Women mine-rock waste collectors in artisanal and small-scale mining in Ecuador: Challenges and opportunities

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ABSTRACT

We conducted an exploratory study of the nature of women mine-rock waste collectors’ (WWC) activities and analysed their working conditions managing mine waste rock in Ponce Enríquez, Ecuador. A WWC is locally known as janchera, and currently hundreds of women are involved in this activity within artisanal and small-scale gold mining. We combined qualitative and quantitative methods developing interviews, surveys, waste rock processing assessment, and carried on training activity to offer women an alternative livelihood.

According to our study, women work individually collecting mine waste rock, but many are involved in associations under a new operational model recycling the collected rock in campsites. The WWC’s associations do not have legal status in mining activity, depending only on the availability of waste rock dumped by small-scale gold mining companies and the will of their owners. The formalisation of WWC is currently difficult to accomplish, suggesting the need for alternative skills and entrepreneurial training, aimed at diversifying livelihood opportunities for women in artisanal and small-scale gold mining (ASM).

1. Introduction

In many Latin American countries, artisanal and small-scale gold mining (ASM) is considered an activity with a marginal impact on the economy (Sandoval, 2001). In Ecuador, at the macro-economic level, the ASM does not exceed 0.32% of GDP (Banco Central del Ecuador, 2017). However, the ASM sector is an integral part of local economies through their on-going activities of prospecting, exploration, exploitation, smelting, refining and commercialisation (Acosta and Sacher, 2012). In 2014, Ecuador's ASM population was estimated to be ~128,000 (Seccatore et al., 2014), and before the start of the large-scale mining operation ‘Fruta del Norte’ (Lundin), it accounted for approximately 90% of gold production in the country (Plan de Desarrollo Minero, 2016).

Despite the fact that the world of artisanal mining has historically been operated informally, largely, by poor individuals seeking a subsistence livelihood, the activity is experiencing a process of transformation, evolving from artisanal to small-scale gold mining practices (Velásquez et al., 2019). The supply chain in ASM involves different activities, from exploration to commercialisation, as well as the exchange of related products that result from a formal industry. In the ASM activities, waste is generated in several stages, one being the rock discharged by mining companies. This becomes an opportunity for an informal association to collect and process the material. The lack of policies, governance and regulations in this area allow this informal and often inefficient sector to operate (Hentschel et al., 2002). In general, 65% of the Ecuadorian workforce is in the informal economy (Gómez et al., 2019). Formalisation is understood to be a gradual process that incorporates people into economic activity through the implementation of a regulatory and legal framework (Araque, 2018).

The involvement of women in artisanal mining, according to some authors, is due to poverty and factors such as: the migration of men, lack of employment in other sectors, high fertility rates, and the imposition of traditional gender roles (Lahiri-Dutt, 2015). Unfortunately, roles which are assigned to women and men by cultural norms and/or specific groups regarding behaviours, attitudes, values, beliefs, etc. (Hinton et al., 2003), result in different opportunities to operate across the value chain in the mining sector. In mineral processing activities, women collect mine waste rock and may carry out activities like crushing, grinding, sieving, washing, and panning, as well as...
amalgamation and amalgam decomposition in the case of gold mining. Hilson et al. (2018a) emphasises that due to lack of understanding about ASM structure, there is great uncertainty as to how women survive when factors such as economic reforms, environmental disturbances and the rise of commodity prices displace other livelihood means for their subsistence.

Women also make a critical contribution to the development of ASM communities, specifically to “community stability, cohesiveness, morale and general wellbeing, and [women] act as primary agents in facilitating positive change” (Hinton et. al, 2003). Likewise, women are of fundamental importance for food security (Hinton et. al, 2003). They have a critical role as food providers, and they are often solely responsible for household tasks and family wellbeing (Hinton et. al, 2003). Unpaid labour undertaken by women, at the household and the community levels, in a way sustains the social life around ASM mines (Lahiri-Dutt, 2015), but at a high cost for them and their children. An analysis of the informal employment in Latin America, in non-urban areas, prepared by the International Labour Organization (2014), confirms that mining is the primary non-agricultural activity for women and men, and the most impacted are the less-educated workers who are most prevalent among the poorest people.

In the Ecuadorian ASM system, many women work in the administration, marketing, environmental, technical and occupational safety areas, and provide leadership in the operation of processing plants or cooperatives. Moreover, in ASM communities, hundreds of women work collecting waste rock and residues from gold mine dumps, and processing the material in order to collect residual gold. The activity is called jancheo, and people involved in this occupation are called jancher or jancheros (women and men). In this article, we refer to jancheras as “women waste-rock collectors” (WWC), whose participation in the ASM we describe as a survival economic activity placed on the borderline of the supply chain. The WWC’s income is key for the subsistence of their families and themselves, but lack relevance for the profitability of small-scale mining operations. Likewise, WWC have precarious working conditions and many of them lack technical knowledge and skills leading to low production performance and poor legal and institutional protection.

In light of the numerous challenges faced by WWCs in ASM, our case study has three main objectives. The first one aims at evaluating the nature and features of the role of women recycling mine waste rock in ASM in Ponce Enríquez. The second is to explore and provide a descriptive account of the key challenges faced by WWC in ASM from the perspective of their labour model, sustainability of their activity, level of knowledge and recognition of their place and role within ASM community. The third objective is to explore and discuss some of the important elements they see as essential to enable their transition from marginal and limited activities, to active participation and sustainable livelihood in and around artisanal and small-scale mining, and in alternative sectors of economic activities.

One of the main sustainable development goals set in the United Nations agenda is gender empowerment and equality. To achieve sustainable development, the Ecuadorian government is discussing the opportunity to develop education and training for the ASM sector, building partnerships with international institutions while supporting governance and technical management of the mining industry. Currently, no official documents provide reliable data on the nature and level of the current engagement of WWC in ASM in the country. The current research makes a valuable contribution in this direction.

2. Methodology

2.1. Mixed methodology

We conducted this study within the University of British Columbia’s (UBC) Canadian International Research and Development Institute (CIRDI) TransMAPE project. The study embodied the characteristics of exploratory and descriptive case-study research. Based on Robson’s (1993) and Yin’s (2014) classifications, the study was exploratory because it sought to:

- discover insights provided by WWC about the nature and features of their informal and formal roles in the ASM sector and their level of satisfaction related to their working reality;
- discover insights into contextual challenges faced by WWC in ASM and their impacts on the quality of their working realities, socio-economic vulnerability, and level of satisfaction;
- discover insights into what WWC deemed essential in terms of training programs to facilitate their transition from marginalisation to active and formalised participation and sustainable livelihood in ASM and in other sectors of the local economy.

We complemented the exploratory nature of our study by a descriptive element that sought to:

- provide an accurate profile of WWC in terms of demography and roles in the supply chain within the working mining environment in a specific area;
- identify, describe, and assess the efficiency of the key mine waste processes used by WWC in the recovery of residual gold.

The case study approach allowed us to collect the necessary quantitative and qualitative data needed to develop an understanding and interpretation of the working experiences, training needs, perceptions of working conditions, and levels of job satisfaction of WWC involved in the processing of waste rocks and residual gold at the periphery of ASM activities. It also enabled us to collect data that revealed the ways WWCs places and roles in the supply chain of ASM affected their working realities, the sustainability of their livelihood, and the need to move toward a more active and formal involvement in the field of ASM. Because this study aimed at understanding the highly contingent and complex nature of the place, role, and training needs of WWC, our intention was to emphasise the personal perspectives of those experiencing the working life of WWC in a specific and well-defined geographical location or site over the analysis of their position in the regulatory framework of ASM.

2.2. Site of the case study

We conducted our data collection in the Canton of Ponce Enríquez located in the Province of Azuay in southern Ecuador (Fig. 1). The Canton consists of fifty-four communities. In the 1980s, as a consequence of the intense crisis in the agricultural sector caused by landslides and floods triggered by El Niño weather patterns, local farmers were forced to search for economic alternatives. Consequently, gold mining became relevant in this jurisdiction (ARM, 2017; Guerrero, 2016). The Canton has rural areas such as Bella Rica, San Gerardo, Santa Martha, El Carmen de Pijíll, and San Salvador. Most ASM miners work in the rural areas. We assessed women waste-rock collectors who were working near the ASM mines and in campsites. The campsites are in the south part of the urban area of Ponce Enríquez close to Siete Ríos at the border between the provinces of El Oro and Azuay.

2.3. Data collection

The study incorporated a mix of quantitative and qualitative data collection procedures (Woolley, 2009). The quantitative data collection procedure provided descriptive information about the nature and status of women’s work and about the key features of their mine waste management practices (Vryonides, 2007). The qualitative data collection procedures supplied data about gold recovery, WWC’s perceptions of issues related to the quality of their working environment, their training
needs, the sustainability and security of their livelihood, and the value ascribed to their roles in ASM by other actors in the mining industry.

**Surveys**

We choose to develop and administer surveys as they allowed us to gather quantitative and qualitative data from a targeted group of WWCs about their opinions, behaviour, perceptions, assumptions or knowledge regarding various aspects of the working realities in ASM. For the surveys, we estimated the sample population size based on information provided by the Ministry of Mines and local miners of Ponce Enríquez. Based on the information provided by national authorities, we estimated a total of ~300 women working as rock gold collectors in Ponce Enríquez, however, the exact number is unknown. Based on this information, we calculated the number of women to interview by applying the following formula.

\[ n = \frac{N}{(E)^2(N - 1) + 1} \]

In the formula, "n" is the sample size, "N" represents the estimated population, "E" is the margin of error, and "1" is a constant for the calculation. The margin of error was 10% at a confidence level of 90% resulting in 56 individuals. Fifty-six women waste-rock collectors in Ponce Enríquez participated in the study. To evaluate our research questions based on the data collected with the help of the survey, we organised the information as follows:

a) Demographic knowledge about WWC in the whole area of Ponce Enríquez.

b) Approach and assessment of the gold recovery process used by two women associations.

c) Understanding of the level of WWC's satisfaction.

d) Assessing alternative livelihood for women gold collectors.

We conducted two surveys in the Ponce Enríquez mining district. The data collected through the first survey was completed by 56 WWC working in all areas of Ponce Enríquez and helped us to get a general overview and understanding about some key characteristics of the WWC group. The second survey, completed by 56 WWC members of two associations, provided in-depth information about their experiences working in recycling ore waste. The two surveys led us to explore their position in the supply chain of the mining sector and their opportunities for formalisation.

**Interviews**

To gather relevant data regarding WWC perceptions about their socioeconomic vulnerability, training needs, and their level of satisfaction about the working realities in campsites located in Ponce Enríquez, we chose to conduct open-ended interviews. This procedure involved asking open-ended questions of a group of WWC and collecting data about their perceptions of the various aspects of their working realities. The research team adopted the use this kind of interviews as part of a co-learning process involving both researchers and WWC to generate knowledge about their current working situation, and the changes needed to facilitate the understanding of their activity and the transition to active and formalised participation and sustainable livelihood in ASM and in other sectors of the local economy. This ongoing conversation between researchers and WWCs helped to establish mutual trust and facilitated the creation and sharing of innovative solutions to challenges faced by women mine-waste rock collectors.

In our meeting with the WWC we raised the question about “what are the most critical issues you would like to change to improve your socioeconomic status? Part of the data collected led us to design and collectively deliver training sessions facilitated by Ecuadorian local instructors followed by further semi-structured interviews aimed at exploring the perceptions of WWC regarding the impact of those training sessions in enhancing their capacity to move into new economic opportunities.

**Processing operations and mine waste management assessment**
We accompanied the association’s members in the campground to observe women’s work in the field and assess rock waste management and gold recovery in the processing plant. The field assessment facilitated the interaction not only with women but also with men who administer the association. By observing their work in the campground during the mine rock waste management process we also learned about their association as an entity.

To understand how the members of the association manages recover the gold, we accompanied the members through the processing operation in the plant they selected. While observing their activity we collected composite samples in the processing plant. We gathered the samples from the head of the mill equipment and the discharge of the mill, and calculated the gold recovery of ore using the head (feed) and final tailings grades using the following equation:

\[
\text{Gold Recovery} = \frac{\text{head grade} - \text{final tailings grade}}{\text{head grade}}
\]

The gold content in the samples was analysed by the Research Institute for Geology, Mining and Metallurgic of Ecuador (INIGEMM) laboratory.

The purpose of this phase of observation and data collection was to assess the methods of gold recovery practiced by WWC to recover residual gold from processed waste rock and identify the fate of the final waste.

3. Findings and discussion

The population in Ponce Enríquez is about 22,000; out of that total, 44.5% are women and 55.5% men. Almost 55% of the total population is in the age range of 1 to 24 years. Regarding the geographical distribution, 22% and 77% of the Canton’s total population live in urban and rural areas, respectively (INEC, 2010). The gender distribution in both regions is unalike. In the municipal area, gender proportions are pretty similar, but in the rural area the number of men is higher than of women: 9759 men vs 7336 women (INEC, 2010). The general population distribution and the gender distribution in Ponce Enríquez is a function of the mining activity, which operates outside of urban centres and is predominantly male (Plan de Desarrollo Minero, 2016). Indeed, 43% of the active economic population in Ponce Enríquez works in the mining and quarry sectors. By contrast, 30% works in agriculture, siliculture, and fishing (INEC, 2010), followed by animal husbandry, business, and transportation (Plan de Desarrollo Minero, 2016).

3.1. WWC: profile and status in ASM

The real population of WWC is difficult to estimate. In the field, the people believe that thousands of women are doing waste rock scavenger type of activity in the mines of Ponce Enríquez. We visited several mining sites of Ponce Enríquez mining district, interviewing those that are individually working near mines of Ponce Enríquez (Fig. 2) and others working in associative manner. From our general survey, fifty-nine percent of women waste-rock collectors are not involved in any kind of partner relationship—single, divorced, widowed, finding themselves in a challenging socio-economic situation. These women are in urgent need of sustaining themselves (with no access to formal work) and, in many cases, their children. The remaining 41% are married, and the relationship is mostly with male-mine workers, and both partners are expected to contribute to the household income.

Concerning age in our study, WWC form a relatively young group; 70% of them are between 15 and 44 years old. On average, women in the 15–24 year-old age range have one child, while those 25–44 years old have three children. Based on the statistics (Fig. 2), we infer that the number of children per woman increases with age. In fact, women waste-rock collectors 45-64 years old have five children on average. This trend declines in the 65+ women age-range but in lower percentage of representation.

Approximately 71 percent of women waste-rock collectors completed primary school, while 29% attended, but did not finish secondary school. In Ponce Enríquez, as elsewhere in Ecuador and Latin America, teenage pregnancy is a social issue, that has direct consequences in school dropout rates. It is also a determining factor in the intergenerational perpetuation of poverty (Vásquez, 2016).

Women waste-rock collectors have to travel long distances to the mines (Fig. 3) spending between 4 and 7 h daily. According to their availability, they work on flexible shifts from Monday to Sunday and in small groups of 2–3 people on the periphery of established mines. Women climb over the rock dumps and overfills, acquiring skills such as fast recognition of valuable minerals in quartz pieces. Ninety-six percent of the total WWC surveyed have an income between US$ 10 and 500 (per sales opportunity) of selected mine rock or gold. Forty-one percent of women have an opportunity to sell the product every month, 43% every two to five months, and 16% every week. This explains the high variability and uncertainty of their earning a regular income through this work and as a consequence, only 41% of women are able to save money. In many cases women have to sell the raw and unprocessed mineral collected, which has very low value. About 88% of WWC regard this income as their primary financial source, and only 4% have access to some credit. It is important to note that for these women to have access to formal credit depends on alternative activities than jamcheo, such as retail commerce in their homes. Seventy-seven percent of women work exclusively in waste rock collection, while 23% supplement their incomes with house cleaning services and agricultural activities, which force them to deal with high and demanding workloads.

The low educational level and informality of their work leaves women waste-rock collectors relegated to the lowest level of the informal mining economy. The majority of WWC surveyed are not members of any artisanal and small-scale mining society or company in which they could invest. Neither do they own a concession or hold a legal permit to work in a mine area. Women mostly depend on the quality and quantity of the waste rock material discharged by mining associations or companies.

Fig. 2. Women gold collectors’ age and family members (number of children). Y-axis shows the range of women’s age; X-axis shows the number of family members per woman (upper scale) and the percentage of respondents (lower scale). Bars in blue colour indicate the age range of women gold collectors. Bars in orange colour mean number of children per women in each age range (N 56 respondents).

3.2. WWC’s working conditions

In 2017 the Ecuadorian mining cadaster showed that in Ponce Enríquez there are approximately 230 mining concessions, and in each concession, there can be between 20 and 40 ASM operations. Our survey shows that in Ponce Enríquez, 98% of the artisanal and small-scale gold mining activity is related to underground mining. We found
six main groups of people associated with the production infrastructure and supply chain: concessionaires, gold buyers, artisanal and small-scale miners, owners of processing plants, mine workers and women waste-rock collectors.

As pointed out by Vangsnes (2018), the root of the ASM inefficiencies is found in the complexity of its structure. On one side, mining concessionaires (mining companies) have the highest economic power as they hold the legal title of the mine and the mine operation management, followed by owners of processing plants. On the other side, thousands of artisanal miners and women waste-rock collectors do not hold any kind of land title, and operate with restricted economic resources and lacking the power of negotiation.

The position that women waste-rock collectors occupy in the mining value chain also undermines their chances of acquiring technical training or demanding labour rights. For instance, only 55% of women surveyed have some technical training in issues related to health and safety, while only 16% of them received this type of training in the previous six months. Furthermore, approximately 75% of WWC in ASM do not have any health insurance; basically, they only use minimal work safety items such as boots, gloves, and helmets.

Fig. 4 describes the flowsheet operation of the ASM in Ponce Enríquez, Ecuador. The operation begins with the ore extraction in the mine company or concession, where miners dump the waste rock making piles in the environment surrounding the mining area. The ASM normative in Ecuador provides a title to a concession for the benefits of a mining company or small-scale mining (a tract of land) to conduct exploration, and eventually exploitation and waste management. To access waste rock—mostly in the discharged tailings—women usually acquire an informal permit provided by the concessionaire, mine owner or manager. As the mining operators discharge their waste around their mines, the women work independently collecting rocks on the piles and roads in the mining district. In Ecuador, the Mining Act (2009) states that the mine and metallurgical waste produced directly by an active mining operation is an accessory part of a mining concession. Who holds the mining title is granted to the right to benefit from the waste and commercialise abandon waste placed into the limits of a concession (Articles 43 and 44). The normative does not consider the activity of waste rock collection part of the mining production chain, conducted either as an individual or a member of an association. As in other ASM countries, regional and local politicians have offered WWC the opportunity for the formalisation of their activity (Verbrugge, 2015). However, unless regulations are changed at the national level, WWC cannot become part of the system or claim a concession title, because they do not work in a specific mine area for exploration and exploitation. The WWC have found a niche in the inefficiencies built in to the ASM system, seeing themselves as recycling agents of waste rocks.

To manage the recycling of the waste mine rock collected by women, mining companies have created facilities for processing small batches of ore. In this approach the companies control the full process collecting the tailings of the processing plant for further reprocessing in their facilities. However, due to the mobility challenges confronted by women in this activity, some concessionaires of Ponce Enríquez promoted the creation of campsites near the town. While the campsites reduce the effort required by women to reach the site of waste-rock collection, it is also a strategy to keep them away from the mines and limit their contact with mine workers. A mine concessionaire mentioned that illicit gold diggers might be luring WWC to get information...
about gold grades or mine conditions. As a consequence, the new model of work at the campsite restricts women’s access to a specific location to process waste mine rock. Overall, out of the 56 women interviewed, about 64% of them are part of an association, whereas the other 35% still work independently in rock collection near the mines. For the women, the association is seen as an opportunity to have access to a job in an organised manner while reducing their risks collecting waste rock around the mining sites without protective equipment.

### 3.3. The operation of women gold collector's association

The associations are usually formed by a group of women, but commonly led by men, for the purpose of collecting waste rock to recover the gold. During our field work in 2018, women we interviewed attested that the Ministry of Social Inclusion of Ecuador acknowledged this kind of organisation, however, they do not have a legal status in the mining operations. This demonstrates an intention to organise the activity, unfortunately like in other countries, there is a lack of attention to ensure formal inclusion and equity for those individuals involved in the ASM (Hilson et al., 2020; Salo et al., 2016).

We approached one campsite in which forty women and ten men were working. The women involved in the association came originally from other regions or had moved from the agricultural sector to artisanal mining. As described in Fig. 4, the association makes informal agreements with mine owners and receives the left-over ore from different mines located around Ponce Enríquez. The WWC and their partners are recognised only in informal arrangements allowing access to the waste rock material. The contract is not formalised in writing.

Men are usually in charge of collecting the waste ore rocks from various mines and transporting it to the campsite for sorting and crushing. The WWC association owns trucks, a bulldozer, and an excavator to move the collected waste rock. The material is then crushed, and the small fractions are usually sold to the nearby aquaculture farms to refill shrimp pond dikes. The 2" sized material is sold at US$ 5/m³ and the 4" sized at US$ 3.50/m³ and represents around 20% of total income for the association. Women sort the ore rocks during the preliminary crushing and men select the processing centre (Fig. 5). In the campsite finest material is passed through sluice boxes, and the association obtains gold concentrates, which are usually sold to buyers in Ponce Enríquez and represent approximately 30% of total income.

In the processing centre, the gold recovery process typically involves grinding followed by gravity concentration described by Velásquez-López et al. (2010). The gold grade of the waste rock of the material was 4.27 ± 1.05 g/ton, recovering approximately 66% of gold by gravity concentration and the tailings resulted in 1.97 g/ton of gold. After the Chilean mill operation, the association leaves the tailings in the rented processing plant. The men of the association explained that the concentrate is stocked for further cyanide leaching. However, we were not able to observe the final stage of the process of gold recovery and tailings management. From the gold extracted in the processing plant the association can get a third income that, according to the manager, represents about 50% of total earnings.

Other results of the TransMAPE project (Velásquez-López et al., 2019), suggest that the gold grades found in the mines located in Zaruma-Portovelo (ancient mining town of Ecuador) are closer to the grades found in the waste rock of Ponce Enríquez’s mining district. The grade of Ponce Enríquez’ mining waste is attractive to WWC because this residual material contains a significant quantity of gold (Velásquez-Lopez et al., 2016). However, WWC attests that getting the waste material in the mines of Ponce Enríquez has become more difficult as many the concessionaries of Ponce Enríquez have decided to reprocess the waste or improve their rock selection. Therefore, the women and their associated partners are becoming aware that their activity will eventually cease.

As stated before, women and men mine waste rock collectors are subjected to unstable and, in some cases, unequal negotiating conditions with their miner/concessionaire counterparts. Hence, there is high uncertainty in the economic benefit of this activity in the mid and long term (Benjaminsen et al., 2009). When some mine owners and concessionaires perceive that the campsite is achieving a functional business with fair gold recovery, they start charging about US$ 50/t for the ore. So, the concessionaire does not see significant direct benefits by allowing gold collectors to work on the mining waste. Instead, he will try to charge for the waste when he realises the benefit of recycling. In this case, the gold collectors’ association must purchase the waste ore from the concessionaire. As an alternative way to afford their access to the waste, the WWC association must leave 50% of the rock material selected with the owner of the quarry (Interview, July 2018). In other cases, the mine owner takes half of the concentrate that the collectors have already processed. Lastly, when the amount of gold increases in the waste rock, the mine owner or manager can unilaterally end the work permit leaving WWC legally and economically vulnerable and helpless, creating frustration and disillusionment (Salo et al., 2016).

Although it is difficult to capture information about gold production, 49% of WWC surveyed said they do not know anything about the mining regulations or environmental policies, and 47% know just “a little.” Based on our general survey, the data indicates that over half of the women gold collectors use mercury in the metal recovery process. During our work with the interviewees, many WWC from the association responded that they use azogue referring to mercury for gold recovery. WWC are using azogue. Since the use of mercury is prohibited in Ecuador, we noted that men leaders of the association were reluctant to talk about it. On a first stage, the discharge of mine rock waste constitutes an environmental threat, including its movement to campsites, and from there to other places such as shrimp farms. The leachate derived from the rock releases hazardous substances that affect wildlife and plants and contaminate surface and underground water (Broadhurst and Petrie, 2010). On a second stage, the metallurgical waste that is continually produced under the operational model described in this study may be released with mercury. In Ecuador, mercury use still is a significant health and environmental issue in ASM activity and waste management. If the WWC association recovers the gold by amalgamation, those tailings should be responsibly managed. In many ASM sites around the globe, the governance of tailings management is still a challenge.

![Fig. 5. Women working at a campsite for recycling the ore waste. After primary crushing, the rock is washed by women, creating a slurry that passes over a sluice box arranged at the campsite.](image-url)
3.4. Assessing alternative livelihood

Forty-seven percent of women waste-rock collectors are only "somewhat satisfied" with their activity, while 20% feel "somewhat unsatisfied or very dissatisfied." Most WWC in our survey perceive few benefits from the association beyond some necessary solidarity with co-workers. WWC who are more satisfied with their work are more likely to understand the grade of gold and the minerals they are selling. Approximately 88% of women view gold collection as a temporary form of employment.

Our first survey identified some training preferences among women such as courses about gold processing methods, criteria for the selection of material, and health and safety at work. However, later the research team and women became aware that due to lack of legal status in the mining sector, it would be almost impossible for WWC to regularise their activity of mine waste-rock collection in the ASM field. Women also acknowledged their exposure to adverse working conditions, to physical exertion, and to difficulties in maintaining their work.

To overcome women's false expectations, the research team organised a meeting with one of the representatives of the Artisanal and Small-scale Mining Sub-secretariat. We explained to women the difficulties of achieving formalisation. Up to that moment nobody had explained them the illegal nature of their activity and the challenges for achieving formalisation under the current conditions and lack of support. Once women became aware of the obstacles in being formalised, they requested to the research team different types of training to diversify their livelihoods and to gain other skills. Based on this conversation and the study's results, in partnership with WWC associations we assessed opportunities to respond to women's needs and interests.

We brought together 46 women to evaluate and plan subsequent steps. The women discussed several training programs including some relative to mining activities such as jewellery. However, later women reflected on the current unsustainable working conditions. At the end of the community event, the majority of participants decided that the best course would be training in an alternative area of work as well as to improve their entrepreneurial skills.

With the active participation of women, we created a 120 h training programme suited to the women's needs in terms of schedule and themes of instruction. The training sessions covered topics like microenterprise management, finance and entrepreneurship. Women's participation in selecting the topics for training allowed them to understand the decision-making process involved in operating a business. Evaluations of the program showed that participants valued the training and saw it as an opportunity to acquire skills and abilities to apply in an alternative livelihood. Women indicated that there are many other women collecting mine waste rock who would like to access to this type of technical training. Other benefits perceived by women through the training are:

- Identify emerging local leaders
- Gain training skills to teach other women
- Strengthening women's interpersonal relationships within the association
- Strengthen relationships with male partners who supported their training commitment
- Assess potential family business

Currently, some of the training participants are running individual microenterprises. Their interest is in implementing in the near future a community entrepreneurship to strengthen their profession by practising continuously while learning to work in a socio-economic sustainable and dignified activity. Strengthening women's participation in searching for other livelihoods and their involvement in training programs is a viable option to improve their socio-economic personal household's situation (Hilson et al., 2018b).

4. Conclusions

In the current Ecuadorian ASM production model, mine waste management is still in its organisational premature stage resulting in women waste-rock collectors working illegally. Either in an individual access or in associative manner, women are exposed to unfair and unsafe labour practices. Many WWC lack access to social security and covered health services. In Ponce Enríquez and across the country, under the current state formalisation in the ASM might not be a realistic solution for WWC.

Undoubtedly, WWC of Ponce Enríquez confront inequalities and inequities daily. Rural poverty, lack of schooling, and lack of economic alternatives drive women to become mine waste rock collectors with no apparent real opportunities to improve their quality of life. Women are subsisting through ASM, but they are not part of a stable job structure in the mining production chain.

This study provides evidence of a disorganised structure of mine-rock waste management which perpetuates the informal work of many men and women and an issue of environmental liability that needs attention. An economic diversification with alternative livelihoods in the long term would be an effective solution to improving WWC livelihood conditions. The study's results presented here contribute valuable insights into what will continue to be a global discussion about the current conditions in which women waste-rock collectors in Ecuador and other countries sustain their families and themselves.

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References


