# Artisanal and small-scale gold mining and food security

## An ecological perspective

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## ABSTRACT

***Artisanal and Small-Scale Gold Mining (ASGM) is one of the emerging economic activities in Uganda and thousands of local communities are involved in the gold rush. The majority of artisanal miners have abandoned other economic enterprises, such as agriculture, with the hope of improving their living standards. Given the ecological and socio-economic challenges that characterise artisanal mining sector, several questions have been raised regarding its capacity to meet the miners' economic needs, such as food security.***

***The author followed an exploratory-descriptive cross-sectional study design using qualitative and quantitative methods to gain a deeper understanding of how artisanal and small-scale gold mining influences food security. A total of 384 respondents were selected from a pool of artisans, minining-rights holders and local leaders. Data was collected using observation checklists, survey questionnaires and interview guides.***

***Specific variables of interest were subjected to bivariate analysis, where respondents were included in the analysis after a log likelihood ratio test. The results showed that 96% of the dependent variables were well displayed by the variables in the model, with a sensitivity of 93.2% and a specificity of 91.6%.***

***The findings indicated that the majority of the artisanal and small-scale miners (71%) who had changed from other livelihood enterprises such as agriculture, had less food security and lower incomes to support their economic needs. To improve food security and income in mining communities, government and other sector players should prioritise strategies, such as formalisation, legalisation and awareness.***

## INTRODUCTION

In most developing countries, artisanal gold mining still remains largely informal and unregulated. Subsequently, small-scale miners rely heavily on inexpensive, outdated and polluting technologies and chemicals, such as mercury. This is detrimental to human health and the environment.

Plus it has a direct bearing on food production and access (Hinton 2011:29). In Africa, a large proportion of artisan miners are women and children who need to contribute to a sustainable livelihood. However, their extensive involvement in the informal mining operations affects other livelihood interventions where they hold key roles (Hentschel 2003:23–25).

In Uganda, artisanal gold mining is on the increase and is largely a poverty-driven activity. Thousands of local communities depend on this labour-intensive, disorganised and unlicensed mining practice to sustain their livelihoods. Communities on the mining sites live in deplorable, unsanitary conditions, use toxic chemicals such as mercury for gold extraction and have severely degraded ecosystems that support their livelihoods (NEMA 2012:107).

The Ugandan government still regards ASGM as an illegal practice. As such, there is no regulatory and policy framework to guide artisanal mining operations. The absence of evidence-based strategies for sustainable mineral exploitation exacerbates the situation. Despite growing community engagement in artisanal gold mining practices, there is a lack of evidence on the implication that mining activities have on miners' livelihoods and food security. Therefore, the research sets out to explore the implications of artisanal gold mining on food security. The aim is to propose best-practice strategies for sustainable exploitation, as well as to highlight other necessary policy interventions.

## CONTEXTUAL BACKGROUND TO ARTISANAL AND SMALL-SCALE GOLD MINING

ASGM takes place throughout the world, but is particularly widespread in developing countries in Africa, Asia, Oceania, Central and South America. Globally commissioned studies on ASGM in over 20 countries provided a detailed overview of ASGM, as well as key points of concern regarding social economic and environmental issues. The International Institute of Environment and Development (IIED) and the World Business Council for Sustainable Development (WBCSD) played a key role in the extensive studies. The studies broadly highlight typical problems of ASGM related to geology, technology, law, human resources, marketing, as well as organisation and financing mechanism (Hentschel 2003:10–12 and Heemskerk 2002:5–6).

The International Labour Organisation (ILO) states that people pursue artisanal mining practices to improve their livelihoods. However, the means do not justify the ends. As such, vulnerabilities that characterise the practice tend to nullify the perceived and actual benefits of the sector. Studies indicate that artisanal mining's ability to contribute to long-term household security depends on a range of factors. These include the type of small-scale mining that is undertaken, whether labour is of an exploitative nature, the number of household members involved, and how it relates to other income-generating activities at household level. For instance, when an entire family is involved in mining activities, it is most likely regarded as a short-term survival strategy to attend to pressing need. However, it may compromise sustainable livelihood of the entire household in the long run (Mwaipopo *et al.* 2004:8–9).

Traditionally, Sub-Saharan Africa's focus has been on large-scale oil, gas and mineral resource mining. It mostly benefitted the elite and often added little value to the sustainable growth of economies. Artisanal and small-scale mining in Sub-Saharan Africa is prominent in poor rural areas where minerals are found. Literature is inconsistent on the actual number of poor and unskilled workers who directly depend on this sector. However, it is estimated that over four million individuals fall into this category. This suggests that, unlike large-scale mining operations, small-scale mining potentially offers greater opportunities for both direct and indirect job creation. However, these economic benefits are not well documented (ILO 1999:9–11).

Studies highlight the need to identify and understand the driving forces for people's participation in artisanal mining in order to guide the requisite interventions. For instance, impoverished individuals who have limited options to sustain their livelihoods are unlikely to support investment in new technologies. In these cases, social protection programmes or basic health and safety guidelines would be a more appropriate intervention. Formalised, legal artisanal mining is more likely to improve livelihoods and require appropriate technologies and strategies (MEMD 2012:48–49).

The ILO notes that African countries strive to develop more sustainable, inclusive growth models. An emerging evidence base is now recognising small-scale mining's potential to bolster economic growth in certain rural areas. As such, it is viewed as a possible resilient livelihood choice to generate a sustainable income base. However, due to the informal nature of operations, the sector is seen in a negative light. Governments, the development community and subsequent poverty reduction interventions tend to ignore this sector.

Owing to its informality nature, there are a host of challenges associated with artisanal gold mining that tend to nullify the potential economic benefits. Academics and practitioners have debated these challenges for decades. These include weak or absent government policies and persistent structural barriers. With regard to the latter, challenges conflict over land-use and access, poor access to financial services, lack of market information and technology, exclusion of certain demographic groups, poor productivity, unsafe working conditions, uncontrolled migration, low entry barriers to illegal activities and an adverse effect on the environment. In addition, child labour, high transmission of communicable diseases and lack of education present major challenges to governments and the wider development community (Hentschel 2002:19–20).

The ecological impact of artisanal gold mining is of particular importance. This affects both food security and sensitive ecosystems. The mining practice is characterised by deforestation and modifications of hydrologic systems, such as constructing reservoirs or through silt accumulation in rivers (Akagi and Naganuma 2000:133–145). In general, mining operations harm the environment and can disfigure the landscape with waste-rock piles and open pits. With surface mining, large areas of land need to be cleared, which has a large-scale impact on the environment.

The environmental degradation associated with excavating large volumes of soil can affect groundwater when the water-table level is reached, as well as the water quality of adjacent drainages. Unsurprisingly, water contamination is one of the major community health risks associated with small-scale mining. Harmful chemicals such as mercury, cyanide, sulphuric acid, arsenic and methylmercury are used in various stages of gold mining. To amalgamate mineral extraction, toxic chemicals such as cyanide, mercury, oil, petroleum products, solvents, acids and reagents are used during the refining process to leach and separate valuable minerals from other unwanted minerals.

Siltation, a by-product of mine waste and deforestation, has large-scale implications on the environment. Coupled with direct discharge tailings into waterways, it causes widespread damage, such as clogged up rivers. One of the main catalysts of siltation is the fact that waste material is piled up near extraction pits. In Gugub Village, Sudan, Ibrahim (2003) estimates that 400 000 to 500 000 tonnes of waste and tailings are piled near pits.

In addition to the toxic substances used during gold processing and metals leached from mine waste, domestic waste, such as sewage, detergents and other chemicals, also contaminate water supplies. This is further exacerbated by a lack of sanitary and public health facilities (Ibrahim 2003:13–15 and Hentschel 2003:19).

Hinton (2011) notes that the use of mercury in gold mining is detrimental to the environment. For every gramme of gold produced, artisanal gold miners release about two grammes of mercury into the environment. Cumulatively, the world's 10- to 15-million artisanal gold miners release about 1 000 tonnes of mercury into the environment each year, which accounts for 35% of synthetic mercury pollution.

Notably, artisanal gold mining is the leading cause of global mercury pollution, ahead of coal-fired power plants. In addition to its impact on the environment, mercury is extremely harmful to human health. The amount of vapour that mining activities release has been proven to damage the kidneys, liver, brain, heart, lungs, colon and immune system. Chronic exposure to mercury may lead to fatigue, weight loss, tremors and behavioural changes. In children and developing foetuses, mercury can impair neurological development.

Hinton (2011) explains that mercury and gold bind as one unit. When sundered by fire, the more volatile mercury is vapourised from the elemental union. In humans, approximately 80% of inhaled mercury vapour is absorbed via the respiratory tract, where after it enters the circulatory system. Case control studies have shown that chronic exposure via inhalation – even at low concentrations in the range 0.7–42 $\mu g/m^3$ – could lead to tremors, impaired cognitive skills and sleep disturbances (Hinton 2011:29).

The organic forms of mercury, specifically methylmercury that is used in gold mining, can cause great damage when it comes into contact with food. Metallic mercury that is discharged into the environment (air, water and tailings) due gold mining practices can be transformed into methylmercury, a bio-available form of mercury. Mercury is biomagnified, which means it increases in concentration higher up the aquatic food chains. As such, communities who rely on fish in mercury-impacted areas could be at risk.

Chronic exposure to moderate levels of methylmercury results in symptoms such as numbness of the extremities, as well as impaired vision, hearing, speech and gait. In cases of acute intoxication, muscular atrophy, seizures and mental disturbance are prominent. Pregnant women are particularly susceptible, as methylmercury crosses placental barriers and is considered to be a developmental toxicant (Hinton 2011:28). Depending on the frequency and degree of exposure, side effects include sterility, spontaneous abortion, as well as mild to severe neurological damage.

In Uganda, artisanal and small-scale gold mining is one of the emerging forms of environmental degradation in different districts. The rapid migration of thousands of people from the villages in search of gold challenges not only places immense stress on the environment, but also poses severe health and socio-economic risks. Undeniably, this practice has a potentially detrimental impact on the livelihood security of mining communities.

The mining sites in Uganda encompass various ecological areas, which range from fragile aquatic systems to fertile agro-ecological zones and rocky areas. On the Kisita, Kamalengera, Tira and Amonikakine mining sites, gold is recovered from hard-rock reefs. Most of the gold is recovered from alluvial material and potential agricultural fields. The gold mining fields in Mubende and Buhweju are located in small, high-grade alluvial deposits around the Proterozoic basin and in wetland ecosystems. This poses a profound risk on the environment, human health and food security (NEMA 2012:107–108).

Communities that are engaged in the mining operations face illness, injury and stress from dust and noise pollution, as well as extreme exertion from highly labour-intensive jobs. Although accidents are severely underreported due to the illegal nature of the practice, the ILO states that non-fatal accidents in artisanal small-scale mining are six to seven times higher than in formal, large-scale mining operations (ILO 2005:12).

In southwestern Uganda's Mubende district, there is an influx of over 3 000 illegal gold miners in Lugingi A and C and surrounding areas near Katugo village in Mudadde Parish, as well as in Lugingi A and C villages in Kaduna Parish, in Kitumbi Sub-county. The excavation of large volumes of material in alluvially fragile ecosystems, particularly wetlands, has affected the hydrological value of these ecosystems, as well as the quality and quantity of water (MDLG 2013:8).

In this area, several people have reportedly been killed by mining collapses and on a single mining site, an average of 10 people die annually (MDLG 2013:32). According to an article published in the *Daily Monitor* newspaper on 10 November 2014, 12 people were killed and several others injured when a gold mine at the Luginji mining site in the Mubende District's Kitumbi Sub-county caved in. An avalanche of soil covered what was initially a 20-foot-deep gaping hole where residents rummage for the gold. Over 1 000 artisans are engaged in mining at this site (*Daily Monitor* 2014).

## THE IMPLICATIONS OF ARTISANAL GOLD MINING ON FOOD SECURITY

An exploratory-descriptive cross-sectional study design was used to examine to which extent artisanal and small-scale gold mining influences food security in Western Uganda's Mubende District. A total 384 respondents were selected, which include artisans, minining rights holders and local leaders. Data was collected using observation checklists, a survey questionnaire and interview guide.

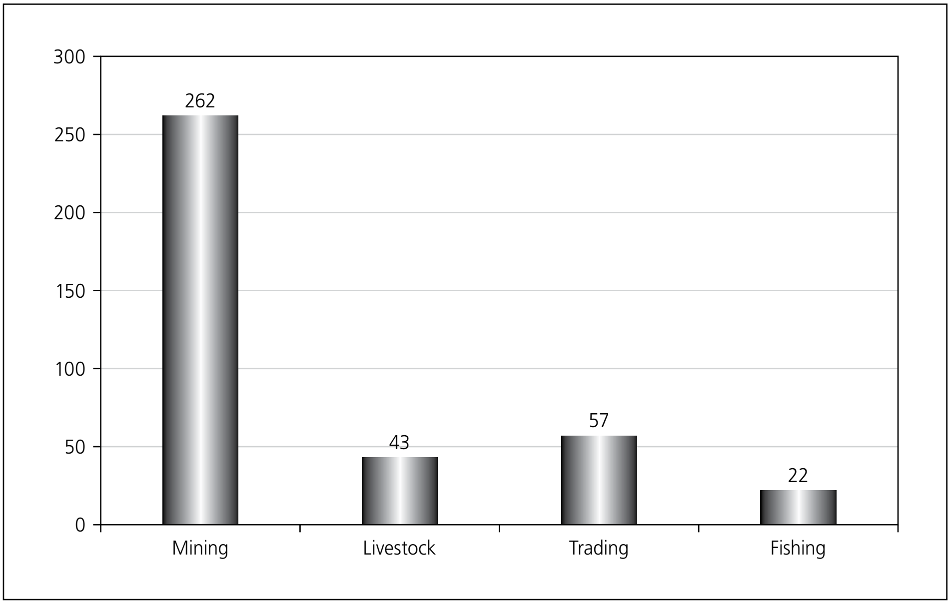
Quantitative data was analysed in stages. At a univariate level, frequencies of variables were generated and tabulated; at bivariate level, cross-tabulations were constructed to establish the associations between variables of interest; at multivariate level, all statistically significant variables at a bivariate level were subjected to the multivariate model to control for confounding.

The findings indicated a strong correlation between the variables of interest (ASSGM and food security). This was determined using an odds ratio and 95% confidence intervals. In addition to the challenges that artisanal gold operations presented to communities' livelihoods and food security, other key markers were also identified. It was established that communities on the mining sites live in deplorable sanitary conditions, use toxic chemicals like mercury in the gold-extraction process, while and ecosystems and agricultural fields that should support their livelihoods are degraded.

### Artisanal gold mining and land use

Land is a key denominator in food production, availability and use. Artisanal gold mining takes place on fertile land that could be used for food production, which supports food

**Figure 1:** Physical hazards associated with artisanal mining




security. In the Mubende District, gold mining has been embraced as one of the economic activities to support livelihoods. However, this is far from the reality community level. A total of 68% of respondents have abandoned sustainable livelihoods by converting their agricultural land into mining sites. As Figure 1 suggest, fishing, livestock and trade are other livelihood enterprises that mining households are phasing out incrementally.

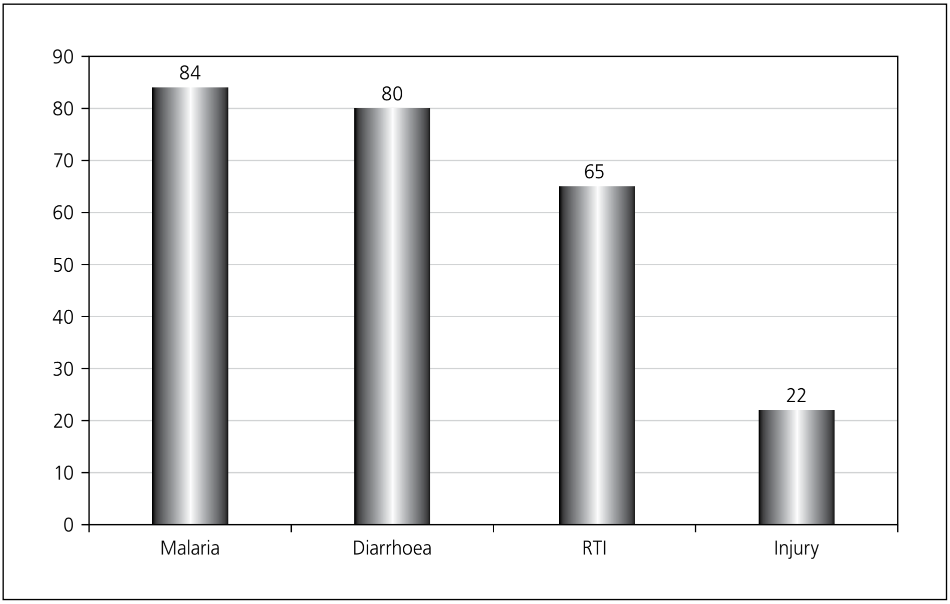
In addition to changes in land use, remaining agricultural land is now degraded due to poor mining practices. Most of this land forms part of fragile wetland ecosystems that provide water sources for domestic and livestock use. As a result, the hydrological, ecological and socio-economic value of the land has been lost. As a result, animal watering points and springs are drying up, while soil moisture that supports high food yields is being depleted.

## Food security and artisanal gold mining: 'Before and after scenario'

Food insecurity at household level can be seen as a combination of two distinct problems, namely acquirement and utilisation. Acquirement refers to household members' ability to acquire enough food through production, exchange or transfer. However, this only forms one part of food security or insecurity. A household with the capacity to acquire all the food it needs may not always have the ability to optimise that capacity. For instance, a housewife might be too pressed for time to prepare food that yields the best nutritional value. Perhaps the household's storage facilities cannot store adequate quantities of quality food outside the harvest season. Despite the two aforementioned scenarios, the researcher focused on acquirement, which encompasses availability and access. The researcher is of the opinion that utilisation, including nutritional content, should be covered by a separate study.

The majority of respondents (71%) reported that the availability of food was compromised in their households during the last 12 months after engaging in artisanal gold mining, while

**Figure 2:** Physical hazards of ASGM




79% reported a low income from selling food after engaging in artisanal gold mining. On the contrary, 77% reported having had adequate food (both availability and access) and a stable income from food sales before engaging in artisanal gold mining. The shortage of food was attributed to less land for cultivation, as well as time and capacity to cultivate the land. Other respondents reported that physical hazards associated with mining contributed to reduced food production and availability. A total of 56% reported physical hazards such as malaria, physical injury, diarrhea and respiratory tract infections, as highlighted in figure 2

## Artisanal gold mining, gender roles and food security

Gender refers to a range of characteristics and physical attributes that differentiate masculinity and femininity. Notably, gender can also refer to a more complex range of ideolical and socio-political dicotomies, as well as the political genealogy of gender-based ontology (Butler 1990:55–56). Gender may also refer to specific attitudes, values and beliefs that a particular socio-cultural group considers appropriate for males and females. Notably, these attributes can shift and change over time, space and circumstance.

Both men and women can experience the negative impact of gender-based discrimination. To address inequalities, both men and women need to confront their prevailing beliefs, advantages and behaviour (Hinton 2011:9 and Mayoux 2009:12–15). It is generally believed that women are more disadvantaged than men. Statistics in Uganda highlight several inequalities between men and women. For example, 23.1% of households are headed by women; men earn over 30% more than women; 76% of adult males and 61% of adult females are literate; women hold 24.7% of seats in Parliament; and only 7% of women own land (UBOS 2004:13). Although national statistics fail to provide a comprehensive picture of gender disparities in terms of vulnerability, access, control, decision-making and poverty, specific gender imbalances exist and are documented.

Women play a critical role in the food security chain and largely influence food production, availability and utilisation. In all the households surveyed, 95% of the women are directly or indirectly involved in artisanal gold mining. Although women fully engage in the mining processes, they are highly marginalised. They are relegated to doing supportive tasks such as transporting and processing materials, cooking and supplying food and drinks, moving tools and equipment, as well as providing sexual services. These supportive roles do not improve their financial circumstances.

Males control the income generated from the mining. However, they end up squandering the money on alcohol, drugs and sexual services. As a result, there are limited financial resources left to cater for the household needs. Mining can be highly feasible, but it is a poor livelihood support enterprise. A key point of concern is that women are less involved in food production, which leads to food insecurity. In addition, it further exacerbates poverty among the mining households.

### The impact of mercury on food security

Mercury, a liquid metal, is used in artisanal and small-scale gold mining to extract gold from rock and sediment. Unfortunately, mercury is a toxic substance that wreaks havoc on miners' health and the environment. As such, the mercury in gold mining is a growing international concern.

Two mining leases and three 'gold rush' sites that formed part of the study used elemental mercury. Gold ore rocks are grinded with steel balls until the ore forms a fine powder. The majority of the respondents (98%) expressed fears regarding the health and ecological implications of mercury use in gold extraction. They expressed specific concern over the possibility of polluting food and water resources.

Indeed observation revealed use of large amounts of mercury in the gold extractions. Besides, the mining sites were close to the water sources that accounted for 99% of water requirements for domestic use putting the health of the miners at a great health risk.

## TESTING THE RELATIONSHIP BETWEEN ASGM AND FOOD SECURITY

To understand the relationship between Artisanal and Small Scale Gold Mining (ASGM) and food security, specific variables of interest were subjected to bivariate analysis.

Table 1 shows a positive link between food security and women's involvement in ASGM. This implied that female respondents who were engaged in ASGM, but also participated in other livelihood enterprises (80.9%), were eighteen times more likely to have food security, compared to their female counterparts who only participated in ASGM (36.2%) [OR 18.14* 95%Cl 8.12–23.19]. This was a statistically significant result. There was also a positive link between a change in land use and food security. Respondents who converted their agricultural land into mining, 133/159 (83.7%) were fifteen times more likely to be food insecure [OR 15.02* 95% Cl 6.30–29.37].

There was a positive association between the use of mercury in ASGM and the food security. A total of 84.7% of respondents [193/228] linked mercury to food insecurity, which is 13 times higher than respondents who were less concerned about mercury usage (33.3%) [OR 13.51* 95%Cl 5.02–24.50].

The findings highlighted a strong link between the physical hazard associated with ASGM and food security. A total of 179/190 (94.2%) respondents strongly believed that physical hazards associated with ASGM, affects food security, which is 14 times higher than those who believed physical hazards had no connection to food security [OR 14.11* 95% Cl 6.10–26.21].

**Table 1:** Link between food security and women's involvement in ASGM–Change of land usage, use of mercury and physical hazards

| Variable | Food Secure n(%) | Food Insecure n(%) | Total (n) | Odds ratio, 95% CI for OR & P-value |
|---|---|---|---|---|
| Women participating in ASGM | | | | |
| Only ASGM | 71 (36.2) | 125 (63.8) | 196 | 18.14* (8.12–23.19) |
| AGM+Others | 152 (80.9) | 36 (19.2) | 188 | 0.0001 |
| Change of land use | | | | |
| No | 49 (21.8) | 176 (78.2) | 225 | 15.02* (6.30–29.37) |
| Yes | 133 (83.7) | 26 (16.4) | 159 | 0.0001 |
| Use of mercury | | | | |
| No | 52 (33.3) | 104 (66.7) | 156 | 13.51* (5.02–24.50) |
| Yes | 193 (84.7) | 35 (15.4) | 228 | 0.00001 |
| Physical hazards | | | | |
| Yes | 179 (94.2) | 11 (5.8) | 190 | 14.11* (6.10–26.21) |
| No | 22 (11.3) | 172 (88.7) | 194 | 0.00001 |
| ASGM = Artisanal and Small Scale Gold Mining | | | | |

A backward stepwise conditional log likelihood ratio was used to control for confounding among the variables. All the factors that were identified during bivariate analysis and other potential factors were entered into a model. A multivariate model was chosen because it increases precision and it is simple and easier to compute (McCaffrey 2004:28)

$$
\begin{aligned}
\text{Logit } P(Y) = \; & \alpha + \beta_1 \text{ (Women involvement in ASGM)} \\
& \alpha + \beta_2 \text{ (Change of land use)} \\
& \alpha + \beta_3 \text{ (Use of mercury in ASGM)} \\
& \alpha + \beta_4 \text{ (Physical hazards of ASGM)} \\
& \alpha + \beta_5 \text{ (Land ownership)} \\
& \alpha + \beta_6 \text{ (Age of respondent)} \\
& \alpha + \beta_7 \text{ (Education level)}
\end{aligned}
$$

Where: LogP(Y) is the probability of ASGM impact on food security, $\alpha$ is the Y intercept, and $\alpha$ is the coefficient value of the likely confounders in the model.

The results of the best fitting model are indicated in table 2. The 384 respondents were included in the analysis after a log likelihood ratio test, where 96% of the dependent variables were well displayed by the variables in the model with a sensitivity of 93.2% and a specificity of 91.6%.

After adjusting for confounding using a log likelihood ratio and testing for effect modification, the variables that remained significantly associated with food security were: ***Physical hazards*** OR 14.11, 95% Cl 6.10–26.21), ***Change of land use*** (OR=15.02, 95% Cl 6.30–29.37) and ***Women's involvement in ASGM*** OR=18.14, 95% Cl 8.12–23.19).

Other variables that were not statistically significant, but that confounded the significant variables, were dropped during the regression levels. These included the age of respondents, education level and land ownership.

**Table 2:** Results of the best-fitting model

| Variable | Coefficient | Adjusted OR | 95% CI |
|---|---|---|---|
| Age | | | |
| 12–35 yrs | 0.41 | 1.56 | 0.28–3.14 |
| 36–65 yrs | | | |
| Women involvement* | | | |
| Only ASGM | 1.62 | 0.71 | 3.12–36.51 |
| AGM+Others | | 8.02 | |
| Change of land use* | | | |
| No | 2.13 | 6.26 | 2.06–25.39 |
| Yes | | | |
| Physical hazards* | | | |
| No | 2.18 | 7.09 | 5.74–44.02 |
| Yes | | | |
| Education level | | | |
| Protestant | 0.19 | 1.73 | 0.18–2.99 |
| Others | | | |
| Land ownership | | | |
| Married | 0.55 | 1.66 | 0.31–5.27 |
| Not Married | | | |
| * Statistically significant | | | |

## CONCLUSION

ASSGM is one of the emerging economic activities that many people embrace in the hope of improving their living standards. This is specifically the case in Africa. However, findings indicate that wealthier community members are better positioned to take advantage of the opportunities that this type of mining activity presents.

In Uganda, ASSGM is embraced as an alternative economic activity, particularly as a means to address increasing poverty and livelihood concerns. However, ecological and livelihood challenges associated with this practice far outweigh the perceived benefits.

The study findings highlight a strong correlation between the variables of interest (artisanal gold mining and food security). This was determined using odds ratio and 95% confidence intervals. This established that communities on mining sites have severe food security problems, as well as lower household incomes. Furthermore, the miners live in deplorable sanitary conditions and use toxic chemicals like mercury for the gold extraction process. In addition, ecosystems and agricultural land, which should support their livelihoods, are severely degraded. Factors such as the involvement of women in ASGM, changes in land use, the use of chemicals, and physical hazards were found to affect the different levels of food production, availability and access.

In line with several other studies, the study found that ASSGM faces several challenges. These include weak or non-existent government policies; persistent structural barriers like conflict over land-use and access; poor access to financial services; lack of market information and technology; pricing challenges; exclusion of certain demographic groups; poor productivity; unsafe working conditions; uncontrolled migration; low entry barriers to illegal activities; environmental damage; child labour; high transmission of communicable diseases; and lack of education.

Undeniable, these challenges affect miners' livelihoods of and worsen poverty in mining communities. Thus, strategies that seek to mitigate these challenges should help to maximise the economic benefits of mining and improve miners' livelihoods. Key strategies should include creating awareness among the miners, legalising and formalising artisanal mining operations, as well as developing guidelines that can help standardise the marketing, pricing and mining processes.

## NOTE

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