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

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Acknowledgements

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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

Photo credit: Sierra Club
What Drives Information Use Among Water Managers?

- Role of Capacity
  - Technical capacity
  - Human capacity and resources
  - Diversity of skills and backgrounds

What Drives Information Use Among Water Managers?

- Intrinsic Factors
  - Perceived "fit" or relevance to decision-making needs
  - Alignment with spatial and temporal scale of decisions
  - Perceived skill, salience, credibility, and legitimacy of the information
  - Accessibility and understandability of the information

- Contextual Factors
  - Decision-makers' management values (e.g. routine/reliability vs. innovation)
  - Past risk management experiences and experiences using new products
  - Trust in information source – localized, sector-specific knowledge

Photo credit: The Nature Conservancy
Photo credit: KNNF.org
Photo credit: wikipedia commons
Strategies for Advancing Information Adoption

**Boundary Chain Model**
(Lemos et al 2014)

**Traditional Boundary Organization 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)
Study Area
<table>
<thead>
<tr>
<th>Time Period</th>
<th>Information Use</th>
<th>Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct - Dec</td>
<td>Begin monitoring the local hydrology and getting a sense of the water supply as early as October</td>
<td>Systems with reservoirs adjust releases to achieve target end-of-season elevation; otherwise, too early to take any action</td>
</tr>
<tr>
<td>Jan - Mar</td>
<td>Increase snowpack monitoring frequency in the case of drier-than-average hydrology; managers have some sort of ‘mid-winter’ signal or indicator that triggers some preliminary action, even if that action is to pay closer attention</td>
<td>Some managers at this time take preliminary actions in anticipation of drought conditions</td>
</tr>
<tr>
<td>Apr - Jun</td>
<td>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.</td>
<td>Begin to make critical and real-time decisions about drought management for the upcoming use season</td>
</tr>
<tr>
<td>Jul - Sep</td>
<td>Ongoing monitoring of reservoir and/or streamflow levels / summer precipitation</td>
<td>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</td>
</tr>
</tbody>
</table>
# Case Selection

<table>
<thead>
<tr>
<th>No.</th>
<th>Organization type</th>
<th>Business type</th>
<th>Customer use</th>
<th>Storage</th>
<th>Total served</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water conservancy district</td>
<td>Wholesale</td>
<td>Irrigation Augmentation</td>
<td>Total reservoir storage 44,000 AF</td>
<td>26,000 AF in contracts</td>
</tr>
<tr>
<td>2</td>
<td>Water conservancy district</td>
<td>Retail</td>
<td>Domestic use</td>
<td>Total reservoir storage 11,960 AF</td>
<td>33,000 accounts 80,000 people 100,000 AF per year</td>
</tr>
<tr>
<td>3</td>
<td>Water conservancy district</td>
<td>Wholesale</td>
<td>Irrigation Augmentation</td>
<td>Total reservoir storage 108,087 AF</td>
<td>1857 AF in augmentation</td>
</tr>
<tr>
<td>4</td>
<td>Municipality</td>
<td>Retail</td>
<td>Domestic use Irrigation</td>
<td>No storage</td>
<td>3500 accounts 2000 AF per year</td>
</tr>
<tr>
<td>5</td>
<td>Municipality</td>
<td>Retail</td>
<td>Domestic use Irrigation</td>
<td>No storage</td>
<td>10,000 people 3377 AF per year</td>
</tr>
</tbody>
</table>
Results
Determinants of Information Use: 
*Intrinsic Factors*

- **Scale**
  
  “The more localized, the more likely I would use it. Because they aren’t local enough to necessarily be meaningful.” (case 5)

- **Skill**

- **Understandability**

  (case 5)
Determinants of Information Use: Contextual Factors

- **Capacity**

  “If you look at the Front Range, you get that intensity, those that are very, very well staffed, very well skilled, and so forth. And you look on the Western Slope, there's no one organization that can come close.” (case 5)

- **Past Experience**

  “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)

- **Generational Turnover**

  “We have a lot of newer employees in our department, that are well versed with that sort of thing, in looking at forecasts and using technology”
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
  “If we heard from an agency 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 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)

- Information source with hands-on experience

- Proof of concept within actual water systems
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
    - Outsize 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

“...someone being able to produce products like paleo-hydrology for rural communities that could be shared across [Western Slope water systems], the science is there, the tools are there, the intellectual capacity is there. So that even the smaller water user group can make the same information and analysis that someone like Denver Water or BOR is using”
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 \( \rightarrow \) 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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