Student name: Bayarlkham Byambaa
Student ID: 47-096838
Department: Graduate Program in Sustainability Science, Graduate School of Frontier Science, University of Tokyo
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Supervisor: Prof. Yasuyuki Todo
Advisor: Prof. Mino Takashi
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ABSTRACT

1. Introduction

Mining industry is now significantly contributing to the economic and social development of Mongolia, however in fact its impact on the environment is becoming more serious specially when it comes to the case of a placer gold mine. Land and water bodies of the eighteen out of twenty one provinces of Mongolia are ruined by the destructive activities of gold mine, and its impacts on the river system are very significant since the water is the main method to recover the gold bearing sands and soils. In consequence, many of the region’s small rivers have been drying up because of the excessive and inefficient use of water in the extraction and outdated recovery processes of the placer gold mining.

2. Objectives

Therefore, driven from the existing problem, the research aims to investigate the main factors in determining the cleaner technology adoption in Mongolian placer gold mine industry and assess the technology impact on water quality.

3. Methodology

In that regard, the research has applied an interdisciplinary approach. Econometric analysis method of binary and multinomial logit models was conducted in order to determine the main factors of cleaner technology adoption. Prior to this empirical analysis, a field study which included water quality sampling and in-situ measurement, site observation and survey to mine managers was conducted in the Zaamar goldfield at the lower reach of the Tuul River Basin (TRB) in order to identify the main types of placer gold mine technologies and scientifically assess the their impacts on the water quality.

4. Key findings

Through the field study, it is found that placer gold mining operation has significant impact on the surface water quality. The water quality in the sampling points varies from mine to mine depending on the types of gold recovery technologies they applied.

Empirical analyses of binary and multinomial logit models find that a change in being owned by local or foreign firms into being owned by Russian or Chinese firm will increase the probability of adopting the dirty technology (DT) by 31%. Also it finds that doubling the sales amount will reduce the probability of adopting dirty technology by 16.5 percentage points, which suggesting that mines with smaller assets are more likely to adopt dirty technology while mines with larger assets are more likely to adopt the cleaner technologies.

5. Novelty

Firstly, the research is distinctive in a way that is attempting to scientifically and empirically investigate the current and urgent problems of water pollution from mining industry in Mongolia with an interdisciplinary approach, combining water quality measurement at the field with the extensive quantitative data analysis to determine the factors of clean technology adoption. Secondly, the study contributes to make a bridge among different stakeholders, water quality, mine managers, mine owners, researchers and government authorities. Moreover the study is original in a sense that it uses scientific data obtained through water quality sampling and measurements at the field and the empirical dataset, which has not been used in any other studies so far.

6. Conclusion

The study finds that there is a dissolved heavy metal and other chemicals concentrations in the surface water making it significantly polluted due to the extensive placer gold mining activities along the river. The water quality in the sampling points varies from mine to mine depending on the types of gold recovery technologies they applied. Existing placer gold technologies are categorized into three different levels as Dirty, End-of-Pipe and Clean technology.

As expected, ownership status of the mine is the largest factor that affects cleaner technology adoption. However, its effects are different depending on the owners' origin. It was found that mines owned by Russian or Chinese firms are more likely to adopt dirty technology [1] than the local owned mines. They tend to adopt EOP technology[2] in very small extent. Therefore, this result is inconsistent with a priori expectation of the foreign ownership on cleaner technology adoption.

Unlikely, mines owned by foreign firms from other advanced countries tend to adopt more CT - clean technology[3] than the local owned mines. In other words, Russian and Chinese are having a less clean technology whereas mines owned by other foreign firms from advanced countries tend to adopt clean technologies.

These could be caused by (i) economical reason: prices of technologies and machineries from Russia and China are much cheaper than that from other countries, (ii) geographical reason: Russia and China are both the neighboring countries and it is perhaps easily accessible to compare with other foreign countries; (iii) geological and mineralogical factors: climatic condition in the north of the country is very similar to the Siberian cold weather, and the climate in the south is similar to semi-arid climatic condition in the north of China; and (iv) historical and cultural reason: since there is a large cultural influence from both countries and they both have a long history and tradition of mining activities, the techniques and practices are probably easier to get diffused and adopted.

That supporting one of the hypotheses, which assumes a cleaner technology adoption due to larger financial assets, was found to be one of the significant factors of technology adoption. Results suggest that more the mines get wealthier, the higher the probability of adopting cleaner technology. However, human capital was found to be insignificant factor to the cleaner technology adoption. It might be related to the absence of experts and lack of involvement of professionals at the mines, which was observed through the field survey. This result supports the first finding

[1] Dirty technology category includes drilling, dredging, high-pressure water cannons, bulldozer-sluice, traditional sluice boxes and riffles etc.

[2] EOP technology category includes primitive technologies but with some modifications such as bucket-line dredges with on-board trommels, self-cleaning sluices and scrubbers etc.

[3] Clean technology category includes hydro-active riffled system, IHC jig systems, and KNELSON centrifugal concentrators, drilling rigs and washing plants etc.

about the foreign ownership, because technologies coming from Russia and China are mostly traditional and primitive types of technologies and do not require advanced or skilled labor. Moreover, it was clear that periodical and regional factors do not influence to the both dirty and clean technology adoptions.

Robustness of the main results is checked with an additional analysis conducted on the effect of firm-specific factors on environmental awareness and regulation adherence and they are proved to be convincing. Results from the linear regressions suggest that mines with larger assets will likely to adhere the environmental regulation by increasing the number of deposit lakes and recycling more water and are likely to have more increased environmental awareness. In case of ownership, mines owned by Russian or Chinese firms tend to be bad performing to adhere the environmental regulation on water recycle rate to compare with local owned mines.

Gold mining, which promises a huge income and prosperity in the short-term, can dry out the rivers and emit the pollutants into the environment just naturally while no one is yet aware of its environmental impacts, which is not possible to be compensated in the long-term. However, it is strongly asserted that every effort in adopting a cleaner technology and practices can improve the environmental conservation while promoting economic gains.