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Pollution, obligation, and care: perspectives from artisanal and small-scale gold mining and farming in rural Colombia

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ABSTRACT

People making a living in rural Antioquia, Colombia, find themselves in a double bind: they require a healthy environment to farm and grow food, but many turn to artisanal and small-scale gold mining (ASGM) to supplement their incomes. The significant environmental harms associated with ASGM – from mercury and other heavy-metal contamination to deforestation and habitat loss – have led to both academic and popular discourse treating ASGM as an environmental problem to be understood and remedied scientifically. Our research in the small town of Andes (Antioquia region in Colombia) investigated how local residents themselves understood “pollution.” Drawing on a literature review, archival research, site visits, and interviews with experts and local residents, we show that rural people understood pollution as emergent from complex webs of relationships and longer histories of government neglect. Exploring how people made sense of harm and expressed care builds on research in STS that demonstrates both the potentials and pitfalls for scientific concepts and tools to understand and intervene in compromised environments.

Poluição, obrigação e cuidado: perspectivas da mineração artesanal e de pequena escala de ouro e da agricultura na Colômbia rural

RESUMO

As pessoas que vivem na zona rural da região de Antioquia, na Colômbia, encontram-se em um dilema duplo: elas precisam de um ambiente saudável para cultivar e produzir alimentos, mas muitas recorrem à mineração de ouro artesanal e de pequena escala (ASGM) para complementar sua renda. Os danos ambientais significativos associados à ASGM, desde a contaminação por mercúrio e outros metais pesados até o desmatamento e a perda de habitat, levaram o discurso

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acadêmico e popular a tratar a ASGM como um problema ambiental a ser compreendido e remediado cientificamente. Nossa pesquisa na pequena cidade de Andes (região de Antioquia, Colômbia) investigou como os próprios moradores locais entendiam a “poluição.” Com base em revisão da literatura, pesquisa em arquivos, visitas a campo e entrevistas com especialistas e moradores locais, mostramos que a população rural entendia a poluição como emergente a partir de complexas redes de relacionamentos e histórias mais longas de negligência governamental. Explorar como as pessoas entendem o dano e expressam o cuidado baseia-se em pesquisas em STS que demonstram os potenciais e as armadilhas dos conceitos e ferramentas científicos para entender e intervir em ambientes comprometidos.

Polución, Obligación, y Cuidado: perspectivas de la minería de oro artesanal y de pequeña escala y la agricultura en la Colombia rural

RESUMEN

Los habitantes de las poblaciones rurales de la región de Antioquia, en Colombia, se encuentran en una encrucijada: por un lado, necesitan de un medio ambiente saludable para cultivar y producir alimentos; por el otro, necesitan de la minería artesanal y de pequeña escala de oro (MAPE) para generar ingresos para sobrevivir. Los daños ambientales asociados con la MAPE – desde el uso del mercurio y la contaminación por otros metales pesados hasta la deforestación y la pérdida del hábitat natural—han llevado a los discursos académicos y populares a tratar la MAPE como un problema ambiental a ser entendido y solucionado científicamente. Nuestra investigación en la población de Andes, Antioquia, busca entender cómo los residentes de esta localidad entienden la contaminación. Partiendo de la revisión de literatura, investigación de archivos, visitas y entrevistas con expertos y residentes locales, demostramos que en poblaciones rurales se entiende la contaminación como un concepto que emerge de complejas redes de relaciones y una larga historia de abandono por parte del gobierno. Partiendo de la literatura de STS que trata este tema, aquí exploramos cómo estas poblaciones entienden los daños ambientales y expresan un sentido de cuidado por el medio ambiente. Asimismo, demostramos los posibles beneficios y limitaciones de conceptos y herramientas científicas para entender e intervenir en entornos comprometidos con la minería y la agricultura.

1. Introduction

Forty million people globally are estimated to rely on artisanal and small-scale mining as a livelihood strategy, with around 10–20 million of those involved in artisanal and small-scale gold mining (ASGM) (PlanetGOLD 2020; F. W. Schwartz, Lee, and Darrah 2021a). Public and academic discourses usually apprehend ASGM as a particular kind of environmental problem: it contributes to the degradation of habitats, increased erosion and turbidity in water sources, water pollution, air pollution, and deforestation (Cuya et al. 2021; Esdaile and Chalker 2018). It is the world’s largest anthropogenic source of mercury (UNEP



Figure 1. A mercury free gold processing center in Andes.

2019) and a particular problem in Latin America, where the ratio of mercury lost to the gold produced is between 4 and 10 times higher than in other regions (Yoshimura, Suemasu, and Veiga 2021). Mercury exposure is associated with multiple environmental and human health problems, including memory loss, respiratory issues, renal failure, nerve damage, brain damage, physical and mental impairments in children, and death (Esdaile and Chalker 2018; Gibb and O’Leary 2014; UNEP 2019; Yoshimura, Suemasu, and Veiga 2021).

ASGM is a crucial issue in Colombia, where the number of ASGM miners is estimated to have increased from about 200,000 in 2011 to 350,000 in 2020 (García et al. 2015; Planet-GOLD 2020), and where gold supply chains have become entangled with nefarious criminal groups (Fernandez Suarez 2022; Pinto García 2019, 25; Velez-Torres et al. 2018). ASGM has led to Colombia being labeled the world’s largest mercury emitter per capita and the second largest mercury importer in Latin America (Rubiano-Galvis 2022; see also Restrepo Baena et al. 2020; Velez-Torres et al. 2018).¹ While regional efforts have been made to reduce ASGM mercury usage, such as the “Cero Mercurio” or “Zero Mercury” initiative in our fieldsite of Andes, Antioquia (Figure 1), national incentives and government aid have

¹One study found that 55% of ASGM miners who provided hair samples had mercury levels higher than the US EPA standard, and that miners who worked around amalgam burning had mercury levels six to eight times higher than miners who performed other activities (Calao-Ramos et al. 2021).



Figure 2. Tailings (mine waste) and sedimentation ponds at processing plant near Santa Rita, with farms in the background.

been sparse, obstructing efforts to stop the use of mercury (Diaz, Katz, and Lawler 2020; Lara-Rodriguez 2018; Restrepo Baena et al. 2020; M. Schwartz et al. 2021b). Beyond mercury, cadmium, lead, copper, nickel, zinc, and manganese have all been found in excess in the soil where Colombian mining activities occur (Marrugo-Negrete et al. 2019; Marrugo-Negrete et al. 2021; Marrugo-Negrete, Pinedo-Hernandez, and Diez 2017).

In many ways, environmental pollution has become the meta-narrative for analyzing ASGM in Colombia and elsewhere. Yet far from being an objective measure, pollution is a contested judgement of the world that embeds particular assumptions about measurement, responsibility, and remedy (Li 2015; Liboiron 2021; Lyons 2022; Ureta and Flores 2022). The statistical judgements of ASGM just summarized present pollution as an entity that can be understood, technically manipulated, and quantitatively assessed through measurement and compared across sites. In this literature, attributions of responsibility vary – some blame poverty for driving the rural poor to mine while others attribute it to miners' own recklessness – but almost all focus on miners' behaviors as the appropriate place for intervention. While these studies of ASGM have provided important insights about its global reach and environmental implications, far fewer have investigated how miners themselves understand how "pollution" comes to be.

Potential contamination was concerning to miners and residents we met in Andes, Colombia, where ASGM is growing alongside a famed coffee industry, smallholder farms, and family gardens that contribute to household subsistence (Figure 2). The environmental implications of ASGM sparked lively conversations and debates and the

people we met had questions about the impacts of mining for their soil and water. Previous research by other members of our team had established the utility of engaging local residents in creating community-informed conceptual site models to help environmental practitioners develop knowledge about contamination flows and locations, and understand differences in perceptions of pollution severity (O'Brien et al. 2021). Yet the people we met did not express a strong urgency to develop tools or programs to assess these impacts and potential exposures, as we had found in academic literature (Landes et al. 2019; Ureta et al. 2022; Velez-Torres et al. 2018). This observation prompted us to investigate local residents' own understandings of "pollution," keeping in mind that they may differ from those that animate monitoring projects and academic literature. In this article we draw from a literature review, archival research, site visits, and semi-structured interviews. Our materials suggest that residents of Andes insisted that "pollution" was emergent from a broader set of relationships and longer history of government neglect that shaped their own desires to assert environmental care.

2. Problematizing pollution

"Pollution" has become a rallying cry for anti-mining social movements around the world and a key focus of academic literature. While bodies of knowledge and technical apparatuses exist to measure and make visible environmental harm, STS scholars emphasize that "pollution" comes to matter socially, economically, politically, and materially through historically and culturally specific practices (Graeter 2017; Li 2015; Liboiron 2021; Lyons 2022; Ureta and Flores 2022). At a basic level, formal definitions of pollution often rest on limits of acceptable levels of contaminants set out by laws and regulations. These legal definitions often conflict with local judgements of environmental wellbeing, as exemplified in the case of contestations over water quality in a Peruvian mining region. Li (2015) demonstrates that the mining company was allowed to continue discharging water that local *campesinos* experienced as unhealthy because it still fell under the legal limits; their sensorial judgements of water quality based on sight, smell, and taste were not legible in that regulatory system. Judgements of whether data demonstrate pollution also depend on a complex process of comparing those studies to environmental "baselines" – collections of technical data constructed by scientists that have particular assumptions of history and contamination embedded in them (De Pree 2020; Kinchy 2016; Ureta 2021; Ureta and Flores 2022).

Contestations over environmental harm understood as pollution frequently take place through scientific registers, as experts and citizens create, marshal, and debate scientific evidence to make harm visible and call for remedy. Graeter (2017), for example, traces how a program run by the Catholic church undertook six years of research documenting heavy-metal contamination in the area surrounding Peru's largest and most controversial smelter. Contesting the smelter through an ostensibly neutral exposure science allowed them to depoliticize their efforts: they created a "situated objectivity" by translating "purported toxic transgressions directly to legal pollution limits" (128). At the same time, project participants were able to use their Catholicism to provide ethical credibility to the knowledge they were creating in the midst of endemic corruption, epistemic mistrust, and polarized mining politics. Their efforts led to the creation of a wide-ranging health ordinance and initiated an ongoing period of uncertainty over the smelter's future.

There are also a few successful examples of using science-based monitoring to better understand the environmental harms that occur in ASGM contexts. In Colombia, an interdisciplinary team developed a community-driven, “closed-loop integration of social action and analytical chemistry research (CLISAR)” in response to concerns held by Afro-Colombian women about mercury’s effect on local streams and fish (Velez-Torres et al. 2018, 423). Meetings, surveys, and a community-led social cartography were used to determine sample site selection. Mercury concentrations were tested and assessed collaboratively using SenSafe, a low cost and transportable monitoring technology. It relies on testing strips that change color based on mercury concentrations. Experts synthesized and analyzed the data and then shared results with the community, working together to brainstorm next steps. Importantly, the project identified the unique implications of ASGM – including its spatial, social, and ecological dimensions – for Afro-Colombian women. In four Peruvian mining towns, researchers studied the issue of lead contamination in soil (Landes et al. 2019). A significant component of this study involved parents from these communities in soil sampling. By using this method, researchers relied on local knowledge of parents to sample in the most important areas, such as where their children commonly played. Because of parent involvement, researchers were also able to find a new lead hotspot that they had previously missed during their surveying. In Chile, a project addressed the lack of information surrounding soil contamination by developing a low-cost toolkit to assess levels of soil pollution, particularly arsenic and copper (Ureta et al. 2022). This toolkit was designed to have an accessible methodology so it could be used directly by communities impacted by soil contamination. Researchers found that incorporating nontraditional elements, such as soil fertility and history, increased the community’s understanding and engagement surrounding soil health.

While there are positive outcomes of these projects, Li (2015, 207) cautions that

the use of science to produce counterinformation inherently creates an unlevel playing field where small organizations with limited resources face corporations that spend incomparable amounts of money conducting scientific studies ... The dominance of science as a tool of accountability has helped direct the actions of NGOs and local activists toward scientific counterarguments in ways that may limit the effectiveness of their efforts. At the same time, the participatory emphasis of new processes of accountability leaves activists with few alternative courses of action, since not participating can be taken as an affront to democratic principles that these processes claim to promote.

Her concerns are borne out in a wider STS literature making visible how scientism creates distinctions between – and differentially values – “expert” and “lay” knowledge (Aitken 2009; Hébert and Brock 2017; Kimura and Kinchy 2019; Zilliox and Smith 2018). Abby Kinchy (2016), for example, shows that citizen science efforts may limit the claims that are made, sidelining some values that are difficult to make legible in a scientific register, and Max Liboiron (2021, 36) traces how the invention of the scientific concept of environmental pollution “flattens” more expansive Indigenous worldviews.

This research underlines that while scientific judgements of pollution can be politically efficacious in making harm legible, it is crucial to consider how scientific claims narrow what counts as environmental knowledge and differentially position members of the public in relation to larger histories and corporate and government entities. Our article explores these insights in the case of ASGM, a controversial practice that has been

debated in both academic and popular discourse primarily in terms of environmental effects made known through technical assessment.

3. Methodology

Our research is part of a multi-institutional and multi-disciplinary collaboration that built on previous relationship-building and research on ASGM in Andes. Restrepo has been leading research on ASGM in Andes since 2015, and his prior studies and community engagement formed the basis for our research questions. Rather than drawing from traditional ethnographic methodologies, we used Rapid Assessment Procedure (RAP), which allows for relatively quicker ethnographic fieldwork by relying on interdisciplinary teams that employ multiple methods and practice triangulation (Beebe 1995; Gibson et al. 2023). Our research team includes faculty and students from the US and Colombia with a variety of disciplinary backgrounds, ranging from environmental engineering and metallurgy to anthropology and STS. The fieldwork also included two research assistants from Andes and two students from our partner university in Medellín. In RAP, fieldwork takes place from a few days to a few weeks and incorporates local community members in the research itself. While RAP is not a substitute for long-term ethnographic research, it facilitates interdisciplinary research and more quickly generates rich data in response to time-sensitive research questions.²

The research was performed in three stages. In the first, Schroeder conducted a literature review on citizen science, including effective methods of community engagement as well as case studies of successful citizen science projects, and ASGM, including studies on its environmental impacts. In the second stage, the team performed research in Medellín, Colombia. In order to better understand the context of ASGM in Colombia, semi-structured interviews were conducted with two professionals with expertise in the mining sector about ASGM, formalization, and miners' relationships with the government. We also visited the physical archives of the Corantioquia office and searched these archives for literature related to community engagement, ASGM, and contamination from mining. This search yielded several reports about citizen science within the mining and coffee farming communities in Antioquia that could not be found online in the United States.

In the final stage, we conducted fieldwork and semi-structured interviews in the municipality of Andes, with the support of two local residents who were hired as research assistants and the Colombian students. The primary field sites were the mining and farming communities of Andes, Antioquia, Colombia. Andes is a municipality of the Department of Antioquia of 250 square miles approximately (400 square kilometers). It is located about 73 miles (117 kilometers) southeast of the city of Medellín (Corantioquia 2005). Founded in 1852, Andes has a population of about 42,000 people dispersed throughout a town center and rural *corregimientos*. We focused on research in two *corregimientos*: Santa Rita and San Agustín. They are reached by traveling along a dirt road through the mountains that is prone to flooding and landslides when it rains (Figure 3). While some interviewees did self-describe as “miners” or “farmers,” livelihood blending was much more common and troubles simplistic occupational identification. Agriculture

²For excellent studies of mining in Colombia that draw from more traditional extended fieldwork, see Caraballo Acuña (2023); Ferry and Ferry (2017); Jaramillo (2020); and Jonkman (2022).



Figure 3. Horses used for transportation outside Santa Rita.

and livestock dominate local cultural identity and formal economic activities, though gold mining is on the rise (Ramírez and Ruiz 2019). Andes has become a flashpoint for national debates about mining and the environment, culminating in a recent (2023) moratorium on mining in the municipality that was done without input from and against the wishes of people who mine. The president described the moratorium as necessary to protect Andes as an “agricultural and ecological district” (El Colombiano 2023), erasing long histories of mining.

All interviews and conversations were conducted in Spanish. Two members of the Alcaldía de Andes, the government of the municipality akin to a mayor’s office, were interviewed in order to understand programs in place for capacity building and engagement, relationships with the community, and perceptions of miners. We also performed site visits in Santa Rita and San Agustín. This entailed visiting farms and *entables* or gold processing centers (Figure 2). Semi-structured interviews were conducted with a total of eight community members, including four in the mining and agriculture sector and two working in community organization. We spoke with more community members informally in order to better understand the context of mining, agriculture, and community organization in Andes. We followed our approved human subject research protocols. Before each interview, interviewees signed an informed consent document that we also explained to them verbally. This document detailed the purpose of our research, any risks involved in interviewing, and assured interviewees that the information they provided would remain anonymous. Interviews were also recorded with the consent of each interviewee.

After each interview, we wrote a summary of the major themes that were brought up by interviewees. As interviews progressed, we took note of common themes between them. Different themes presented themselves depending on who was being interviewed at the time. For example, officials at the Alcaldía de Andes had different priorities than community members in Santa Rita. Overarching themes were developed based on all interview data. Interviews were then transcribed using transcription software, reviewed for accuracy, and then triangulated with fieldnotes to ensure accuracy.

4. *Obligation and neglect*

While we had planned for our interviews and site visits to focus on environmental themes, we found that before our interlocutors could discuss ASGM and the environment they needed to explain their troubled relationship with the local government. Our interviewees all pointed to basic needs that were lacking, such as plumbing, trash pickup, road maintenance, and limited cellular and Internet service, which they thought ought to be provided by the government. When we asked about their main environmental concerns, the most common answers were pollution from trash and water quality. One farmer and community leader commented, “We don’t have trash collection ... the truth is we burn it.”³ A miner observed that “the environmental change ... it has changed, but for the worse ... because it’s changed in such a way that the waters can become more polluted.”⁴ He also expressed frustration with the lack of trash collection and apparent refusal of the Alcaldía de Andes to fix this issue. The insistence that mining takes place in the midst of an already compromised environment can be interpreted as both a rejection of the common assertion that miners are personally responsible for pollution and of the mythologized pristine nature that undergirds baseline studies (Ureta 2021).

The Juntas de Acción Comunal (JACs)⁵ became a flashpoint in our fieldwork. A JAC is a community organization with an executive board that is recognized by the regional government. These JACs function as a kind of city council, with an elected executive board representing its members. Approximately 50,000 JACs exist in the country, with around 6000 in Antioquia (Pareja Restrepo and Restrepo Uribe 2017). The size of a JAC depends on its location. The JAC of Santa Rita has over 300 members who take part in community decision-making, fundraising, and elections of executives. In San Agustín, the JAC consists of only the executive members because San Agustín is a much smaller community than Santa Rita.

JACs are a controversial institution in Colombia, as they have been characterized by clientelism since they were founded by the national government in 1959 ostensibly to encourage civic training and connect rural and poor communities with the state. In practice, JACs have been used as political machines to deliver votes and exchange favors (Orozco and Carlos 2014; Romero Leal 2017). Studies of JACs identify a fundamental tension between their ostensible goals of cultivating civic culture and rigid hierarchies that entrench power with local leaders (Jaramillo Gomez 2009; Pareja Restrepo and Restrepo Uribe 2017; Sánchez Otero 2014). Our study found similar tendencies, as

³“No tenemos recolección de basura ... La verdad la quemamos.”

⁴“... el cambio ambiental ... si ha cambiado, pero a mal ... porque de tal manera sí que se puede contaminar más las aguas ...”

⁵Council of Communal Action.



Figure 4. The town square in Santa Rita, which was constructed by a JAC.

described below. Some scholars and Colombian citizens celebrate JACs for getting things done, for example:

They are not constituted simply to talk and criticize, but to propose and execute; and those who are part of them are self-sacrificing people, willing to work tirelessly, almost with greater enthusiasm than as they do when they go to the factory or workshop where they pay their work. (Orozco and Carlos 2014, 195)

In Andes, the JAC's official goals included gathering community input and funds for projects and implementing said projects using local labor and resources. During our research, a common concern among JACs in Andes was the condition of roads. Landslides are common and rain can wash out portions of the road. Because roads are essential to transporting goods such as coffee and gold, JACs often gather funds and workers to lay cement slabs in highly traveled areas. This prevents major washouts during heavy rainfall, ensuring people can travel to and from work and their homes as well as transport goods. Different JACs, however, have different priorities based on community desires. In Santa Rita, the JAC redeveloped the town square (Figure 4). They laid cement, installed benches and lighting, and planted shrubs so it could continue to be a gathering place for community members. They also constructed a roof over a basketball court for children to play even when it rains. In Andes, at the seat of the Alcaldía, the JAC focused on creating a safe and regulated environment for children to participate in motorsports, such as dirt bikes. Some JACs also focus on environmental concerns. In the JAC of Santa Rita, Corantioquia, the regional arm of the national environmental agency, has set up a committee for the environment.

Miners desired to participate in the day-to-day functioning of the JACs but were excluded by virtue of conflicting schedules. We spoke with a farmer who was very engaged in their JAC and was seen as a community leader. When asked about the participation of miners within JACs, they commented that, while miners were not directly involved, "there is collaboration from some processing plants ... with the roads ... the

school.”⁶ Their attitude towards the miners appeared mostly neutral. Another miner who lives and works in Santa Rita and has family involved in agriculture mentioned that they knew of five or six miners who participated in the JAC, but only because they were more temporary miners. Those who mine full-time as their single source of income do not have the same ability to participate in the JAC because of their work schedules. Miners simply do not have the time to attend the number of meetings required by the JACs. Other members of the JACs, as well as members of the Alcaldía de Andes, also agreed that time was a prohibiting factor in miners’ civic involvement. One miner from Santa Rita who very much enjoys working with the land said, “But the truth is, at three, at three absences. They erase you from the book and that’s it.”⁷ The miners that were interviewed have expressed a desire to participate in community projects but when asked why they were not involved, they simply stated, “There is a lack of time.”⁸ When possible, they still help with projects that impact the entire community, but they are limited in their involvement in suggesting and planning ideas.

Local government leaders attributed the miners’ lack of participation to personal desires to be isolated rather than systemic exclusions and temporal mismatches. When asked why the miners are not active within JACs, a government official with the office at the Alcaldía de Andes stated: “The truth is that these people, they are not discriminated against, but have another, as another way of being. They almost do not like to socialize with other people who are not from their trade.”⁹ They see miners as separate from the rest of society, which is very different from how the corregimientos view miners as part of the fabric of their community.

Fraying relationships also led to an organized group of miners severing their relationship with the University of Antioquia in Medellín. The Mesa Minero Ambiental (Environmental Mining Board) was developed as part of a collaboration with local universities and is comprised of local miners. Its goal is to involve the local community in environmental protection and resource use to balance the power between the government and the people. However, they no longer work with university students due to previous bad relationships, with one previous participant saying that the University of Antioquia used the information they gained from this organization in a way that damaged their relationship, so now Mesa Minero turns away students who request interviews or collaborations.

Obligation, Liboiron (2021) argues, must be considered when making judgements about pollution, responsibility, and remedy; obligation calls attention to the relations we have with each other and the non-human world. The conflicting interpretations of the miners’ non-participation in the JACs point to a broad mismatch between the senses of obligation expressed by government officials and residents. Farmers and miners alike called on the government to provide particular basic services as the basis for a good life and pointed out that their lack placed them in a double bind that engendered environmental harm. In contrast, the government officials rejected that obligation and pathologized the miners’ behavior instead.

⁶ “... de algunos entables tenemos colaboración ... con la carretera ... la escuela.”

⁷ “Pero la verdad, como a las tres, a las tres faltas. O sea, como que lo borran a uno del libro y ya.”

⁸ “Será falta de tiempo.”

⁹ “La verdad es que esta gente no es discriminada, pero tienen otra forma de ser. Lo que pasa es que a ellos casi no les gusta socializar con otra gente que no sea de su gremio.”

5. Asserting environmental care

By highlighting the broader context of environmental problems, the miners and farmers situated pollution as a widespread result of government neglect rather than purely the result of individuals making a living. This act was especially significant for miners. Artisanal and small-scale miners are frequently portrayed as being unaware or indifferent towards the environmental impact of their activities by public figures as well as scholars (Metcalf and Veiga 2012; Ottenbros et al. 2019; Sana, De Brouwer, and Hien 2017; Veiga and Marshall 2019). In contrast, the miners we met in Andes all took care to position themselves as environmental stewards, likely in response to popular caricatures of them as a direct cause of contamination and pollution. Our research confirmed prior studies showing that miners demonstrated care for the environment, recognized the potential negative environmental impacts of their activities, and developed measures to minimize them (O'Brien et al. 2021; Schwartz et al. 2021b). As one miner explained, "We only have one planet, and everyone shares it. There is no other planet." Another attributed his decision to adopt cyanidation with "the mindset of the ancients," connecting his family history in Andes to a responsibility to protect the natural environment (O'Brien et al. 2021). While miners do need the income from ASGM, they viewed it as a way to better their lives rather than just earn money.

The key way that miners in our study drew attention to their care for the environment was by emphasizing the close intertwining of mining with agriculture. As one miner stated,

But agriculture is also very important because it is part of life too, because you can have a lot of gold, you can have ... a lot of money ... but if there is no agriculture, there is no one who cultivates it, there's nobody to buy it. So, the two things go hand in hand.¹⁰

In fact, many miners also participate in the farming sector. During peak harvest seasons, miners work in the fields. Once the harvest is over, they return to the mines in order to maintain a steady source of income. Within families, a spouse may farm on their own land while the other works in the mines. One miner described the overlap by saying there were "not so many personal problems, because the same people who are going to be needed to work or who are needed to work in the agricultural field are the same people who work in mining."¹¹ Miners spoke lovingly about the plants and animals they and their families nurtured (Gibson and Smith ND).

There is a very different perception of the miners outside of the corregimientos. In the Alcaldía de Andes, local government officials view miners as people who are separate from society and exploit the land without concern. One official stated that for miners, "it is not important how long the earth has been growing and how long it will take to repopulate the vegetation."¹² Municipal government representatives expressed a belief

¹⁰"Pero la agricultura también es muy importante porque es parte de la vida también, porque usted puede sacar mucho oro, pero si tiene ... mucha plata, pero no hay agricultura, no hay quien la cultive, pues no hay que comprar. Entonces como que las dos cosas van de la mano."

¹¹"... como problemas personales no tanto, sino por lo de que la misma gente que se va a necesitar para trabajar o que se necesita para trabajar el campo agrícola es la misma gente que trabaja en la minería."

¹²"... a ellos no les importa cuán haya creado la tierra y cuanto se va a demorar todo esto que yo hice aquí para empezar a repoblar en la historia de vegetación."

that miners do not feel a responsibility towards the environment and only mine to earn money.

The miners we met also expressed strong desires to “build capacity” to improve their environmental performance. They took initiative in solving problems and recognizing their broader impacts. Miners reported enjoying capacity-building trainings that were provided by organizations such as Corantioquia, the government environmental agency, and often brought them up unprompted during interviews. One miner from Santa Rita who seemed eager to be included in our research stated that the miners “feel good [about the trainings]. We have been trying to copy them and abide by the rules they set for us.”¹³ These trainings have a long history in the region. In Medellín, the Corantioquia archives showed that community-based soil and water quality monitoring initiatives have existed since the 1990s. At the library in Andes, there are books and reports available about soil and water monitoring projects conducted in collaboration with Manos al Agua and Cenicafé. Manos al Agua is an initiative that promotes sustainable water management. Manos al Agua has worked with coffee farmers to develop erosion control tactics, as well as to prevent contaminants due to coffee farming from entering water sources. These projects place an emphasis on speaking with coffee farmers, performing technical trainings for communities, and using social mapping to identify sites of highest priority. Corantioquia has conducted land management projects similar to the Manos al Agua projects. Corantioquia worked with farming communities, administrations, and public and private organizations to increase technical knowledge of soil management. Citizens helped to create soil erosion prevention tactics and participated in educational sessions about soil management (Alcaldía Andes 2022). These initiatives fit within Colombia’s rich history of participatory research and community capacity building, especially as they relate to agriculture, water, and community development (Martínez, Velez, and Piedrahíta 1994; Rappaport 2020).

6. Conclusion

How do people make sense of and make lives in already compromised environments (Lyons 2022; Ureta and Flores 2022)? While the people we met engaged in mining activities, many also engaged in farming. Even those who did not farm themselves had family who did. This livelihood blending is characteristic of rural Antioquia (Gibson and Smith ND) and elsewhere in Latin America (e.g. Marston 2020), troubling simplistic occupational identifications. People who mine, farm, or engage in both activities find themselves in a double bind: they depend on a healthy environment to make a living, but their livelihood activities also present environmental risks to those very economic activities. While our interlocutors were quick to point out potential contamination from both mining and farming, they rejected the commonsense logic found in both academic literature and local government discourse that people’s irresponsible individual behaviors were to blame. They insisted that pollution came to be through a web of relationships. They critiqued the local government for failing to deliver on their obligation to provide public services that would support health and environmental wellbeing. They asserted their own

¹³“Se sienten bien. Hemos ido como tratando de copiarlos y acatar las reglas que nos pone.”

care for the environment, while pointing out the structural limitations that made it difficult for them to participate in local government programming.

This research builds on broader critiques of the practice of citizen science and participatory environmental monitoring as strategies to make pollution legible. As Kimura and Kinchy (2019, 4) write, citizen science may “inadvertently promote the idea that environmental problems can be adequately addressed on a voluntary basis – when, in many cases, law and policy are required.” They also highlight that the linking of citizen science with environmental causes raises dilemmas of credibility; while these projects help participants make claims grounded in science, the grounding of citizen science in environmental and social causes raises the specter of the science being perceived to be biased or tainted. Moreover, grounding concerns in science can sideline “values, emotions, social inequality, history, and aesthetics, which are not easily reduced to simple, rational measurements” (2019, 5). We hope our work adds to a growing chorus that shows the need for scientific assessments of pollution to be deployed strategically, without losing sight of concerns and hopes that are not reducible to quantitative measurement, so that we may enhance our “capacity of formulating other questions and of considering other ways of living together” (Albagli 2015, 20).

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