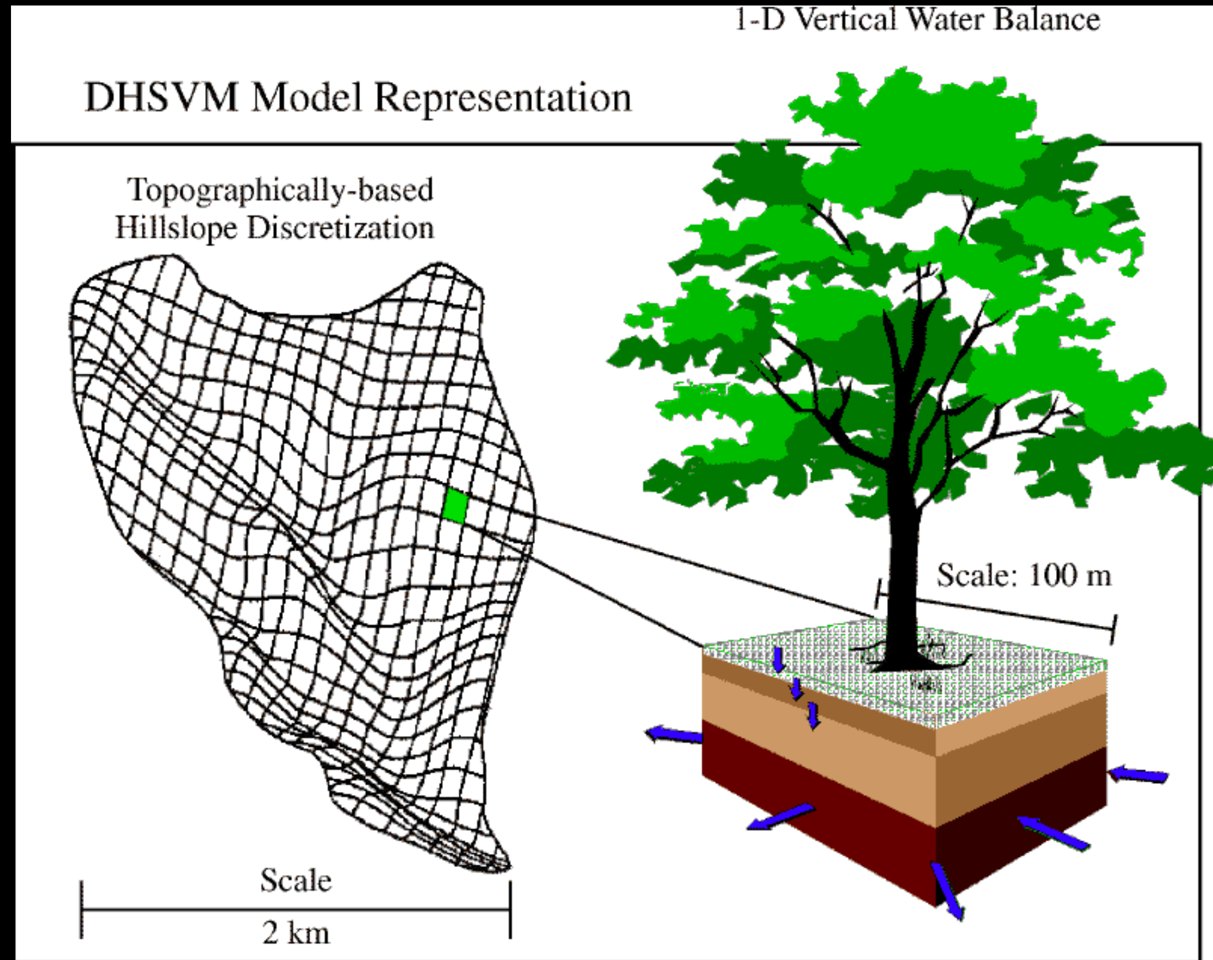
- Snow accumulation & melt
  - increased accumulation
  - reduced interception & sublimation
  - increased melt rates
- Tree water use
  - transpiration reduced/eliminated



Pugh & Gordon, *Hydrologic Processes* (2012)

DHSVM land surface hydrology model

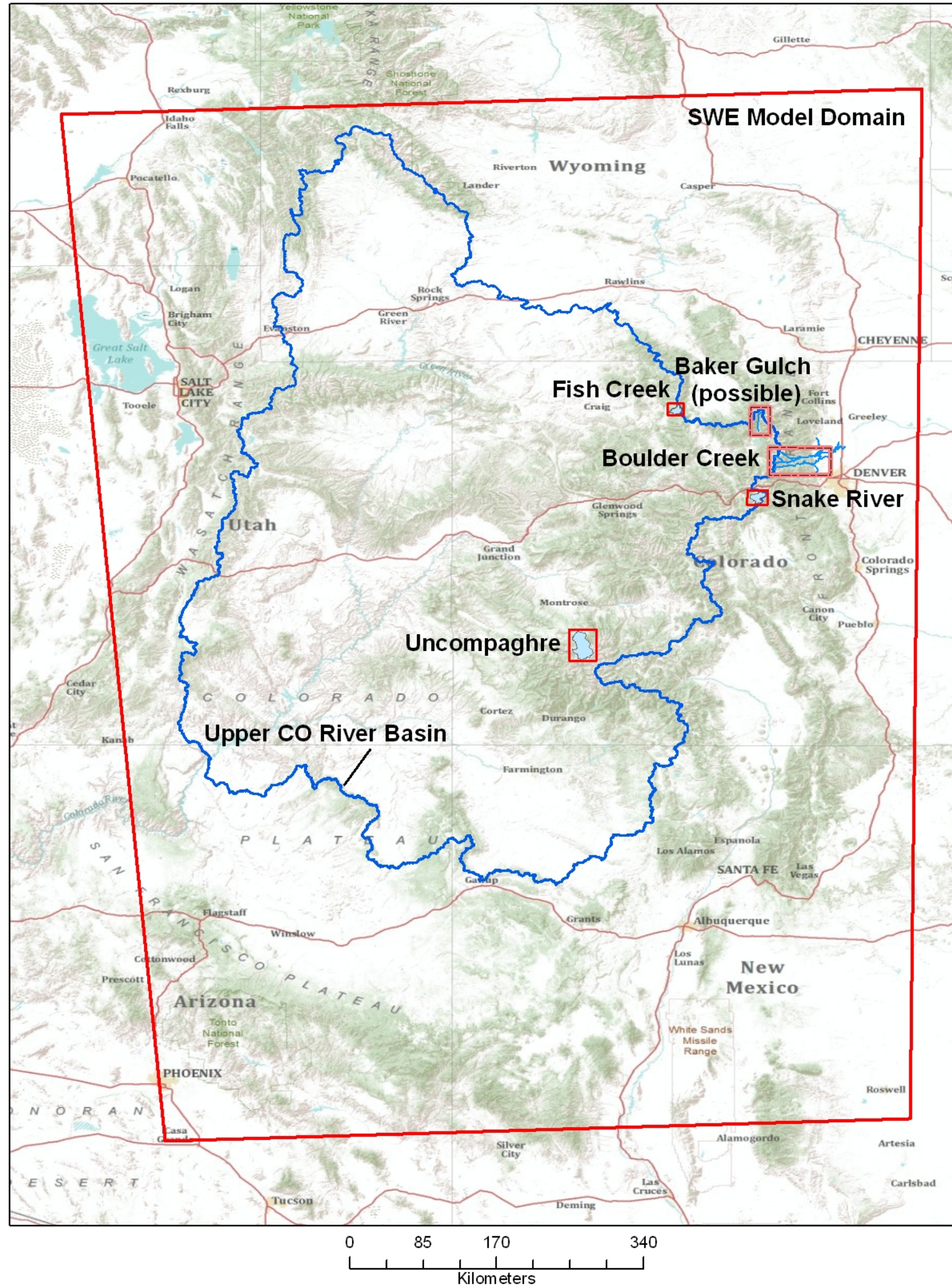
- Physically-based, distributed model
- Solves water & energy balance at each grid cell at each time step
- Integrated routing
- Horizontal scales typically 30 - 150m
- Designed for and used extensively in complex terrain



Details on DHSVM at:
http://www.hydro.washington.edu/

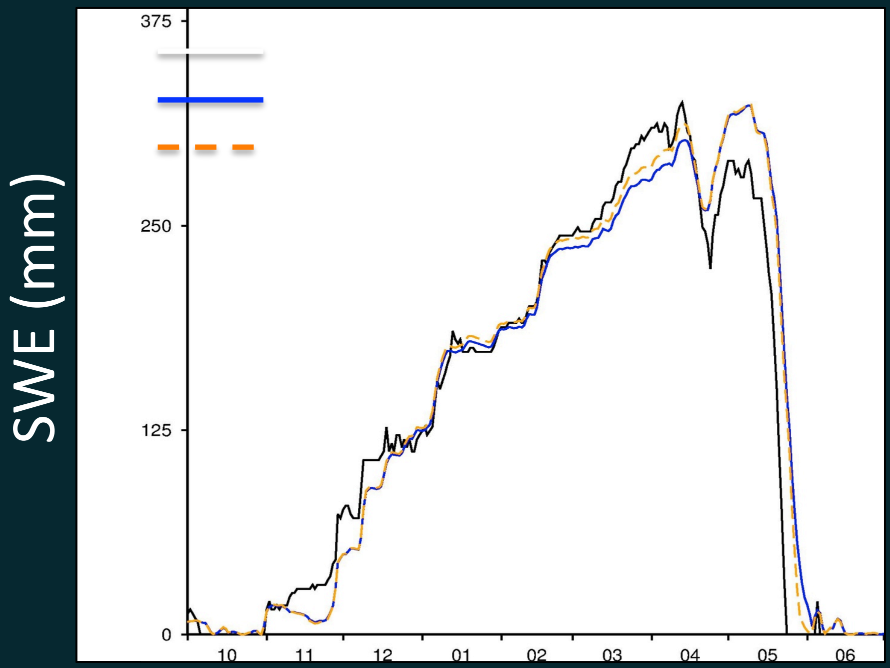
Study Basins

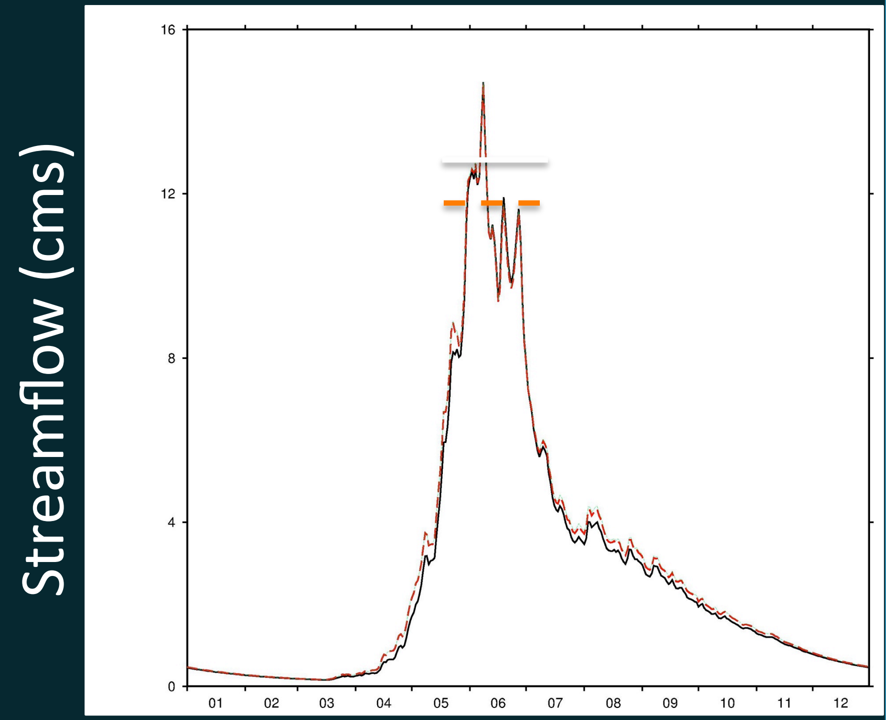
- Fish Creek, 67 km^2 (Yampa River Basin)
  - Storm Peak Lab
  - Zirkel studies / CLPX
- Snake River, 150 km^2 (Upper Colorado)
  - Denver Water
- Boulder Creek, 264 km^2 (Upper South Platte)
  - NWT / CZO
- Uncompaghre River, above Ridgeway Dam, 386 km^2 (Gunnison)
  - CSAS/SBB



Preliminary model sensitivity tests

Grizzly Peak SNOTEL SWE (3833m)





A reduction in LAI similar to field observations produces:

- increased late season SWE
- increased shoulder season runoff

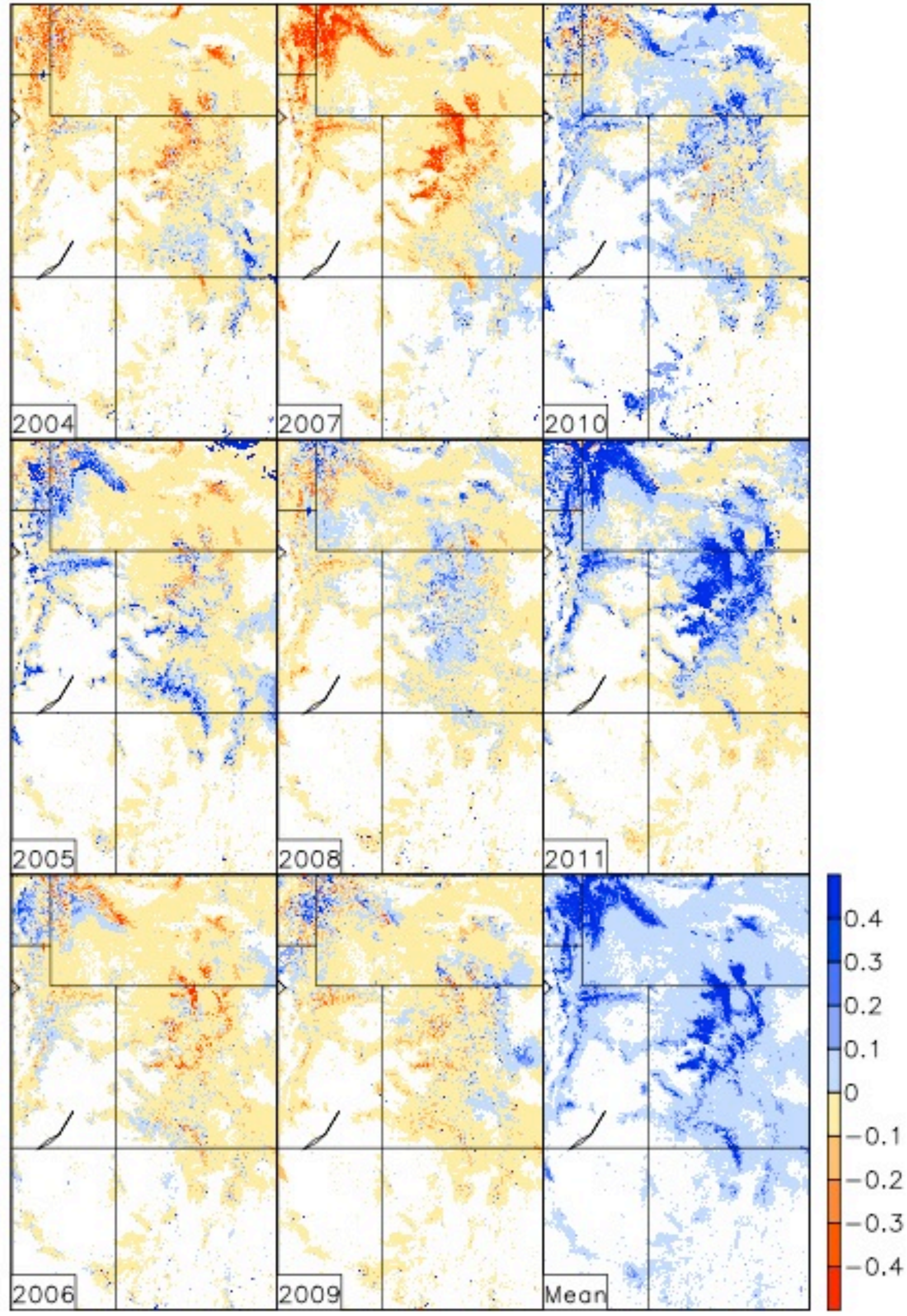
Snake R. Normalized Streamflow :

Daily average WY 2000-2011

SWE Anomaly Time Series

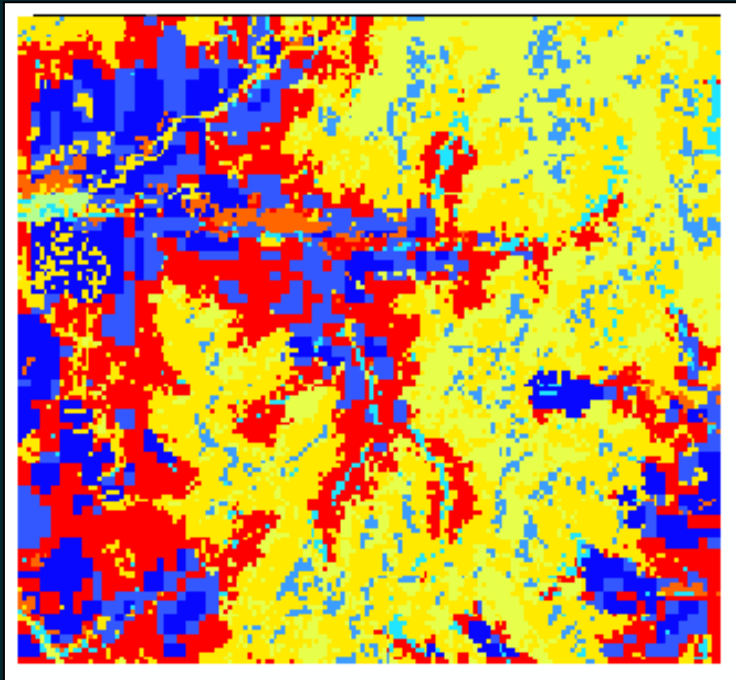
- Using Molotch SWE reconstruction method will allow:
  - assessment of SWE simulations
  - alternative spatial precipitation estimation

courtesy Noah Molotch



MODIS Forest Phenology Products

5 beetle kill classes



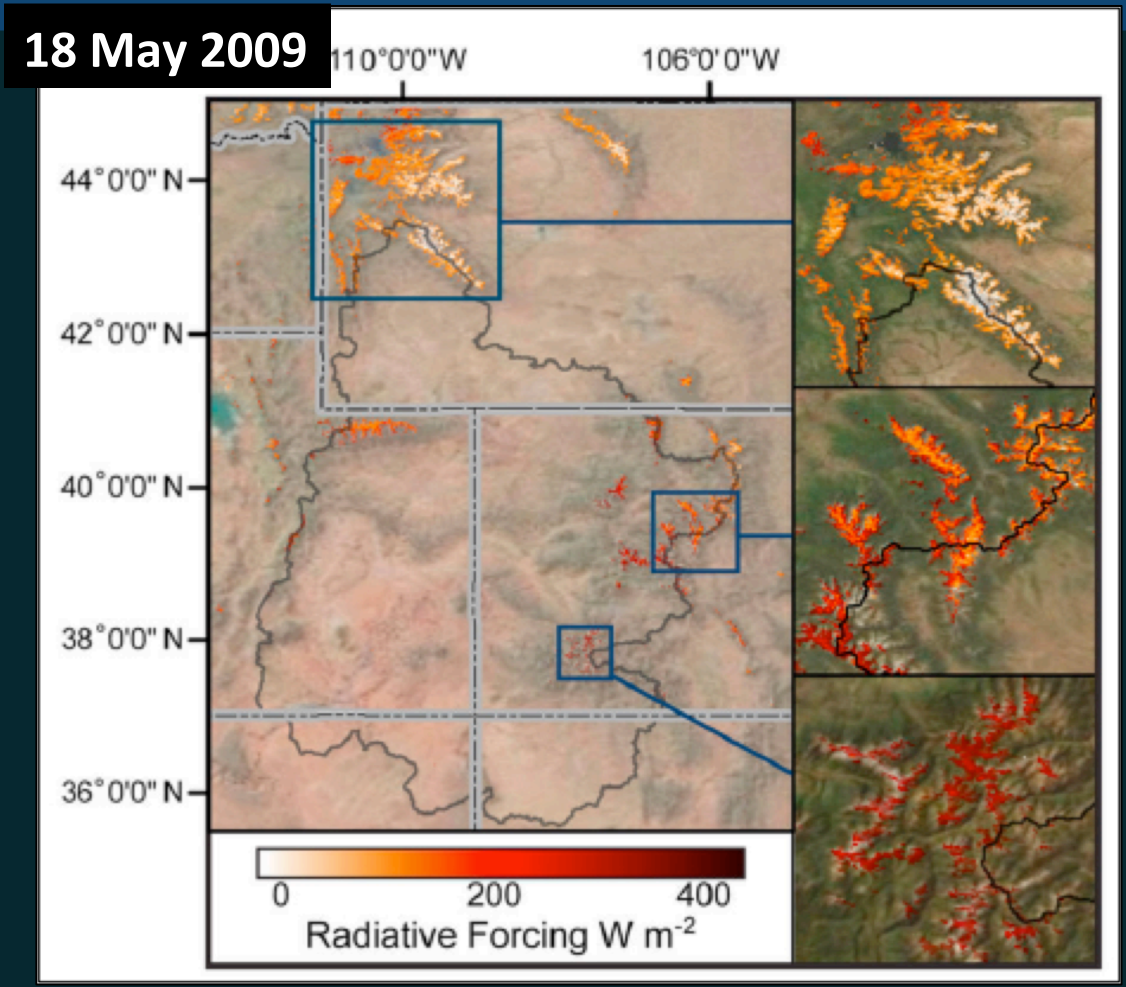
Trees killed per acre

courtesy Brian Buma

- MODIS reflectance product used to:
  - estimate beetle-kill density
  - produce time series of MPB impact maps
- Will allow:
  - spatially explicit representation of vegetation change
  - time series simulation of MPB hydrologic impact

MODIS Dust Radiative Forcing Product

- Retrieval of snow radiative forcing due to impurities
- Will allow:
  - modeling with spatially variable snow albedo
  - assessment of dust RF importance in several basins



Painter, T. H., A. C. Bryant, and S. M. Skiles (2012), Radiative forcing by light absorbing impurities in snow from MODIS surface reflectance data, *Geophysical Research Letters*, 39(17)

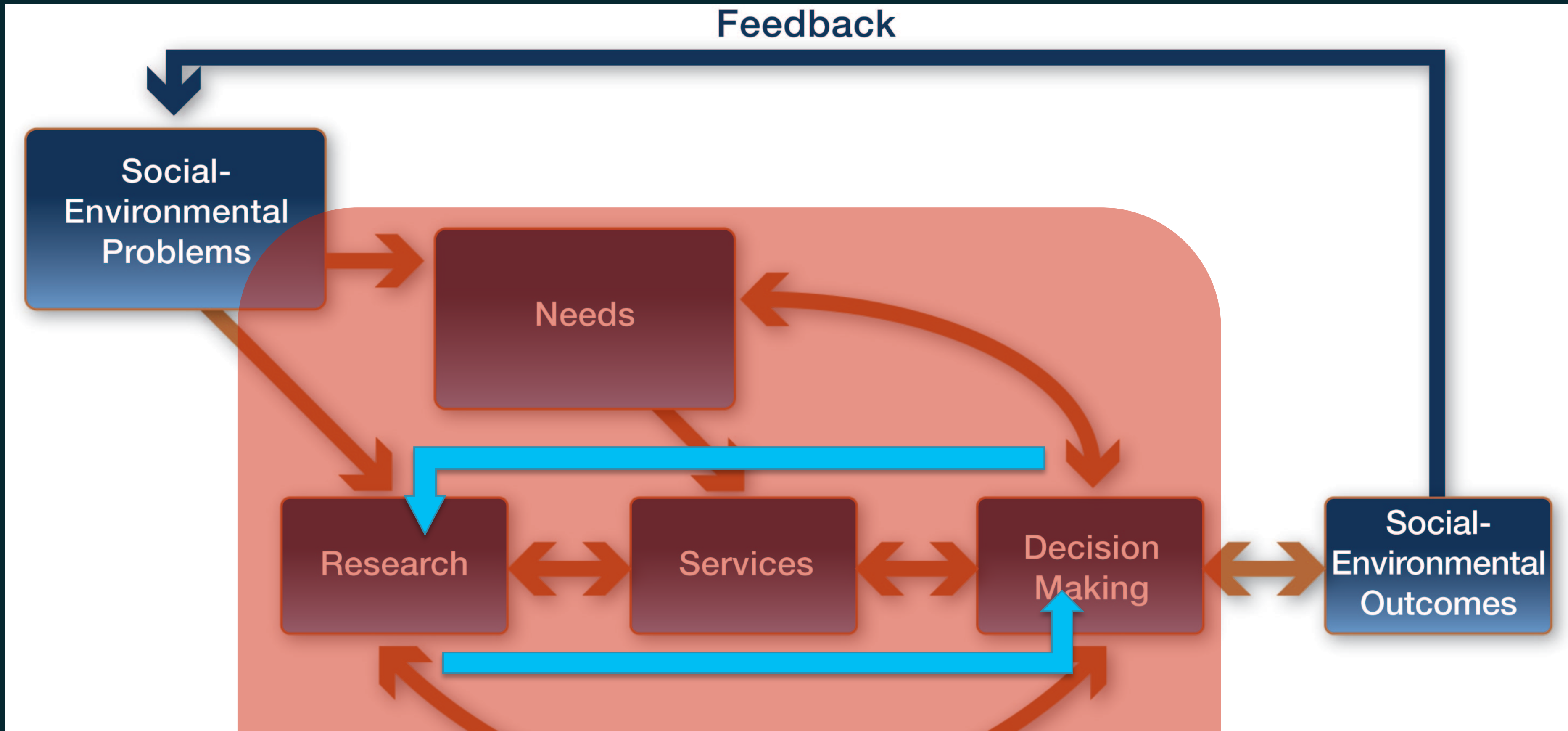
Snow, Dust, Beetles and Climate Change

Next Steps

- Finish MPB sensitivities
- Snow albedo
- Combined MPB & snow albedo
- Incorporate SWE reconstructions
- Forest change time series

Snow pit, San Juan Mountains, March 2009. Courtesy Chris Landry, CSAS.

Building Climate Science into Conservation Planning: Inter-RISA WWA-CLIMAS-TNC Project



Intra-RISA Project (WWA-CLIMAS-TNC):
Build a better bridge between climate science and conservation science

Building Climate Science into Conservation Planning: Intra-RISA WWA-CLIMAS-TNC Project

Bear River Basin, *Utah, Wyoming, Idaho*

- Bonneville cutthroat trout *(Oncorhynchus clarki utah)*
- Abandoned oxbow wetlands

Four Forest Restoration Initiative (4FRI) *Arizona*

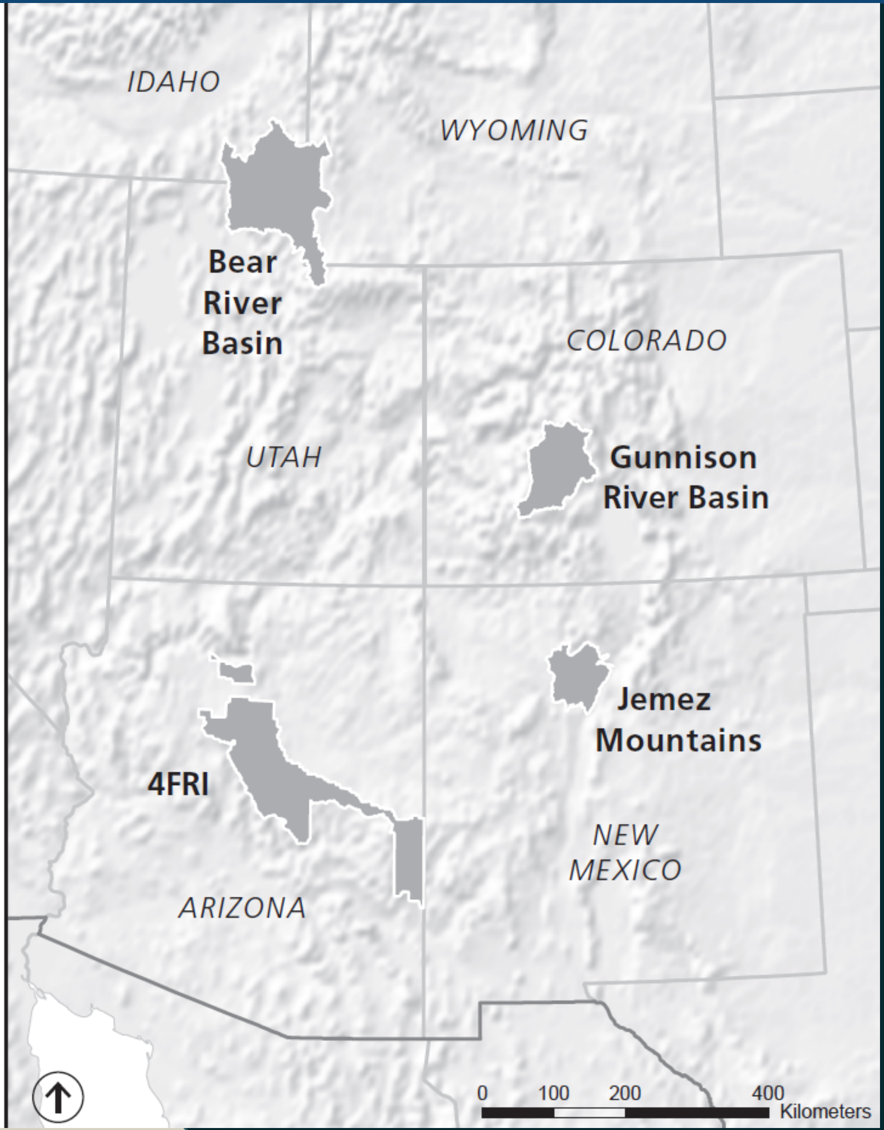
- Mexican spotted owl *(Strix occidentalis lucida)*
- Ponderosa pine *(Pinus ponderosa) forest* fire regime
- Ponderosa pine forest watershed function

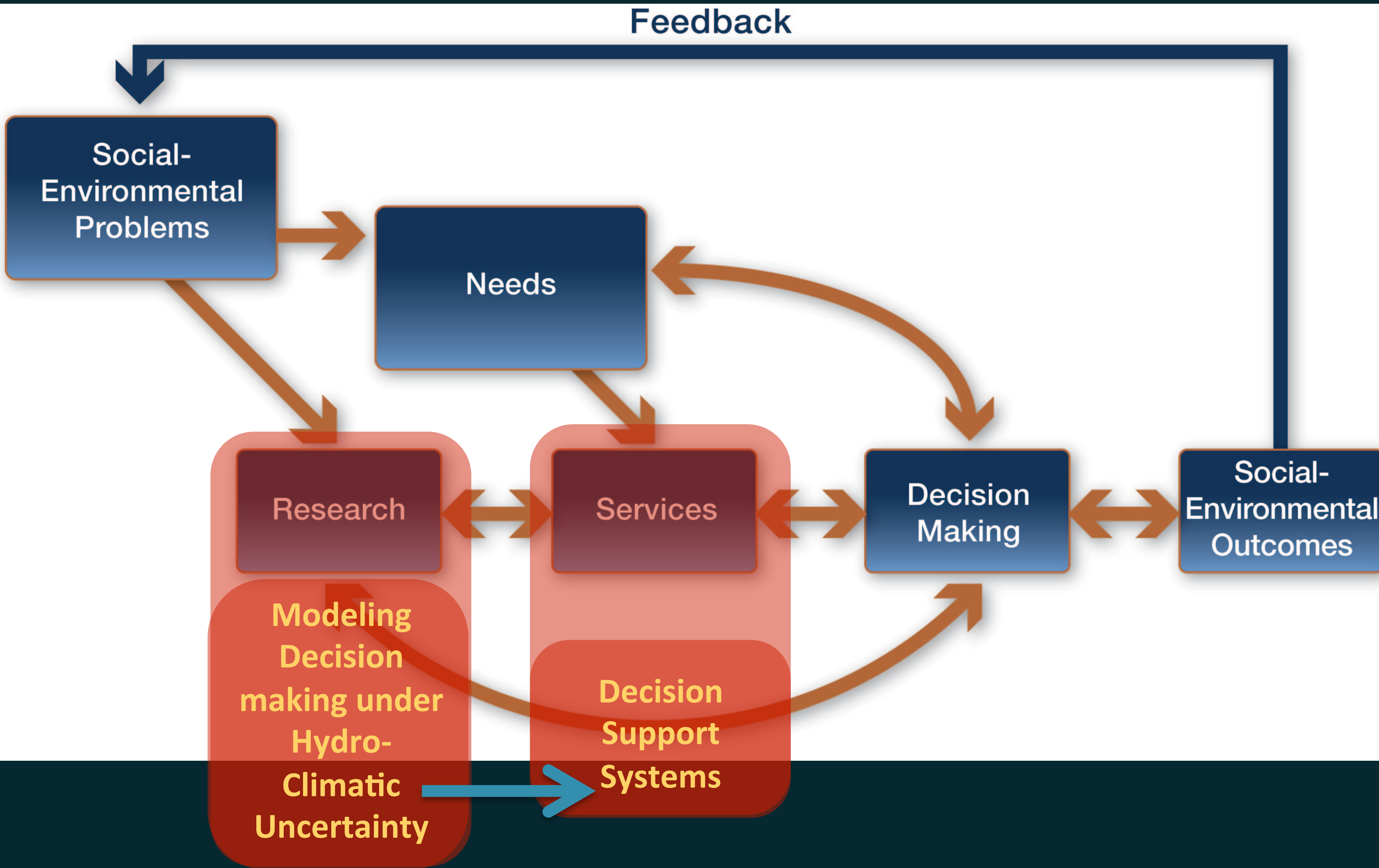
Jemez Mountains, *New Mexico*

- Natural stream flow regime
- Natural fire regime

Gunnison River Basin, *Colorado*

- Gunnison sage-grouse *(Centrocercus minimus)*
- Alpine wetlands
- Natural hydrologic function

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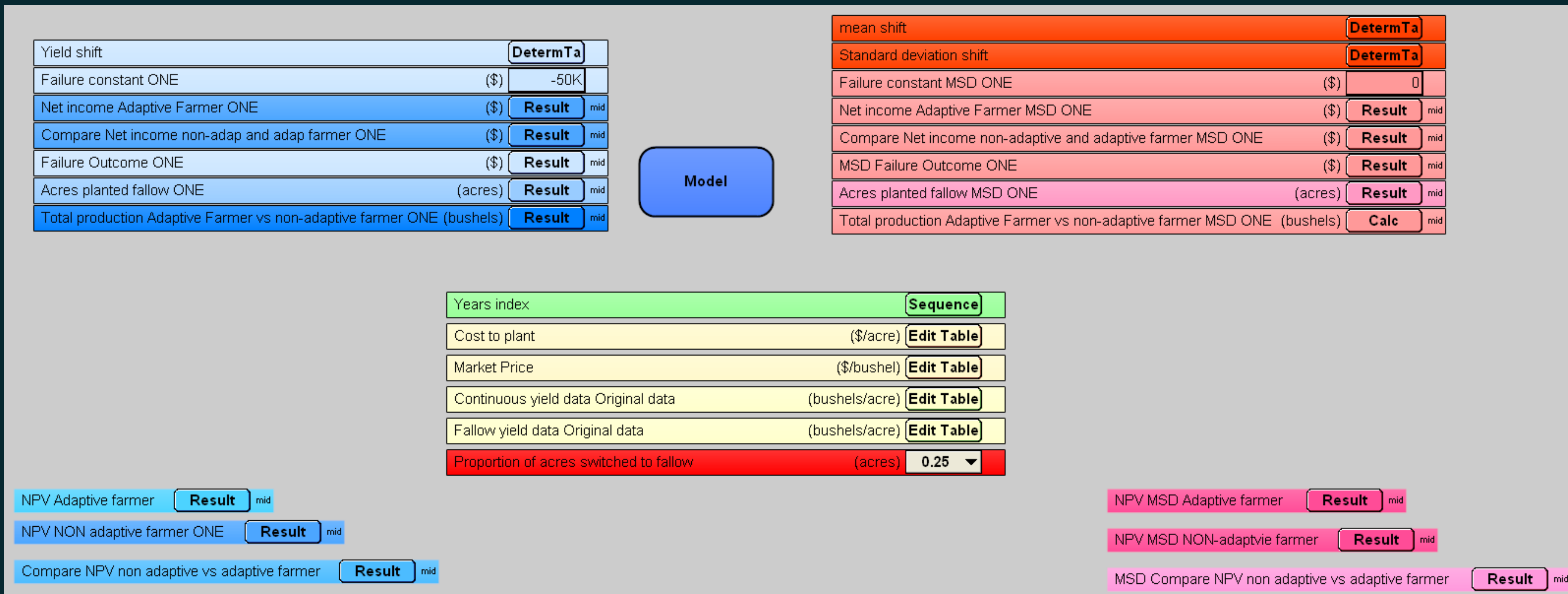
Modeling Decision making under Hydro-Climatic Uncertainty
Decision Support Systems

Decision Making Under Hydro-Climatological Uncertainty

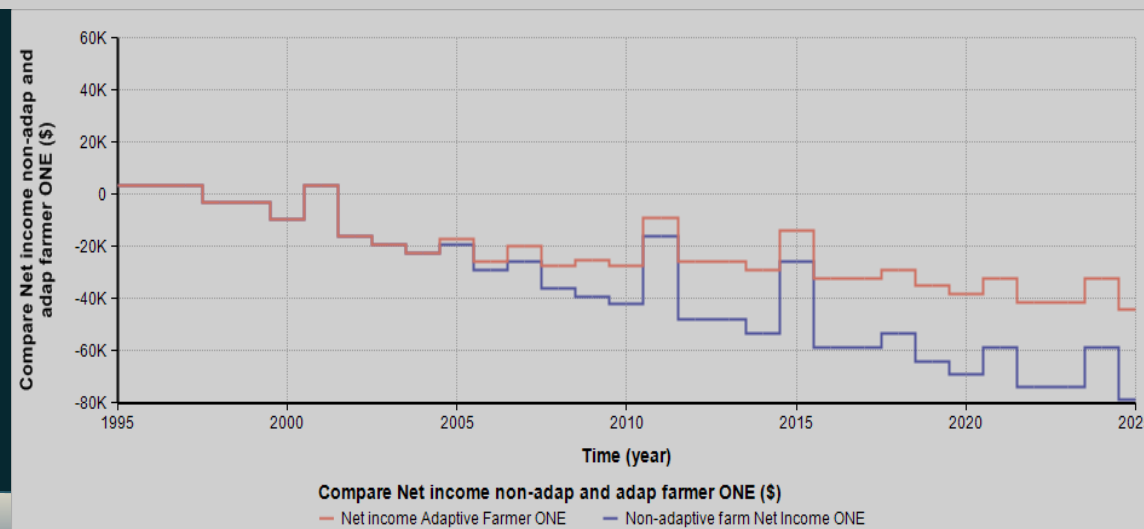
W. Travis, M. Huisenga

- Decision-Analysis modeling for both research and decision-support
  - Great Plains dryland wheat farm facing climate worsening and deciding when to adapt cropping methods
  - Rocky Mountain cattle ranch in drought and deciding whether to cull heard now or wait and see if drought continues into second year

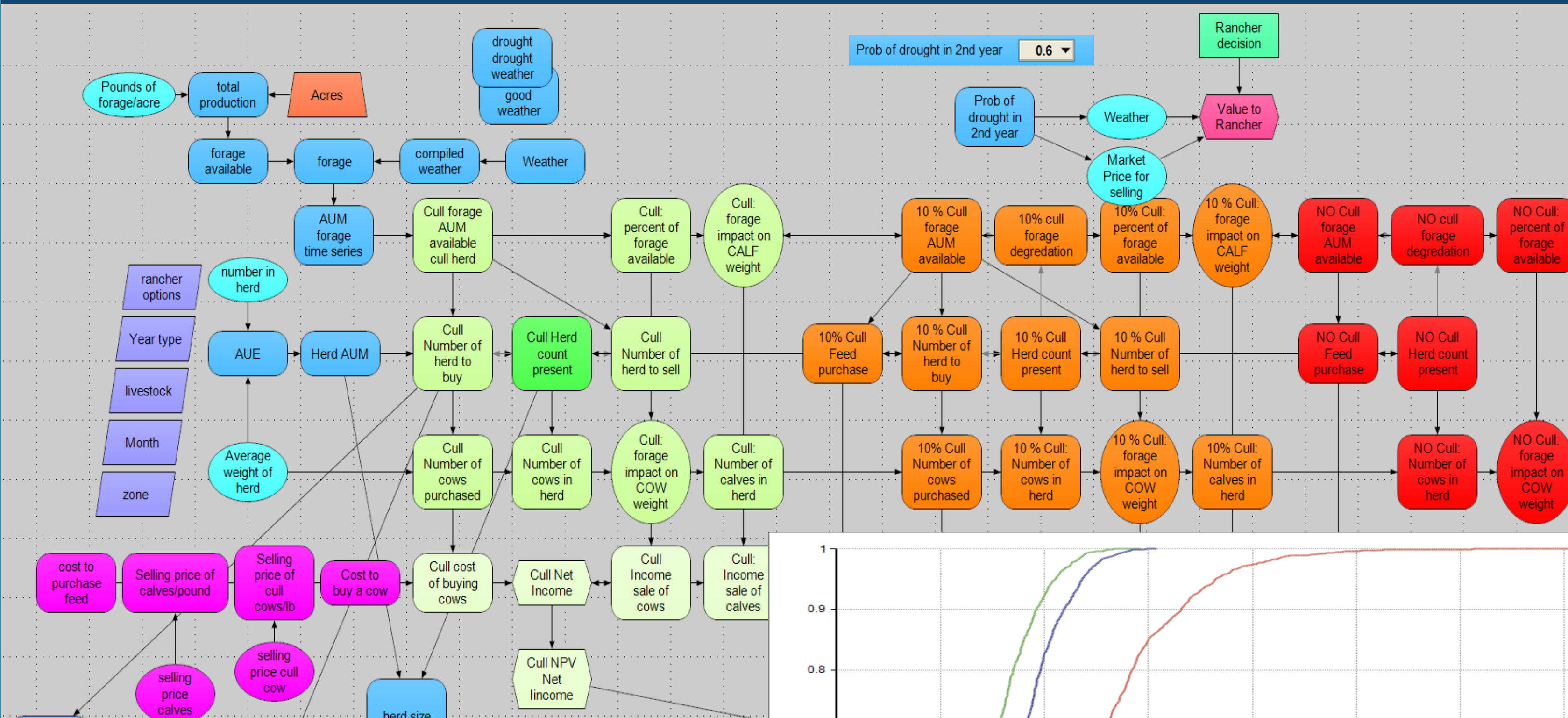
Decision-Making Under Hydro-Climate Uncertainty

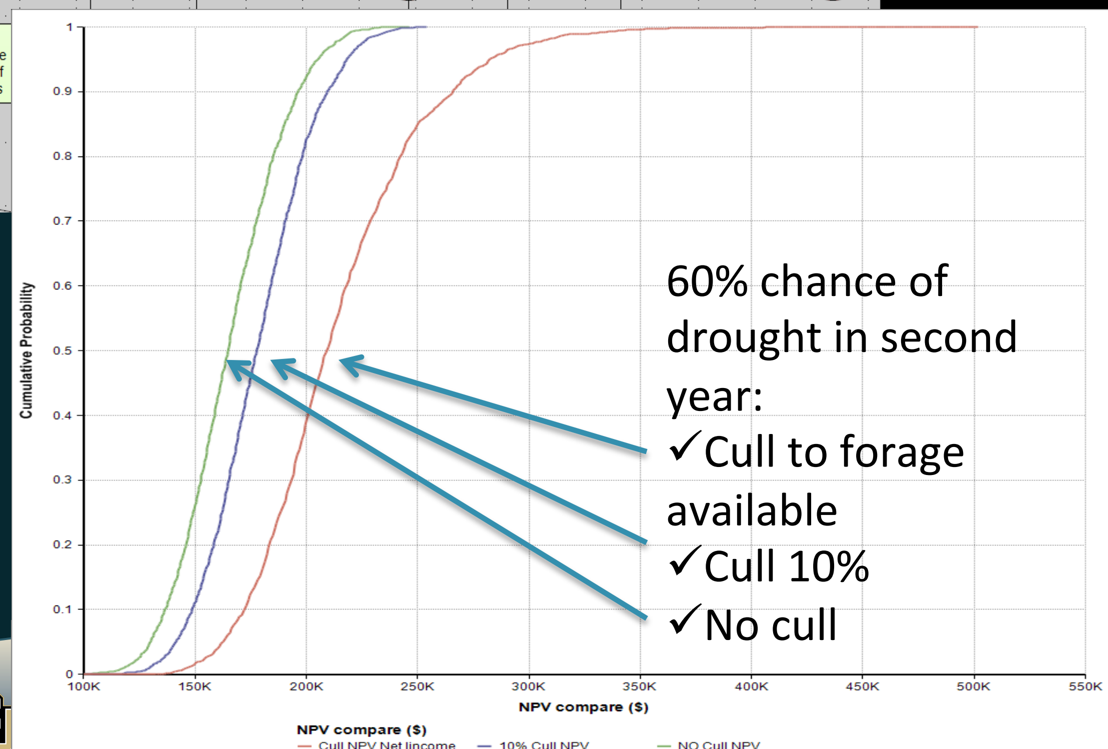


Compare adaptive vs. non-adaptive farmer net incomes, and test for timing and pace of adaptation



Decision Making Under Hydro-Climatological Uncertainty





Model rancher decision-making under hydro-climatological uncertainty: Cull heard now? Will drought repeat next year?

CIRES Western Water Assessment