EXTENSION
College of Agriculture, Biotechnology & Natural Resources

PEER REVIEWED

Fact Sheet 23-28

Stakeholder Engagement in Knowledge Co-Production for Climate Resilience

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Introduction

Synthesizing kNowledge to Optimize Water Policy for Agriculture under Changing Snowpack (SNOWPACS) is a project funded by the U.S. Department of Agriculture, aiming to optimize water policy for agriculture under changing snowpack and snowmelt conditions. The project engages stakeholders in research to co-produce new knowledge to inform and support actionable change on the ground.

Co-production of knowledge is the process of producing usable, or actionable, science through collaboration between scientists and those who use science to make policy and management decisions (Meadow et al., 2015). By engaging stakeholders in scientific research, the resulting co-produced knowledge is more useful, easier to integrate within an existing decision framework, and more likely to be used to make decisions (Lemos et al., 2019).

Stakeholder engagement occurs at one or multiple phases of research, including research design, model specification, data collection, data analysis, and validation and dissemination of research outcomes. However, little is known about how to maximize stakeholder engagement in knowledge co-production. Key factors underlying success include researchers having a clear understanding of who, why, when and how to engage, as well as the historical, physical and political context of the research problem; and available time, resources and capacities of the research team (Kliskey et al., 2021).

To investigate best practices for stakeholder engagement in collaborative research toward knowledge co-production, this fact sheet describes a *collaborative research framework* designed for SNOWPACS, as based on Reed et al.'s (2018, pp. 13-18) theory of participation. Stakeholder engagement is implemented and evaluated in the Walker River Basin, California-Nevada, United States (see Figure 1). The evaluation results reported here help to identify effective engagement processes and how such processes affect collaborative research outcomes.

Designing collaborative research

The SNOWPACS project aims to enhance climate resilience by co-producing new knowledge with irrigated agricultural communities in the arid western U.S. to support the adaptation to changes in the timing and quantities of snowmelt-derived water supplies. Climate change, which impacts snowpack accumulation and timing and amount of annual runoff, is leading to more variable water supply in this region,

which challenges water management (Harpold et al., 2017). The SNOWPACS project adopted a hybrid "top-down" and "bottom-up" approach to knowledge co-production (Reed et al., 2018, p. 5). The top-down portion involved researchers from multiple disciplines working together to identify key research questions, while the bottom-up portion involved stakeholder engagement to clarify and help answer these questions.

Stakeholder engagement processes are based on a theory of participation (Reed et al., 2018). That is, effective engagement is more likely to lead to knowledge co-production when engagement has locale-specific (historical and institutional) context, is highly structured (rather than ad hoc), manages for power and resource disparities among diverse stakeholders, and occurs at a geographic scale where decision-making occurs.

Collaborative research in action

Our collaborative research case study takes place in the Walker River Basin (see Figure 1). Prior to engagement, we developed a historical and institutional profile of the basin that helped to identify stakeholders representing key water management sectors. We then engaged these stakeholders through one-hour, semistructured, individual interviews asking a set of questions to help gain a better understanding of the basin and its water management challenges, *from stakeholder experiences and perspectives.*

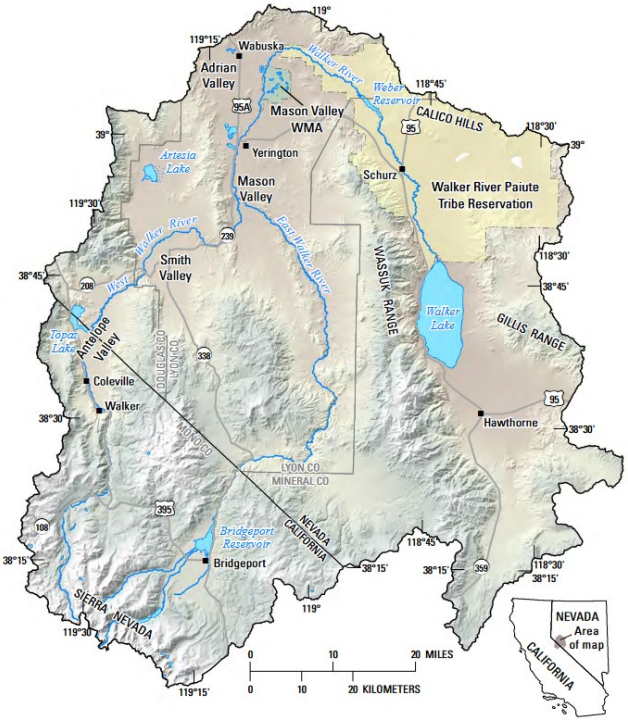

Figure 1. Walker Basin River map. Base from U.S. Geological Survey digital data, 2015.

The interviews serve multiple purposes. First, the questionnaire facilitated collaboration among the broader research team and helped connect scientists with local stakeholders beyond those working directly with stakeholders. Second, the interview experience provided foundational engagement between project researchers and basin stakeholders, informed them about project goals and objectives, set the stage for ongoing stakeholder participation, and allowed for baseline evaluation of stakeholder engagement experiences and challenges managing water. Third, the data collected during the interviews helped to assess the potential for local institutional arrangements that might enhance and/or sustain water security in increasingly variable water supply conditions. Fourth, the authors summarized data for the broader SNOWPACS team in order to inform their hydrologic and economic models. Finally, the authors intended to share a summary of interview results with the public through Extension publications.

Evaluating engagement

After conducting interviews, we asked stakeholders if they wanted to participate in an online survey to provide feedback about the SNOWPACS project goals and their initial engagement experience. Of the 33 stakeholders interviewed, 24 (73%) completed the evaluation survey. The online survey used closed-ended questions to measure stakeholders' understanding of project goals, attitudes towards collaboration, past experiences, attitudes towards researchers, perceived importance of contributions, expectations for project outcomes, confidence in researchers using stakeholder knowledge, perceived

importance of project goals, and satisfaction with existing water allocation and projection models. Qualitative responses were analyzed using thematic content analysis, bringing stakeholders' voices to the forefront.

Evaluation results: closed-ended questions

Table 1 reports the mean scores and standard deviations for the 10 closed-ended questions, which were all evaluated on a 7-point Likert scale. Results show that most respondents perceived the initial engagement experience positively. Indeed, 96% of participating stakeholders agreed that they understand the SNOWPACS project goals and looked forward to working with researchers on the project.

Table 1. Stakeholder survey mean scores and standard deviations.

Survey Item	Mean	SD
I understand the goals of the SNOWPACS project.	5.88	0.68
I am looking forward to working with researchers on the SNOWPACS project.	6.13	0.74
Stakeholders will be critical to the success of the SNOWPACS project.	6.39	0.89
I have worked on similar projects in the past.	4.78	1.44
SNOWPACS researchers are eager to incorporate my knowledge.	5.96	0.82
I feel like I have a lot to offer this project in terms of my expertise.	5.48	0.79
I am not personally expecting to get anything out of this project.	4.57	1.83
I believe my knowledge will be used by SNOWPACS researchers.	5.96	0.56
It is important that I know the goals of the SNOWPACS project.	5.83	0.83
How satisfied are you with the current water allocation models and water projections for the work you do?	2.64[a]	1.23[a]

[a] This question, which does not specifically inquire about the engagement experience, was evaluated on a different 7-point Likert-type scale that was reverse coded, where 1 = extremely satisfied, 4 = neither satisfied nor dissatisfied, and 7 = extremely dissatisfied.

The SNOWPACS team was highly successful in identifying stakeholders to engage, with 65% of respondents having prior experience participating in research projects like SNOWPACS. Stakeholders perceived SNOWPACS researchers as eager to incorporate their knowledge into project research, with 91% of respondents responding positively. Most respondents believed their participation was critical to the success of SNOWPACS and that they had a lot of expertise and knowledge to offer. This suggests that stakeholders see value in engaging in collaborative research, making this project more likely to lead to knowledge co-production.

However, respondents were most mixed on the question item, "I am not personally expecting to get anything out of this project," with 26% agreeing and 17% disagreeing. They generally agreed that their knowledge would be used by researchers and that it was important that stakeholders know the goals of SNOWPACS. This suggests that while stakeholders may see their knowledge and input as valuable to scientific research, they may not necessarily benefit personally from such research, though the broader stakeholder community might benefit.

Finally, 62% of participants reported moderate satisfaction with the basin's existing water allocation models and water supply projections, suggesting that stakeholders may be more open to investigating alternative management regimes and coping actions, which is a key goal of the SNOWPACS project.

Formative evaluation results: open-ended questions

Stakeholders identified water-related challenges in their area as: 1) increasing competition for water supplies, 2) climate change, and 3) inconsistent weather patterns. Several volunteered that existing water allocation institutions may be outdated and/or not based on science or the basin’s hydrology. Climate change and inconsistent weather patterns also presented new challenges to water management responsibilities. Stakeholders acknowledged the potential for growing competition over limited water resources to increase conflict, validating the need for knowledge to aid

stakeholders in finding common ground and new solutions.

Stakeholders defined success for a collaborative research and water modeling project such as SNOWPACS as improved management practices or new information that could inform on-the-ground improvements. They also described project success in terms of helping deal with repercussions from climate change, such as realistic and implementable strategies by water users to adapt to changing water supply. Some participants encouraged researchers to aim for project outcomes that address larger social welfare concerns, such as building consensus and understanding among diverse water use stakeholders.

Furhter, stakeholders suggested researchers also learn about local and state water laws and regulations, water cycles within the basin, and the sustainable agricultural practices of local farmers. Ensuring researchers understand both constraints and opportunities for sustainable water management, whether physical or social, appeared to be a common concern, regardless of water use sector. These concerns voiced by stakeholders should motivate researchers to learn about the local nuances of water use in the basin they seek to model (Reed et al., 2018).

Implications for SNOWPACS

This study evaluated initial stakeholder engagement experiences in SNOWPACS, an USDA-NIFA-funded project to support collaborative climate science knowledge co-production. Results reported here highlight the importance of quality above frequency of interactions between researchers and stakeholders in achieving greater project output utility. The study conducted individual in-depth, semi-structured interviews to introduce and simultaneously inform SNOWPACS empirical research, while creating a safe, creative space for learning and knowledge exchange among researchers and stakeholders.

Stakeholders reported moderate satisfaction with existing water allocation models and water supply projections for the basin, emphasizing the need for new knowledge to inform and improve water management decisions. They also expressed an urgent need for the SNOWPACS project to co-produce new knowledge relevant to issues specific to the Walker River Basin, highlighting the need for power dynamics management in co-production processes. SNOWPACS researchers should learn about their basin in terms of historical water cycles and provide information to help manage water at the farm level.

The findings highlight the importance of context, spatial consideration and power sharing in the design of engagement processes, as project success will lead to new water allocation or management policies at the basin level and more reliable predictions of annual water availability.

Next step

The bottom-up portion of the collaborative research framework involves collaborating with stakeholders to inform model specification, refine model performance and verify model outputs. This helps integrate top-down and bottom-up aspects, allowing researchers to interact directly with stakeholders in the Walker Basin. The SNOWPACS team is replicating the initial engagement experience in the South Platte River Basin in Colorado, allowing a comparative assessment across water management challenges, geographic scales, demographics, economics and institutions. Understanding researchers' attitudes towards collaborative research and stakeholders' challenges can inform future research design and engagement practices.

Study challenges and limitations

We conducted interviews in spring and summer 2020 at the height of unprecendented COVID-19 pandemic-related closures. This posed unexpected and unprecedented challenges for stakeholder engagement in the Walker River Basin, requiring a shift from in-person interactions to virtual video conference technology and telephone interactions.

Despite these challenges, most stakeholders showed participatory resilience, indicating the need for new knowledge to adapt to climate change impacts. However, response bias may exist, as nine out of 33 stakeholders did not complete the online evaluative survey and so may have been dissatisfied with their initial engagement experience.

Reflections on collaborative research toward knowledge co-production

The growing use of co-produced climate science knowledge in the U.S. has prompted scientists and stakeholders alike to advocate for its widespread use and funding (Arnott et al., 2020). Knowledge co-production is an increasingly common approach to closing the gap between climate science research and action. However, questions remain concerning what constitutes effective co-production processes and outcomes (Howarth et al., 2022). Designing co-production processes and outcomes around core principles, as outlined in participation theory, may help influence project success or failure. This requires creating opportunities that can establish and/or enhance a culture of participation.

Effective knowledge co-production does not necessitate high frequency or iterative stakeholder engagement, which may lead to engagement fatigue, but requires an organic approach to tailoring engagement experiences responsive to the nuances of the problem context and scale. Research is needed to clarify how features of engagement processes influence social learning, capacity building and behavioral changes that lead to environmental changes.

Evaluating collaborative research processes and outcomes is necessary to evolve evidence-based best engagement practices. This can help explore, for example, how diverse stakeholders can inform and improve knowledge co-production processes. Supporting both researchers and stakeholders in experimental collaborative research and knowledge co-production is necessary to impove these processes.

International implications for knowledge co-production

Knowledge co-production plays a crucial role in enhancing climate adaptation in agricultural communities worldwide. This approach can inform efforts in arid, snow-dependent riverine environments and other regions. Many water users worldwide face variable water supplies (Qin et al., 2020), increasing competition from municipal entities, urban centers and environmental entities. The quality of interactions among diverse water use interests will impact future decisions on water reallocation and global food security.

Engaging in knowledge co-production can build adaptive capacity and resilience, addressing systemic and contextualized issues such as colonization and data sovereignty for Indigenous peoples and communities. High-quality knowledge co-production processes must manage power dynamics and consider local context to achieve long-term change. Highly structured and thoughtful engagement can build and support the co-creation of information and relationship-building around common challenges, potentially enhancing adaptive capacity and resilience (Church et al., 2021).

Acknowledgement

This fact sheet describes the development, implementation and evaluation of an initial stakeholder engagement experience in knowledge co-production toward enhanced climate resilience. The experience is part of a collaborative research framework focusing on knowledge co-production to support adaptation to climate change. This work was funded by USDA NIFA AFRI [grant no. 2018-69011-28369/project accession no. 1016046]. An earlier version of this paper, https://link. springer.com/article/10.1007/s42532-022-00124-8, was developed through an interdisciplinary workshop funded by USDA NIFA AFRI [grant no. 2020-01551/project accession no. 1023309]. Any opinions, findings, conclusions or

recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the USDA.

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