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Potential and Status of Mineral Exploitation in Thai Nguyen Province, Vietnam

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Abstract:

Considered to be the second mineral-rich province in Vietnam, Thai Nguyen Province has shown its potential and developed the mineral exploitation industry in recent years, making an important contribution to the socio-economic development of the province. This paper uses secondary information, focusing on analyzing and assessing the potential as well as the results of mining activities, the impacts of this activity on local socio-economic development. In Thai Nguyen province, among the minerals, Wolfram has the most outstanding potential, with the largest reserve in the world (excluding of China); mining enterprises are diverse in types of businesses, mining activities are diverse, contributing to the province's total value of industrial production and creating jobs for labors. However, the mining industry also has a negative impact on the local socio-economic life, because this activity creates the risk of resource depletion, environmental pollution, security instability, social order, and does not guarantee employment sustainability for workers. From the results of analyzing and assessing the situation, the study proposes a number of solutions to improve the efficiency and sustainability of mineral exploitation activities in Thai Nguyen province.

Keywords: Mineral, mining, potential, Thai Nguyen, sustainability

1. Introduction

Mineral resources are one of the important factors and contribute positively to socio-economic development in developing countries. As a country with diverse and abundant mineral resources with over 5000 ores and mines of 60 different types of minerals, Vietnam has attracted lots of domestic and foreign investment capital. The output value of mining industry (excluding oil and gas) accounts for about 4-5% of the annual GDP.

Thai Nguyen Province is the economic, political - social center of the Northeast region or the Northern Midland and Mountain region. As a province rich in mineral resources, ranked second in the country, Thai Nguyen has many kinds of minerals with significant reserves that can be organized for industrial exploitation such as fat coal with reserves of over 15 million tons and coal with reserves of about 90 million tons; non-ferrous metals including tin, lead, zinc, tungsten, gold, copper, nickel, mercury ... This is a premise for the development of mineral exploitation and processing industry, contributing positively to economic development - society of the province.

By 2019, the province has 102 mineral mines with reserves of 1855.719 tons, of which 1393.2 tons have been exploited (reaching 75.08%). In 2018, mining enterprises in the province paid 1174.5 billion VND to the budget. Up to now, mining activities have created jobs and stable incomes for thousands of local labors. However, besides these significant contributions, the mining industry also has many shortcomings such as causing environmental pollution, wasting mineral resources, etc. Thus, the research question is posed as: Which achievements do the mineral exploitation activities gain in Thai Nguyen province, and has these activities achieved the potential output level yet? What are the inadequacies and their causes in mining activities in Thai Nguyen province? This article will focus on researching and analyzing the potential and actual situation of mineral exploitation activities in Thai Nguyen province, thereby proposing some solutions to develop this activity towards the effective and sustainable development, reducing the mining activity's negative impacts.

2. Literature Review

2.1. Minerals

Mineral resources are naturally occurring concentrations of materials (solid, gas or liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions [6] [14]. They include ores, industrial minerals, constructional stones, formed through a series of geological activities and are often non-renewable.[2].

According to Vietnam's Mineral Law 2010, Minerals are useful minerals that accumulate naturally in solid, liquid, and gaseous forms existing in the ground and on the ground, including minerals at mines.

Thus, minerals are understood as useful minerals accumulated naturally for thousands of years in solid, liquid and gaseous forms existing in the ground and on the ground. Minerals are a nearly non-renewable resource, an important national asset.

2.2. Mineral Potential

The mineral potential of a locality is the probability that a mineral will occur with sufficient reserves to be exploited under current or future conditions, including the accumulation of metals, non-metals, industrial materials and unexplored energy resources [14].

2.3. Mineral Exploitation

Mining is an activity aimed at recovering minerals, including mine construction, excavation, classification, enrichment and other related activities [10]. Mining activities are conducted after obtaining a license from a competent state authorities, starting from the time the mine starts constructing (or opening the mine) until the mine finished mining (mine closure - environmental restoration).

With the increasing demand for minerals, the mining industry is growing constantly on every continent [8].

The exploitation of mineral resources is a driving force for economic development, very important economically for regions and countries around the world [12]. In addition to bringing in foreign exchange and making a significant contribution to the gross domestic product, this industry has created jobs for a large workforce, contributing to serving the community through taxes and fees paid by local mining enterprises. In addition, mineral exploitation promotes a number of other related activities such as production of mining equipment, provision of technical and environmental services, and development of universities in the field of geology, technique of mining and metallurgy [9]. However, mining activities have negative impacts on the environment such as air pollution, soil pollution, water and sediment pollution, geotechnical problems and soil erosion [7]; There are negative impacts on the health of workers involved in mining because they are exposed to dust and toxins, suffer from stresses from the working environment, and may even get labor accidents [1].

2.4. Mining in Vietnam

Vietnam is a country with many mineral potentials with more than 5,000 mines with about 60 different types of minerals. The minerals assessed as having relatively large reserves according to world standards are Bauxite and Ilmenite [13]. However, the world reserves of Bauxite and Ilmenite are also large. Therefore, these two types are not valuable and rare minerals. Fossil minerals like oil and coal also do not have great potential. The reserves of oil and anthracite coal are forecast at 4.3 billion tons and 18.43 billion tons, respectively. With the current output, oil and coal fields will be depleted in about 56 to 165 years [15]. Other minerals like iron, manganese zinc, lead, etc. have not much reserves and scattered distribution.

In the last 3 decades, Vietnam's mining industry has grown rapidly and contributed significantly to the state budget, which is a resource of national development. However, the management and exploitation of minerals have not been effective, causing waste of resources. Mining activities are a major cause of negative impacts on the environment and ecosystem. Land appropriation and environmental damage from mining activities have seriously affected the lives of local people. In addition, the NRG (Natural Resource Governance Institute) report also points to another shortcoming, namely that revenues such as mining grants and environmental protection fees are collected based on product data that companies declared. Besides, because of the limited monitoring system, the evasion and avoidance of tax are inevitable. Moreover, many financial-related issues such as the allocation and use of current revenues which the government managed are not thorough and not commensurate with the scale of exploitation, investment and environmental costs. Although the Government has banned the export of raw minerals and illegal export, this situation still occurs, causing great corruption and waste. Therefore, in order to reduce the inadequacies in mineral exploitation, the State management agencies unify and ensure the harmonization of interests of the parties, including the State, enterprises and the community; need early disclosure of basic information on mining projects, including: size, duration, power, status, license; environmental impact assessment reports, even mineral revenues contributed to the locality to ensure the rights of people at the place where there are minerals; In particular, transparency and accountability need to be improved to more effectively manage the country's mineral resources.

3. Research Results

3.1. Potential of Mineral Exploitation in Thai Nguyen Province

Thai Nguyen is quite rich in mineral resources, in which minerals with significant reserves can organize industrial exploitation of coal, iron, wolfram, tin, cement limestone, ilmenite. Minerals are mainly concentrated in districts in the North and Northwest of the province. Dong Hy, Vo Nhai, Dai Tu and Phu Luong districts account for nearly 70% of mineral mines in Thai Nguyen province, of which Dong Hy district has the highest number of mines in the province, accounting for 32.06%. Pho Yen, Phu Binh and Dinh Hoa districts Thai Nguyen accounts for 30% of the remaining mines, mainly mines of common construction materials. Meanwhile, Song Cong city does not have any mineral mine explored.

In Thai Nguyen province, there are a number of minerals with large reserves and high economic value. Especially, Wolfram mineral at Nui Phao mine has the largest reserves in the world and is the largest Wolfram producing mine in the world. Nui Phao project spread over an area of over 9,000 m². It is estimated that Nui Phao has reserves of over 100 million tons of wolfram-containing ore. Therefore, this is considered the largest wolfram mine in the world (excluding China). Every year, Nui Phao Company - H.C. Starck (a joint venture between Nui Phao Mineral Processing and Exploitation

Company, belonging to Masan Group and H.C. Starck Group) is expected to supply the market 7% of the total world supply. This output is nearly double the world's second-largest supplier, Russia.

Minerals	Mines / Locations	Reserves (Tons)
Tin	West of Nui Phao	112,887
	East of Nui Phao	76,166
	La Bang commune	75,662
Polymetallic Tungsten	Nui Phao	110,260,000
Lead, zinc	Vo Nhai, Dai Tu district	12,000,000

Table 1: Reserves of Some Major Metal Minerals in Thai Nguyen Province

Source: Thai Nguyen Department of Natural Resources and Environment, 2019

Besides, other metallic minerals such as tin, lead and zinc also have relatively large reserves and high economic value.

3.2. Mining Activities in Thai Nguyen Province

3.2.1. Type of Minerals

As of December 31, 2018 in Thai Nguyen province, there were 135 valid mineral mining licenses (including 23 licenses granted by ministries and 112 licenses granted by provincial-level People's Committees), including: 52 metal mines, 11 coal mines, 6 industrial mineral mines, 10 mineral mines for cement raw materials, 56 mines for common construction materials.

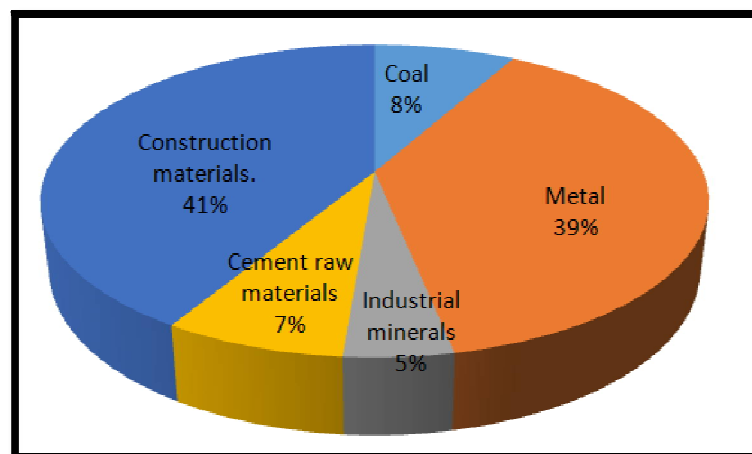


Figure 1: Proportion of Mining Licenses According to the Mineral Groups in Thai Nguyen Province

Source: Thai Nguyen Department of Natural Resources and Environment, 2019

In terms of percentage, mineral licenses in Thai Nguyen are mainly granted for mining of common construction materials (accounting for 41%) and metal mining (39%). This is because the mineral distribution in Thai Nguyen is mainly a number of metals such as iron, manganese, tin, wolfram and other common building materials minerals which have low economic value, including: sand, gravel and limestone.

On the other hand, the number of mineral licenses issued by the central government in Thai Nguyen as of the end of 2018 is 23 out of the total (accounting for 17% of the total number of mining licenses). This shows that the mineral mines in Thai Nguyen are mostly small-scale, with small value.

In the period of 2016 - 2018, the number of mineral exploitation licenses in Thai Nguyen province increased by 22, of which the license granted by the central level increased by 2 licenses and the license issued by the Provincial People's Committee increased by 20 licenses.

Indicators	2016	2017	2018
Mining license granted by the Ministry of Natural Resources and Environment	0	1	1
Renewed mining licenses	6	10	4
Adjusted mining license	1	2	4
Mining area (ha)	147	199	98.9
Mineral reserves newly licensed to exploit (million tons / m ³)	3.2	8.8	8.5
Decision on approving mineral reserves	15	3	9

Table 2: The Licensing of Mineral Exploitation in Thai Nguyen Province
Source: Thai Nguyen Department of Natural Resources and Environment, 2019

According to statistics, the percentage of central licenses issued in this period was 9.1%, lower than the percentage of central licenses granted on the total number of valid licenses. This may be a sign that large-scale and valuable mineral mines in the area are tending to exploit to the potential. In the coming period, the exploration and discovery of large and valuable mineral mines in the province will be more difficult.

3.2.2. Type of Mining Enterprises

Since the mineral law was enacted, Thai Nguyen province has had almost all types of mining enterprises. As of December 31, 2018, there were 91 enterprises licensed to explore and exploit minerals in Thai Nguyen. In which state enterprises have 10 enterprises, 35 joint stock companies, 30 limited companies, 08 private enterprises and 08 cooperatives.

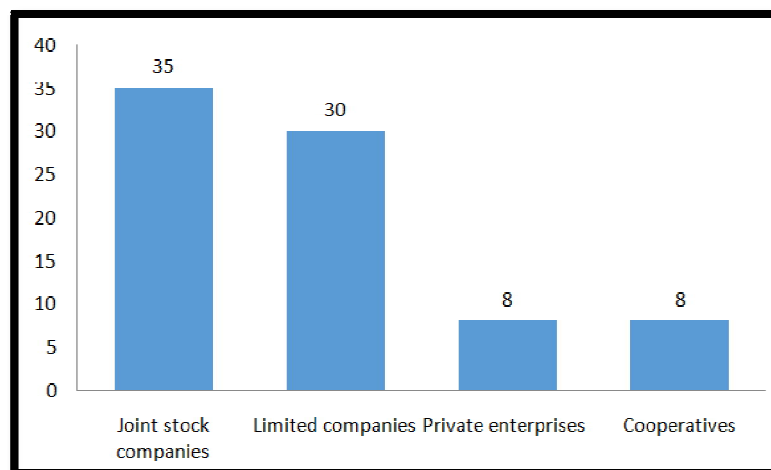


Figure 2: Enterprises Operating in Mineral Exploitation in Thai Nguyen Province
Source: Thai Nguyen Department of Natural Resources and Environment, 2019

Mining companies in Thai Nguyen are mainly small and medium-sized enterprises (accounting for 86%), mainly exploiting small mineral mines, with small scale, small reserves and not high economic value. Most of these enterprises have small capital scale, backward mining equipment, leading to the trend of wasting minerals and causing environmental pollution in the process of mineral exploitation.

Although only accounting for 14% of the number of enterprises exploiting minerals in Thai Nguyen, large enterprises in mineral exploitation and processing are contributing significantly to the value of mining in the province. Generally these businesses have strong capital, high-tech property, can take full advantage of technology to mining efficiently. However, the issue of environmental protection has not been focused by these enterprises.

3.2.3. Scale and Structure of Exploited Minerals

Regarding the scale of exploited mineral mines, although the number and types of mineral mines in Thai Nguyen are relatively plentiful, however, these mineral mines are mainly of small and medium scale.

Of the 135 mineral mines licensed to exploit in Thai Nguyen province, only 16 mineral mines with large reserves are exploited on an industrial scale including: 4 coal mines, 2 iron mines, 1 titanium mine, 1 zinc mine, 1 tin mine, 1 wolfram mine, 2 gold mines and 4 cement limestone mines.

In terms of scale of mineral exploitation output, most of mineral mines in Thai Nguyen province have exploited over 50% of reserves. Especially, the manganese iron mine or placer gold mine, dolomite mine, Barite mine have the exploitation rate up to 80% of the reserve. Currently in Thai Nguyen province, there are 3 new mineral mines in operation in recent years: the original gold mine, tin mine and Wolfram mine with the output of less than 50% of the reserve.

No.	Minerals	Number of mines	Reserves (Ton)	Exploited reserves (Ton)	Remaining reserves (Ton)
1.	Coal	10	27,654,484	16,551,668	11,102,816
<i>Iron</i>					
2.	Iron	18	37,735,621	22,792,710	14,942,911
3.	Lead zinc	4	849,821	470,800	379,021
4.	Tin	4	434,995	127,800	307,195
5.	Manganese iron	2	193,392	170,000	23,392
6.	Original gold	2	187,144	87,000	100,144
7.	Placer gold	1	170,254	130,000	40,254
8.	Titan	4	5,878,187	3,352,228	2,525,959
9.	Polymetallic tungsten	1	110,260,000	28,000,000	82,260,000
<i>Industrial minerals</i>					
10.	Barit	1	20,113	17,600	2,513
11.	Dolomite	2	3,300,000	3,038,000	262,000
<i>Cement raw materials</i>					
12	Cement limestone	4	197,801,390	35,552,000	162,249,390
13	Cement clay	2	24,377,200	7,320,500	17,056,700
<i>Conventional construction materials</i>					
14	Sandstone	3	7,345,365	2,026,000	5,319,365
15	Clay for bricks and tiles	4	2,388,924	1,038,000	1,350,924
16	Sand and gravel (m ³)	17	10,894,366	2,611,800	8,282,566
17	Backfill land	1	1,851,058	390,000	1,461,058
18	Limestone	22	42,147,828	11,690,000	30,457,828

Table 3: Scale of Exploitation and Reserves of Some Major Minerals of Thai Nguyen Province

Source: Thai Nguyen Department of Natural Resources and Environment, 2019

In terms of distribution of mineral mines by administrative area in Thai Nguyen province, there are over 75% of mineral mines concentrated in 3 districts of Dai Tu, Dong Hy and Vo Nhai. Song Cong City is the only administrative unit with no mineral mines.

3.2.4. Impact of Mineral Exploitation on Socio-Economic Development of Thai Nguyen Province

3.2.4.1. Positive Impacts

3.2.4.1.1. Meeting the Demand for Mineral Raw Materials for Industrial Development in Thai Nguyen Province

The scale of mineral exploitation in Thai Nguyen has partly met the production needs of the processing enterprises in the province. The group of industrial minerals meets about 5% - 10% of the input demand for industrial enterprises in the province (Barit ore meets 5% of the provincial demand, Kaolin meets about 10% of the demand.). Coal mines meet about 95% of coal demand for production and business activities of businesses in Thai Nguyen. Metal ores also meet only about 20-50% of the production needs of metallurgical enterprises. The lack of metallurgical enterprises has been actively imported from other localities and from other countries.

3.2.4.1.2. Contributing to Economic Growth of Thai Nguyen Province

The mining industry is an industry that generates income and accumulates for the economy, especially in the context that the economy is still in shortage of capital like Vietnam in general and Thai Nguyen province in particular.

Minerals	2016		2017		2018	
	Revenue (VND billion)	Proportion (%)	Revenue (VND billion)	Proportion (%)	Revenue (VND billion)	Proportion (%)
Coal	458.5	8.1	1505.7	21.68	1728.9	21.48
Iron	5025.8	88.8	5271.7	75.89	6091.2	75.67
Industrial mineral	4.8	0.1	3.8	0.06	1.1	0.01
Cement raw materials	53.3	0.9	42.7	0.61	56.7	0.7
Construction materials	114.6	2.1	122.6	1.76	171.7	2.14
Total	5,657	100	6,946.5	100	8,049.6	100

Table 4: Revenue of Mining Industry in Thai Nguyen Province

Source: Thai Nguyen Department of Natural Resources and Environment, 2019

The revenue of the mining industry in Thai Nguyen grew relatively steadily in 3 years 2016 - 2018. The growth rate in 2017 was 22.8%, in 2018 reached 15.8%. In the mining industry, the revenue of industrial minerals has decreased over the years from 2016 to 2018. This is because of the relatively small reserves of industrial mines which have been exploited up to 60 - 70% of the reserves, so the subsequent years of exploitation are more difficult than the previous year.

The revenue of the metal mining group is the highest, accounting for 88.8% in 2016, 75.89% in 2017 and 75.67% in 2018. Although the proportion has decreased slightly, the growth rate of revenue in metal mineral group is still very stable. The growth rate of this group in 2017 was 4.89%. In 2018, the growth rate reached 15.6%. Growth in the metal mining group is mainly due to Wolfram multi-metallic mining. Wolfram exploitation and supply in Thai Nguyen reaches the world's largest supply with a revenue of VND 5328 billion.

Although the scale of the province's mining industry has grown well, the proportion of Thai Nguyen province's industrial production value tends to decrease.

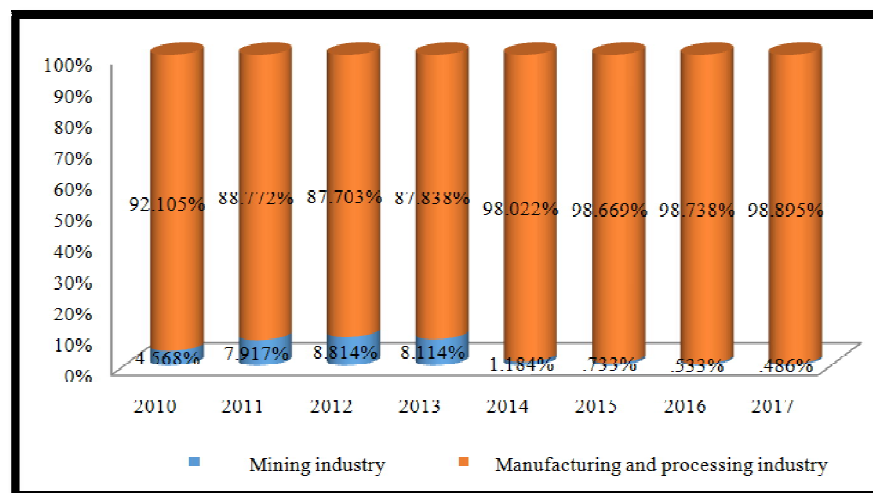


Figure 3: Contribution of Mining Industry to the Total Industrial Production Value of Thai Nguyen Province in the Period of 2010 - 2017

Source: Thai Nguyen Statistical Office, 2013, 2016, 2019

In the period of 2010 - 2013, the contribution of mining industry to the total value of industrial production continued to increase and accounted for 8,114% in 2013. However, from 2014 to the present, the contribution of mining industry to the province's industrial production value decreased and only accounted for 0.486% in 2017. This is because, since 2013, Thai Nguyen province has attracted FDI of strategic partner, Samsung, resulting in a series of big projects in manufacturing industry. Thereby, the production value of the processing industry, manufacturing increased very quickly and accounted for an increasing proportion.

3.2.4.1.3. Contributing to Creating Jobs

In addition to contributing to the economic growth of Thai Nguyen province, the mining industry in Thai Nguyen province also contributes greatly to creating jobs.

Minerals	2016		2017		2018	
	Number of employees (people)	Proportion (%)	Number of employees (people)	Proportion (%)	Number of employees (people)	Proportion (%)
Coal	1,464	31.6	2,232	38.8	2,114	39.5
Iron	2421	52.3	2,591	45.0	2,464	46.1
Industrial mineral	75	1.6	19	0.3	20	0.4
Cement raw materials	93	2.0	148	2.6	165	3.1
Construction materials	581	12.5	769	13.3	581	10.9
Total	4,634	100	5,759	100	5,344	100

Table 5: Labor in the Mining Industry in Thai Nguyen

Source: Thai Nguyen Department of Natural Resources and Environment, 2019

The number of employees in the field of mining in 2016 was 4634 people, in 2017 increased by 24.3% to 5759 people, but by 2018 decreased by 7.2% to 5344 people. The number of employees in the mining industry increased in 2017 and then decreased in 2018 due to the fact that many large mineral mines were put into stable operation and the

application of the technology system which replace for labor, leading to a decrease in the number of employees in the industry.

The number of employees employed by metal mining industry is the largest, accounting for 52.3% in 2016 and 46.1% in 2018. The metal mining industry is the industry with the largest mining scale, the largest mining value so the number of employees is also larger than other sectors. However, in terms of proportion between size and number of employees, it can be seen that labor productivity in the metal mining industry is the largest. Because the metal mining technology has applied modern technologies, especially in Nui Phao multi-metallic mineral mine, using modern mining technology and transmission lines up to international standards. Labor in the coal industry ranked second and accounted for a very large proportion of 39.5% of labor in the industry. The proportion of labor in coal mining continued to increase in the period of 2016 - 2018 due to the increase in scale of coal mining in this period, while coal mining technology was still relatively outdated, so the number of the amount of labor will increase with the increase in the scale of exploitation.

3.2.4.2. The Negative Impacts

3.2.4.2.1. Causing Depletion of Mineral Resources

Mining activities in Thai Nguyen are being exploited, mainly small mines, using semi-automatic technology, weak management capacity, leading to the loss and waste of resources in the process of mineral exploitation.

Currently, there are still illegal mining activities in the area. Illegal mineral mines often use manual technology, causing huge waste of mineral resources in the province and causing difficulties in the process of planning and managing mineral exploitation in the province.

3.2.4.2.2. Causing Environmental Pollution

Regarding the water environment, according to the results of monitoring and supervision of water quality of rivers and streams in Cau river basin in Thai Nguyen province during the period of 2016 - 2018, it shows that water quality of rivers is on the trend. The main reason is due to the relatively high concentration of suspended solids (TSS) in the water, partly due to the flow factors and the impact of rain and flood, however, mainly due to the mining activities (coal, gold, sand and gravel) in the area that have greatly increased the amount of suspended substances entering the water environment. TSS content at many times exceeded the permissible limit from 1.5 to 3 times the permitted limit of QCVN 08-MT: 2015 / BTNMT (A2).

The air environment is monitored for quality at 30 points, including 9 points for monitoring the quality of the environmental status in urban districts, 21 points for monitoring the quality of the area affected by the operation of production and business establishments. . Monitoring results in 2018 showed that 14/21 impact air points were of relatively good quality, the monitoring parameters were within the allowed limits; 7/21 points near mining mines, metallurgical plants, areas near roads with many vehicles, slightly polluted by TSP dust and PM10 dust (dust concentration exceeds 1.07- 2.17 times).

The soil environment is monitored at 4 locations affected by large business establishments in the area. According to the monitoring, three-quarters of the monitoring soil samples have heavy metal criteria exceeding the standard and tend to increase over the years, those locations are: along Cam Gia stream, Cam Gia ward, Thai Nguyen city; Ha Thuong commune, Dai Tu district and Tan Long commune, Dong Hy district.

In addition, mining activities always contain the risk of incident risks such as labor accidents; landslide landslides, incidents of fire and explosion, destabilizing social security of people and workers.

3.2.4.2.3. Increasing the Risk of Instability in Security and Social Order of the Localities

The lives of the people, the security and order in the area of mining activities have been changed. Because the mines often attract labor from many other localities, the migration with a large number of labor leads to many consequences. Increasing market prices, affected local cultural and traditional life, etc.

On the other hand, mineral mining often causes degradation of traffic infrastructure in the mining areas because the mineral transport vehicles which are often heavy vehicles with high frequency of traffic damage the transportation system in the mine regions. That has a significant negative impact on the lives of people in the vicinity of mineral mines.

3.2.4.2.4. Does Not Guarantee Employment Sustainability for Workers

Regarding employment, the current mineral mines are often in remote areas where people mainly live on agriculture - forestry production. Mining activities mainly use land, forest and water resources, and the life of the people directly depends on those resources. On the other hand, the mining industry is not stable and sustainable. This activity mainly depends on non-renewable resources, that is, this activity will cease and workers will lose their jobs when the mine is exhausted.

4. Conclusion and Policy Implications

4.1. Conclusions

Thai Nguyen is one of the provinces with relatively rich and diverse mineral resources, reserves of some relatively large minerals such as Wolfram, tin, iron, and coal. Currently, Thai Nguyen has 135 mining licenses granted to 91 enterprises, of which 23 are issued by the central government. Mining revenue has grown relatively fast in recent years,

the average growth rate of mining revenue reached 19% per year in the period of 2016 - 2018, contributing to promoting economic growth. of the province, creating jobs for more than 5000 workers.

However, Thai Nguyen province still has a number of illegal mining sites, the mines are mainly exploited by small and medium enterprises, the main mining technology used is manual technology and semi-automatic technology leading to waste and loss of minerals, reduce the efficiency in mining and cause problems of environmental pollution and social instability.

4.2. Policy Implications

In order to ensure the effectiveness of mineral exploitation and overcome the negative aspects in mineral exploitation, the local authorities need to implement some following policy solutions:

- Promote the propagation, dissemination and education of laws and guide organizations and individuals engaged in mineral activities to strictly comply with the provisions of law; raise the awareness of participation in management and protection of mineral resources, protection of the ecological environment and interests of the community to all strata of the people. The role of leadership responsibility and direction of the party committees and authorities of the communes is highlighted; In particular, clearly defined the highest authority and responsibility belonging to the head.
- Strengthen inspection and examination in order to promptly detect and handle violations in licensed mines and illegal mines.
- Performing well the detailed development planning of the mining industry in order to determine the objectives and directions of effective solutions for the exploitation and use of mineral resources in Thai Nguyen province.
- Complete the granting of mineral mining licenses and well implement environmental impact assessment for mining projects.
- Enhance the participation of people in supervising mining activities in order to improve the efficiency of mineral exploitation in Thai Nguyen province.
- Promote the mechanization of mineral exploitation to improve labor productivity, reduce labor intensity for workers, increase safety factors and many other benefits.

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