

Economic Valuation of Community Losses from Water and Air Quality Degradation in Nickel Mining Activities

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Unsustainable use of natural resources can cause environmental damage. As in the nickel mining activities of PT. X, water, and air pollution cause diseases such as itchy skin and coughs. The purpose of this study is to analyze the economic impacts of water and air pollution. The study was conducted in the Tinanggea District, covering Lapoa and Bomba-Bomba Villages. The research location was determined using purposive sampling because residents in both villages experienced negative impacts from pollution. This study used a quantitative descriptive approach with economic valuation. Quantitative data were obtained through interviews with 45 rice farmers. Community losses were estimated using the cost-of-illness method, lost income, and decreased productivity. The value of losses due to water quality degradation includes medical costs of IDR 15,974,604/Year and lost income costs of IDR 55,650,604/Year. Air pollution causes coughs suffered by children in Lapoa and Bomba-Bomba Villages. This analysis uses only the medical cost approach, which is IDR 1,089,000/Year. The total loss due to water and air pollution is estimated at IDR 72,714,208/Year. Therefore, government supervision of nickel mining activities is needed, while PT. X must restore environmental quality to prevent further harm to the community.

Keywords: Cost of Illness; Economic Valuation; Community Losses; Environmental Degradation; Nickel Mining; Pollution

JEL Classification: Q51; Q53; Q58; I18

INTRODUCTION

Human survival is highly dependent on the potential of natural resources. However, their utilization sometimes fails to adhere to sustainable environmental practices. In several countries, we often witness environmental damage caused by unsustainable resource use. For example, PT X's nickel mining activities on Gag Island have negatively impacted not only the community's income but also public health (Maga et al., 2025).

Human needs for natural resources include renewable and non-renewable resources. Renewable resources include fisheries, forests, and water resources. Conservation of renewable natural resources is needed to maintain environmental sustainability through stakeholder engagement and sustainable resource management (Hanafi et al., 2025). Non-renewable resources include mining resources, which are used as industrial raw materials. Due to their non-renewable nature, their formation through complex geological processes, and the high demand for mining products, these factors contribute to the high prices of mining products, for example, nickel ore. Based on data from the U.S. Geological Survey (USGS), Indonesia is one of three countries with the largest nickel mining potential in the world. The high demand for nickel will have a positive impact on national and regional economic growth, but it will not be free from negative impacts, including environmental damage and pollution.

According to the Ministry of Environment, mining in Indonesia is classified as shallow deposits based on mineral availability. Mining can cause numerous surface disturbances, including forest damage, water quality degradation, and health problems from contamination by mining waste (Rynaldi et al., 2024). Furthermore, Bidul and Widowaty (2023) stated that environmental degradation is a common problem arising from mineral resource exploration and exploitation.

Southeast Sulawesi is one of the provinces with significant nickel resource potential. Based on the number of Mining Business Permits (IUP) issued, which is 528 IUPs, 350 or 66% of them are nickel mining IUPs. This indicates that mining in Southeast Sulawesi Province is dominated by nickel mining. The distribution area of nickel deposits is estimated to reach 480,032.13 Ha. The distribution of nickel reserves spans several districts, including South Konawe Regency.

According to data from the Southeast Sulawesi Provincial Energy and Mineral Resources Agency, as of 2017, South Konawe Regency had 25 production operations (IUPs), 17 of which were nickel mining permits. The nickel potential is spread across several sub-districts, including Tinanggea District. The nickel potential in the Tinanggea District is managed by two companies, one of which is PT. X, with a total land area of 800 hectares.

Nickel mining includes open-pit mining, carried out on the surface of the ground. Like other mining activities, the nickel mine in the Tinanggea District, South Konawe Regency, managed by PT. X has had both positive and negative impacts. Fauzi (2006) stated that one of the important issues faced in development is how to address the trade-off between meeting development needs and efforts to maintain environmental sustainability.

PT. X's nickel mining operations have had positive impacts on both the community and the government. For example, it has created employment, increased community income through work with the mining company, and opened up business opportunities for the community (Agussalim et al., 2023). However, on the other hand, it has negatively impacted rice farming activities. Maga et al. (2025) reported that PT. X's nickel mining activities have caused environmental degradation, including soil erosion, reduced soil fertility, and pollution of irrigation water for rice fields. This water pollution and decreased

soil fertility have a direct impact on decreasing rice production and farmer income ([Maga, 2022](#)).

Water pollution not only reduces rice production but also impacts the health of the surrounding community. These health problems include itchy skin on the feet and hands, which disrupts farmers' farming activities. Itchy skin is caused by direct contact with contaminated water. Itchy skin disease is commonly suffered by rice farmers. The irrigation water source for rice farming comes from river water that has been polluted by nickel mining. The river's headwaters, which serve as the irrigation water source, are located near PT X's nickel mining operations. As a result, mining waste is carried by the river flow to the rice fields.

In managing rice paddy farming, direct contact with contaminated water is inevitable. This can trigger itchy skin diseases. Farmers suffering from itchy skin diseases may be unable to work and manage their farms. Furthermore, they must incur medical expenses. Thus, skin diseases result in economic losses for farmers.

In addition to causing skin diseases, nickel mining managed by PT. X in the Tinanggea District causes coughs. Coughs are caused by dust generated during mining activities and the transportation of mining materials. The extraction and processing of nickel ore produce dust and toxic gases such as sulfur dioxide, which can pollute the air ([Oktaviani et al., 2024](#)). The intensity of dust-related air pollution is very high during the dry season. The distance between residential areas and the nickel material transportation route is relatively short. This causes air pollution in residential areas due to dust. Coughs are generally suffered by children.

Water and air pollution undoubtedly cause economic losses for communities surrounding mining sites. While the mining sector can have a positive impact on local employment, negative impacts cannot be ignored as a basis for the government to formulate natural resource management policies. The utilization of natural resources should support regional development and community welfare while preserving environmental sustainability ([Raya et al., 2025](#)). However, if this utilization continues to have negative impacts that harm the community, this is an indicator that natural resource management is not following environmentally friendly principles.

Previous studies have examined economic losses from water and air pollution, but most have focused mainly on medical costs and have not fully captured income losses and productivity reductions experienced by affected communities. This study addresses this gap by estimating the economic losses borne by communities around PT X's nickel mining area due to water and air quality degradation. The analysis focuses on health-related impacts, including medical expenses, lost income, and reduced farmer productivity, using an economic valuation approach. The novelty of this study lies in its integration of cost-of-illness and lost-income components to quantify community-level losses from nickel mining pollution. The findings are expected to support local government monitoring, environmental restoration, and compensation policies for affected communities.

LITERATURE REVIEW

Environmental Degradation and Pollution

According to [Suparmoko \(2006\)](#), degradation of natural resources and the environment is the decline in environmental quality or environmental function, which is reflected in the decline in the environment's ability to produce natural resource inputs, in providing environmental services (environmental service and biodiversity service) and direct

pleasure (amenity service), as well as a natural waste processor (natural assimilator). Saputro et al. (2024), nickel mining waste can cause water and soil pollution, which can disrupt aquatic ecosystems and organisms, disrupt plant growth, and potentially damage the sustainability of soil ecosystems. According to Kristanto (2004), impact refers to any change in the environment caused by human activities.

Likewise, as Noor (2006) stated, environmental problems essentially arise when the exploitation of natural resources ignores the principles of sustainable natural resource and environmental management. *The Economics of Land Degradation* (2015), published by the United Nations Convention to Combat Desertification (UNCCD), defines land degradation as the reduction or loss of biological or economic productivity of rain-fed agricultural land, irrigated agricultural land, grasslands, forests, and woodlands. Markandya et al. (2002) suggest that negative externalities arise when the social costs of consumption or production activities exceed the private costs. Pollution is an example of a negative externality.

Environmental pollution is related to residue or leftovers from human economic activities that exceed environmental thresholds, thus disrupting environmental sustainability (Putri & Maresfin, 2015). According to Wardhana (2004), air pollution is defined as the presence of foreign materials or substances in the air that cause changes in the composition of the air from its normal state. The negative impact of water pollution is that it cannot be used to irrigate rice fields because inorganic compounds cause drastic changes in water pH.

According to Batty and Hallberg (2010), over the last decade, the negative view of industry as a major source of environmental contamination has increased. The impact of industry on the ecological environment is usually manifested as reduced biodiversity, either through the direct toxic effects of pollutants or through indirect effects on habitat quality and food webs. Syarifuddin (2022), nickel mining waste (tailings) has caused damage to marine biota and mangrove forests, as well as causing sedimentation on the coast.

Nickel Mining and Community Health

Despite its positive contribution to the economy, nickel downstreaming also has negative impacts, including declining soil fertility, increased threats to biodiversity due to land conversion, and pollution and contamination that threaten public health (Hafiz & Badi'ah, 2025). Nickel mining waste in North Konawe causes water and soil pollution and has the potential to harm public health (Saputro et al., 2024). Darmono (2001) revealed that there are five metals that are dangerous to humans, namely arsenic (As), cadmium (Cd), lead (Pb), mercury (Hg), and iron (Fe). Research by Abriansyah (2022), Amelia et al. (2025), and Nurfatimah (2023) shows that nickel mining activities cause river water pollution. Wardhana (2004) stated that non-communicable diseases can arise due to the environment being polluted by inorganic compounds produced by industries that use a lot of metal elements. Metal toxicity can occur through penetration through the skin (Darmono, 2001). Gunarto and Mokodompit (2024), health problems due to water pollution in nickel mining activities cause people to have to pay medical expenses.

Economic Valuation of Environmental Losses

The economic valuation of natural resources plays a crucial role in the development and implementation of sustainable environmental policies. Through the application of economic valuation, the real value of ecosystem benefits and functions can be quantitatively measured, thereby promoting efficiency, equity, and sustainability in natural resource management (Purba et al., 2025). Environmental economic valuation is a crucial instrument in bridging economic, social, and ecological interests in the context of sustainable development in Indonesia (Fadhli & Maulana, 2025). Sabet and Ari (2022)

stated that the process of determining the economic value of the environment is crucial as a consideration in allocating increasingly scarce natural resources.

Criminal law enforcement against perpetrators of environmental pollution by industrial companies in Indonesia has been comprehensively regulated in Law Number 32 of 2009 concerning Environmental Protection and Management (UUPPLH). This law explicitly recognizes corporate criminal liability and categorizes various acts of pollution, ranging from administrative violations (formal offenses) that can be subject to administrative sanctions, to substantive violations (material offenses) that carry prison sentences and significant fines. This regulation demonstrates the state's normative commitment to protecting the environment and provides a deterrent effect for perpetrators (Lala & Kosim, 2025). Salsabilla et al. (2024), considering these various issues, mining, as a vital activity affecting economic sustainability, public welfare, and the environment, should be conducted by adopting the concept of a green constitution. In this regard, the state, government, and corporations play a crucial role in preserving the post-mining environment. One way to achieve this is to require clear permits and legal status for mining operations.

Several previous studies have shown that environmental damage has caused economic losses. For example, in the study conducted by Sani and Syamsuddin (2025), the destruction of marine ecosystems and the surrounding environment due to mining activities has led to a significant decline in traditional sources of income. Traditional fishing grounds and coastal areas, once vital to local communities, have been transformed into industrial docks for the transport of minerals. Maga et al. (2025), the total loss in the agricultural sector due to environmental degradation in PT X's nickel mining activities is estimated at IDR 498,474,885/year. Huda et al. (2022), the losses due to the 2018 Balikpapan Bay oil spill consisted of spill response costs of IDR 338,913,000.00, socioeconomic costs of IDR 4,261,206,000.00, and environmental damage costs of IDR 17,694,835,704.00.

Cost of Illness Approach

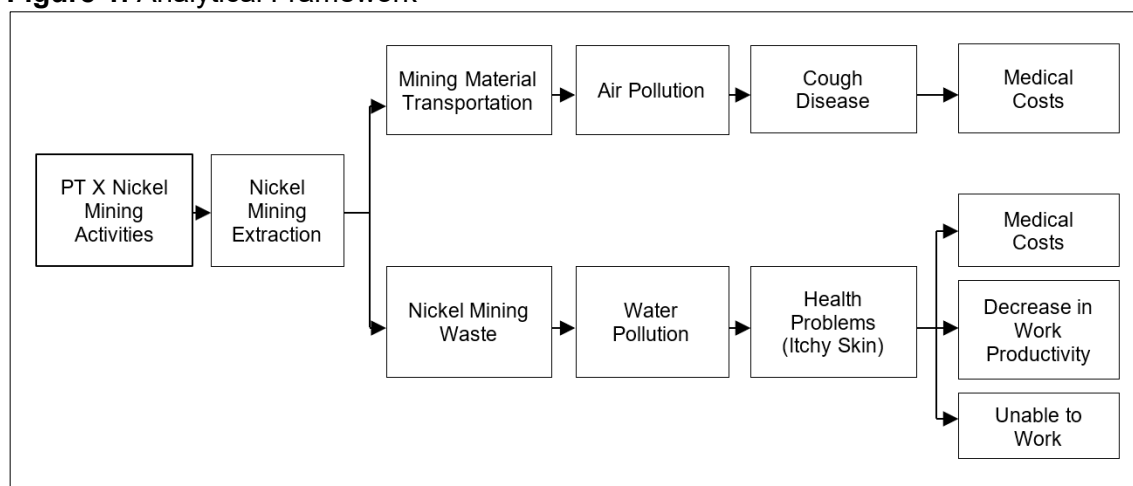
Common methods used to assess morbidity costs include lost earnings and medical costs. The combination of these two methods is often referred to as the cost-of-illness (COI) method. Air pollution (measured by PM10 concentration) in Indonesia results in economic costs of approximately IDR 373.1 trillion. Morbidity costs are worth IDR 146 trillion (39.1% of total costs), with the largest component (approximately 50%) of these morbidity costs being hospitalizations for respiratory diseases (Mursinto & Kusumawardani, 2016). Medical costs for respiratory diseases amounted to IDR 2,962,000, medical costs for eye irritation amounted to IDR 1,139,000, and medical costs for skin diseases amounted to IDR 1,539,000 and medical costs (Burair et al., 2025). In another study by Purtomo et al. (2020), the medical costs due to air pollution were estimated at IDR 1,820,000.00/year.

Analytical Framework

Nickel mining activities carried out by PT. X have not only caused changes in the landscape. They have also caused other negative impacts, namely water and air pollution. Water pollution is caused by waste generated during the mining process. This waste is then carried by the river flow around the nickel mining site. River water mixed with mining waste is used by rice farmers in Lapoa Village and Bomba-Bomba Village as a source of irrigation for their rice fields. This polluted water not only reduces soil fertility and rice production but also causes diseases such as itching on the skin of the feet and hands. This disease often occurs, especially during the rice field preparation stage, due to direct contact with polluted water. To treat this disease, farmers must spend money on medication to relieve the itching.

Some farmers are unable to work full-time because of itching caused by direct exposure to polluted irrigation water. Some farmers are even unable to work at all during the day to manage their rice fields. Meanwhile, air pollution arises from dust generated during mining and the transport of mining materials. The intensity of dust-related air pollution increases, especially during the dry season. Air pollution causes coughs among children, which, in this case, also result in economic losses for the community. The losses due to air pollution are limited to medical expenses. Because the cough sufferers are children, the loss due to decreased work productivity or inability to work due to air pollution was not included in the analysis. Based on this causal pathway, the analytical framework of the study is presented in Figure 1.

Figure 1. Analytical Framework



RESEARCH METHOD

Research Design

This study used a quantitative descriptive approach with economic valuation. This approach was used to describe and estimate the economic losses experienced by the community due to water and air quality degradation in monetary terms.

Location and Time of Research

This research was conducted in the Tinanggea District, South Konawe Regency, Southeast Sulawesi Province. The research location included Lapoa Village and Bomba-Bomba Village. The research location was selected intentionally (purposive sampling), considering that the Tinanggea District is the location of nickel mining activities carried out by PT. X. Moreover, the communities in both villages experience negative impacts from water and air pollution. This research was conducted from March to August 2017.

Population and Sample

Respondents in this study were limited to lowland rice farmers. The number of rice farmers in Lapoa and Bomba-Bomba Villages was 464. The number of respondents was determined intentionally through purposive sampling, namely 45 respondents. The rice fields owned by farmers in Lapoa Village and Bomba-Bomba Village are located in the same area, and the irrigation water source comes from river water that has been polluted by PT X's nickel mining waste. Thus, all rice farmers in the two villages have the potential to suffer from itchy skin diseases due to water pollution.

In this study, the 464 rice farmers were used as the respondent frame for selecting affected rice-farmer respondents. Meanwhile, the estimation of community-level losses refers to the affected farming-household base of 545 families in Lapoa and Bomba-

Bomba Villages, including rice farmers and farmers cultivating other commodities. The valuation components and data sources are summarized in [Table 1](#).

Table 1. Assessment Components Based on the Type of Impact of Water and Air Pollution

Types of Disease	Research Location	Respondents	Affected Population	Assessment Components	Assessment Period	Data Source
Itchy Skin Disease	Lapo Village and Bomba-Bomba Village	Rice farmers	464 rice farmers as respondent frame; 545 farming households as community-level estimation base	Medical expenses	During illness	Primary data
				Frequency of getting sick	Per planting season (4 months)	Primary data
				Number of days absent from work	Per planting season (4 months)	Primary data
				Ability to work during illness (Hours/day)	Per planting season (4 months)	Primary data
				Daily wages of farm laborers	Per planting season (4 months)	Primary data
Cough Disease	Lapo Village and Bomba-Bomba Village	Rice farmers	Affected children/ households	Medical expenses	During illness	Primary data

Types and Methods of Data Collection

The type of data used in this study is quantitative, including the frequency of suffering from skin diseases and coughs, medical costs, working hours per day during illness, days absent from work, and the amount of income per day, which is equivalent to the wages of daily farm laborers. Research data were collected through observation, direct recording of information provided by respondents, and interviews using a prepared questionnaire.

Data Analysis Methods

The impact of water and air quality degradation due to nickel mining activities was estimated over a one-year period. In this study, the impact of the decline or degradation of water and air quality on public health due to nickel mining activities was estimated over a one-year period. The estimated value of losses due to water and air quality degradation was calculated using the health cost method or the cost of illness method ([Hakim & Nur, 2020](#)), using the following formula ([Suparmoko, 2006](#)):

$$ND_{a/u} = (O \times B_k) + (O \times \Delta P_k) + (O \times H_a)$$

Where:

- ND_{a/u} = Water/air quality degradation value
- P_k = Productivity of people affected by illness
- O = Number of people who are sick
- B_k = Health costs
- H_a = Days of absence from work (HOK)
- Δ = Change

The days of absence from work in this study were converted into Work Days (HOK), using the following formula ([Hernanto, 1991](#)):

$$HOK = \frac{\text{Total working hours (JKT)}}{\text{Standard working hours}}$$

$$JKT = \text{Number of people} \times \text{Working days} \times \text{Working hours}$$

The Man-Days (HOK) approach was used solely for the analysis of water quality degradation. This is because the primary sufferers of skin diseases are rice farmers. Skin diseases prevent farmers from working on their farms. Although farmers continue to work, their working hours have been reduced, leading to a decline in rice farmers' productivity.

Meanwhile, the analysis of the impact of air quality degradation only used medical costs. This method was also used in [Hakim and Nur's \(2020\)](#) study to analyze the impact of water pollution. This was based on observations that coughs caused by air pollution were generally among children. Therefore, decreased work productivity and days absent from work were not included in this analysis.

RESULTS

Water pollution from nickel mining waste and air pollution from dust emitted during the mining and transportation of nickel materials have caused health problems for the community. Both types of pollution cause itchy skin diseases and coughs. Thus, water and air pollution have caused economic losses for the community. These losses include medical expenses, lost income due to illness, and decreased productivity for farmers, particularly those suffering from itchy skin diseases. The estimated value of the community's losses due to air pollution is outlined below.

Estimation of the Value of Losses due to Water Quality Degradation

Itchy feet affect people due to water pollution. As stated by [Darmono \(2001\)](#), metal toxicity can occur through inhalation (breathing), the digestive tract, and penetration through the skin. Research by [Amelia et al. \(2025\)](#) and [Rynaldi et al. \(2024\)](#) indicates that chemicals can be produced during the nickel extraction and refining process. Itchy feet generally affect farmers during the rainy season or during land preparation. This occurs because preparing land for rice cultivation involves direct contact with contaminated water.

The value of losses experienced by the community due to water pollution is estimated in one year, because some farmers suffer from skin diseases more than once per year. The value of losses due to water pollution uses several components. These include the frequency of treatment during illness, the cost of each treatment, days absent from work, daily income if working (using a daily wage of IDR 70,000-80,000/day), and the value of lost income when suffering from itching.

The work-day absence component in the analysis of losses due to water pollution uses the HOK approach. This is done because sufferers of skin disease are rice farmers. Furthermore, various analyses of the agricultural workforce always use the HOK approach. The estimated value of community losses due to water pollution is outlined in [Table 2](#).

Table 2. Estimated Cost of Illness due to Water Quality Degradation (Skin Diseases)

Number of sufferers (people)	Frequency of treatment	Medical expenses (IDR/year)	Absent Work Day (HOK)	Loss of income (IDR/year)	Amount (IDR)
a	b	c	d	e	f (c + e)
18	31	1,319,000	58	4,595,000	5,914,000
Average per person	2	73,278	3	255,278	328,556
Total cost of illness (IDR/Year)*		15,974,604	-	55,650,604	71,625,208

As shown in [Table 2](#), the estimated annual loss due to water quality degradation reached IDR 71,625,208. This amount consists of medical expenses of IDR 15,974,604/year and lost income of IDR 55,650,604/year, calculated by applying the average medical cost and lost income per affected respondent to the estimated affected farming-household population.

Estimation of the Value of Economic Losses due to Air Quality Degradation

Environmental degradation due to PT. X's nickel mining activities in the Tinanggea District not only causes water pollution. Mining activities and the transportation of nickel materials produce dust that pollutes the air around the mine site, including in residential areas, especially in Lapoa Village and Bomba-Bomba Village. Air pollution from nickel ore extraction and processing can cause respiratory problems for humans ([Oktaviani et al., 2024](#)). The level of air pollution due to nickel dust will increase during the dry season. Air pollution from nickel dust has caused coughing and contaminated residents' homes.

Table 3. Estimated Cost of Illness due to Air Quality Degradation (Coughing Disease)

Number of Sufferers (People)	Frequency of Treatment	Total Medical Expenses (IDR)
11	23	363,000
Average per person	2	33,000
Total cost of illness (IDR/Year)*		1,089,000

Note: *Estimated using the equation = Total medical expenses (IDR) x frequency of cough attacks (3 times per year)

Based on the estimated loss values outlined in [Table 3](#), efforts must be made to restore environmental quality, both by PT. X and the government. This is done to prevent further worsening of pollution levels and to prevent further worsening of the impact on public health. [Candrasari et al. \(2023\)](#) found that long-term exposure to air pollution can disrupt lung development. Furthermore, decreased lung function can affect physical growth and worsen respiratory disorders in children.

Based on the estimated economic losses identified in this study, the annual losses suffered by the affected community in Lapoa and Bomba-Bomba Villages due to skin diseases and coughs are estimated at IDR 72,714,208. The losses, as outlined in [Table 4](#), include medical expenses, lost income due to decreased farmer productivity, and lost income due to the inability to work during illness.

Table 4. Total Value of Community Losses due to Water and Air Pollution

Types of Disease	Number of Sufferers (People)	Medical Expenses (IDR/year)	Loss of Income (IDR/Year)	Amount (IDR/Year)
Skin disease	18	15,974,604	55,650,604	71,625,208
Cough disease	11	1,089,000	-	1,089,000
Total	29	17,063,604	55,650,604	72,714,208

[Table 4](#) shows that water quality degradation contributed the largest share of the estimated losses, amounting to IDR 71,625,208/year. This value consists of medical expenses of IDR 15,974,604/year and lost income of IDR 55,650,604/year. In comparison, air quality degradation contributed IDR 1,089,000/year, which only includes medical expenses for cough disease. Overall, the estimated annual loss due to water

and air pollution reached IDR 72,714,208, indicating that water pollution created the dominant economic burden for the affected community.

DISCUSSION

Estimation of the Value of Losses due to Water Quality Degradation

Water pollution occurs due to the mixing of mining waste. Nickel log waste produced in nickel processing is included in B3 waste containing hazardous materials (Ressa et al., 2024). It can be further explained that the upstream of the river, as a source of irrigation for rice fields, is located around the nickel mining site of PT. X. The river water is collected in the Lapoa Dam and then used as a source of irrigation for rice fields in Lapoa Village and Bomba-Bomba Village. Darmono (2001) revealed that there are five metals that are dangerous to humans, namely arsenic (As), cadmium (Cd), lead (Pb), mercury (Hg), and iron (Fe). These metals are toxic. Likewise, Wardhana (2004) stated that non-communicable diseases can arise due to the environment being polluted by inorganic compounds produced by industries that use many metal elements.

In addition to impacting health, there are two other aspects that indicate that water quality degradation has occurred. First, water from the Lapoa Dam cannot be used for public consumption or for livestock drinking. Fadhili and Anasstasia (2024) stated that chromium (Cr) metal in nickel mining activities can spread to all environmental strata, including water, soil, and air (atmospheric layers). Similarly, Setiyono and Gustaman (2017) stated that chromium (Cr) is one of the heavy metals that can pollute water. This shows that irrigation sources in Lapoa Village and Bomba-Bomba Village have been polluted by nickel mining waste. Thus, water from the Lapoa Dam is not suitable for use as a source of irrigation for rice fields. Moreover, if used for public consumption, it will certainly cause health problems for the community.

Second, the loss of direct benefits in the form of fish resources in the Lapoa Dam after silting occurs. This is, as stated by Kristanto (2004), the presence of high amounts of sediment in the water will be very detrimental, one of which is reducing the population of fish and other aquatic animals because fish eggs and food sources may be submerged in the sediment. Pollution caused by heavy metals in nickel mining can damage ecosystems and marine biota (Syarifuddin, 2022).

These two indicators are caused by the silting of the dam due to the water being mixed with mud and other elements in the nickel mining activities of PT. X. The content of the metal element Nickel (Ni) in the rivers around Tinaggea District is in the low to high category (Ekawati et al., 2022). It can be further explained, that if this condition is not remediated by the company, water pollution will continue to increase. Thus, it will threaten the sustainability of the development of rice farming businesses. This will continue to have further impacts, especially for the community. Among them is the loss of sources of income for the community, directly increasing the number of unemployed and reducing the level of farmer income. In addition, the community will also be threatened with the loss of their main food source, namely rice.

The estimation shows that medical expenses for skin diseases reached IDR 15,974,604 per year, while lost income due to reduced working capacity reached IDR 55,650,604 per year. In addition to medical costs, water quality degradation also leads to decreased productivity among farmers due to itchy skin on the feet. As a result, farmers are unable to work as usual, as those suffering from these skin diseases can only work less than 8 hours per day. This condition certainly impacts the development of rice farming, meaning that farm management cannot be carried out optimally.

Lowland rice farming requires intensive management, including fertilization, pest and disease control, and crop maintenance. When farmers suffer from itchy skin disease, reduced working hours may disrupt these activities and prevent farm management from being carried out optimally. If these activities are not carried out properly, farmers may face additional production risks beyond the direct health-related costs estimated in this study.

In addition to reduced working hours, people with skin diseases are also unable to work for 2-7 days during their illness. Therefore, farmers can be said to experience a loss of income, assuming the daily income is equivalent to the prevailing daily wage at the research location, which is around IDR 70,000 - IDR 80,000/day. It's important to note that this case doesn't just involve a loss of income for farmers. Further analysis also reveals a reduced ability to meet family economic needs.

To estimate lost income or changes in farmer productivity, the duration of the farmer's inability to work (hours or days) is first determined. According to [Hernanto \(1991\)](#), 8 hours of work in farming is equivalent to one workday. This is then converted into Man-Days (HOK) for each respondent suffering from itchy skin disease. This is then multiplied by the daily income (IDR/day). The estimated number of HOK for farmers unable to work while suffering from itchy skin disease is 58 HOK, and the total income lost during illness is IDR 4,595,000. Thus, the total cost of illness due to water quality degradation can be estimated at IDR 71,625,208/year.

This value is estimated as the total cost of illness due to water quality degradation based on the farming population in Tinanggea District, which is 545 families in Lapoa and Bomba-Bomba Villages. The population in question includes all farmers in these villages, including both rice farmers and farmers cultivating other commodities.

In general, rice paddy farming can employ farm laborers to perform activities such as fertilization, plant control, and weed control. However, farmers' economic resources are very limited, meaning they cannot afford to employ farm laborers. This poses a risk of crop failure if the rice paddy farming business is not managed properly. In the long term, this will undoubtedly have a significant impact on the farmers' economy. As previously explained, they face the potential loss of production and income in rice paddy farming.

When farmers experience a loss of income from their farming operations, they can be considered to have suffered a loss. Therefore, in the next planting season, they will lack sufficient capital. [Dinata et al. \(2021\)](#) found that the weak economic conditions of farmers mean they lack fixed capital for their rice farming operations. Farming capital is a vital element, alongside land availability. [Hasibuan et al. \(2022\)](#) found that farming capital is a crucial factor in increasing the income of rice farmers. With adequate capital, farmers can meet their needs for agricultural production inputs, such as seeds, fertilizers, and pesticides.

Furthermore, if farmers are unable to provide sufficient production facilities, their rice farming will not be able to operate optimally. This will undoubtedly have long-term impacts, such as unproductive agricultural land, potential loss of rice production, scarcity of community food sources, and declining farmer incomes. Therefore, a decline in farmer income will impact their ability to meet family needs, including consumption, education, and health ([Utomo et al., 2024](#)).

Estimation of the Value of Economic Losses due to Air Quality Degradation

Air pollution caused by nickel dust certainly disrupts community activities. During the dry season, air pollution increases, causing health problems such as coughs. Coughs are

generally suffered by children. [Fahrozy et al. \(2023\)](#) noted that the spread of dust can cause various respiratory diseases such as pharyngitis, bronchitis, and asthma. Coughs caused by air pollution will certainly cause economic losses for sufferers. Cough sufferers must pay for medical expenses during their illness. This is done to prevent the disease from worsening.

The estimation of the value of losses due to air quality degradation only uses the medical cost approach. This is because those who suffer from coughs due to dust in nickel mining and transportation activities are generally children. Likewise, the value of lost income is not used in this analysis to estimate the value of losses due to air pollution. [Markandya et al. \(2002\)](#) explain that the cost of illness approach is used to estimate the impact of environmental changes on health. The estimation of air-quality degradation shows that medical expenses for cough disease reached IDR 1,089,000 per year. This value only covers medical expenses, as coughs are typically suffered by children. Therefore, the value of lost income due to decreased work productivity and inability to work during illness is not included in this analysis. This is done with the assumption that cough sufferers are not included in the workforce.

Thus, the total losses incurred by the community due to skin diseases and coughs can be estimated at IDR 72,714,208 per year. This value represents the internal costs borne by the community due to the decline in water and air quality during nickel mining activities. The value of community losses will continue to increase if PT. X does not make efforts to restore environmental quality.

Based on the description, in addition to restoring environmental quality, PT. X must provide compensation to the community suffering from skin diseases and coughs due to environmental degradation. Providing compensation to the community is a form of responsibility for PT. X, which has polluted the quality of public goods in the form of water and air. In addition, environmental pollution also creates an economic burden for farming families during illness; of course, this has reduced the welfare of the community. Recovery is carried out to ensure that all communities around the nickel mining site can live in an environment free from pollution. Because a sustainable environment will have a direct impact on the quality of life of the community, both in health, social, and economic aspects.

The government's role in addressing environmental damage is to conduct more intensive monitoring of mining sites and the surrounding environment. Strict legal sanctions must be imposed on any party proven to have caused environmental damage and harmed the community. This is to ensure that companies continue to implement environmentally friendly mining practices. This ensures that the resulting environmental damage does not significantly impact the environment and the community. Nickel mining activities, by their very nature, will inevitably lead to significant changes in the landscape. However, these changes are expected to avoid negative impacts on social, economic, or environmental aspects. This recommendation is also consistent with community-development studies emphasizing community participation, stakeholder collaboration, and sustainable natural-resource management ([Hanafi et al., 2025](#); [Maryunani, 2023](#); [Raya et al., 2025](#)).

CONCLUSION

The purpose of this study is to estimate the value of community losses due to the degradation of water and air quality around the nickel mining site of PT. X. Based on the results of the analysis, the economic losses caused by environmental pollution can be identified through health-related costs. Skin disease caused by water pollution generated medical costs of IDR 15,974,604/year and lost income due to farmers being unable to work and experiencing decreased productivity of IDR 55,650,604/year. Cough disease

caused by air pollution generated medical costs of IDR 1,089,000/year. Thus, the total value of health-related losses due to water and air pollution was estimated at IDR 72,714,208/year. These health impacts directly affect the community's economy through decreased income and reduced welfare. Therefore, the government must enforce the law strictly against parties that cause economic and environmental losses. Meanwhile, PT. X is expected to restore environmental quality and provide compensation for diseases arising from water and air pollution.

LIMITATION

Several limitations of this study include the relatively small sample size and the use of purposive location selection, so the findings should be interpreted as site-specific estimates. The analysis only covers selected health-related costs, namely medical costs, lost income, and decreased productivity, while broader ecological and social losses were not estimated. In addition, the health impacts were limited to itchy skin disease and cough disease based on the conditions reported by the affected community. Another limitation is the absence of direct laboratory testing of water and air quality around the PT. X nickel mining site. Future studies should involve a larger sample, broader health categories, and direct environmental quality measurements to provide a more comprehensive valuation of community losses.

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DECLARATION OF CONFLICTING INTERESTS

There is no conflict of interest, according to the authors.

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