WESTERN WATER ASSESSMENT
A NOAA RISA TEAM

CIRES

University of Colorado **Boulder**

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Finding New Ground for Advancing Hydro-Climatic Information Use Among Small Water Systems

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Acknowledgements

Principle Investigators:
CU Boulder: Ben Livneh, Lisa Dilling, Jeff Lukas, Bill Travis
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Colorado Climate Center: Nolan Doesken

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Motivation

Photo Credit: University Corporation for Atmospheric Research, National Weather Service Drought Webpage.

Project Goal:

to contribute in depth empirical descriptions of the ***information use practices, preferences****, and* ***institutional context*** *of small scale water systems*

Photo credit: Sierra Club

3 Components:

1. Factors that motivate or constrain managers to change the way they use information

2. Managers' existing knowledge networks and information sources

3. Factors related to dissemination that influence adoption

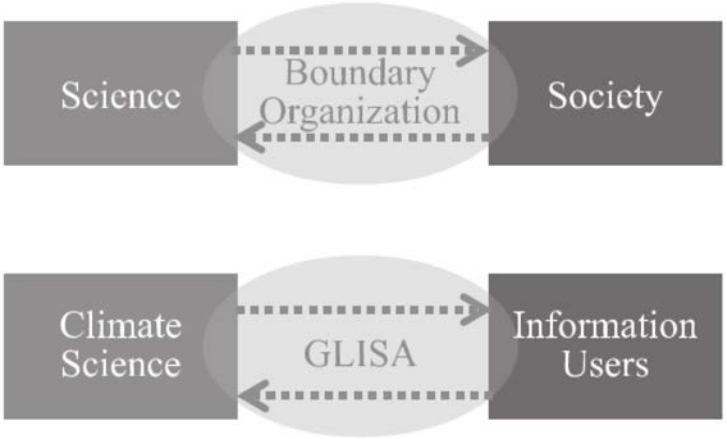
What Drives Information Use Among Water Managers?


Photo credit: wikimedia commons

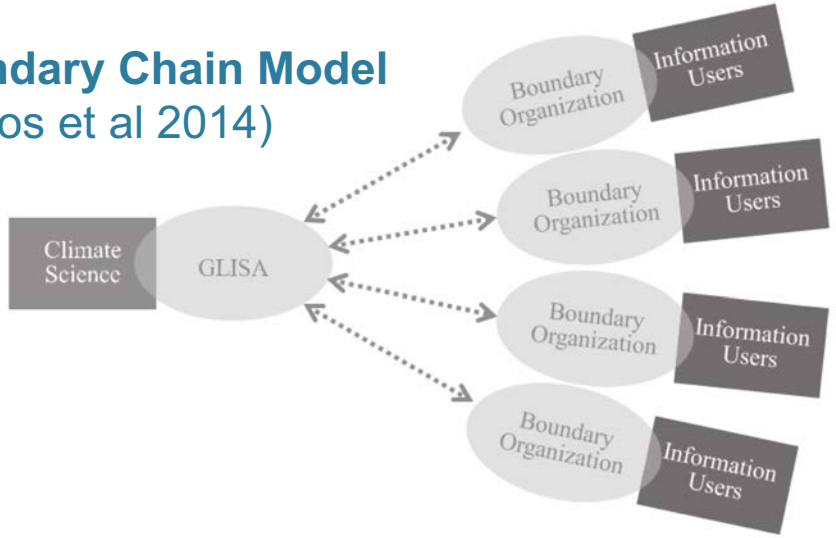

Photo credit:KNNF.org


Photo credit: The Nature Conservancy

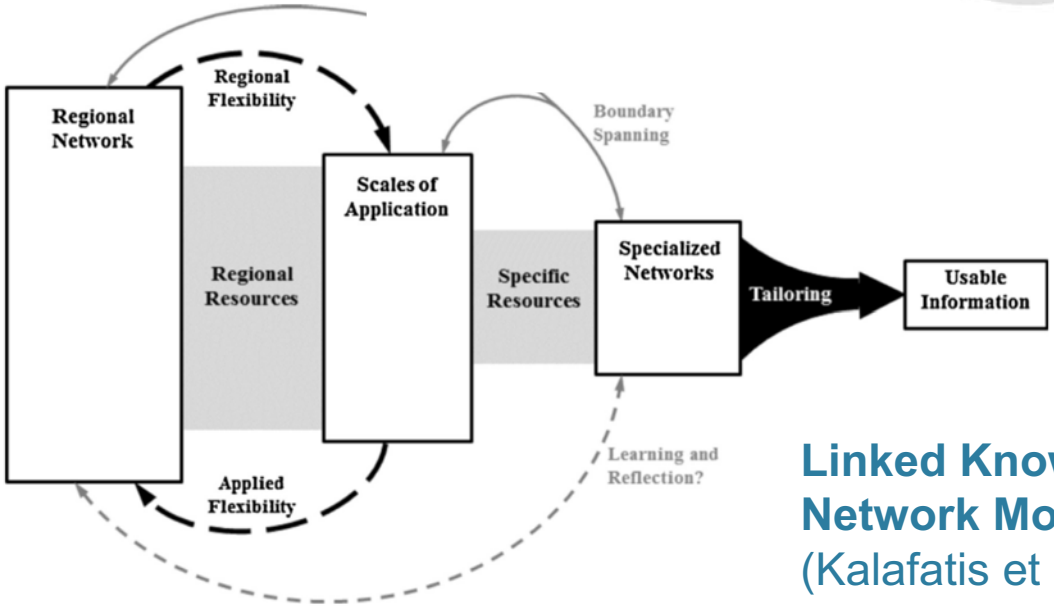
Strategies for Advancing Information Adoption



Traditional Boundary Organization Model
(Lemos et al 2014)



Boundary Chain Model
(Lemos et al 2014)



Linked Knowledge Network Model
(Kalafatis et al 2015)

Diffusion of Innovation
(Rogers 1995)

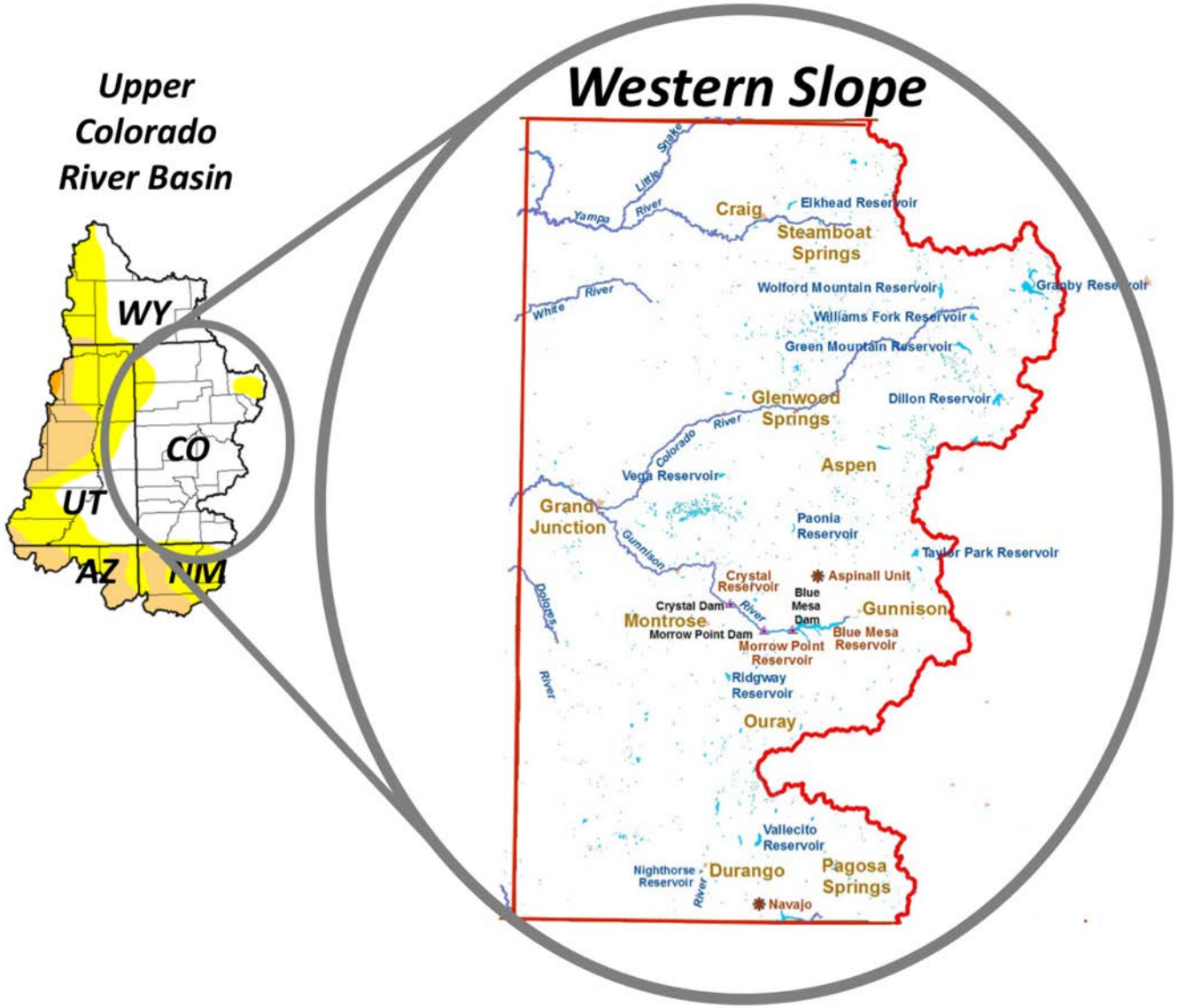
- Roles that different members **within a social system** play in facilitating diffusion of a social, technological, or scientific innovation
- Role of **social system** – common goal / shared identity, shaped by relationships and norms
- **How and from whom** a prospective adopter learns about an innovation matters
- Role of **early adopters** in absorbing risks, normalizing innovation

Methods

- Comparative case study: five water systems
- Individual interviews (n=14)
- Document review (n=28)

Photo credit: wcc.nrcs.usda.gov

Study Area


Upper Colorado River Basin
WY
CO
UT
AZ
NM
Western Slope
Craig
Elkhead Reservoir
Steamboat Springs
Wolford Mountain Reservoir
Williams Fork Reservoir
Green Mountain Reservoir
Glenwood Springs
Dillon Reservoir
Aspen
Vega Reservoir
Grand Junction
Paonia Reservoir
Taylor Park Reservoir
Crystal Reservoir
Aspinall Unit
Blue Mesa Dam
Crystal Dam
Montrose
Morrow Point Dam
Gunnison
Blue Mesa Reservoir
Morrow Point Reservoir
Ridgway Reservoir
Ouray
Vallecito Reservoir
Nighthorse Reservoir
Durango
Pagosa Springs
Navajo
Yampa River
Little Snake River
White River
Colorado River
Gunnison River
Dolores River

Ramp down / observation
Oct - Dec

Information Use: *Begin monitoring the local hydrology and getting a sense of the water supply as early as October*

Decisions: Systems with reservoirs adjust releases to achieve target end-of-season elevation; otherwise, too early to take any action

Anticipation / early warning
Jan - Mar

Information Use: *Increase snowpack monitoring frequency in the case of drier-than-average hydrology; managers has some sort of 'mid-winter' signal or indicator that triggers some preliminary action, even if that action is to pay closer attention*

Decisions: Some managers at this time take preliminary actions in anticipation of drought conditions

Planning / response
Apr - Jun

Information Use: *Drought triggers vary both in terms of the degree to which they are quantified and formalized (e.g. 75% reservoir levels vs. general assessment of streamflow, weather predictions, and temperature) and in terms of the type of information taken into account.*

Decisions: Begin to make critical and real-time decisions about drought management for the upcoming use season

Ongoing drought management
Jul - Sep

Information Use: *Ongoing monitoring of reservoir and/or streamflow levels / summer precipitation*

Decisions: Volume of available water supply for the use season is established; Some entities communicate or coordinate with neighboring water users to make releases or reduce use to avoid administration in their basin; Some follow-up actions are available to step up use restrictions or revise release schedule based on changing conditions

Case Selection

No.	Organization type	Business type	Customer use	Storage	Total served
1	Water conservancy district	Wholesale	Irrigation Augmentation	Total reservoir storage 44,000 AF	26,000 AF in contracts
2	Water conservancy district	Retail	Domestic use	Total reservoir storage 11,960 AF	33,000 accounts 80,000 people 100,000 AF per year
3	Water conservancy district	Wholesale	Irrigation Augmentation	Total reservoir storage 108,087 AF	1857 AF in augmentation
4	Municipality	Retail	Domestic use Irrigation	No storage	3500 accounts 2000 AF per year
5	Municipality	Retail	Domestic use Irrigation	No storage	10,000 people 3377 AF per year

Results

Determinants of Information Use:

Intrinsic Factors

- Scale
- Skill
- Understandability

[illegible] be meaningful." (case 5)

Determinants of Information Use:

Contextual Factors

- Capacity
- Past Experience
- Generational Turnover

“The proposed system is more conservative than relying upon early season forecasts, but it almost guarantees that demands will be met even in the event of a busted official forecast.” (document 1, case 1)

“If you look at the Front Range, you get that density, those that are well versed with that sort of technology, very well staffed, a very well skilled, are also using it. And you look at the Western Slope, there's no one organization that can come even close.” (case 5)

“We have a lot of new employees in that department that are large organization that are very, very young, ...”

Information Dissemination:
Current Knowledge Networks

- Information accessed directly from agency websites and portals – NRCS, USGS, NOAA
- Heard about new products from industry organizations (AWWA, Colorado Water Congress, CO River District)
- University-based boundary activities – little or no participation
- Industry peers as information translators/brokers

Information Dissemination:
Current Knowledge Networks

- Industry peers as information translators/brokers

"In the spring time period, he's in daily communication with the River Forecast Center on what they're expecting. And he gives us the big picture of what's happening everywhere, on the West Slope…I don't know how he does it. Basically you get him on the line, you just say, what's happening this year, do you see anything that's out of the ordinary." (case 5)

Information Dissemination:

Determinants of Adoption Related to Dissemination

- Familiarity with information source
- Information source with hands-on experience
- Proof of concept within actual water systems

"…What we really trust is when someone shows up and says, hey look, we started looking into, whatever parameter, and it has actually given us better results…if someone can come to me with that, that they had an idea, and they tested it, and they saw some positive results, you bet, we're going to look into that." (case 1)

"If we had someone from somewhere else who had been trying in practice, you bet, if I talked to the river basin forecast center who does this kind of stuff for huge scale reservoirs and operations, that have many moving parts and considerations, you bet I'm going to listen to those guys." (case 1)

(case 3)

Discussion

How different exactly are small systems from large systems?

- ***Similarities:***
  - Information needs (skill, scale, understandability)
  - Role of past experience
  - Generational differences / turnover

Discussion

How different exactly are small systems from large systems?

- ***Capacity*** is a key barrier; different flavors:
  - Lack of technical capacity to integrate new products or conduct their own forecasting
  - Lack of financial resources to acquire technical capacity through hiring staff or consultants
  - ***Also*****:** Basic lack of staff capacity to monitor for new information
    - Wearing multiple hats – searching for info is not a priority
    - Outsized impacts of staff turnover

Discussion

How different exactly are small systems from large systems?

- ***Embedded*** within industry networks
  - Narrow range of information sources – mostly industry groups, little to no interaction with boundary orgs
  - Reliance on industry peers – essential role of sector-specific networks
  - Embeddedness / insulation may be driven by geography (lack of proximity to universities) or lower transaction cost of following in footsteps of trusted industry peers

Discussion

How different exactly are small systems from large systems?

- Adoption driven by ***emulation, replication, assessment sharing***
  - *Assessment sharing:* For some, "adoption" will not take form of direct use but of borrowing assessments of conditions from peers
  - *Emulation* and *replication:* disseminating successful examples of adoption by industry peers (early adopters)
    - *Early adopters must be trusted, have local knowledge, but also be able to absorb risks associated with innovation*

Implications for Advancing Information Use

- Free or low-cost **individualized tailoring and translation** is clearly needed

> *"I'd like to see…someone being able to produce [products like paleo-hydrology] for rural communities and small communities. The science is there, the tools are there, no reasons why these tools shouldn't be made available for all communities. So that even the smaller water user group can make the same information and analysis that someone like Denver Water or BOR is using"*

> *"If you somehow had some resources that could be even shared across [Western Slope water systems], that starts to fulfill the intellectual capacity of even the western slope, that would help."*

Implications for Advancing Information Use

In the meantime, in a resource-constrained world:

- Capacity constraints, insulation from boundary activities, trust in local knowledge and hands-on experience → suggests **room for refining** conceptual models of scaling information adoption
- Maybe we **shouldn't expect** small-system managers to participate in boundary activities?
- Capitalize on water managers' **strong community of practice**, shared social identity, and bias toward hands-on experience in larger systems

Implications for Advancing Information Use

In the meantime, in a resource-constrained world:

- Boundary orgs can **strategically engage with larger scale systems** that fit *early adopter* profile
  - Has local knowledge
  - Perceived as sophisticated / cutting edge
  - Ability to absorb risk of adopting a new product
  - Already plays advisory role with other local water managers
- Need **more systematic effort to support dissemination** of successful pilots and adoption

Directions for Future Research

- Test observations on **larger sample** of systems
- **Comparative study** of large vs small systems
- **Social network analysis** to map out knowledge / industry networks and identify early adopters
- Longitudinal evaluation of the **effects of demonstration projects on replication** across networks

Comments or Questions?

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Thank You:

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