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Self-organization for community resilience in an invisible agricultural community

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This study investigates how self-organizing efforts by residents of informal settlements, primarily migrant and informal farmworkers, shape community resilience in Majes, a water-scarce irrigation district in the Atacama Desert of Peru. We collected 45 semi-structured interviews with residents and authorities in Majes and analyzed findings through a framework of self-organizing. Analyses revealed that self-organizing by residents of informal settlements incorporated the three components of White's theory of Community Agency and Community Resilience, which contends that marginalized communities increase resilience by fostering a *commons praxis*, practicing a *prefigurative politics*, and developing opportunities for *economic autonomy*. We also found that residents self-organized into associations to increase access to resources, resulting in increased resilience. However, certain fees, corruption, and undemocratic decision-making processes can be detrimental to self-organizing. Results expand existing theories of self-organization and community resilience by highlighting how residents of informal settlements in agricultural spaces collectively organize to increase their resilience. Findings also begin to reframe narratives that describe migrants and farmworkers as powerless in the face of water scarcity, climate change, and other social-ecological risks.

KEYWORDS

agricultural labor, praxis, informal settlements, farmworker, social-ecological change, Peru, migration, irrigation project

1. Introduction

Scholars from across the social and ecological sciences have long argued that self-organizing entities can display more resilience in the face of a change or disturbance (Berkes and Ross, 2013). Self-organization can be particularly important for communities that face multiple obstacles to gaining support from public institutions. One such demographic is residents of informal settlements (Satterthwaite et al., 2020). For instance, approximately 1 billion people across the globe live in informal settlements, defined as areas, largely outside of municipal boundaries, where people settle and live in often poor-quality homes (Satterthwaite et al., 2020; United Nations, 2022). People that live in informal settlements often live without land titles and thus lack resources such as water, electricity, and sewer (UN-Habitat, 2018; Satterthwaite et al., 2020). Research on informal settlements, especially from a social-ecological change perspective, is still forming. More recently, however, scholars have taken notice and made calls to increase investigation on vulnerabilities and risks caused by climate and other social-ecological changes and adaptations to address those vulnerabilities and risks in informal settlements (Melore and Nel, 2020; Satterthwaite et al., 2020; Carrilho and Trindade, 2022). Even with this recent interest,

there is still an overall lack of research looking at how residents of informal settlements address ongoing social-ecological risks and changes. Even less has focused on informal settlements outside of large urban settings.

This is an important gap because informal settlements do not just develop in urban settings. In Peru, for example, informal settlements emerge as a result of the government's implementation of numerous large-scale water transfer projects (LWTP) that carry water from the eastern part of the country to the coastal desert regions in the west (Stensrud, 2016; Mills-Novoa and Hermoza, 2017; Damonte, 2019; Mills-Novoa, 2019; Erwin et al., 2022). Many of these projects aim to stimulate agricultural development by providing farmers and agricultural companies access to water in a desert region. One example is the Majes-Siguas Irrigation Project, which delivers water from the highlands to the Majes district (from here on, Majes) in the Arequipa department of Peru. In Majes, the irrigation project supports farmers and agricultural companies that sell on domestic and international markets (Stensrud, 2019). Over time, many farms hired migrants to conduct day-to-day farm work and irrigation activities. These employment opportunities prompted many people to continue to migrate, away from smallholder agricultural communities in the mountains, to live in undeveloped, informal settlements and to work on farms (Erwin et al., 2021, 2022). With this influx of migrant farmworkers, scholars estimate Majes's current population to be approximately 120,000 people, even though Majes was only designed to provide land titles and associated water to approximately 40,000 people, including owners of commercial farms, farmworkers who work on these commercial farms, and those who work and live in the town center (Stensrud, 2016, 2018). Consequently, despite the economic success of the irrigation project, Majes regularly experiences water insecurity (Erwin et al., 2021, 2022) and faces ongoing social-ecological risks due to such water insecurity. In particular, the Majes-Siguas canal is Majes' only source of water, and its infrastructure has started to crumble over the years (Stensrud, 2016; Erwin et al., 2022). Furthermore, the region of Arequipa, where Majes is located, is already experiencing shifts in water supply and quality, temperatures and growing seasons, and other related climatic and social-ecological changes (Postigo, 2014; Erwin et al., 2021, 2022; Popovici et al., 2021b; De Moraes et al., 2022).

As is the case with many other places around the world, informal settlements often develop outside of municipal boundaries. Many people arrive and settle in Majes, only to live in informal settlements on the outskirts of farms, without water, electricity, sewer, or legal access to land. This situation tends to result in public institutions in places like Majes neglecting the needs and priorities of the residents of these informal settlements (Nassar and Elsayed, 2018; Satterthwaite et al., 2020; Erwin et al., 2021, 2022). This negligence often renders residents of informal settlements invisible (Shatkin, 2004; Dovey and King, 2011). The lack of consideration for the needs and priorities of informal settlement residents in dominant cultural narratives and discourses, policy and planning documents that shape urban spaces, and social and political entities that create and implement laws tends to further marginalize these residents (Dovey and King, 2011; Erwin et al., 2022). It is also worth noting that in Peru and beyond many new residents to informal settlements are domestic or international migrants (Chambers, 2005; UN-Habitat, 2018; Baye et al., 2020; Tagliacozzo et al., 2021; Erwin et al., 2022), many of whom are employed as farmworkers (Arcury and Quandt, 2020; Tagliacozzo et al., 2021). Research on farmworkers, particularly in the Global North, shows that farmworkers are often rendered invisible by social, political, cultural, and economic factors and processes (Guthman, 2004; Gray, 2013; Minkoff-Zern, 2014; Erwin, 2022b). As such, individuals with the dual identity of farmworkers and new migrants may experience further invisibility, due to their profession and their residence in informal settlements. Even with this invisibility, research across the globe has shown how farmworkers and/or residents of informal settlements gain access to resources through self-organizing and partnering with NGOs (Arguello, 2010; Minkoff-Zern, 2014; Rivera and Kapucu, 2015; Amoako, 2018; Mares, 2019; Braier, 2020; Thompson, 2021; Erwin, 2022a,b). However, there is still limited understanding of how self-organizing can support resilience of those who are both residents of informal settlements and farmworkers in places like Majes.

This case study begins to address these gaps by asking: how do residents of informal settlements built around the Majes-Siguas Irrigation Project, mainly people who work for farmers and conduct in-home agricultural activities, organize to increase their power over and access to water? We address this question by analyzing 45 semi-structured interviews conducted with residents and leaders of informal settlements, as well as public water employees, in Majes. We analyzed the interview data through a framework of self-organization described as a bottom-up process of individuals, households, and communities exercising agency to come together to articulate and address issues of their concern (Berkes and Ross, 2013; Edelenbos et al., 2018). Our analyses revealed connections between self-organizing and community resilience. In particular, our results show that self-organizing in Majes incorporated three integral components of White's (2019) theory of Community Agency and Community Resilience (CACR). This theory contends that communities increase resilience by fostering a *commons praxis* where communities work collectively to access natural resources, encouraging *prefigurative politics* by constructing alternative, democratic decision-making spaces, and developing opportunities for *economic autonomy* through pooling funds to support community-scale development projects. Our results demonstrate that even though there are limits to self-organization, it can be key to increasing the resilience of an invisiblized community, like the farmworkers who are residents of informal settlements around the Majes-Siguas Irrigation Project. Increased attention to how these communities self-organize could contribute to reframing dominant narratives that focus on the powerlessness instead of the agency of these communities in the face of social-ecological change.

2. Literature review: self-organization and community resilience in informal settlements in agricultural regions

Scholars utilize self-organization to understand processes such as collective action, community engagement, and participatory policymaking that urban communities use to make change and work toward more sustainable outcomes (Horelli et al., 2015; Rivera and Kapucu, 2015; Edelenbos et al., 2018; Hasanov and Zuidema, 2018). To date, research on self-organization has often focused on how community-led processes support efforts toward urban sustainability in places like the Netherlands, Sweden, the United States, and the

United Kingdom (Horelli et al., 2015; Edelenbos et al., 2018; Hasanov and Zuidema, 2018). Previous research has illuminated numerous community-driven initiatives while also articulating the limits to self-organization; this research also highlights when support from and collaboration with local government is necessary for moving forward toward community objectives (Edelenbos et al., 2018). Previous research has also made headway into understanding how emergent community processes respond to change; however, much of this work takes place in urban spaces in the Global North. Because of this focus, scholars have called for additional studies into how self-organization unfolds in other contexts and its relationship to community resilience in those contexts (Rivera and Kapucu, 2015).

Scholars and policymakers are also pushing for increased attention to the ways that marginalized communities address their priorities, especially in the face of social-ecological risk and change (Erwin et al., 2021). For instance, the growth of informal settlements, their interconnectedness to urban areas, and the vulnerabilities that these informal settlements produce for residents in these settlements and surrounding areas, has caught the attention of scholars and the United Nations (Nassar and Elsayed, 2018; UN-Habitat, 2018; Satterthwaite et al., 2020; Carrilho and Trindade, 2022). Informal settlements often develop in environmentally fragile areas, such as steep hills, floodplains, coastal shores, garbage dumps, and riverbanks, which expose residents to risks such as landslides, flooding, and toxic pollution (Dovey and King, 2011; UN-Habitat, 2018; Satterthwaite et al., 2020). Informality also leads to political negligence, which can prevent or delay health and sanitation infrastructure projects that address public and environmental health risks (Nassar and Elsayed, 2018; UN-Habitat, 2018). This negligence, in turn, increases communities' vulnerabilities to various infectious diseases, environmental threats, and other risks (Nassar and Elsayed, 2018). Together, this literature demonstrates ongoing challenges that residents of informal settlements experience, as well as a need for research on how these challenges emerge in informal settlements outside of urban areas such as rural mountain communities or agricultural regions (Melore and Nel, 2020; Tagliacozzo et al., 2021).

Increased attention to informal settlements in agricultural regions is important for multiple reasons. Unlike residents of urban informal settlements who often work in industry, residents of informal settlements in agricultural regions often work or have worked as farmworkers, a group that is often rendered invisible by existing social, political, and economic institutions (Guthman, 2004; Gray, 2013; Erwin, 2022b). Scholars argue that this intentional or unintentional invisibilization, along with many farmworkers' undocumented status, limits their social, political, and economic power and their overall capacity to make change (Gray, 2013; Erwin, 2022b). In the United States, farmworkers are also made spatially invisible by living in housing hidden behind farmers' residences or in rural neighborhoods around agricultural areas (Summers et al., 2015). Tagliacozzo et al. (2021) is one of the few studies to focus on informal settlements in agricultural regions. In this study, the authors investigated the ways that the COVID-19 pandemic impacted the livelihoods of migrant farmworkers, largely people from the Middle East and Africa, in the agricultural area of Capinata, Italy. Their results show how informal settlements provided refuge for some undocumented farmworkers; at the same time, their rural, isolated locations increased their vulnerabilities, including COVID-19 infection and death rates (Tagliacozzo et al., 2021). Overall, they argued that informality increased structural and systemic vulnerabilities, rather than decreasing them.

So far, most research on farmworkers has focused on the ways that invisibility and informality produce farmworker vulnerabilities and thwart efforts toward social change. However, recent scholarship has illuminated how Black farmers in the American South increased their community's resilience to ongoing social, economic, and racial oppressions by organizing into agricultural cooperatives (White, 2017, 2019). In this work, White (2019) introduces the theory of CACR, which contends that marginalized communities can increase their resilience by fostering a commons praxis, encouraging prefigurative politics, and developing opportunities for economic autonomy. White's research laid the theoretical foundation for studies that endeavor to illuminate the ways in which marginalized agricultural communities self-organize in the face of numerous vulnerabilities and injustices. Her work also demonstrates the importance of documenting and analyzing how community resilience is important, not only in the face of disasters, but also as communities face ongoing racial, political, and economic oppressions and social-ecological change (White, 2017, 2019).

Even with White's groundbreaking research, there is overall little understanding as to what mechanisms increase the efficacy of self-organizing leading to community resilience, especially as it relates to decreasing vulnerabilities of marginalized agricultural communities. Scholars argue that "there is a need for a careful investigation into the internal and external aspects of different ways of organizing" (Hasanov and Zuidema, 2018, p. 91). In this paper, we begin to address these needs by investigating how farmworkers living in informal settlements in Majes, Peru self-organize and how such process relates to community resilience. Specifically, we investigated how people self-organized into associations to increase their access to basic resources and advocate for laws to both decrease inequality and increase Majes' resilience in the face of social-ecological change. In what follows, we first describe the case background and research site, with a particular emphasis on why and how people experienced water and land insecurity in Majes. We then document how residents of informal settlements actively engaged in activities where they collectively responded to change, with neighbors, in associations, and with landowning-farmers and examine if these associations made space for a prefigurative politics, commons praxis, and economic autonomy.

3. Research design and methods

3.1. Case background: informal settlements around the Majes-Siguas Irrigation Project

This case takes place in the Majes district of Peru, located in the Atacama Desert of in the department of Arequipa, an area that before the 1980s, was largely desert. In the mid-1980s, however, the Peruvian government built the 101-kilometer Majes-Siguas canal (see Stensrud, 2016, 2018, 2019, 2021; Mills-Novoa and Hermoza, 2017; Damonte and Boelens, 2019; Mills-Novoa, 2019; Erwin et al., 2022). The Majes-Siguas Irrigation Project, initially costing 18,000,000 Peruvian soles or 5,000,000 USD, changed the landscape from a desert, unpopulated area, to an agricultural export zone. The canal was initially designed to supply non-potable water to farm lots that were distributed to willing farmers through a lottery process. Approximately 2,600

farmers and their families gained access to land through lottery and a few other means (Stensrud, 2016). With this land, they received land titles and generally used their five-acre plots to grow crops like quinoa, avocado, and cactus using a mix of drip and sprinkler irrigation systems. Some farmers also raised livestock to sell on domestic and international markets.

The canal is the district's only source of water. It supplies water to hydroelectric dams which in turn generates electricity for the district. The canal also supplies potable water to the district including a small commercial center and irrigation water to all the landowning farmers in the area (Stensrud, 2021; Erwin et al., 2022). At the same time, the population has grown significantly over the last forty years, from a population of zero to estimates of up to 120,000 people (Stensrud, 2016, 2018). The district and the canal now support numerous agricultural businesses beyond the initial 2,600 farms, including one of the largest dairy productions in Peru with an estimated output of 600,000 liters of milk a day (Stensrud, 2019).

All water allocated through the canal originates from the Colca Valley, an area threatened by climate and other social-ecological changes (Erwin et al., 2021, 2022; Popovici et al., 2021a,b; De Moraes et al., 2022). The canal, the sole engineered water diversion system in Majes, has also started to degrade due to extensive use and earthquakes (Stensrud, 2021; Erwin et al., 2022). In addition, Majes, along with a neighboring irrigation district, La Joya, have adopted lax irrigation rules that allow farmers to irrigate without limits, increasing the likelihood of landslides (Lacroix et al., 2020; Flamme et al., 2022). Over the last few years, many water cuts have been imposed to conduct maintenance on the crumbling canal (Stensrud, 2016; Erwin et al., 2022). Sometimes these cuts last for up to 10 days. During this time, water is rationed and people who have access to reservoirs rely on stored water, while others without access to such stored water, many of whom are farmers and migrant farmworkers, have to find other ways to secure water.

The construction and continued operation of the canal has been met with resistance since its inception. In the 1990s, the district of Cabanaconde bombed the canal to gain more access to water from the canal (Vera and Vincent, 2013; Stensrud, 2016). There are also plans to build a second canal, named Majes-Siguas 2, which would share the original infrastructure of the Majes-Siguas Irrigation Project to carry water from the district of Caylloma to a neighboring area. While construction of Majes-Siguas 2 has started, it is consistently halted because of political conflicts over water allocation and concerns over social-ecological risks associated with the water transfer (Paerregaard, 2013; Stensrud, 2016).

With the passing of time, many people from across Peru, especially the district of Caylloma and the departments of Cusco and Puno, migrated to Majes to work on the farms that are irrigated by the canal and in various businesses in Pedregal, the urban center of the Majes district (Stensrud, 2018; Erwin et al., 2021, 2022). Many of these migrants are hired as irrigators and live on the farms to manage all irrigation activities. Others are farmworkers that meet with thousands of others every morning in a town square in search for day labor and other forms of temporary work on those irrigated farms. Some people, especially women, also own or work in small stores while caring for animals and children in their homes (Stensrud, 2018; Erwin et al., 2021). The majority of these farmworkers and other migrants live in informal settlements on the outskirts of the irrigated farming areas.

For decades, only farmers, businesses, and *some* residents living within the municipal boundaries had access to any water. In contrast, many residents of informal settlements lived without formal land titles and therefore without access to potable water for domestic use and non-potable water for irrigating household vegetable gardens or watering household livestock. Over time, as we detail in the following sections, people have gained access to water and other resources by organizing independently and into associations. This trend of forming associations follows a longstanding history of migrants from the highlands moving to the coastal, desert regions and cities to escape political violence and poverty and to secure a better future for their families (Jongkind, 1974; Chambers, 2005; Stensrud, 2018). One local leader estimated that there are currently around 100 associations in Majes with approximately 15,000 residents as members.

3.2. Data collection and analysis

This case study builds on existing fieldwork in Majes that investigated water governance, adaptation to social-ecological change, and community resilience (See Erwin et al., 2021, 2022; Popovici et al., 2021a). Our current research focuses on investigating how migrant farmworkers living in informal settlements in Majes self-organize to address water scarcity and other basic needs. The first and second authors traveled to Majes in November 2021 to interview people who live in informal settlements and authorities who work with water distribution across the district. Before conducting all fieldwork, the three coauthors designed an interview protocol in Spanish and obtained approval from the Institutional Review Board (IRB) at Purdue University.

We used a combination of purposive and snowball sampling to interview a variety of actors who lived in informal settlements and association members, largely current of former farmworkers, but also people who work with agriculture in their homes and store owners (Neuman, 2009; Creswell and Clark, 2018). We also interviewed association presidents and authorities that worked with the local and regional Peruvian water administration, JASS (*Juntas Administradores de Servicios de Saneamiento*). Specifically, we used purposive sampling to recruit interviewees with diverse backgrounds (in terms of gender, age, occupation, places they moved from, etc.) and from various associations with and without access to potable water, non-potable water, sewer systems, and electricity. Some associations had succeeded in obtaining access to all basic resources, while others were still under development, sometimes with weekly deliveries of potable or non-potable water. As seen in Figure 1, we also strategically visited associations that had differential access to the canal and its water. In addition to purposive sampling, we used snowball sampling to connect with association members and leaders within the social networks of the interviewees. We stopped data collection after reaching data saturation when an additional interview no longer added new understanding of the situation (Bailey, 2007). At the end, 45 semi-structured interviews were conducted, totaling 1,080 min of audio recording.

We conducted interviews in numerous places including within informal settlements, in the restaurants and shops of people who lived or owned their business in informal settlements, at the local

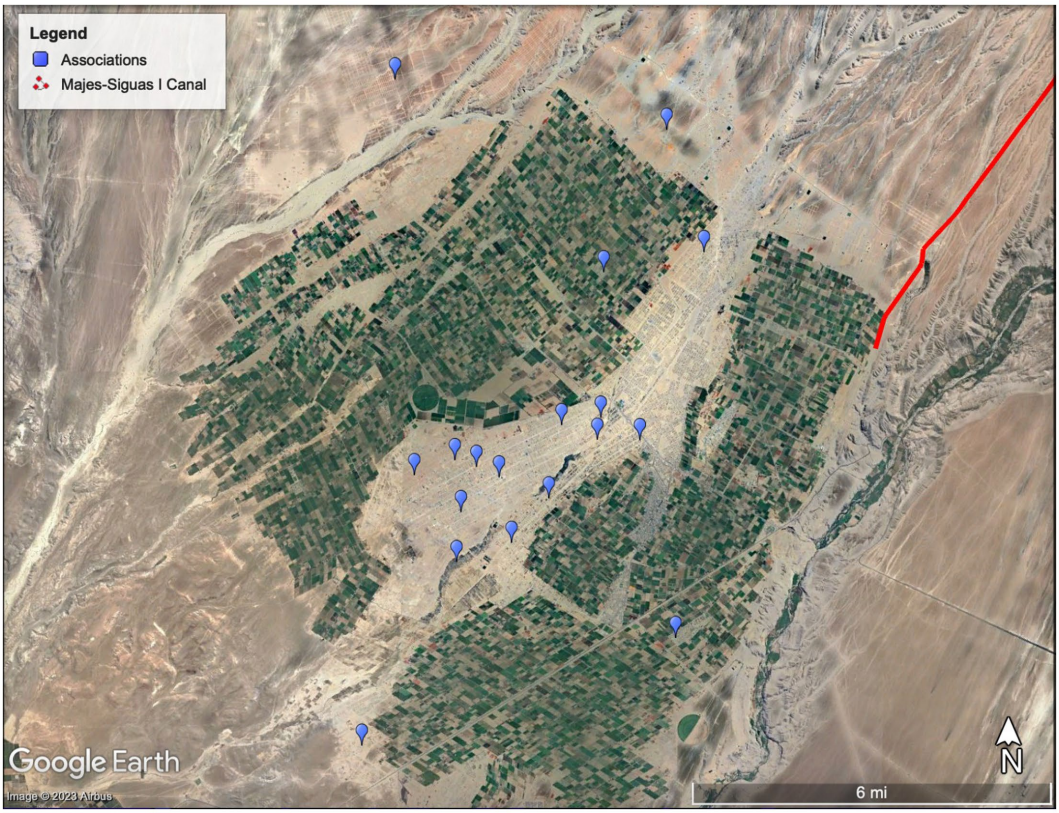

FIGURE 1
Map represent approximate locations of associations where 21 interviewees lived (3 associations had two interviewees each) and location of the canal.

TABLE 1 Summary of interviewees.

Total number of interviews		45
Total number of interviewees		60
Types of interviewees	Number of interviewees who were association presidents	4
	Number of interviewees who were JASS authorities	5
	Number of interviewees who people who were association members that lived in informal settlements and/or who lived in in temporary housing in Ciudad Majes.	51

meat market, on farms, and in an area where farmworkers waited for work in the mornings. In total we conducted 40 interviews with residents of informal settlements, people who have land in informal settlements through possession but live elsewhere, presidents of associations, and migrant farmworkers who lived in in temporary housing in Ciudad Majes, which is a formal part of the city of Pedregal. We also conducted an additional five interviews with representatives of local and regional water authorities (Table 1). The interviews with residents of informal settlements span across 20 different associations in Majes (Figure 1).

Upon completion of interviews, audio recordings were transcribed. The lead author created a draft codebook (See Appendix 1) using an abductive approach, which combines concepts, processes, and ideas from the literature review and our research questions with those that emerged organically from the transcripts beyond the existing literature. The draft codebook was then discussed with the second and third authors and subsequently revised. The first and second authors worked together to complete the intercoder agreement process. Specifically, the first author made edits to the draft codebook based on discussions with the second and third authors. The first and second authors then coded 10% of the 45 transcripts with the updated codebook, and repeated the process of discussion, codebook editing, and recoding until they reached an agreement about a coding structure (Campbell et al., 2013).

Next, the first author used thematic and content analysis and the computer assisted qualitative data analysis software, MAXQDA, to analyze the 45 coded transcripts (Joffe and Yardley, 2003; Hsieh and Shannon, 2005). The coded transcripts were summarized, categorized, and compared and contrasted to identify why people self-organized, how they self-organized, and the results of that self-organization. These emerging themes were further organized and analyzed to identify the relationship between how residents of informal settlements in Majes self-organized. It also pinpointed changes in their community's access to resources such as water, electricity, and sewer services. Analysis concluded by identifying quotes that exemplified why and how people self-organized.

4. Results: why and how people self-organized in Majes

In what follows, we document how and why the residents of informal settlements in Majes self-organized. We also present results on various self-organizing strategies used by the residents of informal settlements to successfully gain access to resources and increase their power. We conclude by presenting the drawbacks of certain associations and the limits to only self-organizing at the community scale, as brought up by our interviewees.

4.1. Mechanisms of self-organizing

4.1.1. The formation of associations

Interviewees informed us that before 2004, Majes mainly consisted of farmers and residents in a small city center and that associations started forming around 2004. These associations have between 100 and 500 members. In general, we found that association members were quite diverse. For instance, one interviewee told us that their association was named after a specific region in Peru. However, when we asked her if most people in the association were from that region, as the name indicated, she said: "*We are a mix, really, of people from Espinar, Puno, Chumbivilcas, Arequipa*." One association even had residents from Chile and Argentina.

Interviewees described numerous ways of forming associations. One association president told us that he and some friends traveled from Arequipa to Majes in a caravan to settle. Over time, they formed an association so that they could gain access to water and other resources. In another case, the association was formed by a family or people who arrived together from the same region. Interviewees also told us that some associations were formed by one individual, who later became the president of the association. This individual is often an earlier migrant who bought land and then sold land to newer migrants who moved to Majes and were looking for land. These newer migrants were then recruited and also became members of the association. Two association presidents also told us that many members were single mothers who had moved to Majes to escape domestic violence and find a way to support their families independently. One president described this as: "*More than half of the members are single mothers… I know a lot of women who are single mothers who come here from another place*." Another interviewee told us: "*There are many mothers here, single mothers and abandoned mothers*."

The majority of interviewees told us that their association formed an executive committee, with a democratically elected president, vice president, treasurer, and secretary. The executive committee conversed with the local municipality, communicated association priorities to the municipality and other authorities, and became knowledgeable in local, regional, state, and national laws. The majority of association members were also required to pay a monthly fee to the association, funds that were often used to fund community projects.

4.1.2. How associations made change

Forming an association often increased interviewees' capacity to organize among themselves and make change by working with the municipality, external to the association. In particular, having an association with an executive committee gave interviewees credibility with the municipality and thus, increased their capacity to gain provisional land rights and water access. One association president told us that upon creating an executive committee, "*we notified the municipality so that it would recognize us as an association*" which *"allowed us to gain provisional land rights*." Another president told us that creating an association stopped the municipality from kicking them off the land. He said: *"Well, we had already occupied the land three times, and each time, they kicked us out. Then, we created an association, and it stopped them from kicking us off the land. The municipality came three or four times. On the fifth time, we stayed. No one moved us anymore*."

Another group of women said they formed an association to demonstrate that they had settled the land, which resulted in them gaining access to more resources. They said: *"Before the municipality did not bring us water because not too many people lived here. So, we created an association, and now, the municipality leaves water, here, in a container*." Others described the relationship with the municipality as an ongoing process. For instance, while some communities had successfully gained access to water from the municipality, others were in different stages of gaining access. One interviewee informed us that some people in their association already obtained access to water, but they were still working with their association to ask for more water because: "*Not everyone has it*." Another interviewee who was a member of an association told us that the municipality was bringing them water in cisterns, but they were now "*asking them [the municipality] for drinking water*" through indoor plumbing.

In some cases, the municipality did not support or comply with associations' needs, even if they had formed and made formal requests. In these associations, interviewees told us that having an association gave residents the capacity to collectively organize funds to implement projects, with or without support of the municipality. They often organized projects in community meetings where members discussed topics such as ongoing challenges with water access, crime, land rights, and landslide risk mitigation strategies if they resided in a risk zone. Four interviewees informed us that many of the meetings had been paused during the COVID-19 pandemic, but it was common to "*investigate issues and ideas during community meetings*." Independent projects varied and depended on the association and their needs. For instance, two interviewees informed us that the executive committee would organize community projects to "*work and clean the street*." Two other interviewees told us that "*the association had organized and installed pipes*" to pump non-potable water from the canal to their lots. An executive committee member told us that her association had pooled resources from association members and installed a soccer pitch and a clubhouse. They had also recently worked independently from the municipality and the electricity provider to install electricity within their association. She told us: "*we self-finance to improve our quality of life, every one of us, for the betterment of everyone*."

4.2. Motivations and functions of associations

This section describes the roles associations played in supporting residents of informal settlements in Majes, specifically how self-organizing secured some residents access to water and other basic resources. It also describes how associations worked to advocate for landslide mitigation and risk reduction.

4.2.1. Self-organizing to increase access to water

We found that the most prominent motivation for creating an association was to gain or improve access to water. The majority of interviewees, including association members and presidents, told us that they worked with associations to improve access to water, which includes gaining access to non-potable water, buying and installing pipes for potable water, and soliciting the municipality to bring potable and non-potable water in each week. One interviewee described how in the past, people had to walk far to obtain water, but they worked with their association to improve access. He told us: "*There has always been water, but the water distribution point was up there… We had to carry it, and since it was really far, we asked our [association] president. He put another pick-up point here, a little closer.*" Another interviewee told us that they had worked with their association to gain access to non-potable water from the canal. She described this as: "*The association was organized, and we bring in water from the canal through pipes… It is an investment that has been made. Every lot has it.*"

4.2.2. Self-organizing for electricity

In addition to gaining access to water, about a quarter of interviewees who were residents of informal settlements told us that they had gained access to electricity through working with their associations to solicit service from the local electricity company. One young business owner described this as follows: "*Without electricity, there was nothing. So, recently, we worked together to gain access to electricity. We just paid our first bill!*" Another interviewee told us that they started by having one meter for the whole association (referred to as a "*collective meter*") and later transitioned to individual meters. The majority of interviewees who had a collective meter aimed to eventually have individual meters, as one interviewee explained: "*Before we had a large meter that was paid by the entire association… Now, we have meters in each little house.*"

4.2.3. Self-organizing for provisional land rights

Because residents lived in informal settlements, they did not have formal land titles. Formal land titles protect people from being evicted and give people automatic access to water. However, formal land titles are difficult to obtain. Therefore, the majority of interviewees, including association members and presidents, told us that one of their key priorities was to gain provisional land titles, which were temporary land titles protected by Peruvian law. As one association president described, provisional land titles provide some protection from eviction: "*You cannot evict them because they have a provisional title... The Possession Law protects them.*" While the Possession Law did not give residents with provisional land titles automatic access to water, provisional land titles did make it "*easier to request water*," as one president commented. Similarly, another interviewee described this as: "*we have to do it little by little. We have land and water, but it is provisional.*"

4.2.4. Self-organizing to advocate for landslide mitigation and risk reduction

Interviewees, including two association members, an association president, and the president of the association of associations (an organization that represented numerous associations) all informed us that the municipality had classified their area as a landslide zone. One president described this as: "*According to the municipality and the authorities, this is a risk area... There's a study where they classify you as high risk. Those that are high risk are on the borders of ravines.*" Because of their location in a risk zone, some associations were forced to advocate for themselves to the municipality. Mainly, they disagreed with the risk classification or wanted the authority to help them mitigate the risk. In a few cases, the authorities wanted to make people relocate out of the risk zone but the association members did not want to move. One interviewee told us: "*Right now, we are asking the municipality to reduce the risk in an eroded area… We are waiting for mitigation.*"

4.3. Organizing beyond single associations

In what follows, we describe how interviewees worked across associations to gain rights to land, water, and electricity. We also document how some associations collaborated with other organizations, like the Water Users Association (WUA; a community organization for formal residents with water rights), to address water risks that Majes continually faces.

4.3.1. Collaboration across associations

We found residents of informal settlements would often work with the association of associations when multiple associations were experiencing the same issue, like with land titles or landslide risks. The association of associations had a president, its own executive committee, and "*approximately 10,000 members...from 24 associations.*" Through it, member associations continually worked together to address emergencies in the community as the president explained to us: "*We are a well-established group. If there is a problem, we all provide support, we work together to solve it. Right now, we are trying to get meters. We worked together, traveled to Arequipa, and had our issues heard.*" At the time of the study, the association of associations had proposed a law to formalize all provisional land titles and had recently traveled to Lima to advocate for the law. This president explained this to us as follows:

> "*If, God willing, the congressmen say: 'Let's approve it,' it would be a win for all the association members here. With that authorization, the mayor can formalize all of us. And you can request your water. We have already knocked on doors to the largest players so that they can do the water and sewage project for us, which is a huge investment… Being united makes us stronger and able to improve our associations.*"

As aforementioned, multiple association members and presidents identified landslides as an issue. Because this was a cross-cutting issue, the association of associations advocated for the municipality to adopt mitigation measures to reduce landslide risks in informal settlements. At the time of the study, they were working together to conduct a survey of landslides across the associations, as one interviewee described: "*Between the presidents of all the associations, all the documentation has to be presented to do all this, to carry out the survey.*" The association of the associations planned to present the survey results to the municipality as way to demonstrate need for mitigation measures.

4.3.2. Working with external organizations to address issues with canal infrastructure

Interviewees from across associations also told us that they were worried that the Majes-Siguas canal would collapse and that they would be forced to leave Majes for good. A water authority representative described the issue as follows: *"It [poor canal infrastructure] is difficult not only for the general population, but also for farmers. If the canal collapses, not only will the population be harmed, but it will also damage farmers."* To address this concern, the president of the association of associations told us that they were working with the WUA and other community groups to advocate for a reservoir to protect them in times of emergency. The president told us that their association and member associations representing the residents of informal settlements had joined with the WUA to ask policymakers to make a reservoir above the district to provide water during water cuts and protect them in the case of an emergency, like canal collapse. The president expanded on this by explaining how the associations were working with other organizations in Majes to address the problem. In particular, the president said:

> *"We already talked to the mayor and the president of the Water Users Association. We are collecting signatures because they have requested more than ten thousand signatures to make the intermediate dam and reservoirs… It's not a solution, but it's a workaround, an emergency plan… The Water Users Association is driving this project, but it has to go hand in hand with the general population and the authorities… Without water there is no life. That's why we have met with the mayor, with the president of the Water Users Association, who explained to us how serious it is right now and requested that we support them in collecting signatures for a petition from all the association presidents."*

4.4. Accessing resources independently when the association did not meet peoples' needs

While many interviewees expressed that their association supported them in pursuing common goals, others were frustrated with their association. One interviewee commented that the monthly fee of being an association member was exorbitant. Two association presidents also told us that many members bought pieces of land, albeit informally or through provisional land rights, in the association as an investment or vacation home, but they lived in the local city of Pedregal or in places elsewhere like Arequipa. Specifically, one president commented that because some members lived elsewhere, overall participation in community meetings and events was limited.

Several interviewees also told us that they had actively participated in their association's community meetings, but that their ideas would often be rejected by other members. While most associations had their own rules for executive term limits and for how one gains an executive position, one interviewee told us that his association did not have term limits. Another interviewee shared an extreme case with a president he called a "*dictator*." The interviewee expanded by telling us: "*when you become president, you do not want to leave… We call it a mafia. He tries to stay, stay, and stay, and well, he stays.*" He expanded by explaining to us that the president of his association would "*traffic [land] lots,*" which means that when "*a neighbor does not live on the lot, the president would sell it to someone else… Why can he do this? Because the owner does not have a title. It's a bit more informal, only possession.*"

Provisional land titles posed additional challenges to the functioning of the associations. First, although residents of informal settlements *could* gain access to water or electricity with provisional land titles, access was not guaranteed, and at best, in flux. One interviewee told us that their association had worked for years to gain access to resources, but projects would discontinue when there was a change of authority. He described this as: "*We have already been conducting studies, but sometimes the authorities are also the ones that fail and discontinue projects that the previous authority left behind… There is often no follow-up when there is a change of authorities.*" Second, several interviewees further expanded on the challenge associated with provisional land titles by saying that authorities are not required to recognize provisional land titles held by their association or respond to the requests made by those holding provisional land titles, even when the association follows outlined procedures to prepare for water and electricity access. One interviewee described this as: *"To get electricity, we have done all of the technical surveys, soil studies, everything… There has been no response."* Third, as demonstrated in section 4.1.2, a key difference between having formal land titles and provisional land titles in informal settlements is that people with provisional land titles often had to self-finance their infrastructure. One interviewee told us: "*Unlike with private property, the municipality hardly intervenes, nobody helps you. We have to self-finance everything.*" At the time of our interviews, the majority of residents in informal settlements had not yet gained formal land titles through working with their associations.

Because of these issues, some interviewees told us that they preferred to live and organize themselves independently of associations. For example, two interviewees told us that they had to open a soup kitchen independently of the association because: "*We talked about it in a community meeting, and the president told us if we want to open a soup kitchen, then we have to organize ourselves. So, we organized ourselves and decided to open the soup kitchen.*" One interviewee had decided to access resources independently without having to pay a fee to an association. This interviewee told us: "*I am an individual. I have nothing to do with the association, because the association asks you for money every month… At each meeting, quota here, quota there. So, I decided to do it individually.*"

5. Discussion: the role of self-organizing in shaping the resilience of farmworker communities in informal settlements

Our results illustrate that while self-organization has its limits, it can support community resilience for agricultural communities living in informal settlements, like farmworkers. First, although it has been recognized that informal settlements pose numerous social-ecological risks, research on these risks, as well as the ways informal resident communities adapt to these risks is still forming; to date, much of this research has focused on settlements that form on the outskirts of urban areas (Shatkin, 2004; Dovey and King, 2011; Mehta et al., 2014; Amoako, 2018; Nassar and Elsayed, 2018; Baye et al., 2020; Satterthwaite et al., 2020; Carrilho and Trindade, 2022).

Notwithstanding these limitations, previous studies have documented that the residents of informal settlements experience challenges to accessing basic needs like water and electricity, often live in areas at risk of landslides or other natural disasters, and rarely hold formal landownership of their lots (Hoffman and High-Pippert, 2010; Dovey and King, 2011; UN-Habitat, 2018; Satterthwaite et al., 2020). Moreover, residents of informal settlements in water-scarce, urban areas "usually face more water constraints and are more vulnerable to increases in food and water prices" (Satterthwaite et al., 2020, p. 147). Our results show that residents of informal settlements in Majes face similar, ongoing social-ecological risks as people who live in informal settlements in urban areas, especially, risks of landslides, challenges accessing water, land, and electricity, and spatial marginalization from town centers. However, while our interviewees did not specifically discuss the relationship between irrigation practices and landslides, ongoing research in the area shows that decades of irrigating Majes's sandy soil has instigated landslides, and ultimately, will destroy villages and agricultural lands (Lacroix et al., 2020; Flamme et al., 2022). Utilizing drip irrigation in future irrigated agricultural projects in the desert, like Majes-Siguas 2, could decrease the distinct social-ecological risks that these communities face (Flamme et al., 2022).

Importantly, our results highlight that political marginalization motivated residents of informal settlements to self-organize into associations. In particular, they self-organized to counter the neglect by the municipality. They also self-organized to gain access to different resources, including water, electricity, and land rights. Literature suggests that communities self-organize in response to discontent and to work together to meet a goal, especially environmental sustainability goals (Edelenbos et al., 2018; Hasanov and Zuidema, 2018). However, in general, research on self-organization has focused more on the results of self-organization, the way self-organization shapes public institutions, and the transformative power of self-organization, but less on why communities self-organize (Edelenbos et al., 2018; Hasanov and Zuidema, 2018). Our research broadens this literature by showing why people self-organized into associations and how they pooled their own resources through association membership fees to develop and legitimize their communities. In addition, there is a history in Peru of migrants from the highlands moving to the coastal desert regions and cities to escape political violence and poverty and to secure a better future for their families (Jongkind, 1974; Chambers, 2005). However, there is limited research investigating how these migrants collectively achieve social, economic, political, and environmental goals (see Stensrud, 2018). As such, our study also contributes to the longstanding research on internal migration in Peru, particularly in the context of Peru's numerous LWTPs.

Our research also contributes to building linkages between community self-organization and community resilience. Our results highlight how self-organizing was integral to the resilience of interviewees who were members of various associations, especially as it relates to CACR's interrelated dimensions of *prefigurative politics*, *commons praxis*, and *economic autonomy* (White, 2017, 2019). White (2017, 2019) describes *prefigurative politics* as the creation of alternative, democratic spaces outside of public institutions where people come together to make decisions and self-reflect. We found that some associations in our study had characteristics that foreground *prefigurative politics*. In particular, many associations had instituted democratic decision-making processes for electing leaders and making collective decisions. Our interviewees who belonged to associations without democratically elected leaders described their associations as ineffective, and some even called their presidents "*dictators*." These results uphold the theory of CACR by showing that *prefigurative politics* with democratic institutions appeared to be recognized as supporting community goals and resilience, while institutions that did not provide such democratic spaces were viewed as ineffective.

Our results also show how self-organizing into associations created a *commons praxis*, whereby communities make decisions "around shared spaces and resources such as access to land, water, and seeds" (White, 2017, p. 19). This was evident in what our interviewees shared with us, particularly that many associations, as well as the association of associations, held meetings where they discussed issues such as access to water and electricity and made action plans together. Creating such a *commons praxis* through self-organizing also supported some associations' efforts toward *economic autonomy*, defined as "an alternative system of resource exchange within the community" (White, 2019, p. 10), by giving people a space to connect plans to resources. As one interviewee told us, her association had to be resourceful and "*self-finance everything*" because the municipality did not address their needs and priorities. Indeed, her association had successfully self-financed multiple community development projects including a soccer pitch, a clubhouse, and even installed electricity in their association. It is worth noting that in our research, while associations were created to provide support for the residents of informal settlements to address their resource needs and basic rights, none of our interviewees discussed their associations creating space for self-reflection, a critical component to *prefigurative politics* for community resilience (White, 2017, 2019). Additional empirical data into how self-reflection works within community groups like these associations and how self-organizing can support self-reflection could help identify relevant strategies to further strengthen community resilience.

As aforementioned, our research and many other studies have illuminated how self-organization can help marginalized communities work toward shared goals (Horelli et al., 2015; Rivera and Kapucu, 2015; Hasanov and Zuidema, 2018; Suhartini and Jones, 2020). However, few studies discuss the limits to self-organization. Our research begins to shed light on these limits by describing how and why individuals avoid self-organizing and prefer to work independently. In particular, some interviewees were unable to reach their goals within their associations, experienced inconsistent or unequal access to communal resources obtained through the work of the association, or expressed a sense of frustration or disappointment in the lack of support from association members for community development projects. Consequently, these interviewees responded to these challenges by joining other associations, collaborating with landowning farmers, or pursuing their goals independent of an association. These results seem to follow other trends within the literature where scholars have argued, "embracing processes of self-organization in decision-making calls for appreciating the different pathways in which local collective action could lead to active and inclusive partnerships between citizens, policy-makers, academics, businesses, and the society as a whole" (Hasanov and Zuidema, 2018, p. 91). Our research thus sheds light on the ways that across-scale collaborations can increase the capacity of informal settlement residents to increase their access to resources and resilience in the face of risks like a failing canal infrastructure.

Finally, addressing structural inequalities is integral to decreasing vulnerabilities for both a specific group and the broader community or

site (Adger, 2000). However, neglecting existing community strengths and focusing solely on vulnerabilities can decrease our capacity to learn from and support existing grassroots efforts that mobilize and organize marginalized communities (White, 2017, 2019). Our research documented and analyzed an example of how farmworkers living in informal settlements in an irrigation district in the Global South, a group that had been rendered invisible to a large extent (Guthman, 2004; Shatkin, 2004; Gray, 2013; Minkoff-Zern, 2014; Erwin, 2022b), worked to obtain access to resources, demand rights, and increase resilience through self-organization. As such, our research joins with other scholars who provide nuanced, counter arguments to apocalyptic narratives that frame climate refugees in the Global South as largely powerless in the face of change (Farbotko and Lazrus, 2012; Bettini, 2013). Our research also complements food justice scholars who focus their research on farmworker agency in the Global North, especially the United States (Minkoff-Zern, 2014; Mares, 2019), by highlighting farmworker agency in a different context. In particular, our research shows how individuals who migrate to informal settlements face various social, political, economic, and environmental challenges; however, some successfully used collective agency to increase their resilience, even in the face of these challenges.

6. Conclusion

This research highlights how an often invisiblized population–farmworkers living in informal settlements in agricultural regions–self-organize to increase their resilience through forming associations, collaborating with other community groups, and working in conjunction with landowning farmers. This research speaks to the importance of *prefigurative politics*, *commons praxis*, and *economic autonomy* in strengthening community self-organization and consequently, community resilience (White, 2017, 2019). Our research also identifies some limits to self-organization, including internal corruption, undemocratic decision-making, a lack of community participation, inefficient communal resource sharing, and frustration with monthly fees. Our findings contribute to reframing dominant narratives that describe migrants and other farmworker populations in the Global South and Global North as powerless in the face of multiple social-ecological changes and challenges. Conversely, our findings show that many migrant and informal farmworkers strategically cultivate collective agency, which has increased their access to land and water. Moving forward, increased scholarship on documenting and analyzing vulnerabilities of invisibilized communities and more importantly, how invisibilized communities address their vulnerabilities by cultivating community resilience, could continue to shift how society as a whole supports these communities.

Data availability statement

The datasets presented in this article are not readily available because it is interview data with some sensitive information, including home addresses and other identifiable information. This was required for analyzes but cannot be shared because of IRB requirements. Requests to access the datasets should be directed to anna.erwin@utrgv.edu.

Ethics statement

Data collection procedures for this study were approved by Purdue University Institutional Review Board (IRB). The IRB waived the requirement of written informed consent for participation from the participants because many of the participants could not read or write. We did obtain verbal consent from all participants to collect and record interviews. All participants were also given the option to withdraw from the study and refuse participation or recording at any time.

Author contributions

AE led the conception of the article, and led the acquisition, analysis, and interpretation of the data. CS participated in the conception of the article, and participated in the acquisition, analysis, and interpretation of data. ZM led in the acquisition of data, and participated in the conception, analysis, and interpretation of data. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1160109/full#supplementary-material

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