

# Sociodemographic Attributes and Dependency on Artisanal and Small-scale Gold Mining: the Case of Rural Gorontalo, Indonesia

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**Submission date:** 04-Jan-2022 12:35AM (UTC+1100)

**Submission ID:** 1737105442

**File name:** Komatsu\_2020\_IOP\_Conf.\_Ser.\_Earth\_Environ.\_Sci.\_589\_012020.pdf (445.15K)

**Word count:** 4509

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## Sociodemographic Attributes and Dependency on Artisanal and Small-scale Gold Mining: the Case of Rural Gorontalo, Indonesia.

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**Abstract.** The objective of this research is to investigate the livelihoods of villagers of rural Gorontalo, where limited job opportunities and poor infrastructure impede improvements in rural settlements. The research focused on rural regions where small-scale gold mining (ASGM) activities are prevalent in the economy. Given the associated complexities of the livelihoods of the villagers, the paper pays particular attention to household income and its sources and then examines associations with key socioeconomic variables, focusing especially on the contribution of educational development. The questionnaire survey was conducted among households in five villages of rural Gorontalo in August 2017, and 310 effective samples were collected. The results indicate that more affluent households receive a higher proportion of income from formal public sectors, such as government institutions. The source of income from mining accounts for approximately 20%, which is almost constant across the income quartiles. Fractional logit models were employed to examine the dependency of household income on mining. The estimation results indicate that educated households depend less on mining income than do uneducated households. Households with young household heads receive less income from mining than do those with old household heads. The paper implies that low educational attainments are related to a higher dependency on mining, probably due to limited job opportunities in the formal sector. Therefore, improvements in educational attainment are associated with a reduced dependency on the mining sector. The results yield key information for formulating policies for remote villages where a substantial improvement in rural livelihoods is pivotal to reduce dependency in the context of poor ASGM regions.

**Keywords.** ASGM; Rural Livelihoods; Income; Fractional Logit Model; Rural Gorontalo

### 1. Introduction

The release of mercury and its components to the atmosphere seriously harms human health. One of the major activities that emit mercury is artisanal and small-scale gold mining (ASGM), which has recently witnessed substantial expansion in response to the hike in gold prices. ASGM accounts for 24% of the



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global mercury consumption and is the largest sector that consumes mercury [1]. Moreover, ASGM is responsible for 17% of mercury emissions to the atmosphere [1].

The common adverse health effects reported by workers in ASGM locations are neurological effects, such as tremors, ataxia, memory problems and vision disorders [2]. Such effects are observed not only in ASGM miners but also in the communities close to the mining sites and in residents living in downstream areas. Therefore, a reduction in the dependency on mercury in ASGM will result in a substantial reduction of total mercury consumption. This has been addressed under the Minamata Convention on Mercury, which calls for protecting the environment and human health resulting from adverse effects of mercury and its composites.

ASGM practices have expanded, especially in many low- and middle-income countries. Approximately 15 million people, including about three million women and children, engage in ASGM activities in developing countries [2]. Many countries have limited or no compliance mechanisms to disclose the health and safety issues of small-scale mining sectors [3]. Most mining communities are located in rural areas that lack basic public resources, such as health care or clean potable water [4]. The background of such environmental hazards is associated with chronic poverty in rural societies, where job opportunities are scarce. Typical cash income sources in rural economies are limited to agriculture, fisheries, drivers for a living, and shops, among other activities. ASGM sites are considered an alternative and promising cash income opportunity for rural markets; thus, it is difficult to immediately eradicate mining and surrounding industries in the short term.

Recently, several field surveys have been implemented to capture the socio-demographics backgrounds of miners' households and communities with miners. For example, a household survey in ASGM communities in Ghana showed that indicators that represent household wealth, such as mobile phone and radio ownership, are more common than in rural Ghana, but electricity and water access are less common [5]. The aforementioned communities are composed of mostly working-age individuals with relatively large numbers of household members; however, 46.7% of females and 29.0% of males have received no education [5]. The household survey for miners in Nusa Tenggara Province of Indonesia found that miners have worked as farmers, casual workers, merchants, etc. prior to becoming, but ASGM activities have resulted in a substantial increase in household income. This result is found by comparing income before and after mining [6]. Compared with the number of studies that have examined adverse health impacts through mercury exposure on ASGM, few studies have been conducted to investigate the socio-demographic backgrounds of miner households, communities with miners, and persons who are indirectly involved with ASGM through markets, transportation services, etc.

To eradicate chronic poverty and to eliminate dependency on ASGM, alternative job opportunities that generate cash income are crucially important. If cash income other than that from mining sectors improves livelihoods, mining will no longer be appealing to villagers, and mercury emissions to the atmosphere will be reduced. Alternative and promising job opportunities are location-specific, i.e., heterogeneity in social, economic, climate, and geographical conditions provides various opportunities for respective villages, such as the harvesting of commercial crops and the establishment of a food industry for adding value to commodities, as well as tourism development, among other activities. Careful investigation is necessary to deploy suitable policy options for respective villages.

Moreover, to identify possible policy direction to overcome issues associated with ASGM, integrated and interdisciplinary approaches that ensure poverty reduction and mitigate adverse health and environmental consequences should be discussed under the debate of sustainable rural development. It is essential to place ASGM within long-term development initiatives and pathways. Maier et al. discusses importance of mining and its relationship with the poverty aspect as well as socially responsible mining and transdisciplinary approaches to overcome the complex issues that local communities face [7]. The importance of sociodemographic backgrounds where ASGM occurs cannot be neglected when pursuing long-term sustainable rural development.

Education is one type of sociodemographic background that could be essential for job opportunities and the pursuit of policy directions for long-term sustainable development pathways. Education is a

productive investment embodied in a person and provides skills, abilities, knowledge, and better health. Educated people are on a path towards good health, empowerment and employment. Education is an asset that has the aspect of positive externality; the benefits of education are not only good for those who are educated but also for the whole society. Despite the commonly known benefits of educational attainment, developing countries typically have low education levels; for example, in 2010, the number of years of schooling for children aged 15 in Indonesia was 7.61; by contrast, children in United States had more than 8 years of education by 1950 [8]. The educational attainments in rural hinterlands are much lower than in urban regions, and low education levels are one of the bottlenecks in the creation and expansion of job opportunities in villages.

In this paper, it is hypothesized that a higher educational attainment can expand job opportunities to those besides the mining sector and can then contribute to a reduction in mercury consumption. To address policy implications associated with the improvement of the livelihoods of rural villagers where ASGM is one of the income-generating activities and strategies to escape from chronic poverty, knowledge of sociodemographic backgrounds, especially educational attainment and its relationship with the dependency on ASGM, is crucially important. While dangers associated with ASGM activities, especially from mercury contamination, are commonly known, limited scholarly journal papers have addressed the sociodemographic backgrounds of the communities where ASGM sites are located. Therefore, this paper addresses the potential of educational attainments and other sociodemographic attributes associated with mercury dependency.

## 2. Background of the surveyed regions

Indonesia is one of the typical countries that have various ASGM sites, and there are concerns about toxicity from mercury emissions. Several articles empirically examined mercury contamination and its adverse effects on human health in Indonesia. For example, Sari et. al. investigated the mercury contamination of foods in the market and the intake of mercury-contaminated food using hair samples in Central Sulawesi, where ASGM occurs [9]. Arifin et al. discussed the impacts of ASGM on the environment and human health in the Gorontalo province of Indonesia and identified mercury contamination and adverse health risks for residents of ASGM sites and those that reside outside of these sites [10]. While the exposure to mercury and the associated health consequences are empirically discussed, to the best of the authors' knowledge, backgrounds and policy directions from a sociodemographic point of view have not been examined.

A case study was conducted in the rural hinterlands of Gorontalo Province in Indonesia where small-scale gold mining (ASGM) activities play a role in the local economy. In addition to the serious human health and environmental degradation, chronic poverty, and poor infrastructure (roads, telecommunication) hinder improvements in rural settlements. In the Suwawa Timur sub-districts, only 69.8% of the economically active population is employed [11]. Since the income-generating activities in the local economy are scarce, villagers have limited job opportunities, which include agriculture, mining, drivers for a living, or other self-employed activities.

## 3. Questionnaire design and socio-demographic statistics

A questionnaire survey was conducted to obtain basic information on the household roster, age, sex, education, income and income source, as well as household assets, which appear to be relevant to understand the rural livelihoods of villagers. The survey was conducted in five villages (Desa), i.e., Dumbaya Bulan, Pangi, Poduwoma, Tulabolo, and Tinemba of the Suwawa Timur sub-districts (Kecamatan), in August 2017. Prior to the survey, investigators received training to ensure that they clearly and precisely understood the survey objectives and questionnaire design. Because the literacy rate of rural households was considered to be low, answers from respondents were collected through individual face-to-face interviews. To obtain reliable and representative answers from households, the investigators sought respondents who were the head of the household or the person who served as the household's decision maker.



Prior to the questionnaire survey, investigators received informed consent from each respondent. The respondents were informed that the findings of the research, which were partly based on their answers, will contribute to improved scientific knowledge and rural livelihoods in Suwawa Timur sub-districts and the whole of Indonesia. Moreover, the respondents were also informed that any information provided would remain strictly confidential and will be used only for research purposes. It was emphasized that their participation was voluntary, and they could choose to not answer any individual question or all of the questions. The respondents were allowed to stop answering whenever they wanted. To ensure that the respondents agreed to provide answers and that they fully understood pertinent information presented by the investigators, they provided a signature or check marks on the questionnaire.

Table 1 shows the descriptive statistics of the characteristics of the respondent households (effective sample size = 310). The total annual income per capita is 6.2 million rupiah, with a total annual income per household of 22.2 million (1 million rupiah is equivalent to approximately 69 USD, as of July 2017). The average number of household members is 4, and the average age of the household head is 45. Educational attainment is relatively poor; the number of years of education of the household head is 7.6. As implied by the educational attainment, there are many households heads whose educational attainment is equal to or less than junior secondary school.

To reflect the recent advancement in school education, Table 1 also shows the educational attainment and number of years of schooling for those with the highest education level among all household members. The highest number of years of schooling per household is approximately 10.7. The results suggest that limited educational attainment could be one of the obstacles hindering better job opportunities in the context of rural Gorontalo.

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**Table 1.** Descriptive Statistics

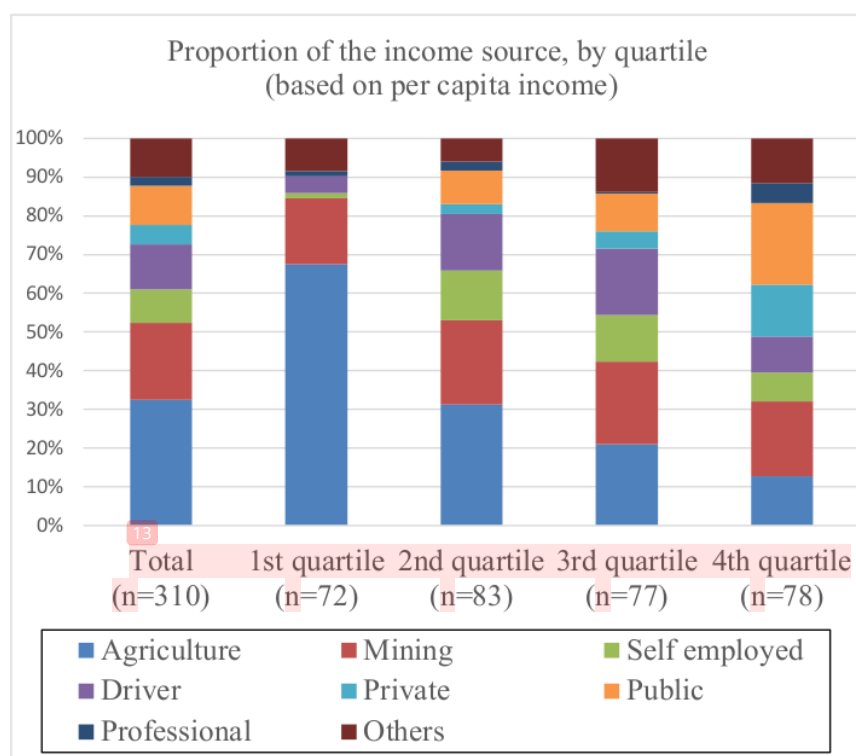
Variable	Mean	Std. Dev.	Min	Max
Total annual income per households (million rupiah)	22.2	37.8	0.0	360.0
Total annual income per capita (million rupiah)	6.2	10.7	0.0	120.0
Number of household members	4.0	1.3	1.0	7.0
Age of household head	44.7	12.5	21.0	87.0
23 Sex of household head (1=male, 2=female)	1.1	0.2	1.0	2.0
Educational attainment, household head *	4.5	1.1	1.0	7.0
Years of schooling, household head (years)	7.6	3.2	0.0	17.0
Educational attainment, highest in household *	5.4	1.1	1.0	7.0
Years of schooling, highest in household (years)	10.7	3.4	0.0	20.0

Note: Number of observations are 310.

\* Educational attainment (for both the household head and the highest in the household) is a dummy variable that represents levels of completion. The values are as follows: 1 = Illiterate, never got education. 2 = Literate, never got education, 3 = Elementary school student, but did not complete elementary school, 4 = Completed elementary school (1-6), 5 = Completed junior secondary school (7-9), 6 = Completed higher secondary school (10-12), 7 = Completed graduate studies (13-16)

Figure 1 explains the breakdown of the income sources of the respondents. The bar on the left side shows the breakdown of the overall respondents, and the remaining bars indicate the share of income sources based on affluence measured by per capital income. As the majority of the cash income is generated by agricultural activities (corn, pepper, banana, etc.), income from mining activities occupies the second largest component of income. Overall, 32% of the cash income is generated by agriculture, compared with 19.9% from mining activities. As rural areas have limited transportation modes, drivers (bicycle drivers, car drivers) are in demand.

Further disaggregation of the income by affluence indicates divergent characteristics of the livelihoods. Households in the lowest quartile (1<sup>st</sup> quartile) in terms of per capita annual income (less than 1.2 million rupiah) received more than sixty percent of their cash income from agriculture. In contrast, households in the highest quartile (4<sup>th</sup> quartile, more than 6.6 million rupiah) receive a higher proportion of income from formal public sectors, such as government institutions. The proportion of income from mining is relatively constant across quartiles; approximately 20 percent of cash income was obtained from the mining sector. The proportion of income from drivers is relatively large in the second and third quartiles. The figure indicates that rural villagers have divergent cash income sources based on affluence. The poorest population has limited access to formal (private, public) sectors, which could be an obstacle to improving livelihood.



**Figure 1.** Proportion of the income source based on affluence

#### 4. Estimation of the dependency on mining income

What household types depend on mining income to sustain their livelihoods? This section discusses the potential sociodemographic factors that potentially affect the proportion of the mining income. As the variable of interest, i.e., the share of mining income, is expressed as a proportion (the value ranges from 0 to 1), fractional logit models are employed for investigation. The estimation enables the association between the dependency on mining income and various sociodemographic backgrounds of the villagers. For a detailed discussion on the fractional logit model, refer to [12].

Table 2 provides the estimation results. The differences among models are the independent variables that represent the educational aspects of the households. In Model (1), the household heads with higher education are less dependent on mining income. Models (2) to (4) include similar but different explanatory variables to take into account the level of education, i.e., the number of years of education of the household head, the highest level of education within a household, and the highest number of years of education among households. Models (2) to (4) also indicate that educated households depend less on income from mining.

Moreover, households with a younger household head are less dependent on income from mining. The variable representing affluence, i.e., total annual income per capita ( $\ln$ ), is marginally significant for Model (3) and Model (4) but insignificant for Model (1) and Model (2). The number of household members and the sex of the household head show no statistically significant results. Note that all models include village (Desa) dummy variables to take into account the heterogeneity of the village level characteristics.



**Table 2.** Estimation Results

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
Total annual income per household, (ln)	0.162	0.106	0.161	0.106	0.174	0.105 *	0.180	0.105 *
Number of household members	0.066	0.106	0.065	0.105	0.152	0.111	0.165	0.111
Age of household head	-0.063	0.013 ***	-0.063	0.013 ***	-0.058	0.012 ***	-0.058	0.012 ***
Sex of household head	-0.255	0.823	-0.222	0.821	-0.315	0.827	-0.307	0.824
Educational attainment, household head	-0.270	0.126 **						
Years of schooling, household head			-0.093	0.046 **				
Educational attainment, highest in household					-0.368	0.122 ***		
Years of schooling, highest in household							-0.147	0.045 ***
Cons.	-0.068	1.839	-0.643	1.837	0.015	1.848	-0.631	1.850
Village (Desa) dummy	Yes		Yes		Yes		Yes	
Number of observations	310		310		310		310	
Prob > chi <sup>2</sup>	0.000		0.000		0.000		0.000	
Pseudo R <sup>2</sup>	0.084		0.085		0.096		0.103	

\*, \*\* and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively.

## 5. Discussion

The results show that higher educational attainments may lead to job opportunities other than mining. This may indicate that improved education can expand job opportunities that require more intellectual capacity and depend less on mining. Low educational attainments impede entry into the job market, and higher education levels are one of the key factors to improving the livelihoods of rural villagers who suffer from chronic poverty and to preventing environmental pollution from mercury emissions. The nexus between education and mining has not been empirically examined in previous literature; however, this paper provides insightful information for understanding heterogeneous livelihoods in the case of rural Gorontalo, Indonesia.

As education is a long-term investment, it is not easy to reap the benefits of intellectual improvement in the form of better income opportunities. Although a higher education level of the household head results in better income-generating opportunities, the household heads are no longer of schooling age. The research implies that it is necessary to improve the intellectual development of adults. Adult education cannot be covered by regular educational programs for those of schooling age. Special educational programs and/or training that simultaneously improve intellectual capacity while ensuring livelihoods are necessary.

At the same time, it is also crucially important to provide job opportunities other than those in the mining sector for potential employees. The promising industries that are suitable in rural Gorontalo are outside the scope of this paper, but the food processing industry, which can utilize local agricultural harvests to incorporate additional values, has potential.

Table 2 shows that households in which the household head is relatively young are less dependent on income from mining. It is likely that younger household heads are physically strong and have various

opportunities, such as driving or self-employed activities. The variable representing affluence (total annual income per capita) that showed a limited influence on the share of mining income indicated that dependency on mining is not relevant to the affluence of a household. This means that poor households do not necessarily depend more on mining activities to secure cash income opportunities. This seems surprising but may indicate that seriously poor households cannot cover the initial costs for mining activities, such as transport costs or accommodation fees associated with mining sites.

## 6. Conclusions

The paper implies that low educational attainment is related to higher dependency on mining, probably due to limited job opportunities in the formal sector. Improvements in educational attainment are associated with a reduction in dependency on mining. Education is one of the key requirements to obtain employment opportunities that require skilled labor; however, Indonesia faces problems with teacher absenteeism [13], including in Sulawesi [14]. To ensure quality education that contributes to students' learning, it is essential to provide incentives and a suitable environment that enables teachers to be present at school will be crucial. As the research did not estimate strong causal inference between socio-demographic variables and dependency on mining, the results imply a relationship between them. The results yield key information for formulating policies for remote villages where substantial improvements in rural livelihoods are pivotal to reduce dependency on ASGM.

## 7. Acknowledgements

The authors thank anonymous referees for their constructive comments and suggestions to improve the quality of an earlier version of the manuscript. This research was supported by the Ministry of Education, Culture, Sports, Science, and Technology, Japan, a Grant-in-Aid for Scientific Research, KAKENHI (No. 26740057, 16H02706, 19K12446), and the Research Institute for Humanity and Nature "Co-Creation of Regional Innovation for Reducing Risk of Environmental Pollution". The authors greatly appreciate the assistance and cooperation of field investigators and survey respondents. The authors do not have any conflicts of interest to declare in terms of financial or personal involvement that may influence the judgments expressed in this manuscript.

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