



Research article

Socio-demographic factors affecting artisanal and small-scale mining (galamsey) operations in Ghana

Issah Baddianaah^{a,*}, Bernard Nuoleyeng Baatuuw^b, Raymond Adongo^c^a Department of Environment and Sustainability Sciences, Faculty of Natural Resources and Environment, University for Development Studies, P.O. Box TL 1882, Tamale, Ghana^b Department of Geo-Information Sciences, Faculty of Natural Resources and Environment, University for Development Studies, P.O. Box TL 1882, Tamale, Ghana^c Department of Ecotourism and Hospitality Management, Faculty of Natural Resources and Environment, University for Development Studies, P.O. Box TL 1882, Tamale, Ghana

ARTICLE INFO

Keywords:

Galamsey
Ghana
Illegal mining
Local communities
Socio-demographic characteristics

ABSTRACT

In spite of the persistent efforts by the responsible state institutions to eradicate galamsey operations in Ghana, little attention is given to the inhabitants' characteristics that may affect the surge in illegal mining operations. This study was designed to investigate whether local community dwellers' socio-demographic characteristics affect their participation in galamsey activities—an aspect that has not been independently investigated in the scientific literature. Cross-sectional survey quantitative data were sourced using 342 semi-structured household questionnaires. The results showed that the majority (69.3%) of the local dwellers engaged in galamsey operations. The binary logistic regression model showed that socio-demographic variables such as age, marital status, religious status and educational status of the respondents significantly determined their participation in illegal mining activities. The study, therefore, concludes that local dwellers' socio-demographic characteristics significantly influence their participation in artisanal and small-scale mining (ASM) operations and contribute to the surge in illegal mining activities in Ghana. The study recommends that the Government of Ghana and related stakeholders should focus on creating more youth jobs of significant prospects in local communities. In addition, investing in education and promoting the agenda of higher educational attainment in rural areas is a forward-looking step to reducing the growing illegal mining activities in the country.

1. Introduction

Generally, artisanal and small-scale mining (ASM) operations are labour-driven, low-tech activities that require less capital. They are executed with the use of simple tools such as shovels, pickaxes, chisels, bowls, pans and buckets (Ofosu-Mensah, 2010; Guenther, 2018; Hilson and Maconachie, 2020). Artisanal and small-scale mining activities are ubiquitous in low-income countries, as recent reports suggest between 80–90 percent, 40–60 percent and less than 10 percent of low-income, middle-income and high-income countries respectively are involved (Pact and ARM, 2018)—ASM activities are strongly correlated with poverty endemic countries. However, evaluating ASM's contributions to national economic growth and development has been mixed because the adverse effects mostly overshadow the positive implications (Hirons, 2020). Nevertheless, the ASM sector remains a safe haven for employment to the youth in these geographies (Tuokuu et al., 2020; Mabe et al.,

2021). For instance, as of 1999, the International Labour Organisation (ILO, 1999) reported 13 million active miners and 80–100 million indirect dependents of the ASM sector worldwide. As it stands, in sub-Saharan Africa (SSA) alone, about 20 million artisanal and small-scale miners, and 100 million associated beneficiaries are chronicled (Hilson, 2017). However, the increasing illegality and clandestine manoeuvrings of the miners continue to mar the prospects of the ASM sector in the sub-region—Ghana, in particular (Forkuor et al., 2020; Osumanu, 2020; Tuokuu et al., 2020; Hausermann et al., 2020).

In their repeated documentation of the dynamics of artisanal and small-scale mining activities in Ghana, Hilson and Potter (2003:237) questioned why the “illegal gold mining activity is so ubiquitous in rural Ghana”. In spite of the fact that Hilson and Potter's work has stayed through a decade and more (2003–2021), we still find this question useful—from 2003 up to date, illegal mining (galamsey) operations have grown enormously across the length and breadth of Ghana, with mixed

* Corresponding author.

E-mail address: yakubuisah1983@gmail.com (I. Baddianaah).

implications (Azumah et al., 2020). The northern part of Ghana, including the Upper West Region which hitherto was precluded in galamsey discussions because of the absence of galamsey activities in this half of the country, has recorded massive illegal mining activities in recent times (Agyemang and Okoto, 2014; Laari et al., 2016; Baddianaah et al., 2021a). As evident in another study by Hilson (2010:296) entitled “Once a Miner, Always a Miner: Poverty and Livelihood Diversification in Akwatia, Ghana”, it is difficult taking local dwellers out entirely from the artisanal and small-scale mining business. Hilson contended that the decision to ‘get rich quick’ as widely championed within the policy cycles as the cause of illegal mining activities in Ghana is a misinformed development. Moreover, this notion culminated in the maligning, discrediting, criminalising and downsizing of the entire process of ASM activities in Ghana (Tuokuu et al., 2020).

Artisanal and small-scale mining operations are no new mineral exploration strategies as far as Ghana is concerned. In fact, Ghana was formerly called Gold Coast, a name earned from its colonial authority, the British, as a result of the undisputed abundance of gold deposits in the region when they first set foot in the country (Ofosu-Mensah, 2010, 2011). According to historical reports by Ofosu-Mensah (2010), local miners (citizens) enjoyed free explorations, gathering and selling of gold and other minerals such as diamond, bauxite and manganese around the Akan territories as early as the 4th century. Thus, the process of extracting, gathering and selling of gold largely by citizens was later coined as galamsey—gather and sell (Akabzaa and Darimani, 2001; Hilson, 2001; Ofosu-Mensah, 2011). Later, around the 19th century, the commercial exploration of the country’s mineral wealth was commenced by large-scale multinational conglomerates (Ofosu-Mensah, 2011; Yankson and Gough, 2019). Conflicts between these foreign firms and the galamsey operators over mineralised concessions have been reported to be chaotic (Hilson, 2002; Hilson and Yakovleva, 2007; Yankson and Gough, 2019). These chaotic conflicts, coupled with the global economic depression, forced Ghana to subscribe to the World Bank Structural Adjustment Programme (Ayee et al., 2011; Twerefou et al., 2015). Under the World Bank Economic Recovery Programme, the commercialisation of Ghana’s mineral explorations was emphasised and tax holidays were awarded to foreign syndicates to increase investment in the mining sector (Hilson and Potter, 2005). Another World Bank directive to the government of Ghana was to regulate ASM operations to bridge the gap in mineral wealth leakages and to also protect large-scale mining concessions from invasion by the illegal miners (Fold et al., 2013; Yankson and Gough, 2019).

Regulating ASM activities means the drafting and implementation of laws to ban and redefine how citizens can engage in mineral resource exploration in the country (Akabzaa and Darimani, 2001; Hilson, 2001; Hilson and Potter, 2005). Because of this, three major regulatory frameworks were framed to govern indigenous mining activities in the country. These laws include the Small-Scale Gold Mining Law (Provisional National Defence Council Law [PNDCL] 218, 1989), the Mercury Law (PNDCL 217, 1989) and the Precious Minerals Marketing Corporation Law (PNDCL 219, 1989) (Akabzaa and Darimani, 2001; Bebbington et al., 2018). The Small-Scale Mining Law of 1989 (PNDCL 218) as amended by the Minerals and Mining Act of 2006 (Act 703) defined small-scale mining as an indigenous enterprise that requires certification of Ghanaians from the Minerals Commission to operate (Akabzaa and Darimani, 2001; Ofosu-Mensah, 2011). It indicated that small-scale mining is exclusively preserved for citizens. Moreover, the high cost of acquiring the small-scale mining license, bureaucracy, corruption, collusion and collaboration as well as massive political interference have been highlighted as drawbacks to the majority of the local miners’ inability to acquire the small-scale mining license (Kwai and Hilson, 2010; Botchwey and Crawford, 2018; Adu-Baffour et al., 2021; Gbedzi et al., 2022).

Consequently, the local miners teamed up with the illegal Chinese miners who are technologically resourced to engage in galamsey. Thus, the use of heavy machines (excavators) by the Chinese illegal miners in the galamsey sector further increased the environmental consequences (Antwi-Boateng and Akudugu, 2020; Hausermann et al., 2020), such as pollution of water bodies and degradation of arable lands and forest reserves (Boadi et al., 2016; Hilson, 2017; Bansah et al., 2018; Owusu et al., 2019; Obeng et al., 2019; Forkuor et al., 2020). Because of the increasing environmental consequences, media groups (e.g. Citi FM’s #StopGalamsey), civil society organisations and pressure groups (e.g. Occupy Ghana), governmental organisations (e.g. USIAD, UNDP) and non-governmental organisations (e.g. A Rocha Ghana) called on the Government of Ghana to take action. The government constituted an Inter-Ministerial Committee on Illegal Mining (IMCIM) tasked with the core duty of coming up with solution-oriented proposals to put a stop to galamsey operations in Ghana. The IMCIM recommended that a moratorium be placed on all small-scale mining activities to pave way for the re-registration of the small-scale mining groups. This took effect from March 2017 to December 2018, spanning almost 2 years (Owusu et al., 2019). In order to enforce the ban, “Operation Vanguard”, military and police combined anti-galamsey taskforce, was unveiled to champion the course (see Tuokuu et al., 2020; Baddianaah et al., 2021a). Though these strategies were devised to put a stop to the galamsey activities, in-depth interrogations of the rationale for the massive engagement of local communities in the ASM sector, their socio-demographic characteristics and prospects of engaging in the galamsey business received paltry considerations. As such, illegal mining activities bounced back stronger than before—that is, after a few registered miners were cleared to continue with their operations in December 2018 (Owusu et al., 2019).

In addition, the IMCIM-proposed Community Mining Cooperative scheme under the Multilateral Integrated Mining Project took a couple of years and is yet to be given the green light, if any. However, the environmental consequences of ASM activities intensified and have caught the attention of several scholars (Bansah et al., 2018; Obeng et al., 2019; Owusu et al., 2019; Kumi-Boateng and Stemm, 2020; Gbedzi et al., 2022). Other scholars have looked at the livelihood implications of the galamsey ban on the local communities (Tuokuu et al., 2020; Zolnikov, 2020). Additionally, a section of the scholars settled on the livelihood coping strategies adopted by local communities to the galamsey ban (Mabe et al., 2021). The harsh treatments meted out to local miners caught at mining sites by the military (i.e., shooting and killing, arresting, persecution and prosecution including the burning of excavators, the implements used in mining) have been reported (Hilson, 2017; Hilson and Maconachie, 2020).

While these and many more issues are currently discussed, a large majority of the local communities’ dwellers in the Upper West Region still defied the odds and continue to engage in galamsey activities. Moreover, the extant literature appears to have turned a blind eye to the compelling factors, including the citizens’ characteristics that may greatly affect their participation in illegal mining activities despite being outlawed. In filling this gap in the literature, our study investigated how local dwellers’ socio-demographic characteristics affect their participation in galamsey operations in the Upper West Region. Thus, we delve into this study intending to find answers to the following research questions: (a) how do local community dwellers participate in galamsey activities? and (b) what personal characteristics of local community dwellers affect their participation in galamsey activities? In addition, the study was guided by the following research hypothesis: H_0 : local communities’ socio-demographic characteristics do not determine their participation in ASM activities; and H_1 : local communities’ socio-demographic characteristics determine their participation in ASM activities. This study is timely, as it will serve as a major policy guide and contribute to the extant literature to unpack the reasons why the illegal gold mining activity is so ubiquitous in rural

Ghana (Hilson and Potter, 2003) for an informed decision to eradicate illegal mining activities in the country and other developing societies.

2. Literature review and conceptual overview

The literature reports a range of factors affecting the engagement of local community dwellers in ASM activities (Hilson, 2016; Mapuva and Dube, 2016; Yakovleva and Vazquez-Brust, 2018), though no specific empirical conclusion has been drawn on the subject matter probably due to the complexities surrounding the sector. Largely, the number one factor responsible for local communities' participation in artisanal and small-scale mining operations across the developing world is poverty. According to Mcquilken and Hilson (2016) and Hilson (2017), ASM operators are mostly poverty-endemic individuals whose aim is to alleviate poverty by engaging in ASM activities. Ahmed and Oruonye (2016) observed from a study conducted in the Mambilla Plateau, Taraba State of Nigeria that people of diverse age, sex and social groupings are attracted to ASM because it provides a window of hope to ending poverty in a snapshot manner. However, these authors were quick to acknowledge that the poor outlook of other related livelihood activities is the underlying reason why a large majority of the populace in their study area are shifting to ASM operations. The situation is not different from the findings of Mapuva and Dube (2016) who investigated the relationship between artisanal gold mining operations and livelihoods in a rural community, Wozoli Silobela Ward 22 of the Kwekwe District, Zimbabwe. Their study revealed that small-scale gold mining activities have a close association with an agglomeration of economic activities. Thus, the miners consider it as a source of diversified livelihood portfolio for reducing poverty.

Similarly, Intergovernmental Forum on Mining Minerals Metals and Sustainable Development (IGF, 2017) described ASM as a pathway out of poverty. To IGF, ASM offers a medium to complement incomes along with the challenge of inaccessible job opportunities. Aghetara (2012) reported an increase in ASM actors in the Upper East Region of Ghana, attributable to extreme poverty coupled with low crop yield often recorded by farmers. On the part of other scholars (e.g. Weng, 2015; Andrews, 2015; Hilson, 2016; Redehey, 2017; Mkodzongi and Spiegel, 2018), ASM should be rethought as an activity that offers employment to a large proportion of the unemployed youth, including the aged in

developing countries—sub-Saharan African in particular. The ASM sector has come to stay because of the role it plays in revitalizing the rural economy and supporting livelihoods (Hilson, 2016; Sidorenko et al., 2020; USAID, 2020:3).

Hilson (2016) posited that the effects of the ASM sector, though numerous, are organised and spread across local communities in a way that dwellers are able to cope with the tragedies. Thus, the ASM sector provides a quick means of acquiring jobs. Hilson's main concern here is that ASM should be given equal respect as other livelihood portfolios in local communities, especially by recognizing the nexus between ASM and smallholder agriculture. Another study conducted by Redehey (2017) focusing on job opportunities and risk dynamics of ASM in Asgede Tsimbla Woredai of the Northern Tigray National Regional State, Ethiopia revealed that a majority of the youth find jobs in artisanal mining either on a permanent or temporal basis. However, the negative ramifications of the ASM operations have kept the author in a state of doubt as to whether ASM could be a worthy source of employment.

2.1. The vicious cycle of poverty in ASM operations

Despite the appeals, prominence and drivers of the involvement in ASM activities by local communities, one commanding aspect of the sector largely emphasised in the extant literature is the tendency of ASM operations to put local communities in a cyclical poverty web (Hilson and Pardie, 2006; Mcquilken and Hilson, 2016). Authors that share this notion have identified a myriad of cyclical linkages (Figure 1) responsible for inducing abject poverty in local mining communities (International Labour Organisation [ILO], 1999; Hilson and Pardie, 2006; Mcquilken and Hilson, 2016). The World Bank (1995) observed that the dynamics of ASM activities have the proclivity to put local communities in a poverty trap. According to this report, a plethora of factors is faced by artisanal miners, which in the long-run often place them in a 'vicious cycle of poverty'. These factors include poor savings habits, low level of technology and investment capital, low earnings, poor environmental and unhealthy conditions, and low output and returns.

Notably, the International Labour Organisation (ILO, 1999) reiterated the need to prioritise the challenges facing the ASM sector in developing societies by stressing that the aforementioned challenges earlier accentuated by the World Bank have kept local miners in a ceaseless cycle of

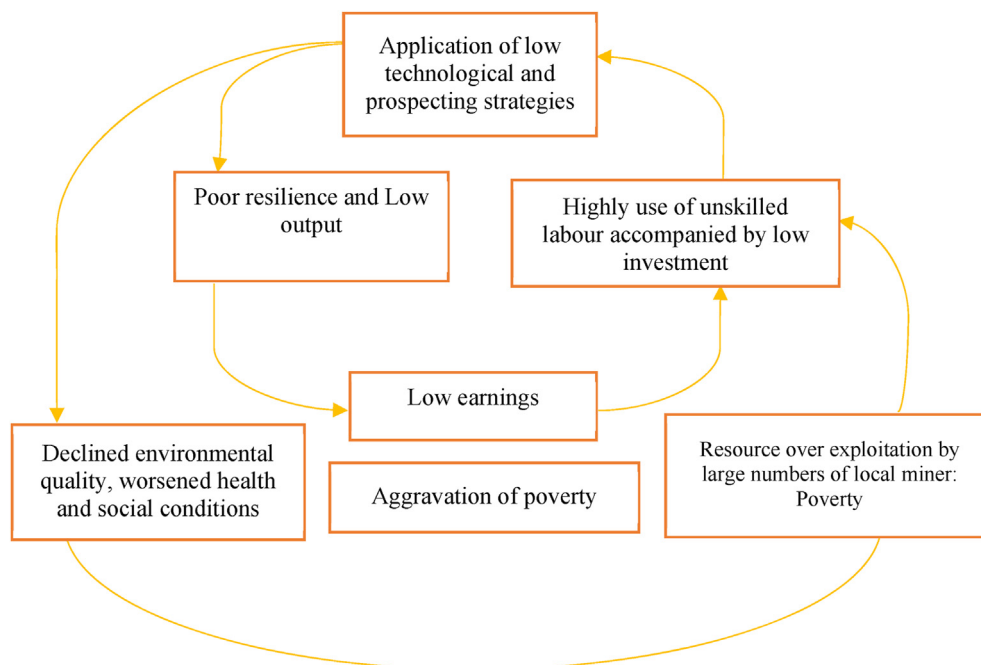


Figure 1. The cyclical web of poverty trap in ASM operations. Source: Adapted from Hilson and Pardie (2006).

poverty. Besides, the ILO further revealed that issues such as poor access to credit because of lack of collateral by local miners, including detestable mining practices such as failure to reclaim mining lands turned around to affect the wellbeing of the local dwellers. Similar views were expressed by [Hilson and Pardie \(2006\)](#) who asserted that the mode and conditions under which ASM activities are done in local communities result in worsening poverty among local miners. Furthermore, a related study by [Mcquillen and Hilson \(2016\)](#) re-echoed that the conditions surrounding ASM activities largely induced poverty in the long-run. These authors opined that ASM operations are characterised by low and poor technological methods involving the use of unskilled labour, low productivity, low income and low investment, competition and overexploitation of the mineral resources leading to the destruction of the quality of the natural environment as well as unhealthy and poor social conditions in mining communities. As such, the position of ASM as a poverty alleviation tool is largely defeated, as most mining communities are caught-up in a cycle of aggravated poverty ([Figure 1](#)). From the forgone discussions, it is widely acknowledged that the conditions surrounding ASM operations are not the best and the negative characteristics are observed to exacerbate poverty among local miners ([Hilson and Pardie, 2006](#); [Opoku-Antwi et al., 2012](#)). However, ASM continues to grow in numbers across local communities in SSA including Ghana.

3. Materials and methods

3.1. Description of the study area

Illegal mining operations have surged in the Upper West Region ([Figure 2](#)) in recent years, justifying the need to investigate the intra-household factors affecting local communities' involvement in ASM activities in the region. The region lies between latitudes 9°35N and 11°N, and 1°25'W and 2°50'W, and shares a boundary with the Republic of Burkina Faso to the north and the Republic of La Côte d'Ivoire to the

southwest. The southern part of the region is bordered by the Northern and Savannah Regions. Upper West Region covers a land area of about 18,476 km² (12.7%) of the total land area of Ghana ([Ghana Statistical Service, 2013](#)). The region is dominated by the guinea savannah vegetation, hosting several economic trees such as the shea (*Vitellaria paradoxa*), neem (*Azadirachta indica*), baobab (*Adansonia digitata*), and dawadawa (*Parkia biglobosa*). The topography is averagely flat with few isolated hills. The Pre-Cambrian rocks consisting of metamorphic and granite are rich in mineralised gold and have been a major source of attraction for exploring and mining of gold by artisanal miners across several communities in the Wa East, Wa West and Nadowli-Kaleo districts. The region also hosts an international mining company, Azumah Resource Limited, operating under the JULIE Concession.

Notwithstanding the fact that the entire mineralised enclave of the region has been awarded to the Azumah Resource Limited, illegal mining activities continue to dominate in the region, with a plethora of environmental ramifications ([Laari et al., 2016](#)). In 2017, the Government of Ghana's quest to halt illegal mining activities that lead to the involvement of a joint police and military taskforce ("Operation Vanguard") could not deter galamsey operations in the region. In addition, the illegal mining operators expressed disinterest and lack of trust in the Government of Ghana 'Community Mining Cooperative' that claimed to provide access to the illegal miners' own mining concessions ([Baddianaah et al., 2021b](#)). Therefore, the illegal miners have been able to resist all attempts to put them out of business. In light of the above, it has become imperative that regulating the illegal miners and their activities requires a deeper understanding of their personal characteristics to allow for tailor-made interventions to be put in place to address their needs. The extraction of precious minerals through the small-scale mining mode, undoubtedly, has many positive economic implications on local community development ([Owusu et al., 2019](#)); nevertheless, the associated environmental conundrums require rapt attention to manage them.

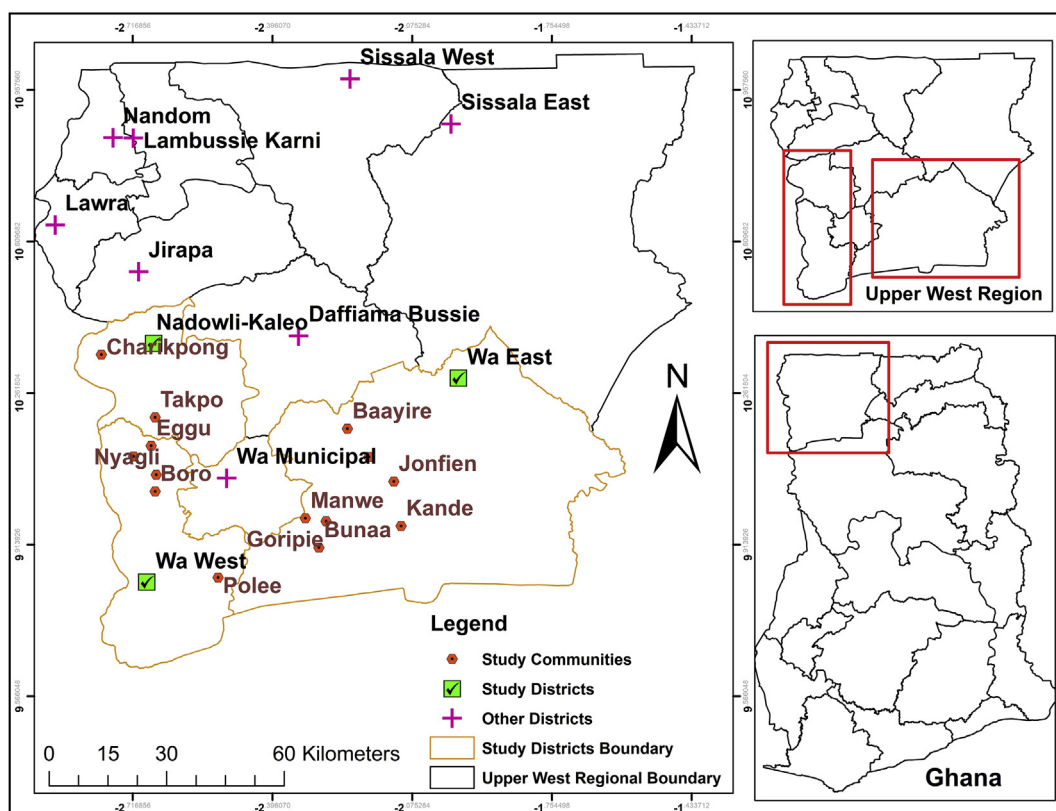


Figure 2. Map of Upper West Region showing study communities.

3.2. Data collection

Data collection for the study occurred between May and September 2021. This involved the collection of household data, focused on the prospects and constraints of participating in the ASM using a semi-structured questionnaire. The questionnaire also captured the personal details of the respondents (household heads). The study adopted the concurrent mixed methods research approach and shaped by the cross-sectional design, multiple sampling strategies were deployed in reaching out to the study respondents. The first stage of sampling involved clustering the Upper West Region based on the existing administrative districts and municipal assemblies (MDAs). Of the 11 MDAs, three (3) districts with records and current dynamics of ASM operations were selected: the Wa West District, Wa East District and Nadowli-Kaleo District. In the Wa East District, seven (7) communities (Danyuokura, Bunaa, Baayiri, Manwe, Goripie, Kande and Jonfien) were covered while in the Wa West District, five (5) communities (Boro, Nyagli, Eggu, Polee and Tandabore) were covered. In the Nadowli-Kaleo District, only two (2) communities (Takpo and Charikpong) were found to host galamsey activities and were covered.

In reaching out to the household heads, the households' population of each of the study communities as captured in the Ghana Statistical Service [GSS] (2013) report was used (Table 1). However, in the event of not finding the household size of a community in the GSS (2013) report, the assembly member of the community was contacted for the approximate figure. Therefore, the collated list of households was used as a proxy in computing the sampling frame and sample size of household heads (HH). A simple random sampling technique involving the generation of random numbers in an excel tool pack was used to randomly list and select households for the survey. In the case of the existence of multiple households within a housing unit, the lottery method was applied in selecting the desired respondent (household head). Also, in the absence of a household head, the questionnaire was administered to any adult deemed appropriate to be knowledgeable of the study's demands. To obtain the sample size of household heads (HH), Yamane (1967:886) sample computation formula was used as follows:

$$n = \frac{N}{1 + N(e)^2} \tag{1}$$

$$n = \frac{2352}{1 + 2352(e)^2} = 342 \tag{2}$$

Table 1. Composition of study communities and house size.

Region	District/Municipal	Study Community	Household Number	Community Proportion
Upper West	1. Nadowli-Kaleo	1. Tarkpo	258	38
		2. Charikpong	367	53
	2. Wa East	3. Goripie	325	47
		4. Baayiri	248	36
		5. Danyuokura	145	21
		6. Kande	88	13
		7. Bunaa	93	14
		8. Jonfien	95	14
		9. Manwe	254	37
		10. Tandabore	54	8
		11. Boro	78	11
		3. Wa West	12. Eggu	105
	13. Nyagli		101	15
	14. Polee		141	20
Total		Sampling Frame (N = 2352)	Sample Size (n = 342)	

In the formula, n = sample size (342), N = Total household population (Sample Frame) = 2352, e = margin of error (0.05) or 95% confidence level. In addition, the proportional quota sampling was applied in sharing the sample size among the study communities (Table 1).

Before the commencement of the field data collection, the researchers had the data collection instruments (i.e., the questionnaire) vetted and approved by the ethics committee of the University for Development Studies, Tamale. Ethical consideration has become an essential part of every research that focuses on human subjects (Creswell, 2014). In addition, informed consent of the respondents was sought by reaching out to the assembly member and chief of each community with an introduction letter signed by the Head of Department of Environment and Sustainability Sciences, University for Development Studies a week or two before the actual field data collection commenced. In addition to this, verbal consent of each respondent was sought with their willingness to withdraw from the survey at any material moment deemed unpleasant in the line of questioning and or administering the survey instruments guaranteed. Furthermore, respondents who could read and write were given the survey questionnaire to answer but those who could not read nor write were assisted by the data collection assistants, postgraduate students of the Department of Environment and Sustainability Sciences, who took time to read and explain the questions in the local dialect (Dagaare) for the respondents to answer.

3.3. Data analysis and empirical model

The data analyses involved coding and entering the data into Statistical Package for Social Sciences (SPSS) version 20. Further transformations were done and quantitative tools such as cross-tabulation, chi-square test of independence, frequency distribution and a binary logistic regression model were employed to determine the statistical relationship of respondents' socio-demographic variables that explains their participation in galamsey activities. The results were presented in tables. The next section details the binary logistic model specification procedures.

3.3.1. Empirical models estimation

The binary logistic model was employed to investigate the socio-demographic determinants of local community dwellers' participation in ASM operations. The binary logistic regression model offered the researchers the opportunity to easily identify the respondents' characteristics that explain their participation in the illegal mining activity. Thus, respondents (household heads) were asked to respond yes or no regarding their participation in ASM operations. In this case, the binary model that takes the value of 1 for yes and 0 for no is best used in modelling the relationship (Sperandei, 2014). Thus, the logistic regression model is required in this regard because it offers the opportunity to obtain the odds ratio using multiple explanatory variables. In addition, it offers researchers the opportunity to combine continuous variables simultaneously, thereby avoiding confounding effects (Gujarati, 2008; Sperandei, 2014). This, therefore, makes the logistic regression model easier to work with compared to the linear regression model. The logistic regression model used in the study follows that of Gujarati (2008). Hence, the cumulative logistic distribution function was specified as

$$\rho_i = \frac{1}{1 + e^{-\omega_i}} = \frac{e^{\omega_i}}{1 + e^{\omega_i}} \tag{3}$$

where: ρ_i = the probability of a household head (HH) to participate in ASM

$$\omega_i = \beta_0 + \beta_i \pi_i \tag{4}$$

where: π_i = Vector of explanatory variables.

β_0 = Vector of a constant term.

β_i = Vector of the logistic regression coefficient.

As ω ranges from $-\infty$ to ∞ , ρ_i ranges from 0 to 1. The probability of non-participation is $1 - \rho_i$, where:

$$1 - \rho_i = 1 - \frac{e^{\omega_i}}{1 + e^{\omega_i}} \tag{5}$$

Simplifying Eq. (3) gives:

$$\ln\left(\frac{\rho_i}{1 - \rho_i}\right) = \beta_0 + \beta_i \pi_i + \varepsilon \tag{6}$$

The relative effect of each explanatory variable on the probability that a household head (HH) in a local community will participate in ASM is given by the marginal effect as:

$$\frac{\partial(\rho_i)}{\partial(\pi_i)} = \beta_i [\bar{p}(1 - \bar{p})] \tag{7}$$

where \bar{p} is the mean of the dependent variable. The empirical estimation of the model for participation in ASM is expressed as:

$$\ln\left(\frac{\rho_i}{1 - \rho_i}\right) = \beta_0 + \beta_1 AGE + \beta_2 GEN + \beta_3 MARIT_STAT + \beta_4 REL_STAT + \beta_5 HSIZE + \beta_6 EDU_STAT + \beta_7 EMPLOY_STAT + \varepsilon$$

The variable definitions, units of measurement and hypothesised relationships are presented in Table 2.

4. Results and discussion

4.1. Socio-demographic characteristics of respondents

The socio-demographic characteristics of the study respondents were first presented (see Tables 3 and 4). Of the sample population of 342 household heads (HH), the majority (55.6%) of them were below the age

Table 2. Variables definition, units, and hypothesised relationships.

Variable	Definition	Unit of Measurement
Dependent Variable		
Y	Participation in ASM	1 = participation; 0 = otherwise
Independent Variables		
1. AGE	Age	0 = <30 1 = 31-40 2 = 41-50 3 = 51+
2. GEN	Gender	1 = Male; 0 = Female
3. MARIT_STAT	Marital Status	0 = Married 1 = Widowed 2 = Single
4. REL_STAT	Religion Status	0 = African Traditional Religion (ATR) 1 = Islam 2 = Christianity
5. HSIZE	Household Size	0 = 1-5 1 = 6-10 2 = 11+
6. EDU_STAT	Educational Status	0 = No formal education 1 = Basic Education 2 = SHS 3 = Diploma 4 = First Degree
7. EMPLOY_STAT	Employment Status	0 = Formal Sector 1 = Informal Sector

Table 3. Socio-demographic characteristics of respondents.

Age	Frequency	Percent
30 years and below	190	55.6
31–40 years	118	34.5
41–50years	22	6.4
51years+	12	3.5
Gender		
Male	218	63.7
Female	124	36.3
Household size		
1-5 members	148	43.3
6-10 members	188	55.0
11members+	6	1.8
Children per household		
0-5 children	222	64.9
6-10 children	120	35.1
Children in school		
1-5 children	230	67.3
6-10 children	6	1.8
Educational status		
No formal education	66	19.3
Basic education	228	66.7
Senior High School (SHS)	34	9.9
Diploma	12	3.5
First degree	2	0.6
Employment status		
Formal sector	6	1.8
Informal sector	336	98.2
Type of formal sector job		
Teaching	6	1.8
Type of informal sector job		
Food crop farming	104	30.4
Artisanal and small-scale mining	146	42.
Other artisan work	92	26.9
Marital status		
Married	232	67.8
Single	102	29.8
Widowed	4	1.2
Divorced	4	1.2
Religious practice		
Christianity	144	42
African Traditional Religion (ART)	31	9
Islam	167	49
Community membership status		
Native	251	73.4
Settler	12	3.5
Migrant	79	23.1
Ethnicity		
Ashanti	2	0.6
Busanga	2	0.6
Dagaati	68	19.9
Moshi	8	2.3
Saamunuu	2	0.6
Sissala	12	3.5
Waala	248	72.5
Years Stayed in the Community		
Less than 1year	34	9.9
2–4 years	18	5.3
5–7 years	10	2.9
8 years +	280	81.9

Table 4. Participation in gamamsey operations.

Participation in ASM	Frequency	Total
Yes	237	69.3
No	105	30.7
Reasons for no participation in ASM		
Old age	6	1.8
Physically incapacitated	4	1.2
Employed in agriculture and related areas	95	27.8
Total	105	30.7
Relative(s) participate in ASM		
Yes	105	100
Relative(s) miner(s) of support		
Yes	105	100
Importance of finance and other support from relative(s) miner(s)		
Extremely important	10	9.5
Very important	52	49.5
Important	41	39
Somewhat important	2	2

of 30 years while the age range of 51years + constitutes the least represented (3.5%). The extant literature has indicated that local communities particularly in mining areas are dominated by a youthful age group—the economically active class (Kala, 2015; Hilson and Maco-nachie, 2020; Mabe et al., 2021). However, the major worry with regard to this youthful population in these localities is that the youth are easily attracted to illegal mining activities at the expense of agriculture (Ant-wi-Boateng and Akudugu, 2020), with implications on food security. The gender distribution showed more males (63.7%) were represented in the survey than females (Table 3). The results appear to be slightly below that of the 2014 Ghana census report that found male-dominated household heads of 74.4% as against female household heads of 22.6% (GSS, 2013). Moreover, the results relate positively with other studies conducted in Northern Ghana involving household heads in ASM communities (Osumanu, 2020). In Northern Ghana, males being household heads is socially constructed with no contestation. The female only assumed the household headship in the absence of an adult male. Thus, the female is either widowed or divorced. By implication, males are likely to dominate in decision-making including the extraction of mineral resources in these geographies.

The results further showed that a household was likely to contain 6–10 members (55%), with fewer households (1.8%) having a membership score of 11+. The results are in tandem with that of the Ghana Statistical Service (2014) survey which recorded large house sizes in the Upper West Region ranging between 6 and 10 or more. Also, a large majority (64.9%) of the households are likely to contain no more than 5 children. However, a household head had about 1–5 (67.3%) children to take care of in school, paying school fees, buying school uniforms and sandals, and providing for their daily bread in school. The aforementioned results like taking care of large household members and children in school may inform the need for the household heads to explore other opportunities at their reach in their communities towards meeting the demands of the family, and the gamamsey sector may not be exempted. Studies have highlighted most rural dwellers engage in ASM to supplement their household income (Mapuva and Dube, 2016; Hilson, 2016; Guenther, 2018; Osumanu, 2020; Hausermann et al., 2020; Mabe et al., 2021).

The majority of the household heads were found to have attained lower levels of formal education—basic education (66.7%) and SHS (9.9%)—while about 19.3% of them had no form of formal educational attainment. Correspondingly, the number of respondents who had tertiary education was woefully low, diploma (3.5%) and first degree (0.6%) with no individual attaining higher educational qualifications such as masters and PhDs (Table 3). The results agree with the GSS (2013) report that recorded 59.5% of people who could not read nor

write in the Upper West Region. Though the majority of the study respondents had basic education, basic education is more or less slightly ahead of no formal education. Besides, the majority of those with basic level education were found not to have completed Junior High School and could neither read nor write, confirming the literature pointing to high school drop-out rate in gamamsey communities (Twerefou et al., 2015; Arthur et al., 2016; Zolnikov, 2020). The low educational attainment of the respondents may have implications regarding their involvement in gamamsey activities. For instance, low educational qualification will equate to the majority of the dwellers seeking jobs in the informal sectors where agriculture is the major informal occupation of the majority (72.8%) of the rural dwellers in the Upper West Region (Ghana Statistical Service, 2018). This is likely to increase the number of participants in the gamamsey sector since recent studies have reported that local community dwellers are shifting from agriculture to ASM activities (Kwai and Hilson, 2010; Redehey, 2017; Mkdodzongi and Spiegel, 2018).

Furthermore, the employment status of the respondents (Table 3) showed that a greater majority (98.2%) of them were employed in the informal sector—they engaged in activities such as food crop farming (30.4%), gamamsey (42.7%) including artisan and other related jobs (26.9%) such as carpentry, masonry, tailoring, smocks and kente weaving, driving among others. The few respondents (1.8%) that had a job in the formal sector were found to engage in teaching. However, artisanal mining appears to command large numbers of job seekers (42.7%) compared to the other job streams. Notably, the results seemed to confirm the findings of previous studies indicating that the youth (activity labour force) are currently showing interest in gamamsey activities compared to agriculture and other related primary sector activities like fishing and lumbering (Hilson, 2016; Mapuva and Dube, 2016). Thus, this behaviour, if unchecked may have future repercussions in terms of food availability as well as provision of essential services in local communities and the country at large.

Moreover, the marital status of the respondents showed that a large proportion of them (67.8%) were married. Only a small proportion (1.2%) each were either widowed or divorced (refer to Table 4). The results correspond to the Ghana Living Standard Survey report (GLSS 7) which found that the majority of household heads in the Upper West Region are married (GSS, 2018). The results further revealed no dominance in terms of the religious affiliation of the respondents though membership of the Islamic Religion (49%) was slighted ahead of Christianity (42%), with the African Traditional Religion recording the lowest representation (only 9%) in the survey. Though more Christians (44.5%) were recorded in the GSS (2013) survey compared to Muslims (35.6%) and ATR believers (13%), the variation in this current study might be attributed to the fact that the study communities were dominated by the Waala tribe who are predominantly Muslims. Nonetheless, the fact that the ATR is swiftly losing its position across local communities may have implications for the protection and conservation of some sacred places in these localities. The steadily growing literature highlights strongly the role of traditional religious practices such as the use of norms and taboos in regulating illegal mining activities in several communities (Ofosu--Mensah, 2010, 2011; Baddianaah et al., 2021). For instance, in the Akan traditional area, some days are set aside as ‘bad days’, and no gamamsey activity is conditioned on these days, adding positive insights into environmental protection.

On a similar trajectory, the community membership status of the respondents indicated that the majority of them were natives (73.4%), predominantly of the Waala tribe (72.5%). However, a recognisable proportion of migrants (23.1%) was also uncovered across the study communities while settlers constituted the least represented groups (3.5%). Besides the Waala, Dagaaba and Sissala which are ethnic groups that traditionally belong to the Upper West Region, other lesser ethnic groups such as the Moshi (2.3%), Ashanti (0.6%), Saamune (0.6) and Busanga (0.6%) are migrants. The Moshi, in particular, traced their origin to Burkina Faso. Moreover, the results showed that the majority (81.9%)

of the respondents have lived in the study communities for 8 years and beyond (Table 3). The results suggest that natives are likely to dominate in the gamsey operations. The results are anticipated because ASM operations have been done by the natives across local communities for centuries even before the start of colonialism (Ofosu-Mensah, 2010) in Ghana. And if not for the growing illegality and massive environmental destructions associated with the operations, ASM is the exclusive right of the natives (Akabzaa and Darimani, 2001; Ofosu-Mensah, 2010). Additionally, the position of migrants in the gamsey sector has been highlighted (Nyame et al., 2009; Hilson et al., 2014; Antwi-Boateng and Akudugu, 2020), but fortunately for the Upper West Region, the devastating environmental effect of the illegal Chinese migrants including worsening social consequences in local mining communities as reported by a large body of the literature (Hilson et al., 2014; Hilson, 2017;

Botchwey and Crawford, 2018; Antwi-Boateng and Akudugu, 2020; Hausermann et al., 2020) were dim in this study.

4.2. Participation in gamsey operations

The study sought to find out the extent to which dwellers of gamsey communities embrace and participate in gamsey operations. The results (Table 4) showed that the majority (69.3%) of the local dwellers in the gamsey communities engaged in gamsey operations. This agrees with a related study by Aghetara (2012) in the Upper East Region of Ghana. Of the respondents who do not engage in illegal mining, it was revealed from the survey that such people were engaged in agriculture and its related sectors such as animal rearing. However, a small proportion of the respondents indicated that they do not take part in illegal mining operations because they were either old (1.8%) or physically

Table 5. Socio-demographic variables association with participation in ASM.

Participation in ASM	Education					Total
	No Formal Education	Basic Education	SHS	Diploma	First Degree	
Yes	56 (23.6%)	137 (57.8%)	34 (14.3%)	10 (4.2%)	0 (0%)	237 (100%)
No	10 (9.5%)	91 (86.7%)	0 (0%)	2 (1.9%)	2 (1.9%)	105 (100%)
Total	66 (19.3%)	228 (66.7%)	34 (9.9%)	12 (3.5%)	2 (0.6%)	342 (100%)
N = 342, $\chi^2 = 37.281$, df = 4, P-value = 0.000						
Participation in ASM	Gender of Respondent		Total			
	Male	Female				
Yes	158 (66.7%)	79 (33.3%)	237 (100%)			
No	60 (57.1%)	45 (42.9%)	105 (100%)			
Total	218 (63.7%)	124 (36.3%)	342 (100%)			
N = 342, $\chi^2 = 2.856$, df = 1, P-value = 0.091						
Participation in ASM	Age of Respondent				Total	
	30 years and below	31–40 years	41–50years	51 years +		
Yes	139 (58.6%)	70 (29.5%)	22 (9.3%)	6 (2.5%)	237 (100%)	
No	51 (48.6%)	48 (45.7%)	0 (0%)	6 (5.7%)	105 (100%)	
Total	190 (55.6%)	118 (34.5%)	22 (6.4%)	12 (3.5%)	342 (100%)	
N = 342, $\chi^2 = 18.698$, df = 3, P-value = 0.000						
Participation in ASM	Household Size			Total		
	1–5	6–10	11 +			
Yes	97 (40.9%)	134 (56.5%)	6 (2.5%)	237 (100%)		
No	51 (48.6%)	54 (51.4%)	0 (0%)	105 (100%)		
Total	148 (43.3%)	188 (55%)	6 (1.8%)	342 (100%)		
N = 342, $\chi^2 = 3.986$, df = 2, P-value = 0.136						
Participation in ASM	Marital Status			Total		
	Married	Single	Widowed			
Yes	170 (71.7%)	63 (26.6%)	4 (1.7%)	237 (100%)		
Not	62 (59%)	43 (41%)	0 (0%)	105 (100%)		
Total	232 (67.8%)	106 (31%)	4 (1.2%)	342 (100%)		
N = 342, $\chi^2 = 8.345$, df = 2, P-value = 0.015						
Participation in ASM	Religious Status			Total		
	Christianity	African Traditional Religion	Islam			
Yes	44 (18.6%)	4 (1.7%)	189 (79.7%)	237 (100%)		
No	40 (38.1%)	0 (0%)	65 (61.9%)	105 (100%)		
Total	84 (24.6%)	4 (1.2%)	254 (74.3%)	342 (100%)		
N = 342, $\chi^2 = 16.190$, df = 2, P-value = 0.000						
Participation in ASM	Employment Status		Total			
	Formal Sector	Informal Sector				
Yes	2 (0.8%)	235 (99.2%)	237 (100%)			
No	4 (3.8%)	101 (96.2%)	105 (100%)			
Total	6 (1.8)	336 (98.2%)	342 (100%)			
N = 342, $\chi^2 = 3.713$, df = 1, P-value = 0.054						

incapacitated (1.2%). This notwithstanding, all respondents who were found not to have been involved in galamsey had a relative or more engaged in it. These respondents also confirmed receiving some sort of support either in cash or kind from their relative galamseyers.

To this end, a hooping majority (98%) of the respondents who do not engage in ASM appraised the support they received from their relative miners as important to their wellbeing. Only a small proportion (2%) considered the support they obtained from their relative miners to be somewhat important to their wellbeing (refer to Table 4). The results suggest that the ASM sector is growing in numbers across local communities (Adu-Baffour et al., 2021), with as high as 69.3% of the household heads in this study involved. This finding confirms an earlier finding by Kwai and Hilson (2010) in Tanzania that the majority of the rural populace are turning to ASM for employment. However, importantly for this study, a respectable proportion of the respondents (30.75%) were found not to have been involved in galamsey at all though they receive financial assistance from their relative miners. The results further imply that the local socio-economic effect of galamsey is great in that respondents who do not involve directly in the operations still benefit through support from their relative miners. Hence, McQuilken and Hilson's (2016) projections that the associated beneficiaries (i.e. about 4.5 million Ghanaians) of the illegal mining business are more than those directly involved (i.e. about one million plus) have been validated by this finding.

Table 5 explores the relationship between the socio-demographic characteristics of the respondents and their involvement in galamsey operations. The aim is to ascertain whether respondents' socio-demographic variables have any significant association with their involvement in illegal mining operations. This was done through cross-tabulations and chi-square independent test of association. From the results, out of the 237 respondents that engaged in galamsey, it was noted that those with basic education dominate (57.8%) while respondents with a first degree do not engage in galamsey operations at all. This suggests that galamsey activities are largely executed by people with lower levels of educational attainment (Mabe et al., 2021). Moreover, the chi-square test of no association of participation in galamsey with respect to a respondent's educational qualification was statistically significant ($p\text{-value} = 0.000 < 0.05$). The results raise questions about the rate at which students at the basic education (Primary and Junior High School) level in galamsey communities' transition to higher educational levels like training colleges, technical universities and the mainstream universities. Several empirical studies, both past and recent, have raised a red flag about the high rate of school drop-out in mining settlements (Akabzaa and Darimani, 2001; Funoh, 2014; Twerefou et al., 2015; Andrews, 2015; Arthur et al., 2016; Boadi et al., 2016).

Conversely, the relationship between a respondent's gender and participation in illegal mining activities was found not to be statistically significant at the alpha level of 0.05 ($p\text{-value} = 0.09 > 0.05$) but significant at 0.1. This explains that there is a weak association between gender and participation in ASM. The results (Table 5) further reveal that more male-headed households participate in ASM (66.7%) than their female counterparts (33.3%). This finding has a close association with findings in the existing literature (Osumanu, 2020; Mabe et al., 2021). On a similar accord, the majority of the respondents within the age group of 30 years and below engage in galamsey operations (58.6%) than the other age groups. More so, the chi-square test of no participation with regard to respondents' age was statistically significant ($p\text{-value} = 0.000 < 0.05$). Moreover, the forgone revelations have a significant relationship with studies projecting ASM as a masculine enterprise (Bryceson and Geenen, 2016; Que et al., 2018) and also, as a youth-induced trajectory (Kala, 2015; Redehey, 2017).

In addition to the above observations, the results (Table 5) show that respondents with a household size of 6–10 participate more (56.5%) in galamsey operations compared to the others. Thus, meeting the household basic needs has strong implications on households' involvement in ASM activities (Zolnikov, 2020). However, the chi-square independence

test of no association with respect to a respondent's household size and participation in galamsey activities was statistically insignificant ($p\text{-value} = 0.136 > 0.05$). The results further reveal that more married household heads (71.7%) participate in galamsey operations compared to single headed households (26.6%) and widowed (1.7%) probably to access 'quick income' to cater for the marital responsibilities (Hilson and Hilson, 2015; Hilson and Maconachie, 2020). The chi-square test of no association was statistically significant ($p\text{-value} = 0.015 < 0.05$). However, in a study involving only women in ASM activities in Akwatia, Ghana, Zolnikov (2020) found that more widowed respondents (70%) were involved in the galamsey operations. This explains that other socio-cultural factors also trigger participation in illegal mining activities.

Respondents who shared the Islamic religious faith dominated in terms of participation in ASM as against Christianity (18.6%) whereas African Traditional (ATR) worshipers were the least (1.7%). The test of association of respondents' religious beliefs with respect to participation in ASM was statistically significant ($p\text{-value} = 0.000 < 0.05$). However, the small proportion of respondents within the ATR participating in galamsey was not surprising. The ATR leans strongly to projecting and promoting natural resource conservation through the establishment of sacred groves and the use of customs, including taboos to trigger conservational agenda (Ofosu-Mensah, 2010; Awuah-Nyamekye and Sarfo-Mensah, 2012). As a result, the land and minerals are revered by these traditional worshipers as gods. The majority of them greatly detest any activity that will degrade the land and its resources (Baddianaah et al., 2021). In addition, the results (Table 5) show that almost all the respondents (99.2%) who engage in galamsey fall within the informal employment sector, with just a minute proportion (0.8%) of the formal sector employees involved in ASM. Moreover, the test of association of the respondents' employment status with respect to participation in galamsey operations was not statistically significant ($p\text{-value} = 0.054 > 0.05$). This finding goes to buttress the findings from the steadily growing literature that reported that galamsey has become the most attractive informal sector job in developing countries (Hausermann et al., 2020; Osumanu, 2020; Tuokuu et al., 2020; Mabe et al., 2021).

4.3. Socio-demographic determinants of participation in galamsey operations

Table 6 presents a binary logistic regression model of the respondents' socio-demographic variables with respect to their participation in ASM activities. Seven (7) personal characteristics of the respondents involving age, gender, marital status, religious status, household size, educational status and employment status were analysed using the odds ratios and p -values. The aim is to establish the respondents' characteristics that influence their participation in galamsey operations. From the results, the age distribution of the respondents shows that respondents within the age group of 51 years+ and 41–50 years are 0.02 and 0.2 times less likely to participate in galamsey respectively compared to those within the age group of 30 years and below. The results are statistically significant ($p\text{-value} = 0.000$ for the two categories < 0.05). Moreover, the results show that respondents within the age group of 31–40 years are 14.8 times more likely to participate in galamsey activities compared to those below the age of 30 years. This notwithstanding, the results are not statistically significant ($p\text{-value} = 0.998 > 0.05$).

The above finding shows that participation in galamsey activities is inversely related to age. As the respondent's age increases (grows older), participation in galamsey appears to be diminishing. The results relate with the literature indicating that galamsey operations are labour intensive and, therefore, tactically fit the exuberant youthful population in local communities (Hilson and Hilson, 2015; Ahmed and Oruonye, 2016; Hilson, 2016; Hilson and Maconachie, 2020). Thus, policies on reducing galamsey operations in local communities should be skewed towards the creation of youth employment models. Several studies have highlighted the absence of jobs for the youth in local communities as one

Table 6. Socio-demographic determinants of participation in galamsey operations.

Explanatory Variables	Participation in ASM Operations		
	Odd-ratios	P-value.	Standard Error
Age			
Age <30 (Reference Category)	1.000		
31–40 years	14.12	.998	7819.460
41–50 years	.160**	.000	.497
51 years+	.015**	.000	.984
Gender			
Male (Reference Category)	1.000		
Female	.337	.051	.558
Marital Status			
Married (Reference Category)	1.000		
Widowed	.291*	.042	.609
Single	58.591	.999	16781.266
Religious Status			
ATR (Reference Category)	1.000		
Islam	21.867	.999	17339.259
Christianity	5.629**	.000	.440
Household Size			
Household Size_1–5 (Reference Category)	1.000		
Household Size_6–10	1.526	.407	.509
Household Size 11+	51.709	.999	14500.053
Educational Status			
No formal Education (Reference Category)	1.000		
Basic Education	38.366	.995	7856.257
SHS	20.621	.997	4431.968
Diploma	35.208	1.000	29127.633
First Degree	.241**	.008	.535
Employment Status			
Formal Sector (Reference Category)	1.000		
Informal Sector	58.614	.995	6378.210

** $p \leq 0.01$, * $p \leq 0.05$.

of the triggering factors for the surge in illegal mining activities across local communities in developing countries (Hilson et al., 2017; Hilson and Maconachie, 2020; Hiron, 2020). Moreover, IGF (2017) opined that these jobs, when created, must be equal in measure of wealth accumulation or payment to that of galamsey activities. Furthermore, the results show that female-headed households are 0.3 times less likely to participate in galamsey operations compared to their male counterparts, but this is statistically insignificant (p -value = 0.5 > 0.05). The results appear to have disagreed with a recent report by USAID (2020) that women constitute 50% of the galamsey labour force and show much interest in galamsey than men.

Other scholars argued that galamsey is purely a masculine activity and that women are mostly employed in doing menial jobs at the galamsey sites (Mantey et al., 2017; Owusu-Nimo et al., 2018; Que et al., 2018). While issues of gender discrimination with regard to ASM operations are highlighted (USAID, 2020), a recent study by Hausermann et al. (2020:1) reported that women in Ghana's galamsey communities are now resisting all forms of marginalisation and have formed "all-women gangs" to rub shoulders with their male counterparts in galamsey operations for equal benefits. Correspondingly, widowed household heads are 0.3 times less likely to participate in ASM compared to those who are married, a sharp contrast to Zolnikov's (2020) finding, though her study involved only women. Moreover, the results were found to be statistically significant (p -value = 0.042 < 0.05). On the other hand, single headed households are 58.6 times more likely to participate in illegal mining compared to married households. However, the results were not statistically significant (p -value = 0.999 > 0.05). In spite of the

fact that many scholars have hinted marital and associated familial responsibilities pushed household heads in local communities to join galamsey operations in order to gather quick income to cater to the family needs (Hausermann et al., 2020; Hilson and Maconachie, 2020; Mabe et al., 2021), this finding proved otherwise, justifying the notion that the unmarried youth are more likely to engage in galamsey activities than the married ones. Besides, some of the single headed households may venture into galamsey to source funds to also marry.

In furtherance of the analysis, the religious status of the respondents (Table 6) showed that respondents within the Islamic religious faith are 21.9 times more likely to participate in illegal mining activities compared to those within the African Traditional Religion (ATR) though the results were statistically insignificant (p -value = 0.999 > 0.05). Again, the results showed that respondents within the Christian faith are 5.6 times more likely to participate in galamsey activities compared to those within the ATR, and the results were statistically significant (p -value = 0.000). These results were expected because both past and recent scholars have indicated that the growth in numbers of believers in foreign religions such as Christianity and Islam at the expense of the African traditional beliefs and practices partly contribute to the proxies of environmental destruction by illegal miners in local communities. For instance, reverence for places of worship (that is, homes of deities such as sacred groves) has been lost and the illegal miners enter these sacred places with impunity to mine (Ofosu-Mensah, 2010; Awuah-Nyamekye and Sarfo-Mensah, 2012; Baddianaah et al., 2021).

The results also showed that respondents with a household size of 6–10 are 1.5 times more likely to participate in galamsey activities compared to those with a household size of 1–5 though the results were not statistically significant (p -value = 0.407). Additionally, the results revealed that respondents with a household size of 11 + are 59.7 times more likely to participate in galamsey activities than those with a household size of 1–5. Notwithstanding, the results were statistically insignificant (p -value = 0.999). Moreover, the results confirmed the extant literature that large household sizes, coupled with the responsibility of the household head to provide for the basic needs of the household such as the provision of food, shelter including the payment of the children school fees, generally pushed most local community dwellers to engage in illegal mining operations (Osumanu, 2020; Mabe et al., 2021). Hence, policies on reducing the house size of local communities such as birth cuts and family planning are pertinent.

Taking the respondents' educational qualification into consideration, the results showed that respondents with a first degree are 0.24 times less likely to participate in galamsey activities compared to those with no formal educational attainment, and this was statistically significant (p -value = 0.008 < 0.05). The results suggest that respondents who have higher educational qualifications may be able to secure jobs in other sectors—particularly formal sector jobs—and may not depend on the natural capital in their localities. Studies have shown that the majority of those who engage in galamsey have low levels of educational attainment (Hilson and Hilson, 2015; Mabe et al., 2021). Furthermore, the results also showed that respondents with basic education, SHS, and diploma educational qualification are 38.4 times, 35.2 times and 20.6 times more likely to participate in galamsey operations compared to respondents with no formal education (refer to Table 6). Moreover, none of these categories of educational attainment was statistically significant (p -values = 0.995, 1.000 and 0.997 > 0.05). The results are not weird at all for respondents with basic educational qualifications. This is because basic education qualification does not give the individual any employable skill to secure a job in other areas especially the formal sector (Arthur et al., 2016). Thus, such individuals are largely classified as school dropouts, and the informal sector including artisanal mining activities remains their main source of employment and livelihood sustenance. However, the fact that people had diploma educational qualification and yet showed greater interest in galamsey operations raises questions about the level of graduate unemployment in the country. According to McQuilken

and Hilson (2016), such individuals use the galamsey sector to source money to further their education or treat it as a permanent employment source.

Additionally, the respondents' employment status (Table 6) showed that informal sector employees are 58.6 times more likely to engage in galamsey activities compared to formal sector employees. Likewise, the results were not statistically significant (p -value = 0.995). Correspondingly, the results were expected since galamsey has become the number one informal sector job in rural communities (Hilson, 2010, 2016). Thus, the policy option here is to explore sustainable pathways of combining mining with other rural livelihood strategies like agriculture to forestall labour deficit and food insecurity in the near future. In so doing, artisanal mining will serve as a sustainable supplementary livelihood activity for rural dwellers.

5. Conclusion

The study investigated how local dwellers' personal characteristics affect their participation in illegal mining activities (galamsey) in developing countries with specific reference to the Upper West Region of Ghana. The results showed that the majority (69.3%) of the dwellers in the galamsey communities engaged in illegal mining. Moreover, the respondents who do not engage in galamsey operations were found to have relatives who are artisanal miners, from whom they draw financial support. The dwellers' socio-demographic characteristics significantly influence their participation in ASM operations and contribute to the surge in illegal mining activities in the study communities. The results from the logistic regression showed a significant relationship between the age of respondents and participation in illegal mining activities. Specifically, the respondents within the age group of 51 years+ and 41–50 years are 0.02 and 0.2 times less likely to participate in galamsey activities respectively compared to those within the age group of 30 years and below. Thus, participation in illegal mining activities decreases as the respondent grows older. Though insignificant, female-headed households are 0.3 times less likely to participate in galamsey operations compared to their male counterparts. Again widowed household heads are 0.03 times less likely to involve in galamsey activities. The results further showed that significantly, respondents within the Christian faith are 5.6 times more likely to participate in galamsey activities compared to those within the ATR. In addition, the results significantly showed that respondents with a first degree are 0.24 times less likely to participate in galamsey activities compared to those with no formal educational attainment.

Based on the forgone findings, this study argued that galamsey activities in rural communities are greatly shaped by the dwellers' socio-demographic characteristics and that galamsey is a youth-dominated livelihood enterprise in rural areas. The study, therefore, recommends that more youth jobs of significant prospects be created by the government and stakeholders concerned in local communities. Stakeholders in the ASM sector such as the Minerals Commission, Environmental Protection Agency and Municipal and Districts Assemblies (MDAs) should explore relevant means of aligning artisanal mining activities with agriculture and other rural livelihood strategies. Besides, investing in education and promoting the agenda of higher educational attainment in rural areas is a forward-looking step to eradicate the growing illegal mining activities in the country.

Declarations

Author contribution statement

Issah Baddianaah: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Bernard Nuoleyeng Baatuuwie & Raymond Adongo: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

We would like to extend our appreciation to Mr. Godwin Kumpong. Naazie, Mr. Abudi Iddrisu, Mr. Inusah Adama Abu, Mr. Peter Dery Bolang, Mr. Abdul-Razak Saaka and Mr. Malik Limman for the diverse support you offered during the field data collection. Our gratitude also goes to the chiefs, assembly members, lead miners and all the artisanal and small-scale mining groups in the study communities for giving us the audience, space and time to conduct the research. May the God Lord bless you all.

References

- Adu-Baffour, F., Daum, T., Birner, R., 2021. Governance challenges of small-scale gold mining in Ghana: insights from a process net-map study. *Land Use Pol.* 102, 105271.
- Aghetara, J.B., 2012. Effects of Artisanal and Small Scale Mining on the Environment and Livelihood in Ghana: A Case Study of Selected Mining Communities in the Upper East Region. MSc. thesis. Kwame Nkrumah University of Science and Technology, Kumasi.
- Agyemang, I., Okoto, H., 2014. Small-scale mining activity in Mengwe Community, Northern Ghana: advantages amidst the disadvantaged socio-economic effects. *Int. J. Educ. Res. Develop.* 3 (2), 23–29.
- Ahmed, Y., Oruonye, E., 2016. Socioeconomic impact of artisanal and small scale mining on the Mambilla Plateau of Taraba State, Nigeria. *World J. Soc. Sci. Res.* 3 (1), 1–12. www.scholink.org/ojs/index.php/wjssr.
- Akabzaa, T., Darimani, A., 2001. Impact of Mining Sector Investment in Ghana: A Study of the Tarkwa Mining Region. A Draft Report Prepared for SAPRI. Third World Network, Accra, Ghana. http://www.sapri.org/ghana/research/gha_mining.pdf.
- Andrew, N., 2015. Digging for survival and/or justice? The drivers of illegal mining activities in Western Ghana. *Afr. Today* 62 (2), 3–24.
- Antwi-Boateng, O., Akudugu, M.A., 2020. Golden migrants: the rise and impact of illegal Chinese small-scale mining in Ghana. *Polit. Pol.* 48 (1), 135–167.
- Arthur, F., Agyemang-Duah, W., Gyasi, R.M., Yeboah, J.Y., Otioku, E., 2016. Nexus between artisanal and small-scale gold mining and livelihood in Prestea Mining Region, Ghana. *Geogr. J.* 2016, 1–18.
- Awuah-Nyamekye, S., Sarfo-Mensah, P., 2012. Mining or our heritage? Indigenous local people's views on industrial waste of mines in Ghana. In: Kuan-Yeow, S., Xinxin, G. (Eds.), *Industrial Waste, Rijeka, Croatia: In Tech*, pp. 151–172.
- Ayee, J., Soreide, T., Shukla, G., Le, T.M., 2011. Political economy of the mining sector in Ghana. *World Bank Policy Res. Work. Pap.* 5730, 1–30. <https://openknowledge.worldbank.org/handle/10986/3494>.
- Azumah, F.D., Baah, E., Nachinaab, J.O., 2020. Causes and effects of illegal gold mining (galamsey) activities on school dropout and residents at the Tutuka central circuit in Obuasi municipality in Ashanti region, Ghana. *J. Educ.* 1–12.
- Baddianaah, I., Peprah, K., Adams, A., 2021a. Exploring spirituality, successes, and land degradation nexus in small-scale gold mining (galamsey) in Ghana: evidence from the Wa East District. *J. Environ. Agric. Sci.* 23 (1&2), 19–29.
- Baddianaah, I., Tuu, G.N., Baatuuwie, B.N., 2021b. Livelihood implications of artisanal gold mining in farming communities: insight from the Wa East District, Ghana. *Ghana J. Geogr.* 13 (3), 85–119.
- Bansah, K.J., Dumakor-Dupey, N.K., Kansake, B.A., Assan, E., Bekui, P., 2018. Socioeconomic and environmental assessment of informal artisanal and small-scale mining in Ghana. *J. Clean. Prod.* 202, 465–475.
- Bebbington, A., Abdul-Gafaru, A., Humphreys-Bebbington, D., Hinfelaar, M., Sanborn, C., 2018. *Governing Extractive Industries: Politics, Histories, Ideas*. Oxford University Press, Oxford.
- Boadi, S., Nsor, C.A., Antobre, O.O., Acquah, E., 2016. An analysis of illegal mining on the Offin shelterbelt forest reserve, Ghana: implications on community livelihood. *J. Sustain. Min.* 15 (3), 115–119.
- Botchwey, G., Crawford, G., 2018. Resource politics and the impact of Chinese involvement in small-scale mining in Ghana. *Africa* 88 (4), 867–870.

- Bryceson, D.F., Geenen, S., 2016. Artisanal frontier mining of gold in Africa: labour transformation in Tanzania and the democratic Republic of Congo. *Afr. Aff.* 115 (459), 296–317.
- Creswell, J.W., 2014. *Research Design Qualitative, Quantitative and Mixed Methods Approaches*, fourth ed. SAGE Publication Ltd.
- Fold, N., Bosse-Jønsson, J., Yankson, P.W.K., 2013. Buying into formalization? State institutions and interlocked markets in african small-scale gold mining. *Futures* 62, 128–139.
- Forkuor, G., Ullmann, T., Griesbeck, M., 2020. Mapping and monitoring small-scale mining activities in Ghana using Sentinel-1 Time Series (2015 – 2019). *Rem. Sens.* 12 (911), 2–26.
- Funoh, K.N., 2014. *The Impacts of Artisanal Gold Mining on Local Livelihoods and the Environment in the Forested Areas of Cameroon*, 150. CIFOR Working Paper, 39-pp. <http://www.cifor.org/library/5089/the-impacts-of-artisanal-gold-mining-on-local-livelihoods-and-the-environment-in-the-forested-areas-of-cameroon/>.
- Gbedzi, D.D., Ofosu, E.A., Mortey, E.M., Obiri-Yeboah, A., Nyantakyi, E.K., Siabi, E.K., Abdallah, F., Domfeh, M.K., Amankwah-Minkah, A., 2022. Impact of mining on land use land cover change and water quality in the Asutifi North District of Ghana, West Africa. *Environ. Chall.* 6, 1–15.
- Ghana Statistical Service, 2013. 2010 Population and Housing Censu. Regional Analytical Report. Upper West Region, Wa.
- Ghana Statistical Service, 2018. Ghana Living Standards Survey Round 7(GLSS 7), Poverty Trends in Ghana, 2005-2017. Accra, Ghana.
- Guenther, M., 2018. Local effects of artisanal mining: empirical evidence from Ghana. In: Presentation at the International Conference 'Environmental Economics: a Focus on Natural Resources', Orléans.
- Gujarati, D.N., 2008. *Basic Econometrics*, fourth ed. McGraw-Hill Institute.
- Hausermann, H., Adomako, J., Robles, M., 2020. Fried eggs and all- women gangs: the geopolitics of Chinese gold mining in Ghana, bodily vulnerability, and resistance. *Hum. Geogr.* 13 (1), 1–14.
- Hilson, G., 2001. *A Contextual Review of the Ghanaian Small-Scale Mining Industry. Mining, Minerals and Sustainable Development*, vol. 76. IIED, London. <http://pubs.iied.org/pdfs/G00722.pdf?>
- Hilson, G., 2002. Land use competition between small- and large-scale miners : a case study of Ghana. *Land Use Pol.* 19, 149–156.
- Hilson, G., 2010. Once a miner, always a miner": poverty and livelihood diversification in Akwatia, Ghana. *J. Rural Stud.* 26 (3), 296–307.
- Hilson, G., 2016. *Artisanal and Small-Scale Mining and Agriculture: Exploring Their Links in Rural Sub-saharan Africa*. IIED, London. <https://pubs.iied.org/sites/default/files/pdfs/migrate/16617IIED.pdf>.
- Hilson, G., 2017. Shootings and burning excavators: some rapid reflections on the Government of Ghana's handling of the Galamsey mining "menace. *Resour. Pol.* 54, 109–116.
- Hilson, G., Hilson, A., 2015. *Entrepreneurship, Poverty and Sustainability: Critical Reflections on the Formalisation of Small-Scale Mining in Ghana*. IGC Working Paper. IGC, London.
- Hilson, G., Maconachie, R., 2020. Entrepreneurship and innovation in Africa's artisanal and small-scale mining sector : developments and trajectories. *J. Rural Stud.* 78, 149–162.
- Hilson, G., Maconachie, R., 2020. Land use policy for the environment : an assessment of recent military intervention in informal gold mining communities in Ghana. *Land Use Pol.* 96, 1–11.
- Hilson, G., Pardie, S., 2006. Mercury: an agent of poverty in Ghana's small-scale gold-mining sector? *Resour. Pol.* 31, 106–116.
- Hilson, G., Potter, C., 2003. Why is illegal gold mining in so ubiquitous throughout rural Ghana? *Afr. Dev. Rev.* 15 (2), 237–270.
- Hilson, G., Potter, C., 2005. Structural adjustment and Subsistence industry : artisanal gold mining in Ghana. *Dev. Change* 36 (1), 103–131.
- Hilson, G., Yakovleva, N., 2007. Strained relations: a critical analysis of the mining conflict in Prestea, Ghana. *Polit. Geogr.* 26 (1), 98–119.
- Hilson, G., Hilson, A., Adu-Darko, E., 2014. Chinese participation in Ghana's informal gold mining economy: drivers, implications and clarifications. *J. Rural Stud.* 34, 292–303.
- Hilson, G., Hilson, A., Maconachie, R., McQuilken, J., Goumandakoye, H., 2017. Artisanal and small-scale mining (ASM) in sub-Saharan Africa: Re-conceptualizing formalization and 'illegal' activity. *Geoforum* 83, 80–90.
- Hirons, M., 2020. How the Sustainable Development Goals risk undermining efforts to address environmental and social issues in the small-scale mining sector. *Environ. Sci. Pol.* 114, 321–328.
- International Labour Organisation [ILO], 1999. *Social and Labour Issues in Small-Scale Mines*. ILO, Geneva.
- Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF), 2017. *Global Trends in Artisanal and Small-Scale Mining (ASM): A Review of Key Numbers and Issues*. Winnipeg: IISD. <http://pubs.iied.org/pdfs/G04266.pdf>.
- Kala, M., 2015. *Entrepreneurship and Poverty Reduction: the Case of the Youth in Small-Scale Mining in Ghana*. PhD thesis. University of Ghana, Legon.
- Kumi-Boateng, B., Stemm, E., 2020. Spatial analysis of artisanal and small-scale mining in the Tarkwa-Nsuam Municipality of Ghana. *Ghana Min. J.* 20 (1), 66–74.
- Kwai, B., Hilson, G., 2010. Livelihood diversification and the expansion of artisanal mining in rural Tanzania drivers and policy implications. *Outlook Agric.* 39 (2), 141–147.
- Laari, P.B., Guan, Q., Cheng, D., 2016. Dynamic of land use change in a mining area: a case study of 'Nadowli District', Ghana. *J. Mt. Sci.* 13, 633–642.
- Mabe, F.N., Owusu-sekyere, E., Theophilus, O., 2021. Livelihood coping strategies among displaced small scale miners in Ghana. *Resour. Pol.* 74, 102291.
- Mantey, J., Owusu-Nimo, F., Aubynn, A., 2017. Operational dynamics of "Galamsey" within eleven selected districts of western region of Ghana. *J. Min. Environ.* 8 (1), 11–34.
- Mapuva, J., Dube, M., 2016. Small-scale gold mining and rural livelihoods: case of Wozoli Silobela ward 22 , Kwekwe district (Zimbabwe). *J. Prog. Res.* 3 (3), 223–231.
- McQuilken J Hilson, G., 2016. *Artisanal and Small-Scale Gold Mining in Ghana. Evidence to Inform an 'action Dialogue'*. IIED, London. <http://pubs.iied.org/16618IIED>.
- Mkodzongi, G., Spiegel, S., 2018. Artisanal gold mining and farming: livelihood linkages and labour dynamics after land reforms in Zimbabwe. *J. Dev. Stud.* 1–17, 00(00).
- Nyame, F.K., Andrew Grant, J., Yakovleva, N., 2009. Perspectives on migration patterns in Ghana's mining industry. *Resour. Pol.* 34 (1–2), 6–11.
- Obeng, E.A., Oduro, K.A., Obiri, B.D., Abukari, H., Guuroh, R.T., Djagbletey, G.D., Appiah-Korang, J., Appiah, M., 2019. Impact of illegal mining activities on forest ecosystem services: local communities' attitudes and willingness to participate in restoration activities in Ghana. *Heliyon* 5 (10), e02617.
- Ofosu-Mensah, A.E., 2010. Traditional gold mining in Adanse. *Nord. J. Afr. Stud.* 19 (2), 124–147.
- Ofosu-Mensah, A.E., 2011. Historical overview of traditional and modern gold mining in Ghana. *Int. Res. J. Libr. Infor. Arch. Stud.* 1 (1), 6–22.
- Opoku-Antwi, G.L., Amofah, K., Nyamaah-Koffuor, K., 2012. Comparative study in the Bibiani, Bolgatanga, Dunkwa and Tarkwa mining districts of the minerals commission of Ghana. *J. Int. Energy Pol.* 1 (1), 19–34.
- Osumanu, I.K., 2020. Small-scale mining and livelihood dynamics in North-Eastern Ghana: sustaining rural livelihoods in a changing environment. *Prog. Dev. Stud.* 1–15.
- Owusu, O., Bansah, K.J., Mensah, A.K., 2019. Small in size, but big in impact": socio-environmental reforms for sustainable artisanal and small-scale mining. *J. Sustain. Min.* 18 (1), 38–44.
- Owusu-Nimo, F., Mantey, J., Nyarko, K., Aubynn, A., 2018. Spatial distribution patterns of illegal artisanal small scale gold mining (Galamsey) operations in Ghana: a focus on the Western Region. *Heliyon* 4, e00534.
- Pact, ARM, 2018. *The Impact of Small-Scale Mining Operations on Economies and Livelihoods in Low-To Middle-Income Countries*. Research for Evidence Division (RED), DFID, United Kingdom.
- Que, S., Wang, L., Awuah-Offei, K., Chen, Y., Yang, W., 2018. The status of the local community in mining sustainable development beyond the triple bottom line. *Sustainability* 10 (6), 1–11.
- Redehey, B.G., 2017. Youth in artisanal gold mining: risks and opportunities; the case of Asgede Tsimbla Woreda, Northwestern Tigray national regional state, Ethiopia. *Int. NGO J.* 12 (3), 22–28.
- Sidorenko, O., Sairinen, R., Moore, K., 2020. Rethinking the concept of small-scale mining for technologically advanced raw materials production. *Resour. Pol.* 68 (101712), 1–12.
- Sperandei, S., 2014. Understanding logistic regression analysis. *Biochem. Med.* 24 (1), 12–18.
- Tuokuu, F.X.D., Idemudia, U., Bawelle, E.B.G., Sumani, J.B.B., 2020. Criminalization of "galamsey" and livelihoods in Ghana: limits and consequences. *Nat. Resour. Forum* 44, 52–65.
- Twerefou, D.K., Tutu, K., Owusu-Afryiye, J., Adjei-Mantey, K., 2015. *Attitudes of Local People to Mining Policies and Interventions*. IGC Working Paper. IGC, London.
- USAID, 2020. *Artisanal and Small-Scale Mining: USAID Activities and Approaches*. Issue Brief. USAID Gov. USAID, USA.
- Weng, X., 2015. *The rural informal economy: understanding drivers and livelihood impacts in agriculture, timber and mining*. In: IIED Working Paper. IIED, London. <http://pubs.iied.org/16590IIED>.
- World Bank, 1995. *Artisanal mining round table: issues for discussion*. In: Background Paper for the World Bank's International Round Table on Artisanal Mining. Washington, DC.
- Yakovleva, N., Vazquez-Brust, D.A., 2018. Multinational mining enterprises and artisanal small-scale miners : from confrontation to cooperation. *J. World Bus.* 53 (1), 52–62.
- Yamane, T., 1967. *Statistics: an Introductory Analysis*, second ed. Harper and Row.
- Yankson, P.W.K., Gough, K.V., 2019. Gold in Ghana: the effects of changes in large-scale mining on artisanal and small-scale mining (ASM). *Extr. Industr. Soc.* 6 (1), 120–128.
- Zolnikov, T.R., 2020. Effects of the government's ban in Ghana on women in artisanal and small-scale gold mining. *Resour. Pol.* 65 (101561), 1–6.