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Coproduction Challenges in the Context of Changing Rural Livelihoods

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Abstract: Coproduction is a process that involves scientists and citizens engaging throughout the production of knowledge, decisions, and/or policies. This approach has been widely applied in an international context for addressing global environmental issues. It is customary for scientists to travel to rural communities, where both scientists and local knowledge holders work together and jointly design solutions to pressing problems. Such collaboration, however, often involves high costs for both residents and scientists, which can reduce project effectiveness. This study examines the challenges associated with coproduction in the context of changing rural livelihoods in beneficiary communities. We specifically conduct a self-analysis of the coproduction process led by our own university team, where scientists designed tools for water and crop management together with community members in Peru's Caylloma province. We collected qualitative data on the coproduction challenges in five local districts in Caylloma, using focus groups and semi-structured interviews. Our results indicate that changing socioeconomic conditions in rural communities undermined the long-term sustainability and effectiveness of the coproduction efforts and deliverables. These included increased migration, market integration, and reliance on regional institutions for water and crop management.

Keywords: *agriculture, Peru, Latin America, participation, governance, community-based natural resource management*

Coproduction is an approach that has been increasingly used to address natural resource management challenges. Coproduction involves collaboration between different stakeholders, such as external experts and local resource users, to jointly determine the problems to be addressed, as well as their solutions (Beier et al. 2017). This approach is often suitable for addressing complex issues, such as climate change adaptation and watershed management, requiring complementary knowledge types (Leimona et al. 2015; Wall, Meadow, and Horganic 2017). Individual stakeholder groups rarely have the full range of knowledge, experience, and expertise required to tackle complex social, economic, and environmental problems (Berkes 2010). Through coproduction, multiple stakeholder groups can discuss, negotiate, and co-create practical solutions to their identified problems (Pohl et al. 2010). Such a process is believed to be more effective than top-down or bottom-up decision making alone (Beier et al. 2017).

Coproduction was originally designed as a mechanism to include citizens in the design and delivery of public services that were traditionally created and provided by government alone (Ostrom 1996; Bovaird 2007). However, the concept and related practices have evolved into a highly participatory and collaborative process that can involve multiple stakeholders (government, civil society, private sector) and have been expanded to areas such as watershed management (Leimona

et al. 2015) and climate policy (Lövbrand 2011). Currently, coproduction is seen as a process that promotes intensive and repeated collaboration between external experts and local experts, as well as other stakeholders such as governments, nongovernmental organizations (NGOs), and businesses, with the specific goal of informing better decisions, management practices, and policies (Prokopy et al. 2017; Djenontin and Meadow 2018; Vincent et al. 2018). Figure 1 describes the coproduction cycle in more detail.

In the university research context, coproduction is closely related to Participatory Action Research (PAR), an approach where the research objectives, methods, and outcomes are co-developed by researchers and study participants (Baum et al. 2006). PAR involves the acknowledgement of different values and different forms of knowledge as valid and important and seeks to empower study participants to design projects that are most beneficial to them (Dudgeon et al. 2017). In an international development context, coproduction is also used in more applied projects and for the generation of specific deliverables, such as educational programs for farmers and technologies for soil and plant management (Almekinders 2011; Dalton et al. 2011; Davis et al. 2012; Akpo et al. 2015). Scholars have indicated that there are different types and levels of engagement between researchers, community members, and other stakeholders, as shown in Table 1 (Biggs 1989; Higginbottom and Liamputtong 2015; Meadow et al. 2015). Using the modes of engagement presented in Table 1 as a reference, the coproduction process represents a move away from top-down, contractual, or consultative relationships and toward more collaborative, collegial, equitable, and inclusive forms of interaction (Ahmad, Kyratsis, and Holmes 2012; Akpo et al. 2015; Higginbottom and Liamputtong 2015; Meadow et al. 2015).

When it comes to the actual interaction between different stakeholders, Pohl et al. (2010) outline two spaces for coproduction: the *agora* and the boundary organization. In the *agora*, researchers, community members, and other stakeholders gather and interact in a common space where they deliberate and negotiate various aspects of the proposed project. In such spaces, the "quality of dialogue" is particularly important, especially when stakeholders hold different views (King and Gillard 2019, 702). It is thus necessary for researchers to take on the role of facilitators and mediate between the different stakeholder interests in a way that promotes fairness, sharing, learning, and joint problem-solving (Akpo et al. 2015). Coproduction efforts can also be led by boundary organizations, whose members are professionals that engage with the different stakeholders and facilitate cross-group discussions and negotiation (Pohl et al. 2010). Boundary organizations can include NGOs, university extension offices, and some local or regional government branches. It is important to note that, while the *agora* and the boundary organizations are presented as separate

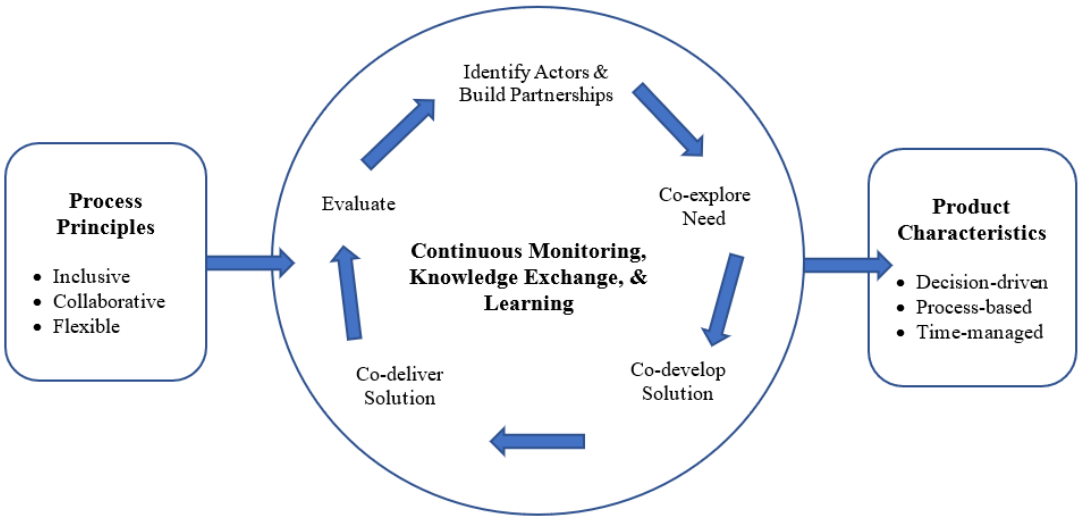

Figure 1. The cycle of coproduction. Source: Adapted from Vincent et al. 2018, 49.

Table 1. Modes of interaction between researchers and other stakeholders.

Mode	Objective	Type of Relationship	Stakeholder Involvement
Contractual	Test applicability of new technology or knowledge	Unidirectional flow of information from researchers to stakeholders	Primarily as passive recipient of new knowledge or technology
Consultative	Use research to solve real-world problems	Researchers consult with stakeholders, diagnose the problem, and try to find a solution	At specific stages of research such as problem definition, research design, diffusion of findings
Collaborative	Learn from stakeholders to guide applied research	Stakeholders and researchers are partners	Continuous with emphasis on specific activities, depending on joint diagnosis of the problem
Collegial	Understand and strengthen local research and development capacity	Researchers actively encourage local research and development capacity	Variable, but ongoing

Source: Adapted from Biggs 1989, 3-4 and Meadow et al. 2015, 183.

elements, they are located on a continuum and can also happen simultaneously. For example, a boundary organization can hold an open discussion in a public space with a wide range of stakeholders (Lemos et al. 2014).

Coproduction, however, is not easy. It is a complex, iterative process that requires time and effort from scientists, local residents, and other stakeholders involved (Lemos and Morehouse 2005). It often requires capacity-building at multiple scales to enable collaboration and knowledge sharing between different actors with different experiences and areas of expertise (van Kerkhoff and Lebel 2015). Stakeholders need to build trusting relationships in order to coproduce, which takes time and effort (Lemos and Agrawal 2006; Bowen et al. 2015; Prokopy et al. 2017), and often includes travel to the sites where coproduction deliverables are implemented (Schuttenberg and Guth 2015). Scholars also advocate for the creation of a coproduction "culture" where collaborative decision making becomes a common approach to solving environmental problems (Lebel, Wattana, and Talerngsri 2015). The literature shows that, when done right, coproduction can be a highly effective and rewarding process, producing benefits that are both tangible (i.e., specific tools or deliverables) and intangible (i.e., new relationships and values) (Alford 2002; Poocharoen and Ting 2015). At the same time, coproduction can be undermined by several obstacles. These include uneven power relations (Bowen et al. 2015; Wyborn 2015; Farr 2018), failure to build trusting relationships (Bowen et al. 2015; Schuttenberg and Guth 2015), lack of support by the larger-scale political or institutional climate (Lebel, Wattana, and Talerngsri 2015), as well as differences in cultural and organizational norms (Castellanos et al. 2013; Campbell, Svendsen, and Roman 2016; Cvitanovic, McDonald, and Hobday 2016).

In this paper, we assess the coproduction challenges that arise in the context of changing rural livelihoods due to shifting socioeconomic conditions, a topic that has been less explored in the literature. Many coproduction initiatives seeking to address issues related to climate change or natural resource management are conducted with local resource users in rural communities (Homsy and Warner 2013; Shaffer 2014; Bremer and Meisch 2017; Laursen et al. 2018). Rural communities are also targeted by coproduction efforts aiming to provide services such as drinking water, electricity, and healthcare to marginalized and underserved populations (Sternberg 2011; Munoz 2013; Brandsen, Steen, and Verschuere 2018; Hutchings 2018). However, rural communities around the world are undergoing rapid transformations caused by globalization, market integration, and migration, among other factors (Aggarwal 2006; Chimhowu 2019). It is unclear how these

socioeconomic stressors affect the coproduction process. We specifically analyze these issues in a coproduction project conducted by our own team in the Caylloma province of Peru. The project is part of a partnership between two universities in which scientists attempted to coproduce tools for water and crop management together with local water users. This paper is a self-analysis of the coproduction process, reflecting on how the process was implemented by our research team and the extent to which coproduction was beneficial for community members in the five districts.

Study Context and Methods

This study examines the difficulties encountered in a coproduction effort led by our own Sustainable Water Management (SWM) team, composed of faculty, staff, and students from Purdue University in Indiana, USA and the Universidad Nacional de San Agustín (UNSA) in Arequipa, Peru. The SWM team is one of several research groups that are part of the Arequipa Nexus Institute for Food, Energy, Water, and the Environment, which is a partnership between the two universities. Over 2018 and 2019, SWM members conducted 144 semi-structured interviews, primarily with community members who earn their livelihood through farming and pastoralism in the districts of Caylloma, Lari, Yanque, Cabanaconde, and Majes in the province of Caylloma, Department of Arequipa, Peru (see Figure 2 for their geographical location and the Appendix for more detailed characteristics). Five of these interviews were conducted with personnel in regional water management agencies in order to obtain contextual information; however, agencies were not the focus of this study. The purpose of this initial qualitative research phase was to both collect qualitative data to understand the context of watershed management in the region and to gather data about community needs as a first step of our coproduction process. Specifically, our interview goals were to: 1) assess the formal and informal institutions for watershed management and 2) identify community needs in terms of water, crop, and pasture management. The interview questions centered around past and present water management practices for agriculture and pastoralism specifically. Participants were asked questions about the formal and informal rules of the local irrigation commission, government regulations for irrigation water, and other laws or organizations that regulated water use for farmers.

As outlined in Table 2, interviewees in the five communities included both leaders (irrigation commission leaders, mayors) and individuals not holding leadership positions. The majority of our interviewees sustained their livelihoods through agriculture and/or pastoralism. As this study specifically targeted farmers, our research participants were relatively homogenous, from a livelihood perspective. All irrigation commission members were farmers, as were irrigation commission leaders who performed their duties without remuneration. Some community members had different professions such as healthcare workers, veterinarians, and tour guides; however, they also practiced some crop farming or pastoralism. The communities were all similar, as most of their residents engaged in crop farming or pastoralism. Because this study specifically targeted farmers, our research participants were relatively homogenous. As will become apparent in the results section, all community members who earned their livelihood through farming activity faced similar socioeconomic pressures.

Based on the information obtained from the interviews, SWM members then conducted focus groups with community members in the five Caylloma districts in 2019. These focus groups gathered feedback on proposed tools for addressing community water management needs, concerns, and priorities in a farming context, as identified in the interviews. As such, the coproduction process in the context of this study involved two phases: 1) semi-structured interviews, where researchers asked participants about their water management practices and their specific needs; and 2) focus groups, where participants were asked to provide feedback on specific tools for water and crop management. Focus groups were conducted using the *agora* approach (Pohl et al. 2010), where SWM researchers worked with local community leaders in each district to organize in-person meetings between the research team and the community members who had participated in the semi-structured interviews. A coproduction approach was considered most appropriate because SWM

researchers wanted to receive as much feedback and participation as possible from farmers when designing the tools, to make sure they effectively addressed local needs.

To obtain feedback on the tools, SWM team members conducted a total of five focus groups, one in each of the study districts. During the focus groups, SWM members reported the needs identified through the semi-structured interviews (specific to that particular community) and sought feedback about whether these needs had been correctly identified. The team presented a preliminary set of tool ideas for water and crop management. These tools included calculation methods for estimating crop water use and irrigation scheduling, fact sheets on 30-year historic climate trends, information on regional crop quantities and growth stage using remote sensing, and water quality testing kits. About 15 people were invited to participate in each focus

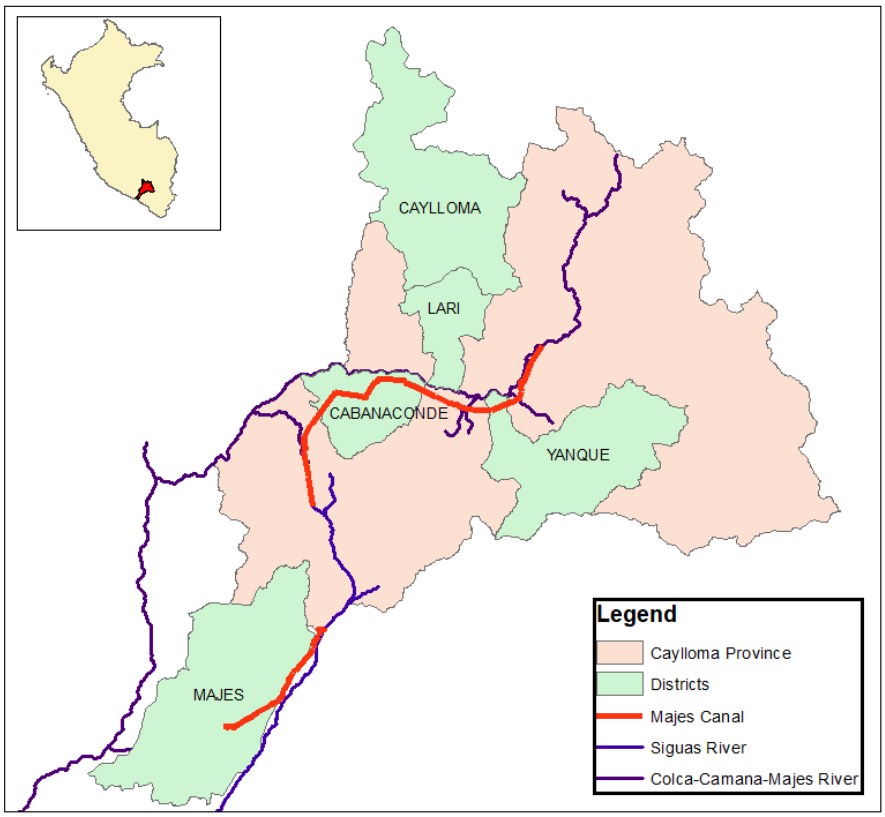

Figure 2. Study districts in the province of Caylloma, Peru.

Table 2. Number of community-level interviews, focus groups, attendees, and key informants.

Location	Interviews (n)	Focus Groups (n)	Focus Group Attendees (n)	Key Community Informants
Caylloma	32	1	1*	• Past and present district authorities (i.e., mayors) • Past and present irrigation commission leaders • Community members that did not hold leadership positions • Community elders
Lari	17	1	~40	
Yanque	25	1	~10	
Cabanaconde	30	1	~40	
Majes	35	1	~10	

*Only one person showed up for the focus group in the Caylloma district. We gave them a paper copy of our results summary, but we did not go through the entire presentation of the tools.

group, including some previously interviewed community members. Attendance ranged from one to about 40 participants (see Table 2).

Focus group participants were invited to provide feedback on the accuracy of the research findings, on the usefulness of the preliminary ideas identified by SWM, and on additional tools they would like the team to develop. SWM members facilitated an open conversation acknowledging the many community needs, the areas of expertise of the SWM team, and the areas of overlap where SWM experts could develop tools to address specific community needs. Figure 3 is an example of a PowerPoint slide that was presented during the coproduction focus groups. The star indicates the "sweet spot" where certain community needs intersected with the SWM team's areas of expertise. Based on information obtained during the initial focus group, the SWM team developed tools and then revised them following additional community feedback to ensure they adequately met community needs.

At the time of the study, SWM members had two additional visits planned to collect input on tool prototypes and to deliver final products. These additional visits were not yet completed and are not reported in this paper. As part of this research effort, SWM members also conducted focus groups with staff from regional water management agencies. However, the community and agency focus groups were conducted separately, and only the analysis of the information from focus groups conducted with community members is explored in this paper.

For this paper, we used the data collected in the first phase to discuss the specific difficulties encountered during the coproduction process, and to explain how these challenges contributed to rising coproduction costs. We analyzed the transcripts of 144 semi-structured interviews and five focus groups conducted by the SWM team during 2018 and 2019. Interview and focus group transcripts were analyzed in NVivo (version 12), a software for qualitative data analysis. We conducted thematic coding (Saldaña 2009), identifying commonly mentioned community needs and obstacles to coproduction. After the obstacles to coproduction were identified, we conducted process coding (Saldaña 2009) by tracing the chain of events and the underlying causes leading to those obstacles. The codebook was revised by two of the coauthors, who convened to discuss definitions and coding methods until agreement was achieved. Interviews were transcribed and analyzed in Spanish, and the quotes included in this paper were translated to English.

Figure 3. Coproduction focus group objective.

Results

This section describes the challenges to coproduction encountered by the SWM team in the context of changing rural livelihoods. We identified two specific challenges, namely community members' declining ability to participate in ongoing coproduction efforts, as well as the transfer of local irrigation water management responsibilities to regional-level organizations.

Declining Ability to Participate in Ongoing Coproduction Efforts

While coproduction focus groups were well-attended in four of the five study communities, we found that community members had limited ability to participate in longer-term coproduction efforts that required follow up with key community contacts. In all five study districts, we found that community members were under economic pressure to work multiple jobs, reducing their capacity for continual participation in coproduction.

Interviewees in Caylloma, Lari, Yanque, and Cabanaconde told us that several decades ago, community members practiced subsistence pastoralism and crop farming. Farmers had few reasons to leave their communities. They would barter in local fairs to obtain food, clothes, and other

items. Over time, the economic pressures created by globalization and market integration led many community members to abandon their farmland and migrate to larger cities or different countries. These pressures also pushed community members who chose to remain in their district of origin to commute and take on additional employment. Interviewees told us that the fluctuating prices of crops and the low price of alpaca meat and wool (usually sold to market intermediaries for a fraction of their market price) pushed them to seek other employment opportunities. As one farmer interviewee put it, "*It used to be possible to live from the farm alone. Now we need to work multiple jobs.*" Villagers supplemented their income by travelling outside their district to larger cities such as Arequipa, where they worked as farm laborers on other people's farms, tradesmen, shop owners, and miners, among other jobs. Some community members also held professional positions such as veterinarians, nurses, engineers, and crop advisors. It was also common for community members to own a house in their district of origin, as well as another one in a larger city such as Arequipa, and to commute between the two places for work. A second house in a larger city also enabled community members to send their children to better schools and ensure their employment opportunities outside the farm after graduation. In the coastal Majes district, formed in the more recent 1970s, the original settlers who migrated in the early 1980s practiced export-oriented agriculture from the onset. However, interviewees from Majes also reported an increase in out-migration and commuting.

In all five study districts, interviewees linked market pressures, out-migration, and commuting to decreased ability to organize and to participate in community meetings and events. As one community leader expressed, "*There is a lot of out-migration and it is difficult to get organized now. It is a lot more difficult, even though it's easier to communicate with technological advances. We have cellphones and communicating is faster than ever."*

Specifically, community members in Caylloma, Lari, Yanque, Cabanaconde, and Majes reported decreased attendance in general assemblies organized by their local irrigation commissions and their municipalities. Interviewees also said there was less participation in community celebrations. Several interviewees made comments such as, "*Before we were more united, everyone attended meetings"* and "*Now, people are less available.*"

Reduced ability to participate in group activities affected the majority of our interviewees across communities. The pressure to commute and/or work multiple jobs affected community members whose income varied based on market fluctuations. Given that our study districts were populated by farming communities, almost all our interviewees and focus group participants were crop farmers and pastoralists. This included the leaders of the local irrigation commissions, who were farmers themselves and did not receive any monetary compensation, as well as some mayors and municipal workers. They reported that the low prices of crops and of alpaca meat and wool forced them to diversify their income by pursuing additional economic opportunities, leaving them with less time to participate in community activities. Even relatively wealthier community members, with professional degrees (i.e., veterinarians, healthcare workers) or employed in the local tourism market (i.e., tour guides, restaurant and hotel owners) told us that they worked long hours and/or multiple jobs which prevented them from attending community meetings. As one healthcare worker and part-time farmer put it, "*I don't really go to meetings because I'm busy working [in the health center]. […] During my free time, I work on the farm. […] I recently went to a community meeting after a year of not attending because I happened to be free that day.*" Community members receiving a fixed and regular salary included schoolteachers and principals, municipal workers (although their position was usually temporary, lasting until the new election cycle), priests, and healthcare workers. However, the wages paid to full-time workers were generally low, and it was very rare to find a person that did not have one or more side businesses in addition to their main job.

Declining community cohesion and participation in meetings and events posed obstacles for the coproduction initiative led by SWM. For example, the SWM team sent personalized invitation letters to key contacts interviewed during Phase 1 of the study. These key contacts included mayors,

community leaders, and farmers who indicated interest in the coproduction process. Though they had initially agreed to participate and the focus groups were scheduled and confirmed several weeks in advance, many community members had to make last-minute trips to Arequipa to attend to other business. In the districts of Caylloma and Majes, none of the key contacts interviewed during Phase 1 were able to participate in the focus groups on specific dates that were set based on their own availability. In Caylloma, only one person showed up and SWM members gave him a pamphlet summarizing the research results but were forced to cancel the focus group. In Majes, SWM members managed to gather ten community members with the help of local contacts, moments before the focus group was scheduled to start. In the districts of Lari, Yanque, and Cabanaconde, a few community members that received invitation letters were present at the focus groups. Additional community members also became interested and decided to attend once the focus group started, a common occurrence in smaller villages. However, members of SWM were not able to follow up with many of their original key contacts. Thus, while some focus groups were well-attended, they were not always attended by the original contacts, making it difficult to establish the ongoing relationships necessary to the coproduction process.

An additional coproduction challenge was that most of the tools developed by SWM were designed to address discrete and specific challenges related to water and crop management. These included apps for selecting an appropriate crop mix given water limitations or monitoring the water demand of currently growing crops. As such, the tools only addressed one part of community members' increasingly diversified livelihoods. Furthermore, the issues that were listed as most pressing by farmers were economic in nature, including fluctuating crop prices and the lack of agricultural insurance. Not only were SWM members not qualified to address economic issues, but these issues were too broad in scope to be addressed by a single team of university researchers. With today's globalized economy, farmers need cross-cutting solutions that address the issues created by markets. While the economic issues that emerged from the qualitative interviews with community members were discussed among SWM members, it was decided that the scope of coproduction would be limited to the specific water- and crop-related issues that fell within the expertise of SWM researchers.

To generate effective solutions, the coproduction process would have ideally included members from regional water agencies and NGOs. Personnel in these regional organizations have a deep understanding of farmer livelihoods and might have been able to brainstorm potential ideas. Therefore, successful coproduction not only depends on creating an *agora* where stakeholders can deliberate, but it is also important to include boundary actors that have the power and resources to address community concerns. In fact, the inclusion of boundary organizations in the coproduction process might be increasingly important as rural communities become more globalized and integrated into regional markets.

Local Responsibilities are Increasingly Transferred to Regional Organizations

An additional reason limiting community members' long-term participation in coproduction is that watershed management responsibilities, previously localized, are increasingly being transferred to regional organizations. While community members agreed to participate in the coproduction process, many saw water management as the responsibility of regional officials.

Before the 1990s, water management for farming practices in Peru was mainly carried out through local irrigation commissions, which were the main bodies governing the allocation of irrigation water. Their boards of directors, composed of elected community members, were responsible for overseeing the irrigation schedule, the amount of water used on each plot, sanctioning for irrigation-related infractions, and irrigation infrastructure maintenance, among other tasks. Irrigation commissions are still in place today[1],

[1]At the time of our study, crop farmers in the districts of Lari, Yanque, Cabanaconde, and Majes were organized in irrigation commissions operating at the sub-district level. In the Caylloma district, pastoralists did not have formal irrigation commissions because their irrigation needs were minimal compared to crop farming. However, they were in the process of forming them at the time of our study.

but they operate in conjunction with regional-level watershed management institutions, which gradually took on some water management tasks.

In the 1990s, the World Bank funded the development and strengthening of regional-level Water Users' Associations (*Juntas de Usuarios*), which are organizations that represent all water users (and multiple irrigation commissions) in a particular region (Vera Delgado and Vincent 2013). In 2009, the Peruvian government adopted a new Water Resources Law (*Ley de Recursos Hídricos*) and established the National Water Authority (ANA, *Autoridad Nacional del Agua*), a central organization with local branches, overseeing water management and distribution throughout Peru (Filippi et al. 2014). Water Users' Associations and local ANA branches took on some responsibilities that were previously conducted by irrigation commissions for which farmers now pay a water fee. Specifically, decisions regarding the irrigation water amount to be used by each farmer are now determined by ANA. Interviewees explained that in the past, they had district-level waterkeepers that allocated water. One interviewee told us that "*My grandfather was a waterkeeper […] He made sure that everyone had sufficient water and that everyone finished irrigating on time. The waterkeeper worked for free […] It was a form of service to the community. We didn't pay […] Now, we no longer have waterkeepers."*

Now, the irrigation water amount to be used by each farmer is determined by the ANA; however, local irrigation commission authorities still set the irrigation schedule and ensure that farmers do not irrigate past their allocated window. In addition, local conflicts that are difficult to resolve can be elevated to the Water Users' Associations, and then to the ANA, which reviews the case and applies the necessary sanctions. An additional responsibility transferred to the Water Users' Association is the oversight of irrigation infrastructure maintenance and repair. This organization collects annual watershed management plans from irrigation commissions, who are given the option of paying a higher water fee in exchange for help with irrigation infrastructure repair and maintenance. In the past, community members organized regular *faenas* (groupwork days), where they gathered to perform canal maintenance and infrastructure repairs. Now, interviewees report a decline in this practice. One farmer said that "*Now, group work is diminishing, little by little.*" Furthermore, community members made comments such as "*Irrigation canal maintenance and repair are the responsibility of the Water Users' Association*" and that "*ANA should come and see what infrastructure we are missing. For example, [ANA should] help us build reservoirs*."

This upward delegation of water management responsibilities (Popovici et al. in press) has made it more difficult to coproduce directly with communities because community members now rely on and expect regional organizations to solve water-related problems. In fact, several interviewees reported that "*ANA and the Water Users' Association should be more present in [their] community*" in order to help resolve conflicts and repair irrigation infrastructure. In theory, the tools could be distributed by local Water Users' Associations and ANA branches, which would involve training their personnel in the coproduction process. In practice, however, these organizations are understaffed and lack the necessary time and resources to participate in the necessary trainings and to take over tool distribution. This was especially true for the Water Users' Association located in Chivay, which represented water users in Lari, Yanque, and Cabanaconde. The manager of the Water Users' Association in Chivay told us that "*According to the 2009 Water Resources Law, Water User Associations are supposed to have nine full-time technical staff. But here, we only have three.*"

Thus, we are witnessing a shift in Caylloma's rural areas where community members are increasingly busy, reducing their ability to participate in community gatherings and efforts to manage their local water resources. At the same time, government agencies are stepping in and taking on some of the local water management responsibilities, although these efforts are incomplete due to lack of capacity. To address the gap between local needs and incomplete assistance from regional water agencies, community leaders in some local districts decided to hire experts such as lawyers, hydrologists, engineers, and business experts, to provide technical and targeted advice

in exchange for payment (Popovici et al. in press). At the time of our study, irrigation commissions in two of the five districts had hired engineers and hydrologists to design blueprints for a small dam that would increase water supply for agriculture. Furthermore, leaders in two other districts had hired lawyers to advocate for a change in ANA water regulations on their behalf. Therefore, we are seeing the emergence of contractual relationships between experts and community members, which, according to interviewees, were less common over ten years ago.

During the coproduction focus groups, some of the community members made comments that suggested they expected to form similar consultant-client relationships with SWM researchers. For example, some community members expected us to give them a diagnosis along with proposed solutions to some of their water-related issues (i.e., what should be the optimal water quality or optimal irrigation schedule). While SWM researchers strived to take on a facilitator role and encouraged brainstorming and open discussion about potential solutions to water-related issues, some community members made comments such as "*We don't have enough knowledge. You're the experts*" and "*What do you think we should do?*" While a top-down transfer of ideas is assumed to produce less effective and less equitable outcomes, there nevertheless seems to be a demand for quick and expedient solutions from busy community members. Such transfer of knowledge would ease their participation burdens and free up their time to be spent on economically productive activities.

Discussion and Conclusions

Coproduction is already recognized as a complex and time-consuming process (Lemos and Morehouse 2005; Briley, Brown, and Kalafatis 2015). This is because coproduction often requires capacity-building to enable stakeholders to build relationships with each other, address power imbalances, and engage with stakeholders in different areas (van Kerkhoff and Lebel 2015). In this paper, we have outlined additional factors that complicate the coproduction process in rural areas, namely the decline in community members' ability to participate in long-term coproduction efforts and the transfer of water management responsibilities from local to regional organizations. Together, these two processes mean that successful coproduction requires additional elements in order to be successful.

Indeed, coproduction must account for community members' changing livelihoods and priorities, posing some obstacles to the iterative and intensive relationship-building needed for this process to be successful. In particular, it was difficult for community members to participate in coproduction because attending a focus group to provide input might result in missed travel or work opportunities. Furthermore, community members had multiple occupations and were becoming less dependent on crop farming and pastoralism, a trend that has been documented in Peru and other parts of the world (Bryceson 2002; Desta and Coppock 2004; Popovici et al. in press). In contrast, the tools presented by SWM in the coproduction focus groups with community members (most of whom were farmers) were mainly focused on improving water management for agriculture. Thus, community members may derive fewer benefits from coproduction focus groups because they only relate to a part of their livelihoods.

Specifically, it might be necessary to involve organizations that can play a boundary role between different stakeholders. This could ease some of the participation burden for community members, as well as some of the travel and other relationship-building costs for researchers. To date, much of the coproduction efforts presented in the literature have focused on empowering community members to be able to participate in the process. However, it might be equally important (if not more so) to focus on building the capacity of regional institutions to conduct coproduction efforts or other appropriate forms of participation. In fact, given the socioeconomic pressures faced by community members, the arena of coproduction might have to shift from in-person meetings with community members to meetings with boundary organizations, whose members can represent various stakeholders, including local communities.

Furthermore, the livelihood changes observed in rural communities pose a new set of challenges when it comes to managing power relations between researchers and community members. In

particular, the heavy participation requirements in the form of an *agora* may be a burden for research participants who are increasingly outsourcing some of their water management responsibilities to regional organizations. Thus, there seems to be a local demand for transactional relationships with experts, as opposed to intensive collaboration that relies on in-person participation. In contrast to these trends, SWM researchers assumed that a collaborative coproduction approach would be the most empowering for community members. Nevertheless, the coproduction process imposed costs on both researchers and community members (Oliver et al. 2019). This indicates that even a collaborative approach can be harmful if it is led by a stakeholder group that is well-meaning but operating on assumptions about collaboration and participation that might not match local preferences for more expedient solutions based on more transactional relationships.

Given these challenges, it might be beneficial for the organizers of coproduction focus groups or other participatory efforts to offer monetary compensation to community members for attending. In addition, coproduction efforts need to consider and accommodate diversified lifestyles. Initially, SWM researchers attempted to identify a subset of community representatives that would be best suited to participate in coproduction, namely local leaders and individuals that expressed an interest in participating in our study. However, these individuals also faced the pressure to travel for work and coproduction inevitably became less of a priority. For this reason, allowing more time for the coproduction process might be necessary in order to identify the community members that have the most time, interest, and ability to participate.

Another strategy for approaching busy individuals, particularly farmers, is through individual interviews, rather than focus groups. In this study, both interviews and focus groups were conducted in each community. Interviews better accommodated schedules of the participants because they could be working in the fields during the process. Interviews were also generally shorter than focus group meetings, taking up less time of each individual. However, this method may be more time-consuming for the interviewer, as they have to repeat the process many times.

The transfer of water management responsibilities for irrigation to regional water agencies further complicates the coproduction process, and changes its focus. The fact that local community members have less decision-making power over the management of their irrigation water makes it difficult for them to take full ownership of the tools developed in the coproduction focus groups. Furthermore, it becomes necessary to involve regional water agencies in the coproduction process. A possible way to do this is to conduct coproduction focus groups with both community members and agency personnel as participants, present in the same room. This way, participants can be prompted to discuss who will be responsible for distributing the tools as well as strategies for maintaining tool continuity after they have been developed.

However, researchers need to be mindful that regional water agencies might not be able to take on additional responsibilities due to limited funding and high staff turnover (Rahmani 2012), among other issues. Coproduction projects thus need to find a way to build capacity without increasing the burden for regional water agency staff members. A possible solution might be to use project funds to hire a local consultant who could work under the supervision of regional organizations and ensure the tools developed through coproduction are distributed to community members. Another solution may be to create a local partnership with in-place institutions that can serve as boundary institutions in the coproduction process. This could provide a level of understanding local norms and information-gathering, as well as ensure distribution of final products developed to community members.

In sum, successful coproduction must operate across multiple scales while at the same time accommodating community members' changing livelihoods. Such efforts are likely to require more funds, time, and effort (Bidwell, Dietz, and Scavia 2013; Briley, Brown, and Kalafatis 2015), as well as a different model of engagement with stakeholders. Rather than relying on a prescriptive manual of who to engage in a coproduction process and a rigid set of procedures of how to engage stakeholders, it is important to recognize that the coproduction approach itself needs to be responsive

and adaptive to the context within which it is applied (Bremer and Meisch 2017). Additionally, with increased globalization and market integration in rural societies, we see less demand for co-creation and more demand for expert consultation. In such a context, a traditional research method with deliverables developed through consultation might be more appropriate. Coproduction can still be pursued through boundary organizations, who could perform negotiations on behalf of community members and/or help build local capacity should communities wish to engage in coproduction through the *agora* method. Ultimately, researchers and practitioners who are interested in coproduction need to carefully consider the following questions before, as well as during, the recruitment and engagement of stakeholders: 1) who would receive direct benefits from engaging in coproduction?, 2) what capacity do different stakeholders have to engage in coproduction?, and 3) what can be done to contribute to stakeholders' agency to influence change as part of a coproduction process? Regularly reminding ourselves of these important questions and adapting our practices of engaging stakeholders accordingly can greatly improve the chance of success for all who are involved.

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Appendix: Characteristics of Our Five Study Districts

As shown in Table 3 below, our five study districts varied in terms of elevation, population, water source and water availability, land owned, and main income source. The district of Caylloma has an elevation of 4,310 meters above sea level, where most crops do not grow. Thus, agricultural producers interviewed were pastoralists raising alpacas, llamas, and some other livestock such as sheep. The districts of Lari, Yanque, and Cabanaconde are small villages largely populated by crop farmers who practice small-scale terraced agriculture. The main crops grown in these districts are maize, barley, garlic, broad beans, quinoa, and alfalfa. In addition to glacier melt and natural springs, the districts of Yanque and Cabanaconde receive irrigation water from the Majes Channel. The Majes Channel is a government-sponsored water diversion project constructed in the 1970s that brings water from the Condoroma Dam near the Tuti district (located upstream from the Yanque district but downstream from the Caylloma district) to the coastal Majes District (Stensrud 2016). Thus, the Majes district is a "new" community that does not have the same social history as the other study districts. The Majes Channel is the main source of irrigation water for the Majes district, where crop farmers practice larger-scale agriculture.

Table 3. Characteristics of the study districts.

Study Districts	Elevation (m)	Population	Water Sources	Average # Hectares per Household	Main Sources of Income
Caylloma	4,310	3,697	Glacier melt; Natural springs and rivers	100	Pastoralism; Mining industry
Lari	3,330	904	Glacier melt; Natural springs and rivers	1	Agriculture; Some pastoralism
Yanque	3,417	2,117	Glacier melt; Natural springs and rivers; Majes Channel	1	Agriculture; Some pastoralism; Tourism
Cabanaconde	3,296	2,096	Glacier melt; Natural springs and rivers; Majes Channel	1.5	Agriculture; Tourism; Remittances
Majes	1,410	60,108	Majes Channel	5	Agriculture