


The “Nuts and Bolts” of Doing Coproduction

Exploring Implementation Decisions in Climate Adaptation Research with Stakeholders

K. R. Clifford , J. Henderson, Z. McAlear, L. Dilling, B. Duncan, S. Ehert, S. Arens, R. Page, and U. Rick

ABSTRACT: Developing local climate adaptation strategies that respond to weather and climate extremes is increasingly salient. Coproducing knowledge and climate adaptation strategies can be an important approach to ensuring that they are context specific, meet community needs, and are deemed usable by local decision-makers. Most of the guidance for coproduction has focused on important, overarching themes and ethical considerations like trust, iteration, and flexibility; these are incredibly valuable, but little attention has been focused on specific, highly consequential research decisions that researchers must make that shape project outcomes. Here, we reflect on our experience in a pilot project coproducing climate adaptation knowledge and strategies in six rural communities. We identify eight questions that researchers coproducing science with communities will need to grapple with when designing and conducting research and discuss some of the related trade-offs of each. Topics include community recruitment, champion selection, participant makeup, geography, clarifying expectations, timing, prioritization, and next steps. The questions are broadly applicable to knowledge coproduction and important especially as greater attention is being given to the ethics of doing this work, the power relations, and the potential risk associated with it. We hope that these questions can guide a dialogue for others and motivate explicit discussions of trade-offs involved in planning research that is coproduced with communities. We call for more of this type of self-reflection and sharing across our research community to deepen our knowledge and hopefully lead to a more rapid improvement in outcomes across the many efforts underway today to cocreate climate knowledge for adaptation.

KEYWORDS: Adaptation; Decision support; Planning; Resilience; Societal impacts

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Corresponding author: K. R. Clifford, katie.clifford@colorado.edu

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AFFILIATIONS: Clifford, Duncan, Arens, and Rick—Western Water Assessment, University of Colorado Boulder, Boulder, Colorado; Henderson—Geography Department, Texas Tech University, Lubbock, Texas; McAlear—Department of Urban Studies and Planning, Massachusetts Institute of Technology, Cambridge, Massachusetts; Dilling—Western Water Assessment, and Environmental Studies Program, and Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, Colorado; Ehart—Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland; Page—Puget Sound Partnership, Seattle, Washington

Accounting for local, place-specific vulnerabilities within community adaptation planning has become more and more essential, as weather and climate extremes increase (Moser and Ekstrom 2011; Kettle et al. 2014; Klenk et al. 2017). Adaptation is fundamentally a locally specific experience, although also constrained and enabled by governmental and socioeconomic processes at other scales (Nalau et al. 2015). Strong evidence indicates that experts actively engaging stakeholders, including local government officials, can advance adaptation planning (Moser and Ekstrom 2011; Cvitanovic et al. 2019) and that involving stakeholders in the research process will increase the likelihood that research findings are relevant to local decisions (Cash et al. 2003; Dilling and Lemos 2011). Furthermore, engaging stakeholders helps bring in local knowledge that can be critical for developing strategies that are culturally sensitive and inform implementation tactics (Naess 2013; Boillat and Berkes 2013; Owen et al. 2019; Clifford et al. 2020). In many cases, this takes the form of knowledge coproduction, the “collaboration among managers, scientists, and other stakeholders, who, after identifying specific decisions to be informed by science, jointly define the scope and context of the problem, research questions, methods, and outputs, make scientific inferences, and develop strategies for the appropriate use of science” (Beier et al. 2017, p. 288). In recent years, researchers have become increasingly engaged in coproducing knowledge with stakeholders to support community adaptation and are beginning to assess the methods, results, and assumptions of these processes (Meadow et al. 2015; Arnott et al. 2016; Beier et al. 2017; Lemos et al. 2018; Colavito et al. 2019; Grecni et al. 2019; Tuler et al. 2020; Jagannathan et al. 2020; Wilmer et al. 2021).

Coproduction represents an opportunity for more relevant research and greater impact with communities, but it can also carry risks in terms of time, career trade-offs, reputational impacts, and damage to relationships if done poorly or without intention (Lemos and Morehouse 2005; Lemos et al. 2018; Turnhout et al. 2020; Bamzai-Dodson et al. 2021). Furthermore, it can exacerbate existing inequalities and lead to unintended outcomes (Daly and Dilling 2019), and because it asks a lot of partners, it is worth determining what level of engagement is required to meet the project goals (Bamzai-Dodson et al. 2021; Ferguson et al. 2022). As stated by Moser and Ekstrom (2011), there is a need to “chronicle and critically assess emerging adaptation planning processes to learn broader lessons and share them widely both in the science and in the practice communities” (p. 63). Coproduction scholars have outlined important themes and contributed to theorizing this type of knowledge production, identifying important elements such as trust (Meadow et al. 2015; Owen et al. 2019), communication (Meadow et al. 2015; Wall et al. 2017), power (Daly and Dilling 2019; Turnhout et al. 2020), flexibility (Lemos and Morehouse 2005; McNie 2007), iteration (Dilling and Lemos 2011;

Beier et al. 2017; Wall et al. 2017), and the evaluation (and even meaning) of success (Owen 2020; Tuler et al. 2020).

These elements are foundational for any coproduction research project and require increased reflexivity. Orr and Bennett (2009) call for a “radical reflexivity” that “unsettles” coproduction and ask researcher to recognize “the social and political aspects of methodological choices” (p. 87). They highlight challenges and dynamics that research teams might encounter to share their reflections and provoke reflections of other researchers. This type of radical reflexivity needs to be intentional, iterative, and collective to guide successful and ethical coproduction. Chambers et al. (2021) similarly call for greater reflexivity and develop a heuristic tool to guide researchers and participants toward a more reflexive research design for coproduction through considering trade-offs in how the project is designed. Within coproduction scholarship, reflexivity is an emerging focus that can help fight extractive research practices, decolonialize methods, explore inclusions and exclusions, illuminate power dynamics, and engage with nuanced ethical dimensions (Klenk et al. 2017; Chambers et al. 2021; Durose et al. 2021; Phillips et al. 2021; Plank et al. 2021; Groot et al. 2022; Maclean et al. 2022). Even the most seemingly straightforward, banal, and inconsequential research decisions can benefit from reflexivity.

Despite growing calls for usable science, most scholarship offers high-level suggestions (i.e., develop trust). Here we contribute to a steadily growing body of work focusing on the specifics of the methodological decisions required to do this type of research. These high-level themes and important concerns can sometimes be hard to operationalize, can leave even informed researchers struggling to design and conduct coproduction research, or can lead to others making methodological decisions by default without seeing their research consequences. Even guiding principles and recommendations aimed at supporting researchers (see Beier et al. 2017; Meadow et al. 2015) still often do not engage with the small—but consequential—decisions that need to be navigated by the research team and that ultimately shape the coproduction process, the “nuts and bolts” of planning a project. Coproducing research is ultimately context specific, defies standardized processes, and requires researchers to make judgment calls that reflect the needs and circumstances of the partners they work with, particularly in cases with underserved, rural, or marginalized communities. These types of decisions include ones that shape the research design like selecting a community, inviting participants, or prioritizing adaptation actions.

In this essay, we reflect on our experiences with coproduction as researchers in the NOAA-funded RISA Western Water Assessment (WWA),¹ where our aim is to coproduce scientific information that will help communities adapt and build resilience to weather and climate extremes across our region (Colorado, Utah, and Wyoming). We identify eight questions that researchers coproducing science with communities will need to grapple with when designing and conducting research as well as some of the trade-offs, nuances, and considerations of each.

¹ WWA (<http://wwa.colorado.edu>) is 1 of 11 NOAA-funded Regional Integrated Sciences and Assessments (RISA) programs across the United States (<https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/RISA/About-RISA>).

Importantly, these questions come with two important qualifiers. First, our team identified these decision points and corresponding questions through evaluation *after* completing a pilot project. This means in many cases we had not deliberated on these questions and trade-offs during the process and did not ourselves navigate these challenges well. Instead, we offer up the important questions and difficult trade-offs we wished we had explicitly considered in hopes that our lessons may serve future projects. Second, these questions arose out of one model of coproduction, a researcher-initiated approach, but these questions may be less relevant to other models of coproduction, like, for example, community-initiated projects.

We hope that these questions can guide a dialogue for others and motivate explicit discussions of trade-offs involved in planning coproduction research. Although these questions

emerged as part of a WWA-led pilot project following a specific approach, they apply to the broader body of research focused on providing usable science for adaptation. Of course, these research decisions must be made by an informed, thoughtful, and reflexive research team that has taken the time to explore the critically important ethical questions and considerations as they relate to the high-level themes described above. Finally, we conclude with a set of considerations for coproduction researchers to improve shared learning and increase transparency in coproduction efforts.

Key questions for research teams doing coproduction

In 2018, we piloted an engagement method developed by the Carolinas Integrated Sciences and Assessments (CISA), called Vulnerability Consequences and Adaptation Planning Scenarios (VCAPS).² VCAPS was designed to facilitate community planning around locally salient climate extremes (Kettle et al. 2014; Webler et al. 2014; Tuler et al. 2020). WWA piloted VCAPS in six rural communities in Colorado and Utah, all of whom were interested in exploring climate hazards and increasing their resilience to those impacts. The VCAPS process centers local knowledge and concerns about hazards, and asks communities to map out different hazard scenarios and social consequences so that specific, place-based interventions can be developed to reduce vulnerability. Engagement begins with a “community champion”—an individual within a community who has the knowledge and social capital to bring individuals from that community together to discuss the issues of interest. Workshops themselves included 8–15 community participants. To understand the perspectives of participants, our research team used three postworkshop methods of evaluation: an immediate postworkshop survey, interviews with community champions 7 months later, and a follow-up survey and additional interviews with participants a year

² See <https://vcapsforplanning.org>.

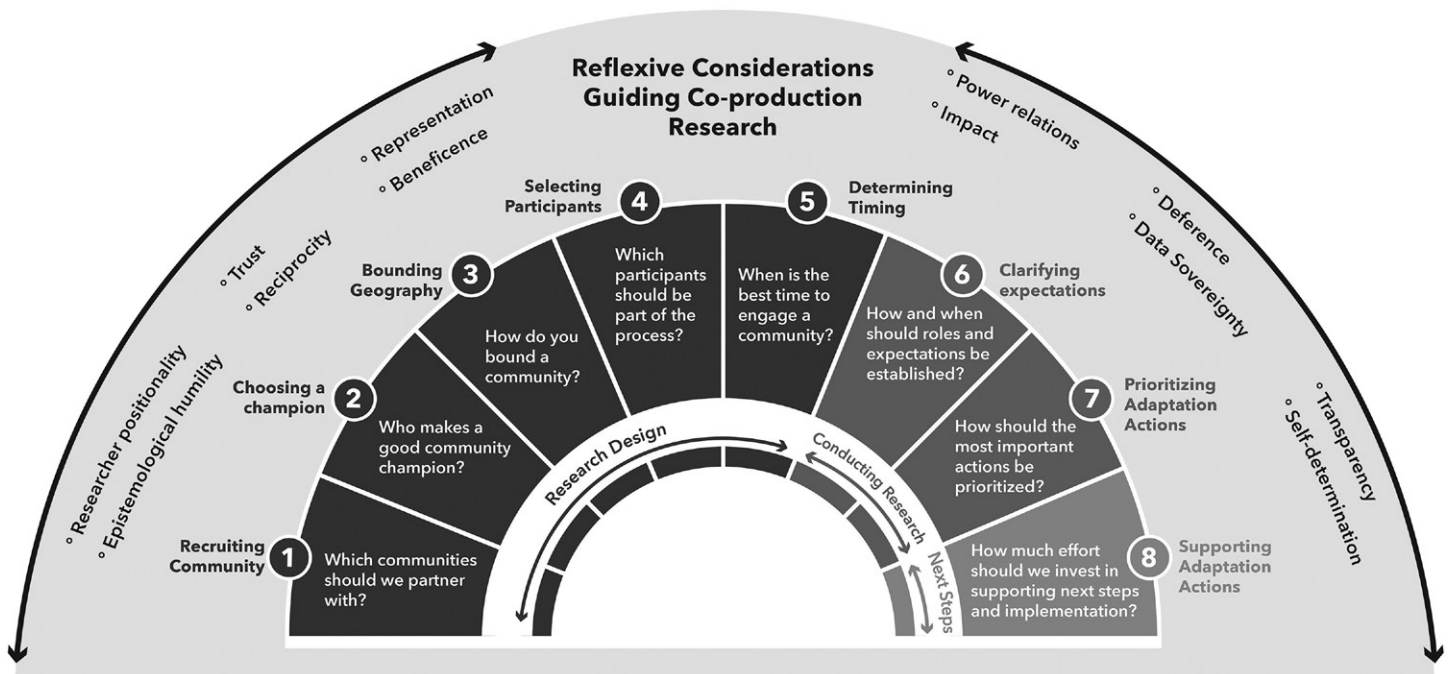


Fig. 1. Eight methodological decisions and questions for research teams doing coproduction: The eight questions are ordered in incremental phases, starting with ones that need to be made during research design, then ones made while conducting research, and finally ones at the conclusion when the team considers next steps. Each decision has a corresponding question to help guide the research team (researchers and community champions). We surround our eight highlighted decisions with larger considerations guiding coproduction research to indicate the critical importance they must play in shaping each of these more concrete, methodological decisions. The research team should bring in ethical, reflexive, and critical considerations to guide the questions and decisions raised in this paper.

postworkshop. The following questions arose from a detailed analysis of the evaluation data (McAlear 2020) in combination with the research team's own reflections after conducting six of these VCAPS processes in our region in 2018/19.

Below we summarize our reflections on the practical implications of choices made in these processes and identify eight questions for researchers doing coproduction (Fig. 1). Importantly, many of the questions raised need to be discussed by the entire research team (including the champion) and some of the questions may fall almost entirely to the champion who knows the local context best. We use research team broadly to include researchers and champion. While generated from experiences with the VCAPS process, these are broadly indicative of the questions researchers will need to ask and the trade-offs they must weigh.

Question 1: Community recruitment—Which communities should we partner with? In our pilot, we identified potential communities to work with through two avenues: approaching people we had existing relationships with and posting an advertisement to a large pool of cities. Both methods of recruitment had trade-offs. Selecting a community through existing relationships was relatively easy and required less initial work to recruit communities. We also benefited from greater trust at the beginning of the process. However, this opportunism also increases chances of repeat engagements with the same community and concentrating resources in fewer communities, which limited the reach of our work. Opportunism also risked working with communities who were convenient, but not necessarily the best fit nor the highest need. Our other method of recruitment was posting a call for applications through a Colorado Municipal League newsletter sent to municipalities across Colorado. The posting allowed us to reach new communities with which we had no relationship, and because we required them to apply, it selected for motivated communities who saw a need for this type of work and who had the capacity to engage in the VCAPS process. However, this option was more time intensive, particularly in reviewing applications and building trust between researchers and the community. The recruitment of communities also raises important equity concerns. Should we select communities that cannot afford to do this type of work on their own? Should we only select communities that already have the capacity to take next steps for implementation? And, can we support capacity within these communities that will alter power dynamics within coproduction so that communities are the ones initiating projects and playing a central role in their development?

Question 2: Choosing a champion—Who makes a good community champion? A strong community champion is critical to enhance community buy-in, participation, and overall workshop success, but important questions remain about who to select and even how many champions to select for a single project. A champion that has high levels of social and/or political capital, often as a longtime member of the community, is able to convene important local decision-makers and enhance community buy-in and trust in the process. For example, we were able to convene ranchers, a community that is hard to access in the rural west and particularly on climate change, because one of our champions used their social capital within the community. Champions who are enthusiastic and can convince other participants of the project's importance result in more productive workshops. With any champion, it is important to consider their history in the community, local context, and their relationship to existing conflict and political struggles in the community.

Champions can also provide important inroads into marginalized or historically excluded communities who may be wary of joining a project but at the same time are critical for understanding impacts to vulnerable communities or envisioning just adaptation strategies. It is important to balance not reinforcing traditional power structures by considering champions from different backgrounds with recognition that a champion who represents

a less privileged community may have real capacity limitations. In these cases, securing funding for a community champion (or participants) may alleviate some of the capacity issues and ensure the process is more equitable.

A challenge in some rural communities may be limited options for who has interest in or capacity to be a community champion, and sometimes researchers may have to work with who is available rather than a person who meets all their criteria. Researchers may need to consider how to best support the champion who steps forward. Capacity may be less important than if the potential community champion is a polarizing figure that may undermine the process because their presence raises questions about legitimacy (see Cash et al. 2003) or it inadvertently excludes other populations in a community. These considerations may raise questions about the trade-offs of multiple champions. While having multiple champions may help with capacity, drawing in diverse communities and bring multiple perspectives, they also can make it more challenging for the researcher than having a single point of contact for communication, planning, and iteration.

Question 3: Geography—How do you bound a community? Determining what (and who) counts as a community is challenging and anything but straightforward (a challenge echoed in academic spheres as well; see Gurney et al. 2017; Harrington et al. 2008). Communities are not one thing. They are dynamic, always changing, and shaped both by current residents and issues as well as their historical and environmental contexts that together influence emotions, memories, and sense of place. Further, communities are shaped by larger structural forces that are beyond their boundaries (i.e., political economic systems that lead to disinvestment in rural communities, changing land use and development, etc.).

In our pilot, what was considered a “community” varied, with some centering on decision-makers within a city’s borders and others focused on decision-makers and stakeholders across a larger region (like a county). Each choice had important implications for how the hazards were viewed and what types of actions were generated. We found in many cases that it helped to have participants with a common geography, such as the municipal level. Of course, policies at multiple levels were relevant but a shared scale of action (i.e., municipal) and decision-makers who could take action within that shared scale helped ensure robust actions were generated. For example, in one of our communities that convened municipal employees, the champion identified that the local county government was not interested in acting and wanted to focus the workshop on what the municipality could do without county approval. This focus helped participants avoid long conversation sidetracks related to decisions over which they, as municipal employees, had no control.

However, a tight geographic bounding may exclude some important perspectives and external linkages. It may omit consideration of the consequences of adaptive decisions on other regions outside the scale under discussion (such as water users outside of the municipal boundary). Some survey respondents and interviewees shared thoughts on stakeholders they saw as missing from their workshops, including representatives from an additional level of government (i.e., county government) or a specific stakeholder group (i.e., agricultural producers) (McAlear 2020). These participants noted that a more complete representation of community interests would have helped to identify a more complete range of possible actions. Thus, bounding a community will likely carry trade-offs between depth of a narrow focus that develops fewer, context-specific strategies and breadth that produces a greater number of less focused strategies.

Question 4: Who is involved—Which participants should be part of the process? Any participant-led process will inevitably be shaped by who is in the room, and their perspectives, knowledge, and experience. Thus, trade-offs exist when determining who to

engage, especially in processes where participation is limited by practical constraints such as room size and facilitator availability. Who is in the room critically shapes what the process looks like, how the climate threats are understood, and what actions are generated. In our pilot we had champions select the participants, and we saw a very different makeup of participants in each community process which ultimately led to different postproject outcomes.

The differences across pilots highlighted an important consideration for participant selection that researchers should discuss with the champions during the planning phase: decision-making power. We found that having decision-makers, those with authority to make community-relevant decisions, participate helped to generate more feasible interventions. Specifically, participants valued having elected officials as part of the process, as they were often key figures in maintaining enthusiasm and driving forward action after the workshop ended (McAlear 2020). Additionally, at least one workshop illuminated the important role that a representative from an anchor institution—such as a college, university extension, or an NGO—can play in moving actions forward and assisting with follow-up community engagement efforts (McAlear 2020). Of course, decision-making authority occurs at multiple levels of government, in both public and private sectors, and sometimes those with this authority may have incentives to maintain current practices rather than change them.

However, bringing in a broader swath of the community beyond traditional “decision-makers” may illuminate key concerns not otherwise captured in the process or potential unintended consequences. This is particularly true for communities that may have systematically been excluded from positions of power within the community and not offered a seat at the decision-making table. Some of the most vulnerable populations in a community often lack decision-making power, but they often are more exposed to climate impacts and have less capacity to adapt. A nuanced lens is required to think about justice in rural communities that might depart from typical environmental justice populations (Carolan 2020; Ashwood and MacTavish 2016). It is critical that the research process engage these communities ethically and not reproduce marginalizing dynamics within the project. A broader sampling might also allow for multiple constituencies or interests—agricultural, environmental, socioeconomic, etc.—to be considered together. Future workshops, and stakeholder engagement more generally, should consider who is not at the table, and consider ways to include those without decision-making power.

Question 5: Timing matters—When is the best time to engage a community? The timing of the research in relation to local climate hazard events matters for momentum, feelings of salience, and community bandwidth. Most of our participating communities experienced intense droughts during the summer of 2018, right before we held workshops, which galvanized attention and drew interest in building climate resilience. Participants had recent, first-hand knowledge of drought impacts—fires, municipal water shortages, and community conflict—which motivated the seriousness with which they engaged the topic in the workshop. If it had been years since a significant drought, communities might have been less invested in the process. However, while engagement shortly after or concurrently with the occurrence of a hazard can offer salience and relevancy, research teams should exercise caution when approaching communities that are currently or have recently experienced a hazard. They might have little capacity for envisioning future scenarios or making time for research activities if all their attention is understandably focused on current stressors. Further, some of our communities had a reprieve from the droughts with a very wet year after the workshop and did say that this slowed the momentum for carrying out planned actions generated in the workshop. While research teams cannot control for weather variation it might be helpful to think about these trade-offs and the previous and concurrent events when planning research and evaluating adaptation actions.

Question 6: Clarifying expectations—How and when should roles and expectations be established? For any engaged process, it is important to clarify roles and expectations of all the parties involved. While most of the labor for managing a process falls to the researchers, the community champion has a number of responsibilities that are important for the success of the process. We asked champions for their most valuable resources—time and social capital—specifically in iterating with the research team, convening the participants at a workshop, motivating participants, and engaging in evaluation activities. For this type of process to generate actionable results, the participants themselves must feel some sense of ownership over the framing and outcomes of the process. Accordingly, it may be advantageous for the champion to develop shared expectations within their group and discuss the importance of the workshop with participants who may then feel more accountable to each other than to the research team. One strategy for clearly establishing expectations is creating a memorandum of understanding (MOU) with the community champion that explicitly describes the roles and responsibilities of the researchers and the champion, as well as the intended outputs, so that there is a shared resource to hold both parties accountable. Describing the expectations researchers have for the community after the process is complete may be especially important.

However, determining *when* to establish these roles is a research decision with important trade-offs. Researchers need to consider whether to establish roles and a specific, detailed plan in the early phase to offer structure or whether to embrace flexibility that might allow the process to evolve in new ways before establishing expectations, which would offer less direction or efficiency in early phases. Establishing clear expectations for the champion at the outset will allow for more efficiencies in setting up the process. However, keeping expectations malleable in the early phases of the process, especially before more participants have been engaged, might allow for the process to evolve in ways that change roles and expectations but are beneficial for the output. Of course, this type of evolution can be time intensive and is not always efficient.

Question 7: Selecting the top priorities—How should the most important actions be prioritized? The researchers and champions need to decide if the goal of the process is to generate many local strategies or to focus and prioritize the most important strategies. Each VCAPS process generated many different potential actions, yet feedback from participants indicated that they wished the process had also identified near- and long-term priority actions. This represents important trade-offs as prioritization may take time away from generating actions and questions remain regarding which metrics should be used to prioritize. Because many of the communities do not often convene a group in this way—across departments but also focused on a particular hazards (e.g., drought)—the time together is extremely valuable for identifying actions in real time that can be carried out and worked on postproject.

In our pilot, communities generated a number of actions in the last step, but we heard from many that when it came time to take action, they felt overwhelmed and not sure where to start implementing with such a long list. Adding a prioritization process that allowed participants to both rank actions based on importance and feasibility might help distill which actions the community should focus on first. However, questions of feasibility might need more community input from those not convened and dedicating time to prioritization may take away time from other parts of research activities, specifically the generative portion that comes up with an expansive list of options. Thus, the research team needs to consider whether it is more helpful to focus on expanding strategies and alternatives or narrowing to the most feasible and important. And, what is the best process for prioritizing actions to weigh key factors, including the values of different constituencies, the importance of the factors, and feasibility?

Question 8: Supporting adaptation actions—How much effort should we invest in supporting next steps and implementation? One of the big questions about processes like VCAPS is whether they lead to actual on-the-ground changes. The VCAPS process resulted in a wide range of potential public and private actions focused on education, planning and budgeting, regulation, and infrastructure development (McAlear 2020). While many context-specific actions were generated, evaluations suggested that some communities were confused about how to take next steps: some did not find the process motivated them to act, and some explicitly requested more support after the workshops including presentations to the public and/or elected officials, additional facilitated meetings, access to resources and data, and assistance with public engagement efforts (McAlear 2020). This led us to grapple with the following question: When do we as researchers hand off the responsibility to our partner communities? Our organization has limited time and resources, so extending the process and commitment to a community will limit our ability to work with other communities that might similarly need support. However, we already have a lot of knowledge and a good working relationship with our partner communities and increasing adaptation actions might only require moderate additional work to help them prioritize actions and facilitate implementation. The challenge of scaling and how to best use resources to reach across multiple communities is an active area of research in creating usable knowledge for climate adaptation (Kirchhoff et al. 2015; Kalafatis et al. 2015).

Concluding thoughts

The ultimate success of a coproduction project depends upon many small and nuanced details of how the project is designed. The research community owes it to itself and the communities with whom it engages to more deeply contemplate these questions and share their own lessons learned (e.g., Morss et al. 2011; Owen et al. 2019). This is not an exhaustive list of questions that researchers and the research team needs to consider for successful coproduction. Instead, this is a subset of methodological decisions that through our evaluation efforts we identified as important and ones we wished we had collectively discussed. Good coproduction requires the research team, but especially the researchers, to have done deeper reflexive work to guide these decisions considering questions like the following: What are our own intentions and biases? What is our positionality and role in coproduction? How do we integrate different knowledge systems? Who should be on our team? And what type of engagement reflects reciprocity? We envision a more transparent coproduction process where researchers share how they designed their project and why they made the decisions, no matter how seemingly insignificant (Forsyth 2011; King and Tadaki 2018). This practice of self-reflection and sharing across our community will accelerate our own knowledge diffusion process and deepen the impact of coproduction efforts.

These eight questions only represent an entry point into the important trade-offs involved in designing equitable processes that produce usable science outcomes. Future work should illuminate other salient study design details, discuss the important trade-offs and consequences of different decisions, and describe how and why researchers design their research process. Each of the eight questions we raised deserve greater discussion, which can help us design thoughtful procedures to test ideas, identify trade-offs, and evaluate and share results. More attention also needs to be given to considerations of diversity, equity, and inclusion and explicit attention to how these trade-offs shape power relations in the scientific process (Turnhout et al. 2020; Wilmer et al. 2021) to ensure researchers “do no harm” (Dilling et al. 2021, p. 102–404). This is especially important for research focused on climate adaptation, where the most marginalized communities will likely experience the greatest threats and where coproduction has the ability to reenvision and alter or exacerbate and reproduce some of these power relations (e.g., Daly and Dilling 2019).

This transparency will not only help other researchers see “under the hood” of coproduction research to help them make informed decisions, but it may produce a more honest scientific process that acknowledges all the important design questions, more accurately describe the study in all its richness, and ultimately lead to improved support for communities on the frontlines of climate impacts.

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References

- Arnott, J. C., S. C. Moser, and K. A. Goodrich, 2016: Evaluation that counts: A review of climate change adaptation indicators & metrics using lessons from effective evaluation and science-practice interaction. *Environ. Sci. Policy*, **66**, 383–392, <https://doi.org/10.1016/j.envsci.2016.06.017>.
- Ashwood, L., and K. MacTavish, 2016: Tyranny of the majority and rural environmental injustice. *J. Rural Stud.*, **47**, 271–277, <https://doi.org/10.1016/j.jrurstud.2016.06.017>.
- Bamzai-Dodson, A., A. E. Cravens, A. Wade, and R. A. McPherson, 2021: Engaging with stakeholders to produce actionable science: A framework and guidance. *Wea. Climate Soc.*, **13**, 1027–1041, <https://doi.org/10.1175/WCAS-D-21-0046.1>.
- Beier, P., L. J. Hansen, L. Helbrecht, and D. Behar, 2017: A how-to guide for coproduction of actionable science. *Conserv. Lett.*, **10**, 288–296, <https://doi.org/10.1111/conl.12300>.
- Boillat, S., and F. Berkes, 2013: Perception and interpretation of climate change among Quechua farmers of Bolivia: Indigenous knowledge as a resource for adaptive capacity. *Ecol. Soc.*, **18**, 21, <https://doi.org/10.5751/ES-05894-180421>.
- Carolan, M., 2020: The rural problem: Justice in the countryside. *Rural Sociol.*, **85**, 22–56, <https://doi.org/10.1111/ruso.12278>.
- Cash, D. W., W. C. Clark, F. Alcock, N. M. Dickson, N. Eckley, D. H. Guston, J. Jäger, and R. B. Mitchell, 2003: Knowledge systems for sustainable development. *Proc. Natl. Acad. Sci. USA*, **100**, 8086–8091, <https://doi.org/10.1073/pnas.1231332100>.
- Chambers, J. M., and Coauthors, 2021: Six modes of co-production for sustainability. *Nat. Sustainability*, **4**, 983–996, <https://doi.org/10.1038/s41893-021-00755-x>.
- Clifford, K. R., W. R. Travis, and L. T. Nordgren, 2020: A climate knowledges approach to climate services. *Climate Serv.*, **18**, 100155, <https://doi.org/10.1016/j.cliser.2020.100155>.
- Colavito, M. M., S. F. Trainor, N. P. Kettle, and A. York, 2019: Making the transition from science delivery to knowledge coproduction in boundary spanning: A case study of the Alaska Fire Science Consortium. *Wea. Climate Soc.*, **11**, 917–934, <https://doi.org/10.1175/WCAS-D-19-0009.1>.
- Cvitanić, C., M. Howden, R. M. Colvin, A. Norström, A. M. Meadow, and P. F. E. Addison, 2019: Maximising the benefits of participatory climate adaptation research by understanding and managing the associated challenges and risks. *Environ. Sci. Policy*, **94**, 20–31, <https://doi.org/10.1016/j.envsci.2018.12.028>.
- Daly, M., and L. Dilling, 2019: The politics of “usable” knowledge: Examining the development of climate services in Tanzania. *Climatic Change*, **157**, 61–80, <https://doi.org/10.1007/s10584-019-02510-w>.
- Dilling, L., and M. C. Lemos, 2011: Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environ. Change*, **21**, 680–689, <https://doi.org/10.1016/j.gloenvcha.2010.11.006>.
- , ———, and N. Singh, 2021: First, do no harm: Scaling usable knowledge for just and equitable outcomes. *Global Environ. Change*, **71**, 102404, <https://doi.org/10.1016/j.gloenvcha.2021.102404>.
- Durose, C., B. Perry, and L. Richardson, 2021: Co-producing research with users and communities. *The Palgrave Handbook of Co-Production of Public Services and Outcomes*, Palgrave Macmillan, 669–691.
- Ferguson, D. B., A. M. Meadow, and H. P. Huntington, 2022: Making a difference: Planning for engaged participation in environmental research. *Environ. Manage.*, **69**, 227–243, <https://doi.org/10.1007/s00267-021-01585-5>.
- Forsyth, T., 2011: Politicizing environmental explanations: What can political ecology learn from sociology and philosophy of science? *Knowing Nature*, University of Chicago Press, 31–46.
- Grecni, Z., L. Shore, and B. Duncan, 2019: Learning from success in climate-informed decision-making: Case studies across three U.S. regions. East-West Center Rep., 34 pp., www.eastwestcenter.org/climate-case-studies.
- Groot, B., A. Haveman, and T. Abma, 2022: Relational, ethically sound co-production in mental health care research: Epistemic injustice and the need for an ethics of care. *Crit. Public Health*, **32**, 230–240, <https://doi.org/10.1080/09581596.2020.1770694>.
- Gurney, G. G., J. Blythe, H. Adams, W. N. Adger, M. Curnock, L. Faulkner, T. James, and N. A. Marshall, 2017: Redefining community based on place attachment in a connected world. *Proc. Natl. Acad. Sci. USA*, **114**, 10077–10082, <https://doi.org/10.1073/pnas.1712125114>.
- Harrington, C., A. Curtis, and R. Black, 2008: Locating communities in natural resource management. *J. Environ. Policy Plann.*, **10**, 199–215, <https://doi.org/10.1080/15239080801928469>.
- Jagannathan, K., J. C. Arnott, C. Wyborn, N. Klenk, K. J. Mach, R. H. Moss, and K. D. Sjoström, 2020: Great expectations? Reconciling the aspiration, outcome, and possibility of co-production. *Curr. Opin. Environ. Sustainability*, **42**, 22–29, <https://doi.org/10.1016/j.cosust.2019.11.010>.
- Kalafatis, S. E., M. C. Lemos, Y.-J. Lo, and K. A. Frank, 2015: Increasing information usability for climate adaptation: The role of knowledge networks and communities of practice. *Global Environ. Change*, **32**, 30–39, <https://doi.org/10.1016/j.gloenvcha.2015.02.007>.
- Kettle, N., K. Dow, S. Tuler, J. Webler, J. Whitehead, and K. Miller, 2014: Integrating scientific and local knowledge to inform risk-based management approaches for climate adaptation. *Climate Risk Manage.*, **4–5**, 17–31, <https://doi.org/10.1016/j.crm.2014.07.001>.
- King, L., and M. Tadaki, 2018: A framework for understanding the politics of science (core tenet #2). *The Palgrave Handbook of Critical Physical Geography*, Palgrave Macmillan, 67–88.
- Kirchhoff, C. J., M. C. Lemos, and S. Kalafatis, 2015: Creating synergy with boundary chains: Can they improve usability of climate information? *Climate Risk Manage.*, **9**, 77–85, <https://doi.org/10.1016/j.crm.2015.05.002>.
- Klenk, N., A. Fiume, K. Meehan, and C. Gibbes, 2017: Local knowledge in climate adaptation research: Moving knowledge frameworks from extraction to co-production. *Wiley Interdiscip. Rev.: Climate Change*, **8**, e475, <https://doi.org/10.1002/wcc.475>.
- Lemos, M. C., and B. J. Morehouse, 2005: The co-production of science and policy in integrated climate assessments. *Global Environ. Change*, **15**, 57–68, <https://doi.org/10.1016/j.gloenvcha.2004.09.004>.
- , and Coauthors, 2018: To co-produce or not to co-produce. *Nat. Sustainability*, **1**, 722–724, <https://doi.org/10.1038/s41893-018-0191-0>.
- Maclean, K., W. Woodward, D. Jarvis, G. Turpin, D. Rowland, and P. Rist, 2022: Decolonising knowledge co-production: Examining the role of positionality and partnerships to support Indigenous-led bush product enterprises in northern Australia. *Sustainability Sci.*, **17**, 333–350, <https://doi.org/10.1007/s11625-021-00973-4>.
- McAlear, Z. L., 2020: Building community resilience to climate change with facilitated, collaborative dialogue: Evaluating the VCAPS process. M.S. thesis, Massachusetts Institute of Technology, 96 pp., <https://hdl.handle.net/1721.1/127619>.
- McNie, E. C., 2007: Reconciling the supply of scientific information with user demands: An analysis of the problem and review of the literature. *Environ. Sci. Policy*, **10**, 17–38, <https://doi.org/10.1016/j.envsci.2006.10.004>.
- Meadow, A. M., D. B. Ferguson, Z. Guido, A. Horangic, G. Owen, and T. Wall, 2015: Moving toward the deliberate coproduction of climate science knowledge. *Wea. Climate Soc.*, **7**, 179–191, <https://doi.org/10.1175/WCAS-D-14-00050.1>.
- Morss, R. E., O. V. Wilhelm, G. A. Meehl, and L. Dilling, 2011: Improving societal outcomes of extreme weather in a changing climate: An integrated perspective. *Annu. Rev. Environ. Resour.*, **36**, 1–25, <https://doi.org/10.1146/annurev-environ-060809-100145>.
- Moser, S. C., and J. A. Ekstrom, 2011: Taking ownership of climate change: Participatory adaptation planning in two local case studies from California. *J. Environ. Stud. Sci.*, **1**, 63–74, <https://doi.org/10.1007/s13412-011-0012-5>.

- Naess, L. O., 2013: The role of local knowledge in adaptation to climate change. *Wiley Interdiscip. Rev.: Climate Change*, **4**, 99–106, <https://doi.org/10.1002/wcc.204>.
- Nalau, J., B. L. Preston, and M. C. Maloney, 2015: Is adaptation a local responsibility? *Environ. Sci. Policy*, **48**, 89–98, <https://doi.org/10.1016/j.envsci.2014.12.011>.
- Orr, K., and M. Bennett, 2009: Reflexivity in the co-production of academic-practitioner research. *Qual. Res. Organ. Manage.*, **4**, 85–102, <https://doi.org/10.1108/17465640910951462>.
- Owen, G., 2020: What makes climate change adaptation effective? A systematic review of the literature. *Global Environ. Change*, **62**, 102071, <https://doi.org/10.1016/j.gloenvcha.2020.102071>.
- , D. B. Ferguson, and B. McMahan, 2019: Contextualizing climate science: Applying social learning systems theory to knowledge production, climate services, and use-inspired research. *Climatic Change*, **157**, 151–170, <https://doi.org/10.1007/s10584-019-02466-x>.
- Phillips, L., L. Frølund, and M. B. Christensen-Strynø, 2021: Confronting the complexities of “co-production” in participatory health research: A critical, reflexive approach to power dynamics in a collaborative project on Parkinson’s dance. *Qual. Health Res.*, **31**, 1290–1305, <https://doi.org/10.1177/1049732321110038>.
- Plank, C., W. Haas, A. Schreuer, J. Irshaid, D. Barben, and C. Görg, 2021: Climate policy integration viewed through the stakeholders’ eyes: A co-production of knowledge in social-ecological transformation research. *Environ. Policy Governance*, **31**, 387–399, <https://doi.org/10.1002/eet.1938>.
- Tuler, S. P., K. Dow, and T. Webler, 2020: Assessment of adaptation, policy, and capacity building outcomes from 14 processes. *Environ. Sci. Policy*, **114**, 275–282, <https://doi.org/10.1016/j.envsci.2020.09.003>.
- Turnhout, E., T. Metz, C. Wyborn, N. Klenk, and E. Louder, 2020: The politics of co-production: Participation, power, and transformation. *Curr. Opin. Environ. Sustainability*, **42**, 15–21, <https://doi.org/10.1016/j.cosust.2019.11.009>.
- Wall, T. U., E. McNie, and G. M. Garfin, 2017: Use-inspired science: Making science usable by and useful to decision makers. *Front. Ecol. Environ.*, **15**, 551–559, <https://doi.org/10.1002/fee.1735>.
- Webler, T., S. Tuler, K. Dow, J. Whitehead, and N. Kettle, 2014: Design and evaluation of a local analytic-deliberative process for climate adaptation planning. *Local Environ.*, **21**, 166–188, <https://doi.org/10.1080/13549839.2014.930425>.
- Wilmer, H., and Coauthors, 2021: Expanded ethical principles for research partnership and transdisciplinary natural resource management science. *Environ. Manage.*, **68**, 453–467, <https://doi.org/10.1007/s00267-021-01508-4>.