



КООПЕРАЦИЯ НАУКИ И ОБЩЕСТВА КАК ИНСТРУМЕНТ МОДЕРНИЗАЦИИ И ИННОВАЦИОННОГО РАЗВИТИЯ

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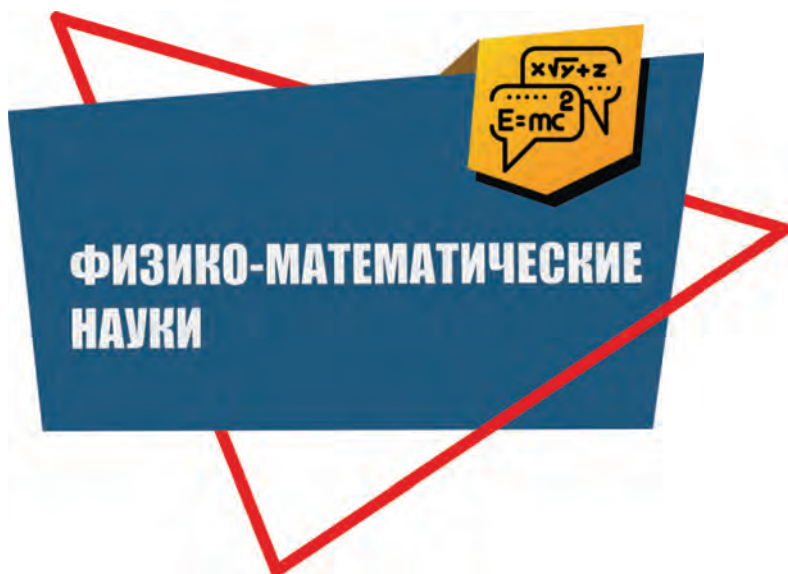
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Nguyen Thi Hoa

Doctor of Philosophy, Hanoi University of Mining and Geology,
Hanoi, Vietnam

**ASSESSING THE CURRENT ENVIRONMENTAL STATUS AND DETERMINING
THE CAUSES OF ENVIRONMENTAL POLLUTION IN MINERAL EXPLOITATION
ACTIVITIES IN COASTAL AREA
OF DUC THO, CAN LOC, HA TINH PROVINCE**

Annotation

The mining industry has been increasingly occupying an important position in our country's economy and is an important resource in the country's industrialization process. According to the results of the investigation and actual survey in Duc Tho - Can Loc area, there are currently 9 mineral mines including: 03 manganese mines, 02 construction stone mines and 04 landfill mines. Based on the field survey, analysis of samples and documents related to the research area, the article analyzes the current status and causes of environmental pollution. The results of the investigation and assessment of the current environmental status related to mineral exploitation activities have shown that the environment in the research area shows signs of pollution to serious pollution. Through the results of measuring and analyzing surface water samples, it shows that some indicators exceed the allowable standards many times, typically: DO is 2.7 - 1.07 times lower; pH is 1.01 times lower; COD is 2.4 - 31.2 times higher; BOD₅ 2.8 - 3.8 times; Mn: exceeds 3.9 times. Groundwater in people's domestic wells is particularly seriously polluted. The water is opaque white and soil sample analysis results show that Cu content exceeds 1.2 - 15.7 times; Mn exceeds 1.3 times; As exceeds 2.2 - 8.9 times. It is acknowledged that there are two main causes of environmental pollution in the study area as identified by the authors including: natural causes (including topographic factors, river network factors) are the prerequisite factors for environmental pollution and human causes are the most direct and important factors causing environmental pollution in mineral exploitation mines.

Keywords

Environmental pollution, mineral exploitation, Duc Tho, Can Loc

1. Introduction

The mining industry has been playing an increasingly important role in our country's economy and is an important resource in the country's industrialization process. However, besides the positive aspects, mining activities also cause many negative impacts on the ecological environment and human life and property. The exploitation and use of mineral resources in general have a strong impact on the natural environment; including the living environment. [4]. In addition, the work of assessing the current state of the environment has not been given due attention and has not been

well implemented, so the problem of environmental pollution in mineral exploitation activities is increasing in both quantity and scale. The main factors affecting the environment are activities from mineral exploitation sites, waste dumps, toxic gases, dust and mine wastewater,... which disrupt the natural balance, causing serious pollution to the environment and directly affecting human health.

The actual situation in recent years shows that the problem of environmental impact and risk of pollution related to mineral exploitation activities is becoming more and more complicated, the phenomenon of environmental accidents due to mineral exploitation occurs with increasing frequency, intensity and density, causing great damage and becoming more and more serious. Along with the high growth in exploitation capacity are the risks of environmental accidents at mines, mineral processing areas, waste dumps, tunnels in underground mining, etc., the risk of breaking tailings dams as well as the possibility of subsidence and subsidence in underground mining and their consequences on the ground surface can also cause the spread of toxic substances into the surrounding environment, causing environmental pollution in the mining areas and surrounding areas in the research area [3].

Duc Tho - Can Loc area is an area with strong mining activities, including mining types such as manganese and mining of soil and stone for construction materials with different scales and technologies. [3]. Mineral exploitation activities have contributed to job creation, increased budget revenue, and promoted local economic development, but due to the lack of advanced mining technology and the lack of attention to environmental protection in mineral exploitation areas, the environment in many mineral exploitation areas has been seriously polluted and degraded. Therefore, assessing the current state of the environment related to mineral exploitation activities and identifying the causes of environmental pollution risks in mining, thereby proposing solutions to prevent, minimize, and overcome environmental pollution in mineral exploitation activities in the Duc Tho - Can Loc area of Ha Tinh province is extremely necessary and urgent.

2. Current environmental status related to mining activities in coastal area of Duc Tho - Can Loc, Ha Tinh province

2.1. Current status of mineral exploitation in the study area

Duc Tho is located in the north of Ha Tinh province, about 57 km north of Ha Tinh city, about 325 km south of the center of Hanoi capital . According to data collected at the Department of Natural Resources and Environment of Ha Tinh province and the results of actual surveys in the Duc Tho - Can Loc area as of the end of 2024, in the area there are 09 mines in operation including: 03 manganese mines, 02 mines construction stone, 04 landfills Some places mine ore without a license [4].

2.2. Principles for determining the level of environmental pollution

Environmental status in mining areas is based on pollution levels regulated by the Circular of the Ministry of Natural Resources and Environment No. 07 / 2007 / TT - BTNMT dated 03 / 7 / 2007, classifying and listing environmental pollution factors that needed to handle and the Circular No. 04 / 2012 / TT - BTNMT dated 08 / 05 / 2012, regulating criteria as basis for determining the classification for environmental pollution factors, causing serious environmental pollution.

Environmental pollution levels are determined in detail for each parameter based on the comparison between the results of sample analysis with the National Technical Regulations on Environmental Quality Standards (TCCLMT) [1,2]. According to above provisions, the environment status in mining sites of Quy Hop, Nghe is determined based on the data at the time of the survey and the results of the sample analysis following four levels:

- Environment without pollution: As environmental parameters are between the permitted level of TCCLMT.

- Environment with pollution: the pollutants exceed TCCLMT.
- Environment with serious pollution: the levels of chemicals and heavy metals exceed the TCCLMT 3 times, or other contaminants exceed the TCCLMT 5 times or more.
- Environment with extreme pollution: the levels of chemicals and heavy metals exceed the TCCLMT 5 times or more, or other contaminants exceed the TCCLMT 10 times or more.

2.3. Environmental status of mining sites

From the results of field surveys, data collection and analysis of the current environmental status in the research area, the current environmental status of Duc Tho - Can Loc, Ha Tinh is as follows:

*** Water quality:.**

Mineral mines in Duc Tho - Can Loc area are located on main surface water sources: Lam stream, Lang stream, Bai Da stream. The current environmental status of surface water sources is as follows:

- *Lam Stream*: Is the water source of the tributaries of the U Bo mountain range to the southwest and the Xanh mountain range to the northeast (Tan Huong commune). The stream flows northwest through village 1, Tan Huong commune to hamlet 4, Duc Lac commune, then flows into Ngan Sau river, the length of the polluted river is about 15km. This is the source of domestic water for about 300 households and irrigation for about 600 hectares of agricultural land in Tan Huong commune. On the tributaries of the stream basin, there are 2 manganese mines and 2 landfill mines that regularly discharge wastewater into this stream.

At the tributaries of Lam stream basin, the analysis results of 7 surface water samples, 4 groundwater samples and 1 comparison sample in a stream without an exploited mine were collected.

Investigation results in 2024 showed that the entire Lam stream was polluted. The stream water was light yellow to yellow - brown in color, had a fishy smell, and contained a lot of suspended solids.

The results of surface water sample analysis determined that the stream water was seriously polluted, DO content: 4.78 - 5.03mg / l, 1.25 - 1.19 times lower than the standard, pH: 5.60 - 5.95, 1.07 - 1.01 times lower than the standard; COD content: 27 - 54mg / l, exceeding the standard by 2.7 - 5.4 times; BOD5: 10 - 22mg / l, exceeding the standard by 2.5 - 5.5 times.

Groundwater in people's domestic wells is particularly seriously polluted. The water is light yellow, COD content: 26 - 125mg / l, exceeding the standard by 6.5 - 31.2 times. Heavy metal content: Mn: 0.6mg / l, exceeding the standard by 1.2 times.

Facilities discharging solid waste and wastewater causing water pollution include: Manganese mines of Ha Tinh Manganese Minerals Joint Stock Company; landfill mines of Cam Tu Company Limited, Quyet Tien Private Enterprise.

- *Khe Lang*: Is the water source of the ditches in the Northeast slope of U Bo mountain range (Duc Dung commune), flowing in the Northeast direction through hamlet 1 to hamlet 8, about 13km long. The upstream part of Khe Lang is dammed to contain water, providing domestic water for about 500 households and irrigating about 800 hectares of agricultural land in Duc Dung and Duc Lap communes. On the tributaries in the stream basin, there is a manganese processing factory of Ha Tinh Manganese Minerals Joint Stock Company discharging wastewater into Khe Lang basin.

At the tributaries of the stream basin, 4 surface water samples, 4 groundwater samples and 3 comparison samples were taken at streams without mines.

Investigation results in June 2011 showed that Khe Lang water was polluted. The stream water was yellow - brown, had a fishy smell and contained a lot of suspended solids.

The results of surface water sample analysis determined DO content: 2.38 - 4.33mg / l, 2.52 - 1.38 times lower than the standard, pH: 5.96, 1.01 times lower than the standard; COD: 24 - 34mg / l, exceeding the standard by 2.4 - 3.4 times; BOD₅: 11 - 15mg / l, exceeding the standard by 2.8 - 3.8 times.

Groundwater in people's domestic wells is particularly seriously polluted. The water is turbid, near the processing area, containing a lot of suspended solids, COD content: 47 - 102mg / l, exceeding the standard by 11.8 - 25.5 times.

Heavy metal content: Mn 1.95mg / l, exceeding the standard 3.9 times.

Facility discharging solid waste and wastewater causing pollution: Manganese processing workshop of Ha Tinh Manganese Minerals Joint Stock Company.

- *Bai Da Stream*: Is the water source of the tributaries of the southwestern mountain range, Thuong Loc commune. The stream flows in the northeast direction, from Thanh My hamlet to Phu Tho hamlet (Thuong Loc commune), about 10km long, providing domestic water for about 600 households and irrigating about 500 hectares of agricultural land.

On the tributaries of the stream basin, there is 1 manganese mine and 1 landfill mine.

At the tributaries of the stream basin, 4 surface water samples, 3 groundwater samples and 3 samples were taken from streams without exploited mines.

Investigation results in July 2011 showed that Bai Da stream water was polluted. The stream water was yellow - brown, had a fishy smell and contained a lot of suspended solids.

The results of measuring and analyzing surface water samples determined DO content: 2.23 - 5.43mg / l, 2.7 - 1.1 times lower than the standard, pH: 5.98, lower than the standard; COD: 25 - 33mg / l, exceeding the standard by 2.5 - 3.3 times; BOD₅: 10 - 19mg / l, exceeding the standard by 2.5 - 4.8 times. FFFFF

Groundwater in domestic wells is particularly seriously polluted. The water is colorless, COD content: 31 - 113mg / l, exceeding the standard by 7.8 - 28.2 times.

Heavy metal content: Mn 0.68mg / l, exceeding the standard by 1.4 times.

The facility discharging solid waste and wastewater causing pollution is the manganese mine of Ha Tinh Manganese Minerals Joint Stock Company (Fig 4.94).

Characteristics of water pollution in stream basins in Duc Tho - Can Loc area are listed in Table 1.



Fig 1: Waste and wastewater from the Duc Lap manganese mine's ore dressing workshop discharged into Lam stream basin

Table 1. Statistics Surface water and groundwater pollution in Duc Tho - Can Loc area

TT	Location	Water source	Pollution characteristics			Pollution level
			Scale	Color	Parameter	
1	Khe Lam	Surface water (32M)	The polluted stream is about 8km long.	Pale yellow to yellowish brown, containing suspended	DO is 1.2 times lower; pH is 1.07 - 1.01 times lower; COD is 2.7 - 5.4 times higher; BOD ₅	Polluted

				solids	is 2.5 - 5.5 times higher	
		Groundwater (25N)	Quaternary porous aquifer, area 4.8km ²	Pale yellow, fishy smell	pH lower than standard; COD exceeds 6.5 - 31.2 times; Mn exceeds 1.2 times	Particularly serious
2	Khe Lang	Surface water (33M)	10km long polluted stream	Pale yellow to yellowish brown, containing suspended solids	DO is 2.52 - 1.38 times lower; pH is 1.01 times lower; COD exceeds 2.4 - 3.4 times; BOD ₅ is 2.8 - 3.8 times	Polluted
		Groundwater (26N)	Quaternary porous aquifer, area 6.6km ²	Pale yellow, fishy smell	COD exceeds 11.8 - 25.5 times; Mn: exceeds 3.9 times	Particularly serious
3	Rock Creek	Surface water (34M)	The polluted stream is about 10km long.	Pale yellow to yellowish brown, containing suspended solids	DO is 2.7 - 1.1 times lower; pH is lower than standard; COD exceeds 2.5 - 3.3 times; BOD ₅ is 2.8 - 4.8 times	Polluted
		Groundwater (27N)	Quaternary porous aquifer, area 2.5km ²	Pale yellow, fishy smell	COD exceeds 7.8 - 28.2 times; Mn exceeds 1.4 times	Particularly serious

*** Soil quality:**

In the Duc Tho - Can Loc area, the polluted land area is plain land, mainly distributed in Duc Lap, Duc Dung (Duc Tho district) and Thuong Loc (Can Loc district). The current status of the soil environment in these areas is as follows:

- Duc Lap Area

The soil of Duc Lap area is distributed on both sides of Khe Lam basin, from village 3, Tan Huong commune to the bank of Ngan Sau river, with an area of about 700 hectares. This is the rice and vegetable growing land of the people of Tan Huong, Duc Lap and Duc Lac communes.

On the land area of Duc Lap, 11 samples were taken in polluted areas and 3 samples in places that did not affect the mining environment.

The analysis results show that 6 soil samples are extremely seriously polluted. Cu content: 59 - 787ppm, exceeding the standard by 1.2 - 15.7 times; Mn: 4,048ppm, exceeding the standard by 1.3 times; As: 26.8 - 107.1ppm, exceeding the standard by 2.2 - 8.9 times.

The cause of pollution is the dispersion of solid waste and wastewater from manganese mines of Ha Tinh Manganese Minerals Joint Stock Company; and landfill of Cam Tu Company Limited and Quyet Tien Private Enterprise.

- Duc Dung area

The soil of Duc Dung area is plain land, distributed from the foot of Khe Lang dam to hamlet 9, Duc Lam commune, with an area of about 650 hectares. This is the land for two - crop rice cultivation of the people of Duc Dung commune, Duc Tho district and Thuong Nga commune, Can Loc district.

On the land area of Duc Dung, 7 samples were taken in polluted areas and 3 samples in places that did not affect the mining environment.

Results of soil sample analysis showed that 4 samples were particularly seriously polluted, with As content of 23.9 - 123.6ppm, exceeding the standard by 2 - 10.3 times.

The cause of pollution is due to solid waste and wastewater from the manganese processing factory of Ha Tinh Manganese Minerals Joint Stock Company being dispersed into the environment.

- *Thuong Loc area*: The soil of Thuong Loc area is plain land, distributed from Thanh My hamlet to Phu Tho hamlet, Thuong Loc commune, with an area of about 420 hectares.

On the land area of Thuong Loc, 5 soil samples were taken in the polluted area and 2 soil samples in places that did not affect the mining environment.

Results of soil sample analysis showed that 3 samples were particularly seriously polluted, with As content of 46.4 - 125.6ppm, exceeding the standard by 3.9 - 10.5 times.

The cause of pollution is solid waste and wastewater from the manganese mine of Ha Tinh Manganese Minerals Joint Stock Company (Figs 4.95 and 4.96).



Fig 2: Solid waste and wastewater at Duc Dung manganese mine discharged directly into Khe Lang lake



Fig 3: Solid waste and wastewater at Duc Dung manganese treatment plant are discharged directly into the environment.

Characteristics of soil pollution in Duc Tho - Can Loc area are listed in Table 2.

Table 2. Summary table of contaminated soil in Duc Tho - Can Loc area

TT	Location and area code of pollution	Polluted area (km ²)	Pollutant components	Pollution level
1	Duc Lap Area (35D)	7.91	Cu exceeds 1.2 - 15.7 times; Mn exceeds 1.3 times; As exceeds 2.2 - 8.9 times	Particularly serious
2	Duc Dung Area (36D)	3.96	As exceeds 2.0 - 10.3 times	Particularly serious
3	Thuong Loc Area	2.54	As exceeds 3.9 - 10.5 times	Particularly serious

*** Air quality**

According to the results of environmental sample collection at Thuong Loc manganese mine, the environment was monitored at 2 stations, 13 air samples were taken in the polluted area and 3 air samples outside the polluted area.

Environmental monitoring results in 2024 determined that in the Duc Tho - Can Loc area, the suspended dust concentration exceeded the limit by 1.02 - 1.98 times, and noise exceeded the limit by 1.16 - 1.28 times.

The facility discharging waste causing air pollution is a manganese mine in Thuong Loc commune, Can Loc district.

3. Affected area and pollution causes

3.1. Affected area

- *Duc Lap area*: The affected area belongs to Lam stream basin from hamlet 2, Duc Lap (Duc Tho) to hamlet 7, An Phu (Vu Quang). Environmental pollution causes some of the following consequences:

- Nearly 450 hectares of agricultural land in Hamlet 1 (Duc Dong Commune), Hamlet 4 and Hamlet 6 (Duc Lac Commune) were affected, many areas of land were barren (Fig 4), of which about 30 hectares near the mines were filled with solid waste (Fig 5).



Fig 4: Rice fields in hamlet 6, Duc Lac are barren, some fields are abandoned.



Fig 5: Rice fields near Duc Lap manganese mine are filled with solid waste.

- More than 200 families in Duc Lap, Duc Dong, and Duc Lac communes living near Lam stream lack water for daily use. In the summer, people and livestock have to use well water. Some families have to get water from Ngan Sau river for daily use.

- About 50 families in hamlet 6 (Duc Lac commune) are regularly affected by dust and noise from construction machinery.

- *Duc Dung area*

The scope of influence is Khe Lang basin and Khe Lang lake, from hamlet 6 to hamlet 1 (Duc Dung commune). The consequences of environmental pollution have left some consequences as follows:

- Over 70 families from hamlet 6 to hamlet 1 lack water for daily use, and are constantly affected by dust and noise from engines. The results of a sociological survey have determined that the rate of people suffering from respiratory, intestinal, and dermatological diseases... is many times higher than the average annual statistics of Duc Dung Medical Station.

- Nearly 200 hectares of agricultural land in Duc Dung commune are degraded or abandoned.



Fig 6: Agricultural land in Duc Dung commune is degraded, low productivity leads to abandonment



Fig 7: Agricultural land near Mn mines is filled with solid waste, losing the ability to cultivate.

- About 100 hectares of planted forest were affected, of which over 30 hectares were cut down due to mining as shown in Figs 6 and 7.
- Due to solid waste sedimentation, the bottom of Khe Lang Lake gradually dries up, reducing the water storage capacity.



Fig 8: Vegetation in forests in Duc Dung commune affected by Mn exploitation



Fig 9: Some forest areas at mining sites were cut down, leaving the mountainside bare of rocks and gravel.

- Thuong Loc Area

In Thuong Loc area, hundreds of cubic meters of wastewater from the manganese ore processing plant are discharged into the environment every day ^{without} treatment (Figs 4.103 and 4.104). The waste and wastewater contain a lot of mud, clay, and heavy metal elements, causing widespread environmental pollution. Environmental pollution causes the following consequences:



Fig 10: Solid waste and wastewater at Thuong Loc Mn mine fills the entire Thanh My stream



Fig 11: Solid waste at the Mn treatment plant has a volume of hundreds of thousands of cubic meters, into the environment, causing trees to die.

- Affects more than 80 households in Thanh My, Tra Son, Bai Da, Xuan Mai, Dong Thanh, Dong Phong hamlets, Thuong Loc commune, Can Lo district. Wastewater and solid waste overflow into residential areas. Especially in the dry season, the dust content in the air is quite high, greatly affecting the health of families near the mining area.



Fig 12: Tra Son Hamlet, solid waste spills over into residential areas, encroaches on roads, and affects high - voltage power lines.



Fig 13: On traffic routes, the density of ore - carrying vehicles is high, stirring up dust and dirt, causing serious environmental pollution.

- About 23 hectares of agricultural land were affected, the crop yield was lower this year than the previous year so it had to be left fallow.



Fig 14: Solid waste and polluted wastewater have caused rice fields in Thanh My village to become unproductive and have to be abandoned.



Fig 15: Solid waste buried agricultural land in Tra Son hamlet

- About 30 hectares of planted forest on the gentle hills of the mine area were destroyed, the hills were left with exposed rocks and gravel, at risk of erosion, causing the risk of mud and rock floods.

3.2. Environmental pollution causes in study area

Based on the collected materials, documents and practical experiences in the study area of the authors, it is obvious that the main causes of environmental pollution in mining sites includes natural and human cause.

Natural factors that play a role as a premise for environmental pollution or promote the increase and complex development of environmental pollution include factors related to terrain, river networks and specific tectonic and geological factors: This group of causes is primarily due to the mineral mining areas having steep terrain, strong dissection, and low coverage. This is a factor that creates favorable conditions for waste sources from mining activities to be easily transported along the mountain slopes, dispersed quickly and widely. In fact, the investigation results show that mineral mines in dissected, steep mountainous terrain all cause serious or extremely serious pollution, typically mines exploiting lead - zinc, manganese. At the same time, with the characteristics of rivers and streams in Ha Tinh province developing, but the flow is short and

steep, some places develop underground flows in karst caves, combined with harsh climate conditions, heavy and irregular rain are factors that strongly impact the environment in mineral exploitation areas, increasing and aggravating the level of pollution in many places.

Besides, human factors are the most direct and important factors causing environmental pollution at mineral mines such as outdated mineral mining and processing technology with high risk of pollution, environmental protection work in mineral mining and processing has not been well implemented and environmental management work of management agencies still has many shortcomings and is unreasonable.

4. Conclusion

1. Research results show that the biggest impacts on the environment due to mineral exploitation activities in the Duc Tho - Can Loc area are the deformation of the terrain and landscape of the area; changing the cultural and social environment both positively and negatively. After the mining process,,it often leaves behind terrain forms that are at high risk of landslides, polluting the environment, especially the water environment.

2. *Mineral exploitation activities have caused many negative impacts on the surrounding environment. Through the subjective assessment of the group of authors, it can be summarized in a number of main causes including natural factors such as river network, terrain, origin of mineral formation and human causes such as ineffective use of natural mineral resources; outdated mineral exploitation and processing technology; poor implementation of environmental protection in exploitation and management work still has many shortcomings.*

3. Practice shows that assessing the current state of the environment and determining Environmental pollution issues related to mineral exploitation activities in Duc Tho - Can Loc area in particular and mineral exploitation areas in the country in general are important issues in the sustainable socio - economic and environmental development of the research area in particular and Ha Tinh province in general.

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450076, г. Уфа, ул. Пушкина 120

<https://aeterna-ufa.ru>
info@aeterna-ufa.ru
+7 (347) 266 60 68