Small-Scale Gold Miners' Preferences on Formalization: first steps toward sustainable supply chains in Colombia

Abstract

Artisanal and small-scale gold mining employs millions of poor people, globally, yet also significantly degrades the environment. Support from conscientious buyers, based on the information within certifications, could lower environmental impacts and raise incomes, leading miners to be willing to incur costs to participate in sustainable supply chains. As supply-chain certification may require formalization, we explore miners' motivations for and barriers to formalization within a choice experiment in two Community Councils in Afro-descendent areas of Colombia's Pacific Region: Yurumangui, in Valle del Cauca; and San Juan, in Choco. Community Councils have collective land rights—which might make them more willing to engage in collective actions often required for formalization. We find that while all miners prefer to leave their status quo, the Councils differed in miners' views of formalization. Given the options we offered, Yurumangui expressed more interest overall, perhaps due to negative past formalization experiences in San Juan. Yurumangui was also more willing to form or join an association to formalize, very likely due to its positive past outcomes from organization. We found no consistent effect of gender regarding preferences, though prior voluntary restoration correlates with individual miners' willingness to restore sites, one requisite of formalization. Our results inform interventions to support formalization in small-scale gold mining communities, as we found miners willing to try formalization yet perceiving costs that can hinder adoption and in ways that vary with Council legacies.

JEL Codes*:* C25, D04, D71, Q31, Q32, Q38

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1. Introduction

Over 40 million people are engaged in artisanal and small-scale mining (ASM) globally, most in the Global South. Artisanal and small-scale gold miners (ASGM) provide close to 20% of the total global supply of gold, while often operating informally with large negative environmental impacts (IISD, 2018). ASM has generated significant local land-use changes as well as local and global environmental pollution through the release of heavy metals such as mercury, arsenic, and lead into the air, water, and soil. This has spurred global efforts to support shifts in ASM practices.

Sustainable mining initiatives, such as Fairmined (FM), Fairtrade, and Swiss Better Gold (SBG), have arisen to confront environmental and social challenges with both local and global elements. Yet, despite sensible approaches, the adoption of new practices has been slow—while many of the operations certified were already close to compliance with the standards. In response to the low rates of adoption, which especially for the smallest producers may be due to technological and market barriers, less onerous systems such as the Code of Risk-mitigation for ASM engaging in Formal Trade (CRAFT) are now being promoted in Colombia and globally (ARM & RESOLVE, 2020). Within every certification's code of conduct, however, miners are required to "formalize", i.e., to obtain an official government license to operate. Unlike agriculture, where formal land title is not required, in mining formalization is a necessary step to even consider supply-chain certifications.

Colombia is a small player in gold, with only ~2% of global annual production (World Population Review, 2022). Yet gold mining supports hundreds of communities, with profound socioeconomic implications but often in fragile and biodiverse ecosystems of environmental importance. Small-scale mining operations account for ~70% of national production in Colombia (Sarmiento et al., 2013), benefiting more than 180,000 small-scale gold miners (Cremers et al., 2013). Mining is also

an important income source for illicit groups, noting that most metallic-mineral-production units operate within conflict-ridden areas, without mining permits or titles (UNODC, 2022).

Distributional issues across and within sectors are also relevant in Colombia and more generally. Despite $400 billion in annual trade (OEC, 2023), miners are among the most marginalized workers in the world (World Bank, 2020), while women and children are among the poorest participants within ASM. Although women make up an important part of the labor force occupied in mining (up to 50% in Africa (Forum for Mining, 2017)), they often suffer discrimination of multiple forms: women are paid less for similar tasks; and they have limited access to some activities, as well as credit, asset ownership, and decision power (Buss et al., 2017). In many cases, it is women who work the outskirts of mines to recover gold from low-value ores that male miners have left as residue (Cruz, 2016). Female participation in mining is also constrained by caregiving and involvement in other economic activities such as agriculture (World Bank, 2020). In sum, the benefits of mining are very often highly gendered, with men in charge of the higher-paying activities, such as digging, while the women who grind, pan or wash earn a fraction of what males make (Reichel, 2020). Therefore, despite women's interest in sustainable mining for the wellbeing of their households and communities more broadly, low shares of the gains from participating in mining formalization, and eventually in certification, could well drive female views to differ from those of male miners.

In principle, initiative which advance more sustainable mining could be a contributor in alleviating environmental damages, improving livelihoods, reducing violence, and even closing gender gaps in perceived benefits from mining. That could be particularly important along the Pacific coast, where traditional mining has been practiced since pre-Columbian times, but where small-scale

gold mining territories face the threat of encroachment of illegal mining operations, controlled by criminal organizations.

Today, 40% of the gold produced in Colombia comes from this Pacific region, a particularly interesting one because communities here hold collective land titles under the form of Community Councils (CC). This institutional juxtaposition may well suggest greater potential for sustainable mining. Collective titling could facilitate formalization and sustainability, as community organizations and other forms of collective action are already present. Further, formalization could help differentiate small-scale from illegal mining, with implications for government intervention in these territories.

To understand the motivations for formalization required for certification, as well as some barriers, we studied miners in two of these Community Councils: Yurumangui in Buenaventura (Valle del Cauca department); and San Juan in Tado (Choco department). We explore which, of a number of possible bundles of benefits and commitments, miners indicate they would be willing to accept to become formalized. Factors explored offered were gold price, restoration activities, local associations, and fees. Contrasting CC histories, including with formalization, could affect perceived costs and benefits. As participation in mining and its benefits is a gendered activity, we also compared female to male views. Understanding miners' preferences relevant for formalization can help guide public, civil, and private actors in achieving both environmental and social benefits.

We found that these two Councils differ in the miners' average views about formalization options. Miners in the CC with prior experience of formalization were actually *less* attracted to it—holding other elements of formalization constant— suggesting the influence of past negative experiences. In contrast, miners in the CC with higher levels of prior social organizing were more willing to form associations that could facilitate the formalization process, suggesting a positive past matters.

Restoration willingness rose with individuals' prior voluntary restoration experience. On average, we found no differences in perceptions and preferences across gender within these communities.

We believe that these results are reflective of the ongoing need for more attractive policy options for formalization, from the perspectives of these miners (as opposed to other important actors in the sector whose objectives may differ). Mining communities may be willing, in principle, to move away from their current situation, yet they will need greater confidence that this would bring gains. Public and civil actors could provide better information on what formalization requires, including the gains from forming groups to comply with markets' requirements at lower transactions costs, and could adjust important details of formalization options' details, if trying to increase adoption.

The rest of this article is organized as follows: Section 2 reviews the relevant literature. Section 3 describes our field context and Section 4 our methods, presenting the hypotheses behind our models. Section 5 presents the results, and Section 6 discusses the implications for theory and policy.

2. Literature Review

2.1 Mining Formalization

UNEP's handbook defines formalization as: "a process that ensures that ASGM actors are licensed and organized in representative entities that represent their needs; policies are implemented, monitored, and enforced; and ASGM actors receive technical, administrative, and financial support that empowers them to adhere to requirements prescribed by national regulations" (UNITAR & UN Environment, 2018, p. 17). Legality and building capacity to meet requirements are linked: miners with few assets often need support to take steps to become legal, while becoming legal may make miners eligible for government support. Further, governments have often focused

on legality without providing support, with poor outcomes (Hilson 2020a; Veiga and Fadina 2020). As the Swiss Agency for Development and Cooperation (SDC) argues in a review of multiple efforts: “formalization … must not be limited to the pure legal aspects, but incorporate community development and broad capacity building” (Hruschka, 2011, p. 43). A purely legal focus can paralyze momentum if miners are not organized in ways that would allow them to become formal.

Global rhetoric about formalization tends to be framed around improved environmental and social results, as compliance with environmental and labor laws is expected to render better outcomes (Fritz et al., 2018; Spiegel et al., 2015). However, such efforts have frequently fallen short, as few actors succeed in formalizing while those who do often are already much better off than average ASGM actors and as a consequence may well be better able to navigate the barriers noted. Further, those who got formalized have not necessarily had better social and environmental performances.

In Rubiano et al.’s review (2020), strategies for the formalization of the small-scale gold mining face several challenges. There is a need for more flexible state institutions that adjust regulations, bureaucracies and fees depending on actor size and characteristics. Access to permits and mining titles should not be the only purpose of formalization, which should also advance both labor and environmental regulations and equitable access to land and natural resources. It is important to see not only who owns a mining title but also who controls key capital in the process of formalization.

Challenges leading to low formalization rates include a shortage of official information concerning miners, the biases in favor of large-scale mining and high-capacity entrepreneurial lifetime miners over those compelled by poverty to mine part-time, the time required to obtain permits, and one-size-fits-all approaches (Hilson et al., 2021; Hilson, Gillani, & Kutaula, 2018; Hilson, 2020a; Sippl, 2020; Coy et al., 2021). These yield what Veiga & Fadina (2020) term a formalization “fiasco”: to date, less than 1% of the artisanal miners in Latin America are formalized (Veiga and

Fadina 2020). **¡Error! No se encuentra el origen de la referencia.** below includes some common barriers to formalization identified by UNEP.

We emphasize that hurdles to formalization are especially daunting for artisanal miners who work independently, lacking capacity to meet requirements such as work plans or environmental impact assessments. Those steps require literacy, technical know-how, and time that many subsistence miners do not have. As a result, those miners who work independently might not be able to access prices or capital which could move them ahead: "Only larger and organized clusters of artisanal miners […] are able to develop beyond subsistence economy, overcome dependencies from local middlemen and even engage with international markets on their own" (Hruschka. 2011, p. 28). In fact, it is precisely when acknowledging such hurdles for the individual artisanal miners that the SDC recommended as a formalization pre-requisite that ASGM actors form associations or other formal organizations. Existing social capital is key here, as formal organizations can be developed more easily when groups have successfully worked together in the past than when they have not.

[Figure 1]

However, formalization is not free of controversy. Some authors link formalization to the lack of progress in outcomes, including exacerbated forest loss (Álvarez-Berríos et al., 2021). Some operators face incentives to extract quickly, secretively, and destructively since they believe access may not last.

A legal focus has gone hand-in-hand with enforcement that can be socially and environmentally damaging, increasing conflicts and pollution. In some cases, titling has allowed outsiders to make claims on indigenous lands; reductions in mercury use have not come about with formalization

and the focus on raising tax revenues − rather than capacities − has created more illegality rather than less (Alvarez-Berríos et al., 2021; Spiegel, 2015; Rorato et al., 2020; Veiga and Fadina, 2020).

Further, miners do not necessarily perceive any benefits of formalization, including better market prices or reduced violence. In cases when formalization has been a centralized top-down decision, it has driven increased militarization and state violence (Geenen, 2012, Kaufmann & Côte, (2021).

Finally, some suggest "formalization fiascos" may be by design. Formalization is state-driven, yet some governments do not value the poor rural ASGM sector, versus large-scale mining's greater economic and political potential. ASGM may be seen as a competition or a nuisance that can ruin states' reputations (Hilson et al., 2020; Hilson, 2019). In Zambia, after the government's mining priorities had shifted, a massive push to formalize gold-panners was transformed into a military operation to shut down illegal mining, which made targets of previously identified beneficiaries (Hilson, 2020b). In Zimbabwe, progress in the 1990s linked to empowerment of local authority stalled when a re-centralization blocked local governments' ability to issue permits (Spiegel, 2015). In sum, while formalization offers an interesting pathway to improve conditions for ASM suppliers it is riddled with challenges, especially when designed without regard to the miners' aspirations.

2.2 Mining Certification

ASGM organizations sometimes obtain better gold prices or market access if they meet externally determined standards (e.g., workers' rights or environmental behavior) in certification schemes, such as Fairmined and Fairtrade. Certifications are promoted by NGOs—who often are working with development agencies to improve ASGM supply chains, predominantly to Western markets. Formalization is often one prerequisite, linked to compliance with exporters' national laws and

sometimes also importing countries' standards. International development agencies, for instance, can be restricted to funding only formalized actors, due to the official nature of their cooperation.

Like for formalization, discussions on certification are broadly organized around access, adoption, and impact. Early literature concerning certification in small mining focused mostly on "Fairtrade-Fairmined", a collaboration of the Fair-Trade Organization (FLO) and the Alliance for Responsible Mining (ARM). Distinct certifications, "Fairtrade" and "Fairmined", arose after the organizations split due to disagreements about how to address difficulties faced by the original certification (Sippl, 2020). Studies highlighted that certification would not reach the miners most in need of help (Hilson & McQuilken, 2016) and might be rejected by vulnerable miners given their past negative experiences with interventions and the certifications' lack of answers to challenges miners face (Childs, 2014). Miners trying to get certified faced requirements including obtaining formal permits (Sippl, 2015; Hilson & McQuilken, 2016; Fisher, 2018). These allegedly pro-poor schemes neither empower nor target the most impoverished miners (Hilson et al., 2018). Fairtrade and Fairmined miners earned almost ten times more than the average artisanal miner before becoming certified (Sippl, 2020; Sippl, 2019). Certification has reached only a small amount of 'low-hanging fruit' (Hilson et al., 2018) and may inevitably serve only a niche (Sippl, 2019). Ultimately, certification challenges appear to imply that, as for formalization, at least current efforts apply to and affect a small and well-organized, high-capacity subset of ASGM actors already very close to compliance.

Monroy et al. (2022) suggest new interest within international organizations in financing initiatives aimed at the most vulnerable miners. ARM, which promotes Fairmined, has responded to demands of both international agencies and mining groups for a more attainable certification by creating the CRAFT code of conduct. Codes of conduct are less rigorous than certification schemes and tend

to favor continuous improvements over strict compliance (Rueda et al., 2017). CRAFT criteria aim to expand access in ASGM by privileging anti-conflict over environmental standards and focusing on "legitimacy"—permission of landholders to mine, including compliance with national laws—rather than "legality" in meeting all formalization requirements. This lowers participation costs for miners, in part via self-reporting, instead of paying for audits (Sippl, 2020). While not promising price premia or access to international buyers, CRAFT connects small producers to more formal buyers who offer prices closer to spot price—which could be a substantial incentive, given that informal miners frequently receive significantly less than the international price (Coy et al., 2021).

2.3 Mining Formalization & Certification in Colombia

Formalization in Colombia has been found to be onerous, with over 380 steps costing on average $50,000 over 2-3 years (USAID, 2021). Thus, few miners complete the process, despite claims that formalization would be profitable (Coy et al. 2021). Reports about its impacts have also been quite mixed. Some say formalization has allowed land grabs and intimidation of land users (Alvarez-Berríos et al.202), while others argue it reduced mercury contamination (USAID 2020). Some contest the latter claims, drawing on visits to formalized small-scale processing plants to argue that the majority of those formalized plants are misusing mercury, creating pollution similar to that in informal mining and processing (Alvarez-Berríos et al. 2021; Veiga and Marshall 2019).

Colombia has been a pioneer in sustainable gold production. In 1996 it created "Oro verde", the first project in the Choco Forest that developed and tested an environmental and social standard for production of artisanal gold (Sarmiento et al. 2013), one which later became the basis for the Fairmined certification. Colombia is also the home country of ARM. Still, the rate of certification remains relatively low. Further, attrition has occurred, with currently only two active Fairmined

certified operations, down from a peak of 5 in Colombia and 10 globally in 2018. Certifications can show that best practices are possible, even if potentially for relatively few actors (Sippl 2019).

Low adoptions have multiple causes. Informality is widespread. Low associativity of miners offers an additional challenge, making it harder to create business structures that manage the mining title, collect the gold, and include the miners in the social protection system. Finally, gold production using artisanal methods is highly variable, thus many small mining communities cannot guarantee certification partners like Fairmined a minimum stable supply of one kilogram of gold per month.

3. Field Context

Although Colombia is a relatively small player within the global gold market, gold mining is a key source of income for impoverished communities along its Pacific coast, where close to half of the nation's gold supply is produced. About 40% of this extraction happens in the territories of Afro-Colombian communities (UNODC, 2021). Law 70 of 1993 recognize their collective rights under Community Councils (CC), each governed by a Board and a Community Assembly (Vélez, 2011). Currently, over 190 CCs administer almost 6 million hectares of collective property (ANT, 2022). CCs have rules to manage their territory and resources (Vélez, 2011), perhaps with some impacts: evidence suggests that without collective titling, deforestation would be higher (Vélez et al., 2020).

While these CCs can design rules to manage gold mining in their territories (Rodríguez et al., 2019; Rodríguez et al., 2021), the subsoil belongs to the State. From the national government's perspective, tools beyond pans are illegal unless a miner or community has a concession. Gold mining is a traditional activity (Leal-León, 2016), though, and the main source of income for an important share of CC families. As the Law 70 framework chapter that regulates mining in this territory has not been developed, regulations vary depending on local governance. There are

tensions with national level regulations. Some CCs effectively prohibit the use of backhoes, as well as the presence of any external miners. In others, only small motor pumps, mini-dredges, and very basic tools such as pikes, shovels, and *almocafre* are allowed. Others restrict mining spatially (e.g., from some areas of the river), replant logged forest, or prohibit the use of toxic chemicals which can damage human health, fishing, and agriculture. Enforcement varies with the social capital of the community (Rodríguez et al., 2019; Rodríguez et al., 2021).

[Map 1]

Under current legislation, CCs with small-scale gold operations must use the procedure established by Resolution 266 of 2020 to regulate traditional mining. CCs must define Special Reserve Areas (ANM, resolution 266 of 2020), prepare an Environmental Impact Study (ANM, resolution 546 of 2017, art. 22), have a Work Plan (ANM, resolution 266 of 2020, art. 20), and get an environmental license and special-concession title (Decree 1378 of 2020). On average, costs of complying with formalization requirements for such Special Reserve Areas are around US$50,000 (USAID, 2021). Hardly any CCs could cover such costs without external aid. For artisanal miners using only pans, the only formalization requirement is to register online to receive a tax identification number and then register with the mayor's office. Yet many mining villages lack the required internet connection to complete these steps.

In fact, communities face several barriers to comply with the requirements (Monroy et al., 2022; ARM, 2018). Beyond the costs and barriers noted, Law 70's mining chapter has never defined roles for CCs in the administrative process or been adapted to traditional models of organization for the Pacific. Instead, the national government employs identical policy tools as when dealing

with substantially different contexts. This makes the informal mining communities vulnerable, including to illegal mining groups (Rubiano et al., 2020; Zabyelina & Uhm, 2020).

We conducted our fieldwork and choice experiments in two CCs that differ in their organization and formalization experiences: San Juan, in Choco; and Yurumangui, in Valle (**¡Error! No se encuentra el origen de la referencia.**). They offer empirical contrasts for considering how formalization could be expanded in Colombia's Pacific, with different levels of formalization, and social cohesion, as well as contact with external actors. World Wild Fund for Nature (WWF) has been in San Juan motivating miners and the CC board to formalize, while nobody has approached Yurumangui's residents suggesting this course of action. San Juan is highly connected to urban markets of gold and other products. Yurumangui's miners are hours from the closest buyer. Social capital also varies, as will become apparent from the study.

4. Methods

To understand formalization motivations and barriers for these Community Councils, we conducted semi-structured stakeholder interviews to understand local contexts then define an adequate experiment. Next, we did a choice experiment to capture the preferences of participants regarding formalization. This was followed by a survey to capture both individual and household-level characteristics. Each of these instruments was applied to both female and male miners and their responses were analyzed separately to capture possible gender differences. This section provides details about our methods.

4.1 Interviews

For the first stage of our research, we conducted 18 semi-structured interviews with mining leaders from Yurumangui and San Juan. We also held meetings with the CCs' Boards to understand local

productive practices, gold markets, community-based governance, and current formalization level. These meetings also allowed us to discuss our survey and choice-experiment designs to tailor our questions and choice-experiment attributes and levels to these local contexts. We also interviewed six mining experts from the government and NGOs who work on formalization and certification.

4.2 Surveys

We collected demographic information (age, gender, education level, etc.) as well as information regarding local mining practices, governance structures, and relevant gold-market outlets. Surveys and choice experiments were administered to 423 participants within these two communities: 219 in Yurumangui; and 204 in San Juan. Our survey and choice-experiment participants were all individuals who have derived part or all their income from artisanal and small-scale gold mining.

We trained and hired a local team of surveyors within each community. Surveys were collected mainly in an-online platform (KoboTools) using cellphones (one numerator conducted the survey on paper). Each team spent a month in their CC implementing surveys and researchers supervised this data collection. We eliminated outliers when the time to fill out a survey was infeasibly short.

4.3 Choice Experiment

Since formalization has been infrequent, it is important to assess miners' preferences to understand what combinations of costly and beneficial characteristics miners would accept for formalization options. Choice experiments explore such preferences by presenting many potential bundles. They have been used to study resource uses and the design of incentive schemes that could reward shifts toward further pro-social/environmental behaviors: estimate preferences for varied attributes of environmental programs, including willingness to accept payments for environmental services (Lliso et al., 2020; Raes et al., 2017; Beharry-Borg et al., 2013); consider collective versus

individual payments, as well as provision of technical assistance in Mexico (Costedoat et al., 2016); explore impacts of agri-environment certifications involving externally preferred practices (Christensen et al., 2011; Broch & Vedel, 2012; Rodríguez-Entrena et al., 2019); and examine restrictions on third-party access to common-pool resources in Ecuador (Maldonado et al., 2019). Our study contributes to this literature by applying this method to consider formalization programs or offers in ASGM.

Our discrete-choice experiment elicits preferences for ASGM-formalization options in these CCs. Each participant was presented with a set of six choice tasks. For each choice task, the participant picks one of three scenarios: two distinct formalization offers and the "status quo" (i.e., remain not formalized, maintain environmental practices and organization level, and gain no price premium). Formalization offers have attributes, linked to the costs and benefits of becoming formalized, that we determined based on interviews with local actors and a review of formalization requirements:

i) participation in an association

ASGM miners operate independently or as a family or as part of larger groups. Even when miners exploit the same area as family and friends, each miner tends to keep the gold they extract. Miners also tend to choose individually when and to whom to sell gold. Formalization process, however, often requires joining associations, in order to help to access land titles and gain external support. From the state perspective, such associations may well be easier to support, permit, and regulate. Yet this deviates from how miners operate. It implies less independence, constraining decisions with costly collective action. Thus, joining can be perceived as costly for independent operators. In places where local collective action has occurred and succeeded, though, it may not be perceived to be very costly. This is a discrete attribute whose levels are: participate in an association; or not.

ii) investment of time in mining-site restoration

Site restoration is required and can be costly. Once alluvial operations finish, the common behavior is to depart without restoration, leaving barren pits of mud and stones. This has costs downstream, as pits stripped of vegetation erode, raising waterways' turbidity and sedimentation. Restoration effort, such as re-introducing vegetation and/or filling mining pits, can lower those costs and also have local benefits such as lower incidence of mosquito-borne diseases. Such effort in restoration can be translated into days of non-paid work, so we represent this attribute in terms of four levels: 0, 1, 2, or 3 days per month. We acknowledge that some miners view certain restoration efforts as locally beneficial, yet we suspect most view a requirement to restore their exploited sites as costly.

iii) contribution to the community council

For formalization to be effective may require efforts by local authorities, which may require some compensation for the effort. We include this as a financial contribution to the Community Councils, since CC Boards are the initial level of local political organization for managing collective lands. Boards define rules to manage those lands, as well as access to other resources, and to raise funds for public works via voluntary contributions or external donors. They are the formal authority who mediate local interactions with external actors. Boards could support formalization by providing administrative assistance with environmental and social requirements, as well as documentation. Boards might then expect compensation for time and for the exploitation of communal resources. We consider fees of 0, 2,000, 4,000, or 6,000 Colombian pesos (COP) per 100,000 COP of income from gold (at that time one dollar (USD) equaled 3,855 COP). These fee levels imply that miners contribute 0%, 2%, 4% or 6% of their revenues from selling gold to the Board. Beyond covering the costs of administrative support, however, such contributions could be understood as a way to redistribute the local benefits from mining to various members within the

community. Boards are likely to want to channel some of such earnings into local development projects and public goods.

iv) gold price per gram

Formalization is expected to improve access to markets and perhaps differentiate products. Either could raise the price. At the time of our study, while miners received 130,000 COP/gram on average when they sold to the informal gold buyers closest to their communities, formal buyers paid much closer to international spot price, at least when buying from fully formal, legal mining operations (at that time 220,000 COP/gram was ~90% of the London Fixed Spot Price, although of course the prices fluctuated considerably and depended on gold purity). To represent plausible outcomes, we used the levels of 130,000; 160,000; 190,000; and 220,000 COP/gram within our choice cards.

[Table 1]

summarizes the attributes and their levels (those in the "status quo" are labelled as "s.q".). To create the potential bundles of characteristics included within hypothetical formalization offers, we randomized each attribute. Each card presents two potential offers plus the "status quo" option {no association, 0 days of restoration, $0 contribution to the CC, and 130,000 COP/gram price}. We produced cards with attributes (**¡Error! No se encuentra el origen de la referencia.**). F ollowing Kaczan & Swallow (2013), to reduce hypothetical bias we also provided an introductory paragraph to explain the value of learning from this choice experiment to actors who design actual formalization offers that may be implemented.

We first generated all possible unique formalization offers' (128 =2 x 4 x 4 x 4) attribute-level combinations. These could be combined into 16,256 (128 x 127) distinct pairs of two alternatives. We applied the DCREATE algorithm in Stata to reduce this number to 30 pairs to maximize design

D-efficiency, based on the covariance matrix of the conditional logit model (Hole, 2017). For this new design, with a new population, we had no firm priors for attributes' coefficients and used zero in DCREATE. We discarded 5 pairs in which we suspected one alternative would be dominated.[1]

[Table 1]

[Figure 2]

Finally, we randomly eliminated one alternative to get 24 choice tasks to be evenly and randomly divided into four packets of six choice tasks each. By providing only 6 choice tasks to each survey respondent, we avoid burdening participants with too many choices. Each of these four blocks or packets of six-choice-tasks each was administered a roughly equal numbers of times in both communities.

We carried out a survey with miners before this experiment. The survey asked about: miner history and practices; perceptions of mining environmental impacts; gold trade actors; mining governance; community relations; and formalization. After the discrete-choice experiment, we asked additional questions to understand the participants' perceptions concerning miner associations, formalization process, restoration work, contribution to community council, among others (Johnston et al., 2017).

4.4 Analysis Strategy

The empirical analysis of our experiment is based upon random-utility theory. We model utility as a function of observed and unobserved characteristics. The former are the attributes and surveyed variables. This strategy assumes utility functions in an ordinal sense, so the magnitudes of utilities

[1] It is common practice to remove illogical combinations (Maldonado et al. 2019; Huber and Zwerina 1996)

for different alternatives are meaningful only when compared to each other (Hensher et al., 2015). The basic model assumes that the utility of the respondent depends on the levels of the attributes:

$$U_{ij} = \beta_0 + \beta_1 Assoc_{ij} + \beta_2 Rest_{ij} + \beta_3 CC_{ij} + \beta_4 GP_{ij} + \epsilon_{ij} \quad (1)$$

where U_{itj} indicates a utility level for individual i from alternative j, while $Assoc_{ij}$, $Rest_{ij}$, CC_{ij}, and GP_{ij} indicate attribute levels in a choice task, and ϵ_{ij} is the random component or unobserved factors in utility. Then β_1, β_2, β_3, and β_4 are the estimated parameters that reflect the marginal utility of each attribute in a Multinomial Logit Model. Finally, β_0 reflects the alternative-specific constant ($ASCSQ$) for the status quo or the utility associated with staying at the status quo (Adamowicz et al., 1998). Results can be read in terms of the average willingness to accept (WTA) for marginal changes in the level of each attribute, as indicated by the negative marginal rate of substitution[2] between an attribute parameter and a monetary attribute, in this case the gold price, putting attributes' effects in monetary terms. WTA_k, where k is the attributes ($k = 1, 2, 3$) can be estimated as the ratio (β_k / β_4) using parameters that are obtained estimating equation (1).

Equation (1) assumes linear utility as a function of each choice attribute, yet we hypothesize that restoration preferences vary with prior voluntary tree planting effort. Thus, we interact the attribute of including restoration work within the formalization option with a survey measure of miners' prior experience in voluntary restoration (measured by voluntarily planting trees, *VPT*). Thus, we also use the specification in equation (2) in which the *VPT* is interacted with previous restoration:

[2] WTA is the average amount of currency (additional price of gold per gram) CE respondents are willing to accept in exchange for shifting the value of an attribute by one unit. A positive sign indicates that respondents are willing to accept that shift in the attribute if they also have an increase in the gold price per gram equivalent to the WTA value (the implications being that this shift in the attribute generates negative utility). In contrast, a negative sign indicates that respondents are willing to accept a reduction of gold price per gram, of magnitude equivalent to the calculated WTA value, in order to get that increase in the level of the attribute (i.e., this attribute generates positive utility).

$$U_{ij} = ASCSQ + \gamma_1 Assoc_{ij} + \gamma_2 Rest_{ij} + \gamma_3 Rest_{ij} * VPT_i + \gamma_4 CC_{ij} + \gamma_5 GP_{ij} + \epsilon_{ij} \quad (2)$$

However, the relationship between accepting a formalization offer and the inclusion of restoration might not be linear in the number of restoration days per month one requires as part of the bundle. The individuals may have some preferences for voluntary work up to a certain point after which they invert their preferences because they perceive that the costs outweigh the benefits. In this context, a linear interaction would not be sufficient. Therefore, we also want to test whether a non-linear relationship is observable. Equation (3) describes non-linear dummy effects for this variable, which we test below:

$$\begin{aligned} U_{ij} = ASCSQ &+ \theta_1 Assoc_{ij} + \theta_2 Rest_1 day_{ij} + \theta_3 Rest_1 day_{ij} * VPT_i + \theta_4 Rest_2 day_{ij} \\ &+ \theta_5 Rest_2 day_{ij} * VPT_i + \theta_6 Rest_3 day_{ij} + \theta_7 Rest_3 day_{ij} * VPT_i + \theta_8 CC_{ij} \\ &+ \theta_9 GP_{ij} + \epsilon_{ij} (3) \end{aligned}$$

5. Results of Interviews & Surveys

5.1 Qualitative Results: regional context & community differences

5.1.1 Community Council of Alto San Juan (ASOCASAN)

Located in Southeastern Choco Department, between the municipality of Tado and the border with the neighboring Department of Risaralda, this Community Council holds 354,517 hectares that are collectively recognized in the name of the Afro-descendant communities of Alto San Juan. It is

locally known as ASOCASAN (INCORA, Resolution 02727 of 2001). This CC is made up of 21 local councils (or villages), within which 4,637 people reside in 1,460 families (UNDP, 2020).

This ethnic-territorial governance body is led by a Board of five people and a legal representative elected in the Community Assembly every three years (ASOCASAN, 2009). Board decisions rely on a Use-Management-Environmental exploitation plan, an Ethno-Development plan, and internal regulations on land use, and natural-resources uses, and economic activities (ASOCASAN, 2020).

Inhabitants of Alto San Juan engage in gold mining, platinum mining, and subsistence agriculture (ASOCASAN, 2009). Some community members still use traditional artisanal mining techniques, such as the *zambullidero* and the *mazamorreo*[3]. External pressure to mechanize mining production has been growing since the construction of the highway linking Tado to Risaralda (Ayala, 2005). Such pressure rises with the international gold price. Local miners are well connected to markets and sell their output in the main urban areas of Tado, Istimina and Quibdó, the capital of Choco.

All forms of mining coexist in ASOCASAN: from artisanal alluvial mining, predominantly carried out by women; to semi-mechanized alluvial mining performed by local crews of mostly men, using mini-dredgers and low-power motor pump; to semi-mechanized underground mining, performed by crews; to mechanized mining using draglines, backhoes, and hydraulic lifts, which is carried out clandestinely by outsiders but supported in some cases by community members albeit without authorization from the Board. The risk that mechanized mining is co-opted by illegal armed groups is high, due to the presence of several organized crime and drug trafficking groups in the region, something that exceeds the capabilities of the CC Board to regulate (Ángel et al., 2019; Uhm, 2020).

[3] The *zambullidero* is a wooden box which is used to take out the sands from the riverbed. The term *mazamorreo* refers to the action of panning gold with the use of water and a shallow tray.

Some areas within this CC were declared a Special Mining Zone for Ethnic Communities in 2006. That prevents others from claiming titles (Ministry of Mines, Resolution 181792 of 2006). In 2019, a group of community members managed to have 695 hectares (divided into seven polygons) declared a Special Reserve Area (ARE) (ANM, Resolution 315 of 2017). In 2021, the local Council of Cértegui requested the declaration of an ARE of 3,000 hectares. The request is still under review (ANM, 2022). Currently, the CC receives technical advice from WWF-Colombia and ARM to support their application for the environmental license and the mining title.

There is some expectation in the CC and supporting NGOs of eventually connecting gold output to higher-value 'sustainable supply chains' certified by Fairmined.[4] One challenge, however, is a cohesive and sustainable model for managing the mining title, including an appropriate distribution of benefits, since not all community members have access to the mining operations covered by the current and requested ARE. The Board needs to balance the interests of some miners and ARE for a market-oriented exploitation and the needs of the community (including non-miners) as a whole.

5.1.2 Community Council of the Yurumangui River

Located in southwest Colombia, within the rural area of the municipality of Buenaventura, in the Valle del Cauca Department, this Community Council holds 54,000 hectares that are between the Cajambre River to the north, the Naya River to the south, the Farallones National Natural Park to the east, and the Pacific Ocean to the west. These lands were declared collective territories in the year 2000. The population of this CC is roughly 3,000 people who are distributed across 13 villages along the Yurumangui River. In the upstream villages Juntas and San Antoñito, people are engaged

[4] Since 2008, private companies have filed concessions requests for 8,907 hectares within the Community Council (ANM, 2022). These requests are unlikely to pass, though, since they need to undergo a prior-consultation process.

mainly in gold mining. One area has been declared a Special Mining Zone for Ethnic Communities (ANM, resolution 308 of 2017). However, the CC has not initiated formalization processes in their territory. Further, most local miners are not registered at the municipal office as artisanal miners.[5]

Three types of mining occur in Yurumangui: ravine; river; and mountain or hill. The first two are usually carried out by crews of between 10 and 120 miners. The third approach, however, is done individually or using small crews that dig soil from the mountain by hand and wash it in the river. On average, a crew of 20 miners could extract between 20 grams and 2 pounds of gold monthly.

Miners who manage to aggregate considerable gold tend to sell it in Buenaventura. Others find it more convenient to sell to *tenderos*, i.e., store owners from the village who supply food to miners and sometimes grant loans for mining expenses. In this CC, *tenderos* face high transportation costs to gold markets, with a 12-hour trip by both river and sea to reach Buenaventura's gold market.

Yuramanguí has been nationally recognized for its effective social organization, even having won a national prize for the successful defense of its territory. Its resistance and more generally its high levels of collective action, including avoiding the expansion of illicit crops, have been documented (Lobo and Vélez, 2020), as have their practices for managing gold mining (Rodríguez et al., 2019; Rodríguez et al., 2021). The CC's Community Assembly established rules on gold mining—including restrictions on using high-power motorized pumps or mercury. A limited number of mini dredges are allowed, yet no miner is authorized to use big dredges or high-capacity machinery. External miners are not allowed to exploit local gold mines at all—and, at least to date, such outsiders' presence has been avoided.

[5] Since 2017, private companies have filed concessions requests for 5,835 hectares within the Community Council (ANM, 2022). These requests are unlikely to pass, though, since they need to undergo a prior-consultation process.

Yet Yurumangui currently faces a crisis involving the forced disappearance of well-known mining leaders who had previously led community resistance to residual FARC-EP and ELN armed groups who compete to capture mining rents and to control rivers to facilitate transport of cocaine and weapons. Despite the Colombian Peace Agreement with FARC, there has been an increase in violence, confinement, and displacement for many Afro-Colombian communities within the Pacific region.

5.2 Survey Results

Our sample is made up of 423 artisanal and small-scale miners from these CCs in Choco, San Juan and Valle del Cauca, Yurumangui (see **¡Error! No se encuentra el origen de la referencia.**). The miners' average age is 42, while 55% of them are women. Miners from Yurumangui are, on average, 15 years younger than those from San Juan and have 1.3 additional years of education. The average monthly income for miners is substantially higher in Yurumangui, due to higher quantities extracted: in San Juan, a miner extracts on average, 2.73 grams per month; while in Yurumangui, the average extraction per miner is more than double that, at 6.42 grams per month. That difference is due, in turn, to a large difference in availability. High international gold prices produced a gold rush in 2008 and, since San Juan is located on the highway, it was easy for outsiders to use backhoes to extract significant quantities of gold illegally. Surface gold was drastically reduced, so that now the community must work harder to obtain gold.

Incomes are higher in Yurumangui, despite a lower reported average gold price than in San Juan. The latter is likely to be at least partially explained by the fact that only about a quarter of miners in San Juan sell their gold in their village, while almost 90% Yurumangui sell gold in their villages,

where prices are lower than when selling in the nearest major city (albeit after the cost of transport). Satisfaction with price is consequently almost three times higher in San Juan than in Yurumangui.

[Table 2]

Almost all miners in San Juan have access to the public health-care system, while in Yurumangui less than half do. Nearly all the surveyed miners volunteer within their communities, mainly doing church activities and cleaning public spaces − although some restoration of the mining sites and replanting of trees occurs in each of these Community Councils. A third of the miners within San Juan reported participating in some reforestation activities, while only15% did for Yurumangui. Participation in the CC Assembly is almost three times as common in Yurumangui as in San Juan — suggesting stronger social cohesion and legitimacy of the local governance structure. Finally, mining associations are uncommon in these communities, practically nonexistent in Yurumangui.

Local mining governance is perceived to be stronger in Yurumangui than in San Juan. Most miners in Yurumangui recognize that the CC Board establishes rules concerning mining activities, which is indeed the case, and half of these miners know that there are penalties for breaking the rules.

Nearly all miners in Yurumangui are willing to contribute to cover the CC's costs of formalization, while only about one third are willing to do so in San Juan. Miners in San Juan are more aligned with national mining requirements: 42% are registered in the mayor's office as artisanal miners; and 38% have tax identification numbers. In contrast, the focus in Yurumangui seems to be local: only 8% of miners are registered in the mayor's office; while only 5% have the tax identifications.

6. Results of Choice Experiment

6.1 Constant Marginal Effects (by Community Council)

We analyze data from our choice experiment using a standard multinomial logit model, estimating coefficients for each of the attributes. Given differences in characteristics, we estimated separate models for each Community Council (**¡Error! No se encuentra el origen de la referencia.**). Coefficients are estimates of marginal utilities (holding all other attribute levels constant). Positive signs mean the attributes increase miner utility from the bundle, while negative signs mean that those attributes decrease the utility for the miner.

These CC results reveal substantial variations in preferences, in line with prior observed behaviors. San Juan miners are indifferent to forming associations while Yurumangui miners are in favor of associating, quite consistent with a positive past experience with organization. Respondents from Yurumangui regarded the requirement of restoration activities as a negative (a cost or a disutility). In contrast, San Juan miners valued restoration positively, consistent with our survey finding that there were more voluntary restoration efforts done in the past in San Juan than in Yurumangui.

Miners in both communities indicated that financially supporting the local Community Council is a net cost. It is a literally a financial cost, of course, but one's feeling about what CC's achieve could have made contributing a net positive. Finally, a higher gold price is always a positive, yet the expected potential price reward after formalizing is lower for San Juan than for Yurumangui, consistent with Yurumangui having lower gold prices (and, as we found, lower price satisfaction).

[Table 3]

The coefficient for "the status quo" (SQASC) is also useful for summarizing any general leanings, independent of these characteristics (the full set of coefficients predicts acceptance for any bundle). **¡Error! No se encuentra el origen de la referencia.** has negative significant SQASC coefficients f or each CC. In considering formalization, relative to the status quo, given whatever 'unobserved'

– i.e., not in our attributes − characteristics that affect participants' views, people from both CC generally seem to be in favor of formalizing (in line with the fact that facing the choice cards, Status Quo was chosen in only 10% of the cards). Disutility from staying in the status quo is more extreme in Yurumangui (almost 3 times as high).

Results can be interpreted in terms of the average willingness to accept (WTA) marginal changes for each attribute in a bundle. In Yurumangui, miners would need to observe a higher gold price of 1.14 USD per gram to accept an additional day of work in restoration per month. In San Juan, respondents are willing to accept a lower price (2.77 USD per gram) for that additional day, i.e., on average – see more below concerning heterogeneities and nonlinearities − they value including restoration. Given this striking difference in views, which lines up well with more prior restoration in San Juan, next we will investigate how impacts vary with prior effort and with the level of effort.

6.2 Varying Marginal Effects (by Community Council)

6.2.1 Linear Interaction with Prior Effort

Following (2), Table 4 adds linear interactions between restoration and voluntary tree planting. Those who previously chose to plant trees might like restoration more. The interaction coefficient is positive and significant in both CC, indicating that individuals who voluntarily plant trees value that. For San Juan, those volunteers with a significant positive valuation (i.e., sum of restoration coefficients is significant) drove the positive result in Table 3. For Yurumangui, non-volunteers have a significant negative value on restoration, while volunteers have a significant positive value.

[Table 4]

6.2.2 Linear Interaction with Prior Effort & Split Sample by Gender

Table 5 uses the specification in Table 4 above but splits the sample by gender in each of the CC. For San Juan, in the case of the Association attribute, the lack of significance in Table 3 proves to blend a significant negative on Association for women with a non-significant positive for the men. In contrast, concerning Association in Yurumangui, both genders confirm the message in Table 3.

Table 5 shows that an interesting prior miner-level result within each community – those who had done volunteer tree planting felt more positive about including restoration in formalization – turns out to be driven by men. The sums of coefficients here show only men valued restoration on net. While the Contribution and Gold Price effects are not strikingly different by gender, the preference to move away from the status quo does vary. Yet the direction for this differs across communities. The stronger negative view on keeping the status quo for Yurumangui come more from women, while in San Juan the men are considerably more negative about the status quo than are the women.

[Table 5]

6.2.3 Non-linear (stepwise in restoration days) Interaction with Prior Effort

Following (3) above, Table 6 examines a non-linear interaction of prior tree planting and restoration days. One may not object to a little restoration effort as part of formalization, yet still dislike it when a lot of restoration is required (in Table 6 we test this out using dummy effects but the quadratic results are very consistent). Further, that kind of non-linear response to marginal changes in effort could well vary with 'type', e.g., one's prior efforts in planting trees. Putting that directly, people who have chosen restoration in the past might not tire off it as quickly.

Along those lines, Table 6 shows that, once again, prior behavior matters. Here, the CC with more prior effort in tree planting, San Juan, does not fall off in its valuation of marginal restoration days

for those who did that prior tree planting − as occurs in Yurumangui, even for those who did such prior effort. This also confirms that those who did planting before view restoration more positively.

7. Discussion

Our results inform interventions aiming to support small-scale gold mining formalization, showing communities are willing to move away from the status quo and engage in formalization processes. Yet some requirements, such as forming local associations and engaging in restoration practices, are perceived as costly by at least some community members, hindering efforts to get formalized.

Perceptions are linked with past experiences. For instance, miners in Yurumangui are more willing to form associations and, more generally, express more gains in utility from leaving the status quo than do miners in San Juan. That is consistent with a strong history of social capital accumulation. However, even though Yurumangui has a strong and legitimate Board they perceive paying fees to a Board as a cost. Maybe contributing to both productive and political organizations is too costly. San Juan has had more experience with external actors and formalization – though not always so positive experiences − and are more connected to the markets than Yurumangui, yielding higher average gold prices. These may explain why the perceived benefits of formalization are lower here. Miners in San Juan are more willing, though, to include site restoration as a part of formalization. Past experiences at the individual level matter here as well, in that the individuals who voluntarily planted trees in the past are found to be significantly more willing to include restoration of sites.

Gender differences are small − yet suggest tensions regarding the costs implied in terms of time. Although women in Yurumangui seem more willing to engage in formalization than men (and to accept lower prices for their efforts), they are not as keen on devoting time to restoration activities. In San Juan, women are not willing to form an association (in this case the opposite from the men).

While these results are community specific, all may reflect that women have obligations at home. They could also reflect different tasks, e.g., the fact that women are mainly artisanal pan miners, which in principle means they need only to register at a municipality office to become formalized. The more striking differences in preference appear to be along community rather than gender lines.

8. Conclusions

Formalization is a first step towards access to sustainable supply chains, including via certification. We explored miners' preferences about formalization in two small-scale gold-mining communities in the Pacific Region of Colombia. We studied some characteristics highly relevant for the process according to academic literatures as well as our field work: formation of a local mining association; contribution to local governance authorities; days of unpaid work in restoration; and the gold price.

We found that Councils' distinct histories and contexts strongly influence what characteristics of formalization offers miners prefer (i.e., what benefits and associated costs). At the Council level, prior experience with formalization seems associated with less interest, yet prior local organization that was successful raises the perceived value from requiring association into groups to formalize − though nonetheless none of these miners are eager to contribute to local governance authorities.

We saw some differences between men and women, though not consistent between communities. The only consistent difference between genders is the women's willingness to accept lower prices. An individual difference that matters consistently is prior voluntary experience with planting trees, as those who already did so were far more receptive to accepting restoration within formalization.

These results suggest that public actors and civil society should communicate transparently about what formalization will truly bring, including restoration requirements, and facilitate the formation of groups in order to address legal processes and administrative burdens at lower transactions cost.

Unfortunately, such results cannot address other important issues such as illegal armed groups that threaten community-based organizations and miners' livelihoods. Without the permanent presence of the state, formalization will fall short. In fact, as expressed in interviews, miners wonder whether formalization would expose them to a higher risk of being targeted by armed groups in the region who try to capture the rents from mining exploitation. This is a topic that deserves further research.

Methodologically, we contribute a new area to a longstanding literature using choice experiments to understand the contexts for policies concerning the environment and various natural resources. Ours is the first study to apply this approach to miners' preferences and we see the role of the local context in responses to formalization options. Replication of such surveys in other contexts with gold mining communities could improve the program designs within development interventions.

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groups trying to control the territory and mining rents. This tragic episode is a reminder that any formalization process will fall short without the permanent presence of the State in rural areas. #YurumanguiNosfaltanDos.

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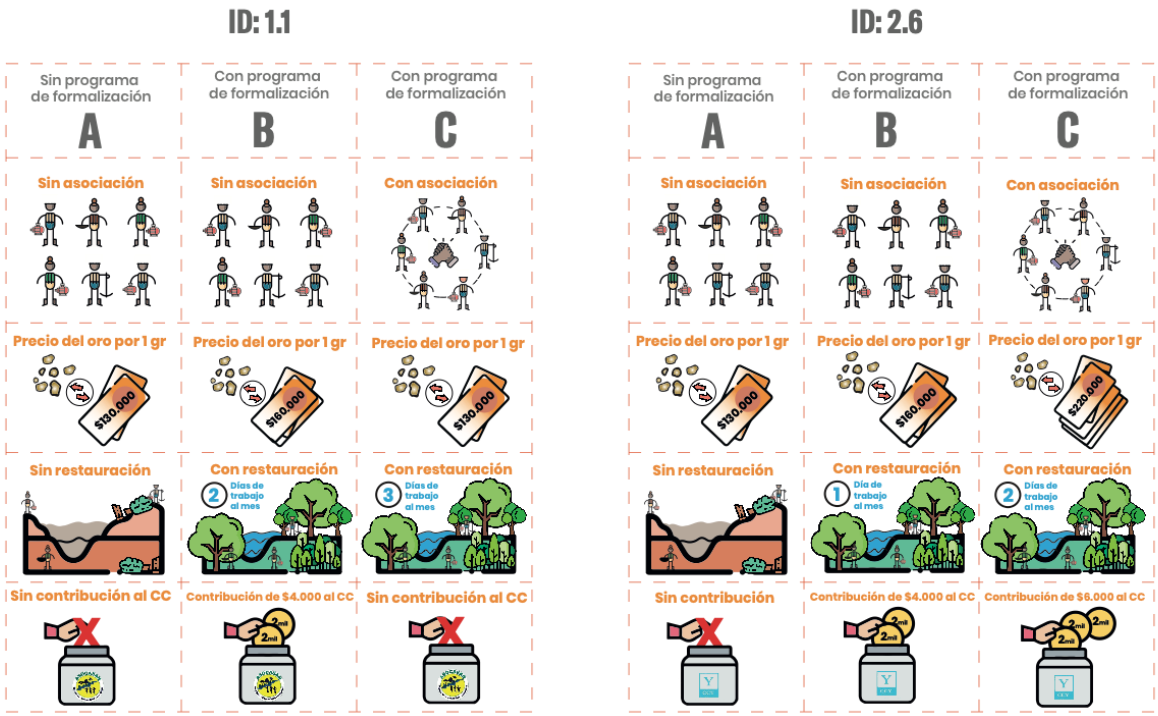
Appendix 1: Figures

Figure 1. Common Formalization Barriers

- Limited access to reliable information on ASGM at the national, regional, and global levels.
- Lack of capacity of local government agencies and inadequate decentralization processes.
- Prioritization of LSM due to lack of appreciation for sector's development potential.
- Long, costly, and cumbersome formalization processes and lack of incentives to formalize.
- Inadequate understanding of dimensions of formalization and local dynamics of the sector.
- Limited financial, administrative, and technical assistance to ASGM.
- Marginalization of the sector and culture of informality.
- Competing normative frameworks (customary law).
- Prevalence of illicit financial flows investing in sector.
- Resistance from actors who have vested interest in maintaining informality.
- Lack of funding to implement and monitoring of formalization.

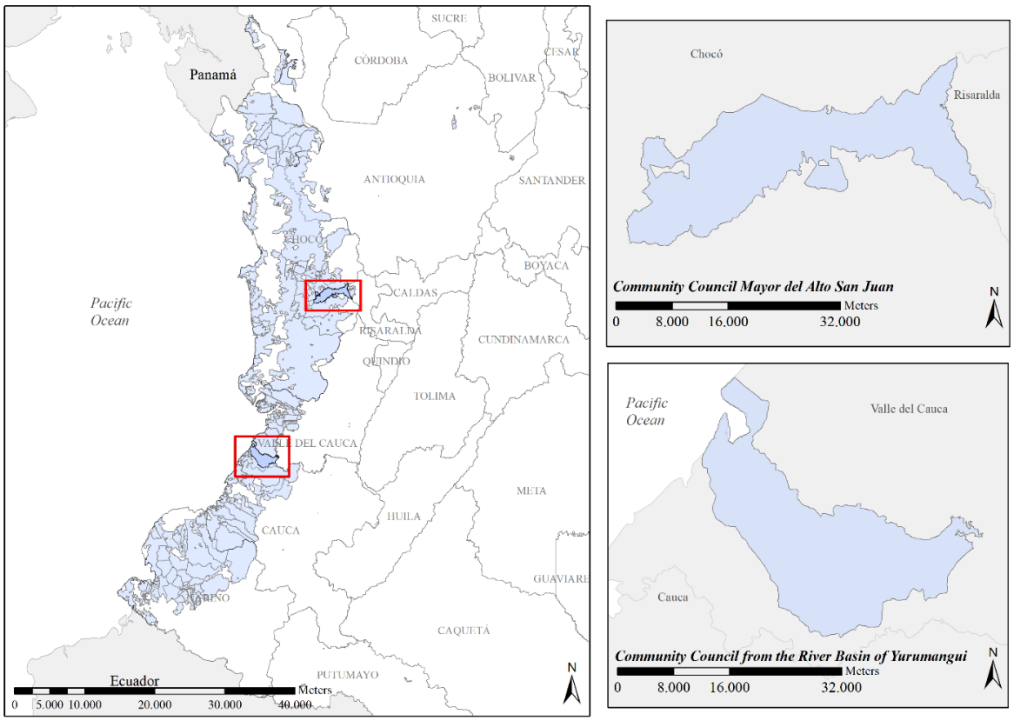
Source: UNITAR &UN Environment (2018).

Figure 2. Example of choice cards presented to respondents in each community council.



Appendix 2: Maps

Map 1. Communities' Locations



Appendix 3: Tables

Table 1. Choice Attributes (with their levels)

Attribute	Description	Specific Levels
Forming Association (*Assoc*)	requiring the individual mining operator to join an association to access titling in formalization	1. Without association (s.q.) 2. With association
Restoration Effort (*Rest*)	days per month in implementing restoration plans to fill the mining pits after any site is exploited	1. 0 days (s.q.) 2. 1 day 3. 2 days 4. 3 days
CC Board Contribution (*CC*)	required contribution (per each $100k) to the CC to support formalization / governance processes	1. $ 0,000 COP / 100k (s.q.) 2. $ 2,000 COP / 100k 3. $ 4,000 COP / 100k 4. $ 6,000 COP / 100k
Gold Price (*GP*)	monetary value per gram of gold to be received	9. $ 130,000 COP/g (s.q.) 10. $ 160,000 COP/g 11. $ 190,000 COP/g 12. $ 220,000 COP/g

Table 2. Descriptive statistics for both communities (mean values unless otherwise stated)

	San Juan	**Yurumangui**	***difference***	
Socioeconomic Characteristics				
Age	49.50	34.76	14.74	***
Percentage of women	51.96%	57.99%	-6.03%	
Years of education	6.23	7.57	-1.35	***
Average monthly income (USD)	69.88	142.10	-72.22	***
Miners in the subsidized healthcare system (%)	96.08%	48.86%	47.22%	***
Social Capital				
Miners who do volunteer work in communities (%)	88.73%	100.00%	-11.27%	***
Miners doing reforestation (%)	34.31%	15.07%	19.25%	***
Miners who participate in the CC-assembly (%)	32.84%	91.78%	-58.94%	***
Miners belonging to an association of miners (%)	4.41%	0.46%	3.96%	**
Mining Governance				
Miners think CC Board sets rules on mining (%)	14.22%	82.19%	-67.98%	***
Miners think authorization for operations required (%)	31.37%	52.05%	-20.68%	***
Miners believe in penalties if break CC rules (%)	5.39%	51.14%	-45.75%	***
Miners think mining prohibited for outsiders (%)	0.98%	34.70%	-33.72%	***
Miners say CC allows mining by some outsiders (%)	29.90%	48.40%	-18.50%	***
Miners think owner can allow outsider mining (%)	85.78%	60.73%	25.05%	***
Percentage of miners with tax identification (%)	38.24%	5.02%	33.21%	***
Percentage of miners registered in mayor's office (%)	41.67%	7.76%	33.90%	***
Miners willing to contribute to the CC for costs (%)	35.78%	96.80%	-61.02%	***
Local Gold Market				
Monthly gold extraction (grams) per miner	2.73	6.42	-3.69	***
Percentage of gold sold in the village (%)	27.45%	88.58%	-61.13%	***
Share of gold sold in the nearest major city (%)	2.45%	50.68%	-48.23%	***
Average gold Price per gram (USD)	41.22	26.12	15.09	***
Miners satisfied with the gold price (%)	63. 73%	23.29%	40.44%	***
Percentage of miners who know buyer is legal (%)	35.78%	30.59%	5.19%	
Percentage with agreement to sell to same person (%)	22.55%	28.77%	-6.22%	
Mining Operations				

Percentage of people involved in alluvial mining (%)	30.39%	40.64%	-10.25%	*
#obs	204	219	423	
** p<0.05, ** p<0.01, *** p<0.001*				

Table 3. Multinomial Logit Model Results by Community

Marginal Utilities	San Juan			Yurumangui		
	Coeff.		*Std. Error.*	*Coeff.*		*Std. Error.*
Association	-0.081		0.068	0.220	***	0.069
Restoration work	0.088	**	0.037	-0.102	***	0.040
CC Contribution	-0.081	***	0.019	-0.105	***	0.021
Gold Price	0.008	***	0.001	0.023	***	0.001
SQ ASC	-0.616	***	0.129	-1.741	***	0.191
Log-likelihood	-1,229			-881		
Willingness To Accept (compare to effect of price)						
Association (USD/gram to balance association)	*2.55*		*2.05*	*-2.47*	***	*0.82*
Restoration (USD/gram to balance day of restoration)	*-2.77*	**	*1.28*	*1.14*	***	*0.44*
Contribution (USD/gram to balance contributing 1%)	*2.53*	***	*0.61*	*1.17*	***	*0.02*
OBSERVATIONS	204 x 6 choice sets = 1,224			219 x 6 choice sets = 1,314		

*** 99% significant; ** 95% significant; * 90% significant

Table 4. Multinomial Logit Results, adding a linear interaction of restoration with prior tree planting.

	San Juan		Yurumangui	
Association	-0.081		0.223	***
	(0.069)		(0.069)	
Restoration	-0.044		-0.145	***
	(0.042)		(0.042)	
Restoration * Prior Planting	0.404	***	0.297	***
	(0.063)		(0.102)	
[Restoration coefficient sum]	*[0.359]*	***	*[0.153]*	
	(0.057)		*(0.096)*	
CC Contribution	-0.081	***	-0.105	***
	(0.020)		(0.021)	
Gold Price	0.008	***	0.023	***
	(0.001)		(0.001)	
SQ ASC	-0.623	***	-1.743	***
	(0.130)		(0.191)	
Log-likelihood	-1,208		-876	
Observations	204 x 6 choices = 1,224		219 x 6 choices = 1,314	

Notes: *** 99% significant; ** 95% significant; * 90% significant; estimated parameters corresponding to the sum of restoration coefficients are given in square brackets; standard errors are given in parentheses.

Table 5. Multinomial Logit Results, with linear interaction as in T4 but splitting by gender (for each CC).

	San Juan				Yurumangui			
	Female		**Male**		**Female**		**Male**	
	Coeff.		*Coeff.*		*Coeff.*		*Coeff.*	
Association	-0.203	**	0.040		0.215	**	0.254	**
	(0.099)		(0.096)		(0.089)		(0.113)	
Restoration	-0.015		-0.067		-0.107	**	-0.215	***
	(0.056)		(0.068)		(0.053)		(0.070)	
Restoration * Prior Planting	0.117		0.514	***	0.152		0.496	***
	(0.094)		(0.094)		(0.142)		(0.151)	
[Restoration coefficient sum]	*[0.102]*		*[0.447]*	***	*[0.045]*		*[0.282]*	**
	(0.091)		*(0.076)*		*(0.136)*		*(0.139)*	
CC Contribution	-0.108	***	-0.054	*	-0.098	***	-0.122	***
	(0.028)		(0.028)		(0.027)		(0.034)	
Gold Price	0.009	***	0.008	***	0.021	***	0.027	***
	(0.002)		(0.002)		(0.002)		(0.002)	
SQ ASC	-0.331	*	-1.314	***	-1.977	***	-1.438	***
	(0.171)		(0.221)		(0.259)		(0.288)	
Log-likelihood	-674		-495		-516		-356	
Observations	106 x 6 choice sets = 636		98 x 6 choice sets = 588		127 x 6 choice sets = 762		92 x 6 choice sets = 552	

Notes: *** 99% significant; ** 95% significant; * 90% significant; estimated parameters corresponding to the sum of restoration coefficients are given in square brackets; standard errors are given in parentheses.

Table 6. Multinomial Logit Results with stepwise interaction of restoration days with prior tree planting

	San Juan		Yurumangui	
Association	-0.066		0.254	***
	(0.069)		(0.071)	
Restoration = 1 day	0.090		0.049	
	(0.130)		(0.123)	
Restoration = 1 day * Prior Planting	0.863	***	1.160	***
	(0.192)		(0.303)	
[coefficient sum for 1 day]	*[0.953]*	***	*[1.209]*	***
	(0.171)		*(0.286)*	
Restoration = 2 days	-0.046		-0.177	
	(0.134)		(0.128)	
Restoration = 2 days * Prior Planting	1.072	***	1.137	***
	(0.199)		(0.324)	
[coefficient sum for 2 day]	*[1.027]*	***	*[0.960]*	***
	(0.179)		*(0.306)*	
Restoration = 3 days	-0.024		-0.370	***
	(0.137)		(0.136)	
Restoration = 3 days * Prior Planting	1.196	***	0.961	***
	(0.206)		(0.340)	
[coefficient sum for 3 day]	*[1.172]*	***	*[0.591]*	*
	(0.189)		*(0.324)*	
CC Contribution	-0.078	***	-0.096	***
	(0.020)		(0.022)	
Gold Price	0.008	***	0.023	***
	(0.001)		(0.001)	
SQ ASC	-0.491	***	-1.567	***
	(0.144)		(0.203)	
Log-likelihood	1,202		-867	
Observations	204 x 6 choices = 1,224		219 x 6 choices = 1,314	

Notes: *** 99% significant; ** 95% significant; * 90% significant; estimated parameters corresponding to the sum of restoration coefficients are given in square brackets; standard errors are given in parentheses.