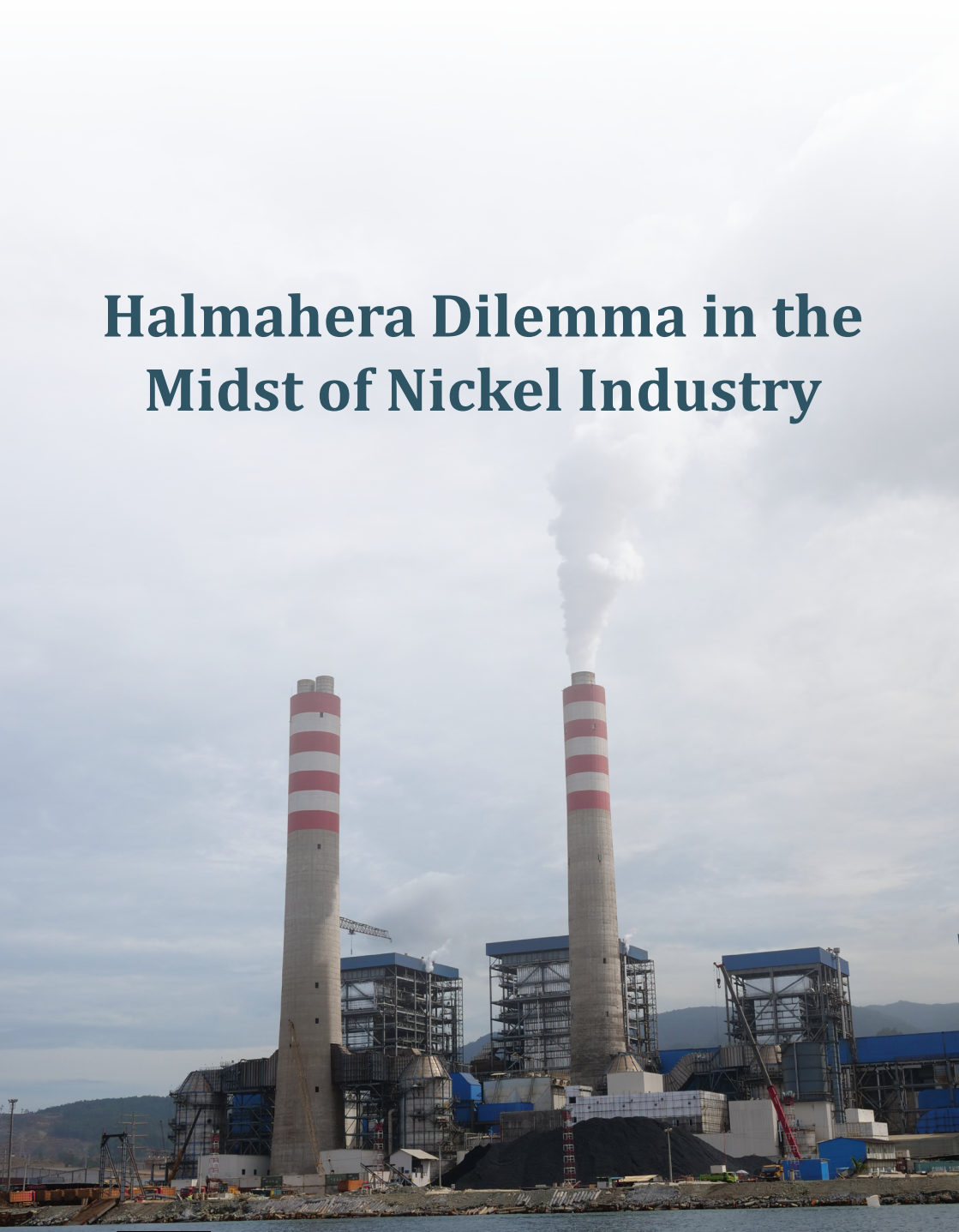
Halmahera Dilemma in the Midst of Nickel Industry



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Website: http://aeer.or.id
Email: aeermail@gmail.com

Author:
Andi Rahmana Saputra
Cintya Faliana
M. Arfah Durahman
Pius Ginting

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Table of Contents

List of Figures

List of Tables

Executive Summary

Nickel mining activities frequently result in adverse effects on the social and environmental dimensions of the surrounding regions. The onset of mineral exploration and extraction operations can instigate conflicts over land and resources. Local communities often find themselves compelled to forsake their traditional livelihoods and relocate to alternative areas. Moreover, the nickel mining process contributes to water and air pollution, deforestation, and a decrease in biodiversity indices. As a result, environmental degradation poses significant potential risks to human health.

In Indonesia, nickel mining activities are flourishing in response to the escalating global demand for electric vehicle batteries and anti-corrosion steel. Nickel plays a pivotal role in the production of lithium-ion batteries, powering electric vehicles and electronic devices. Its exceptional energy storage capacity in a compact form enables electric vehicles to achieve extended endurance with just one battery charge. Additionally, owing to nickel's resistance to corrosion, high temperatures, and rust, it serves as a widely sought-after steel coating in the construction, automotive, household appliances, as well as food and beverage industries. The expansion of nickel mining operations, including downstream nickel industries, is planned beyond Java, holding immense promise for stimulating regional economies. Nevertheless, this endeavor also raises concerns regarding potential adverse effects on the living standards of local communities and environment.

One of the notable nickel industrial zones that demands attention is the Indonesia Weda Bay Industrial Park (IWIP). The various phases of construction, operation, and post-mining activities within this region are overseen by PT IWIP, a joint venture company comprising Chinese investors, while the technical aspects of mining, encompassing extraction, processing, and refining of nickel ore, are undertaken by its tenants. Covering an expansive area of 5,000 hectares, the industrial site of PT IWIP is strategically situated along the coastline in Central Halmahera Regency, North Maluku Province. It

encompasses two villages in the Weda Tengah District, namely Lelilef Sawai and Lelilef Woebulen, with the potential to impact two other villages in the Weda Utara District, namely Gemaf and Sagea. Initiated in August 2018, the construction phase is ongoing, with continuous development within the IWIP region. Presently, IWIP is fully equipped with Rotary-Kiln Electric Furnace (RKEF) smelters boasting a total capacity of 500 kiloton of nickel metal per year, complemented by coal-fired steam power plants with total capacity of 1,000 MW, alongside other supporting facilities, such as a port, offices, and accommodations for employees.

The establishment of PT IWIP has catalyzed significant social and economic transformations in the affected villages. However, concerns have arisen regarding the perceived lack of fair and equitable compensation procedures. Local farmers have been compelled to relinquish their agricultural lands and shift professions, resulting in a reduction in agricultural areas. Additionally, the company's activities, including reclamation and deforestation of mangroves, have forced fishermen to venture farther into the sea for their livelihoods. While PT IWIP's presence has indeed created new economic prospects, benefiting both local inhabitants and newcomers from other Indonesian islands like Sulawesi and Java, and even from China, the demographic shift has brought forth environmental challenges, including the accumulation of waste, dusty roads, and contaminated groundwater. These environmental degradations have, in turn, led to a rise in cases of diarrhea and acute respiratory infections (ARI) among the community.

The manual laborers of PT IWIP face a range of challenges as well. Their wages are perceived as low when compared to the total working hours and cost of living. Moreover, the accommodations provided by the company are considered inadequate for habitation, with issues such as poor sanitation and an abundance of rats. Furthermore, some workers are unjustly dismissed by the company based on suspicions of familial ties or relationships with residents who oppose land clearance. These circumstances leave the workers in a vulnerable and precarious position.

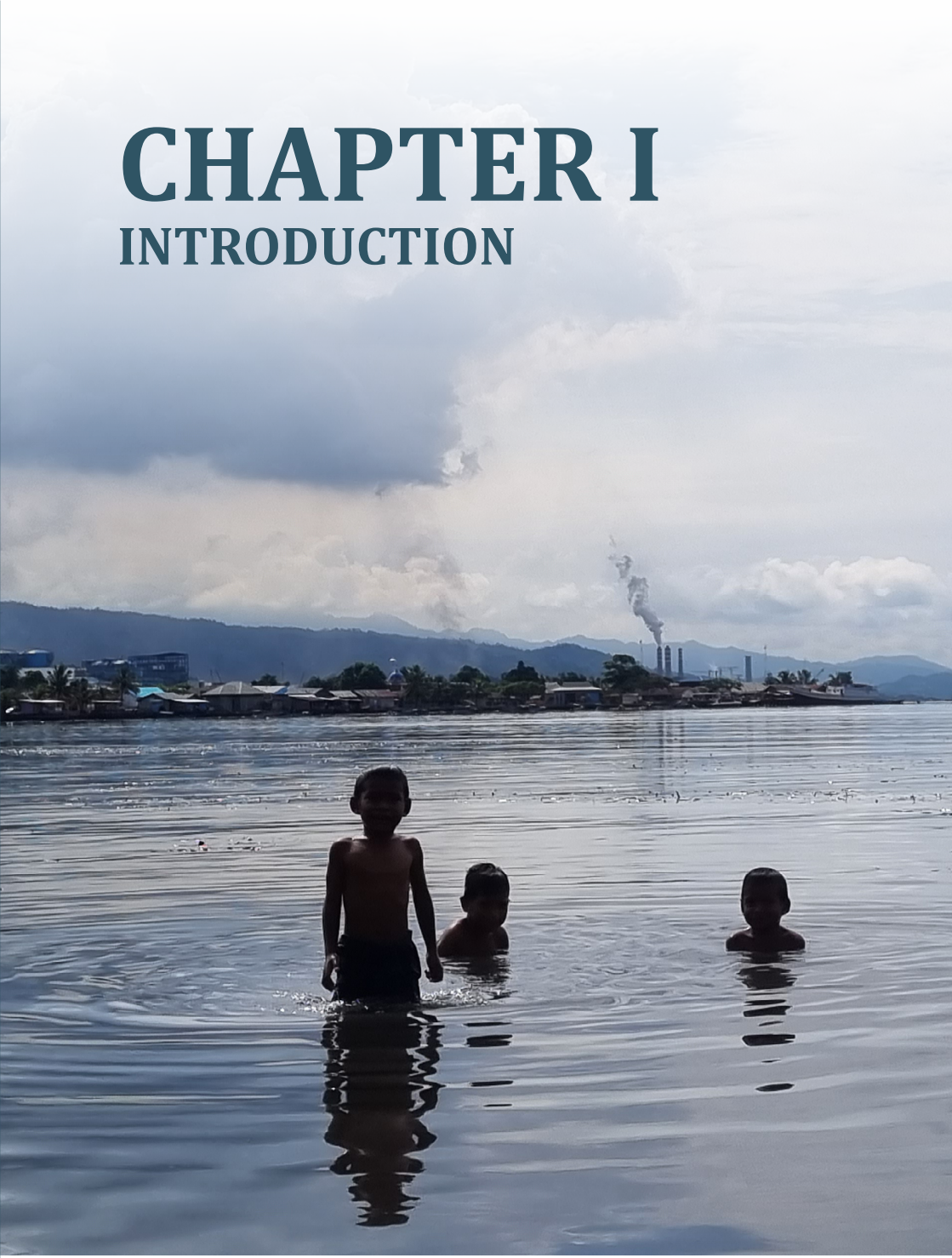
With the ongoing development of the PT IWIP area, there have been notable changes in the water quality of rivers and the sea. In fact, certain rivers have been buried, ceasing their flow into the sea. The Wosea River, which has narrowed due to dumping activities on its banks, now contains detectable levels of hexavalent chromium compounds. These concentrations exceed the standards set by the Initiative for Responsible Mining Assurance (IRMA). Similar deviations have been observed in the wastewater discharge estuary of the coal-fired steam power plant, the estuary of the Ake Doma River, and Tanjung Ulie, all exceeding the standards stipulated in Government Regulation No. 22 of 2021. Beyond causing coral reef degradation, the accumulation of hexavalent chromium in the sea poses a risk of bioaccumulation in fish, potentially impacting human health when consumed. If these concentrations continue to rise, this compound could lead to morphological changes, digestive system disorders, or even cancer in the long term.

The air quality changes in the vicinity of the PT IWIP area require serious attention. Alongside population growth, the reduction of vegetation cover, and the increased traffic frequency in the affected villages, contribute to elevated levels of airborne dust. This is visibly evident on the district road that passes through Lelief Sawai and Lelilef Woebulen, situated directly to the west of the industrial zone. Nearly all motorcyclists now wear masks and goggles to shield their faces and eyes from the pervasive dust. Moreover, the measurements reveal that the presence of the coal-fired steam power plants within the PT IWIP area leads to heightened concentrations of particulate dust in the surroundings, surpassing the IRMA criteria. The constant exposure to dust poses potential health risks to local residents. According to the Community Health Center in Lelilef, cases of acute respiratory infections (ARI) have surged since the establishment of PT IWIP. Previously, there were approximately 300 recorded cases per year, whereas the current number has escalated to 800 to 1,000 cases per year.

This study presents a current overview of the ongoing social changes and environmental conditions in the villages surrounding the PT IWIP area in Central Halmahera Regency. By comprehending the actual impacts

experienced by the villagers, this report aims to raise awareness among various stakeholders, including the central and local governments, academics, companies, community organizations, and non-governmental institutions. The goal is to shape policies and mitigation strategies that effectively mitigate broader impacts and avert potential future disasters. By fostering an understanding of the significance of adopting a sustainable approach, we hope to motivate the nickel industry to address social and environmental challenges proactively. As a result, nickel mining companies, especially in the study region, with support from the government, can emerge as responsible growth catalysts, contributing to an inclusive and sustainable development path for all stakeholders involved.

CHAPTER I
INTRODUCTION



Chapter I
Introduction

1.1. Background

In 2022, Indonesia recorded a possession of 21% of the world's nickel reserves and contributed more than 48% to the global demand for nickel ore1. With the downstreaming of the nickel industry, Indonesia is expected to become a primary leading producer, achieved through the development of nickel ore processing and refining facilities (smelters) within industrial zones, located close to mining areas. Currently, Indonesia has operational Rotary-Kiln Electric Furnace (RKEF) technology smelters capable of meeting 74% of the world's nickel pig iron (NPI) demand. Additionally, Indonesia has three High-Pressure Acid Leaching (HPAL) technology smelters that produce mixed hydroxide precipitate (MHP), a semi-finished product, and raw material for nickel sulfate used in electric vehicle battery production. This contribution emphasizes Indonesia's vital role in the global battery component supply chain while participating in global emission reduction efforts within the transportation sector.

The downstream of the nickel industry is not only focused on electric vehicle battery production but also the manufacturing of stainless steel, relying on nickel pig iron (NPI). Indonesia has successfully become the second-largest producer of non-stainless steel NPI, after China, with a production of 5.7 million tons in 2022, an increase of 700 thousand tons within just one year. This growth is attributed to the contributions of nickel-based industrial zones, such as the Indonesia Weda Bay Industrial Park (IWIP) located in Central Halmahera Regency, North Maluku Province.

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1 Annur, C.M. (2023). *Deretan Negara Penghasil Nikel Terbesar di Dunia pada 2022, Indonesia Nomor Satu!* Databoks. https://databoks.katadata.co.id/datapublish/2023/03/02/deretan-negara-penghasil-nikel-terbesar-di-dunia-pada-2022-indonesia-nomor-satu

Nickel mining in North Maluku has experienced rapid development in recent years, driven by the increasing global demand for nickel in the electric vehicle battery and stainless steel industries. It began with PT Aneka Tambang Tbk (ANTAM) starting mining operations on Gebe Island in 1997, and since then, the mining concessions have expanded to cover an area of 156,197.04 hectares, with a significant portion located in Central Halmahera2. Nickel mining in North Maluku is considered to have provided economic benefits and opportunities for local development, but it has also clearly resulted in negative impacts on social and environmental conditions.

This study is expected to provide an initial overview of the current social and environmental situation in the vicinity of PT IWIP. The information and insights generated from this study are valuable for stakeholders, including the government, the mining industry, local communities, and environmental organizations. By identifying and understanding the existing impacts, this report is intended to serve as a foundation for formulating appropriate policies and mitigation measures in the management of nickel mining in North Maluku. Consequently, negative impacts on social and environmental aspects can be prevented or at least minimized, ensuring that the growth of the nickel industry aligns with the vision of sustainable development and genuinely contributes to the improvement of local community welfare.

1.2. Potential Impacts of Nickel Mining Activities

Nickel mining is considered a crucial activity in the transition from fossil fuel to renewable energy use in the transportation sector. The current global discourse suggests that large-scale nickel supply is a necessity for modern societies shifting towards electric vehicles. However, on the other hand, nickel mining activities bring about negative changes to the environmental and social conditions in the vicinity of the mining sites. Often, there is a decline in environmental

2 Abubakar, K.S., & Karim, A.G. (2011). *Kehidupan Masyarakat Pulau Gebe Studi Tentang Kondisi Masyarakat Pasca Berakhirnya Kontrak Kerja PT. Aneka Tambang di Kabupaten Halmahera Tengah. Universitas Gadjah Mada.* https://etd.repository.ugm.ac.id/home/detail_pencarian/50850

quality, and certain groups within the community bear the burden of these losses[3].

The extractive efforts of nickel mining always require massive resources. Extensive land, adequate transportation access, large water volumes, and a high labor force are always essential requirements. As a consequence, significant environmental and social changes occur at each stage of the project, starting from exploration, construction, mining, processing, refining, transportation, and post-mining activities. These negative impacts are not only felt by the local communities but also affect biotic factors (such as flora and fauna) and abiotic environmental factors (such as temperature and surface water chemistry). For the residents affected by nickel mining activities, their living spaces are narrowed, both in economic and social contexts. Due to environmental degradation, the health quality of the local population also declines. For the biotic factors in the environment, nickel mining can reduce biodiversity indices. In other words, this endeavor eliminates specific habitats for flora and fauna and threatens their survival.

Here are the potential impacts that can occur due to nickel mining activities:

1. Deforestation

Nickel mining requires extensive land coverage for exploration, mineral extraction, and mining infrastructure development. The need for large areas of land can result in the loss of forest cover.

2. Water pollution

The disposal of tailings into the sea by nickel mining operations can potentially release harmful chemical compounds, such as heavy metals, leading to water pollution and damage to aquatic ecosystems.

3. Air pollution

3 Nancy, N. (2022). *Potential Distortion of Sustainable Development in the Conflict of Interest of Nickel Mining and Indigenous Communities in Halmahera, North Maluku*. Journal of Global Environmental Dynamics, 3(2), 11-20. https://jurnal.uns.ac.id/jged/article/download/61384/36332

Activities involved in mining infrastructure development, mineral excavation, and various other operations at mining sites can generate dust and emissions released into the air. Particulates and other compounds adversely affect air quality and lead to several issues, such as respiratory problems for humans and ecosystem changes.

4. Changes in the livelihood patterns of the surrounding communities
The alterations in the landscape resulting from nickel mining lead to socio-economic changes for the local residents. This can trigger conflicts over land and resources in the vicinity of the nickel mining area.

5. Damage to flora and fauna habitats
Nickel mining has an impact on ecosystem changes in the surrounding mining areas. These changes in aquatic and terrestrial ecosystems can lead to the destruction of natural habitats for flora and fauna. This condition has the potential to decrease the biodiversity index for the regions where nickel mining is conducted.

1.3 Profile of Indonesia Weda Bay Industrial Park (IWIP)

Indonesia Weda Bay Industrial Park (IWIP) is an industrial zone that accommodates the downstream efforts of nickel resources in Central Halmahera, North Maluku. The development of this industrial zone is part of a national project stated in Presidential Regulation No. 18 of 2020, Presidential Regulation No. 109 of 2020, and Presidential Decree No. 62 of 2004.[4] In addition to being a target for the development of strategic areas and nickel resource processing, IWIP is also aimed at strengthening integrated intermodal connectivity for sea, river, land, and air transportation. Access roads, ports, and airports are being constructed in the central industrial zone to achieve these objectives.

Administratively, the IWIP industrial zone is located in the districts of Central Weda and North Weda. Most of its area has covered almost the entire coastal region of Lelilef Sawai Village in Weda Tengah. However, its impacts have the potential to spread to three surrounding villages,

4 *Tentang IWIP*. https://iwip.co.id/tentang-iwip/

namely Lelilef Woebulen Village, Gemaf Village, and Sagea Village. The area has reached 5,000 hectares, and according to residents' estimates, the size of this industrial zone is likely to continue increasing.

The IWIP industrial zone is managed by PT IWIP, a joint venture company involving three Chinese investors, namely Tsingshan, Huayou, and Zhenshi. This company was established on August 30, 2018, concurrently with the groundbreaking ceremony of the industrial zone[5]. The total investment amounts to 10 billion US dollars, previously agreed upon between Eramet Group (France) and Tsingshan, along with local partner, ANTAM[6]. Initially, they intended to develop nickel ore deposits and a Rotary-Kiln Electric Furnace (RKEF) ferronickel smelter with a capacity of 30 kilotons of nickel pig iron (NPI) per year. Now, the IWIP industrial zone has been equipped with 30 RKEF smelters connected to 49 production lines. The total capacity of these ferro-nickel smelters has reached 500 kilotons of nickel metal per year.

Several companies have collaborated with PT IWIP to build and operate nickel ore processing and refining facilities. For example, PT Youshan Nickel Indonesia, PT Weda Bay Nickel, and PT Angel Nickel Industry operate RKEF smelters with various nickel products and capacities. Other tenants, such as PT Huafei Nickel Cobalt and PT Sonic Bay, are also conducting feasibility studies for hydrometallurgical smelters using High-Pressure Acid Leach (HPAL) technology. All these smelters obtain nickel ore from PT Weda Bay Nickel, whose mining concession overlaps with the IWIP area. In addition to facilitating metal refining activities, the IWIP industrial zone is also open to investors interested in building nickel sulfate (NiSO4) production facilities, NCM/NCA, precursors, and even lithium-ion batteries for electric vehicles[7].

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5 Lia, A. (2023). *PT IWIP : Profil Perusahaan, Visi Misi Perusahaan, Lowongan, Prospek Kerja.* https://blackgarlic.id/pt-iwip/#:~:text=%E2%80%93-,Sejarah%20PT%20IWIP,Menengah%20Nasional%20Tahun%202020%2D2024.

6 Rafael, E.C. (2018). *Kawasan industri Halmahera senilai US$ 10 miliar resmi dibangun.* Kontan.co.id. https://nasional.kontan.co.id/news/kawasan-industri-halmahera-senilai-us-10-miliar-resmi-dibangun

7 Direktorat Jenderal Bea dan Cukai , Kementerian Keuangan. (2020). Bea Cukai Resmikan Kawasan Pabean Baru di Halmahera Tengah. https://www.beacukai.go.id/berita/bea-cukai-resmikan-kawasan-pabean-baru-di-halmahera-tengah.html

1.4 Research Objectives

1. To study the impacts of PT IWIP's nickel mining activities on the local communities in four villages in Central Halmahera, North Maluku. The social components studied include land disputes, economic conditions, labor conditions, declining health quality, and women's involvement.
2. To examine the impacts of PT IWIP's nickel mining activities on the water and air environment inside and outside the industrial zone. The environmental components studied include surface water, seawater, and ambient air.
3. To provide a current overview of the affected villages for policymakers so that immediate mitigation strategies can be implemented to address the social and environmental challenges in the nickel mining industrial zone.

CHAPTER II
METHOD

Chapter II
Method

2.1. Location

This research was conducted in Central Halmahera Regency, North Maluku Province, precisely in four affected villages: Lelilef Woebulen Village, Lelilef Sawai Village, Gemaf Village, and Sagea Village. Administratively, the first two villages are located in the Weda Tengah sub-district, and the other two villages are in the Weda Utara sub-district. Field surveys for the social and environmental aspects in these villages, about PT IWIP mining activities, were conducted in June 2023. Figure 2.1 shows the 5,000-hectare area of PT IWIP marked by a blue line, while the administrative boundaries of the villages are marked by a yellow line.

Figure 2.1. Map of PT IWIP's location (blue line) in Central Halmahera Regency, North Maluku Province

2.2. Data Collection Methods

2.2.1 Social Aspect

In this study, data collection for social and economic components was conducted using in-depth interviews with the impacted communities, including residents of the surrounding villages and workers at PT IWIP. Additionally, the study involved participatory mapping with the village residents related to the context of landscape changes in Central Halmahera Regency, particularly in the four affected villages. Participatory mapping resulted in sketches of the area showing the differences in landscape conditions before and after the establishment of PT IWIP. The changing landscape conditions over time can serve as a basis for analyzing the impacts on the socio-economic conditions of the communities surrounding the company's area.

2.2.2 Environmental Aspects

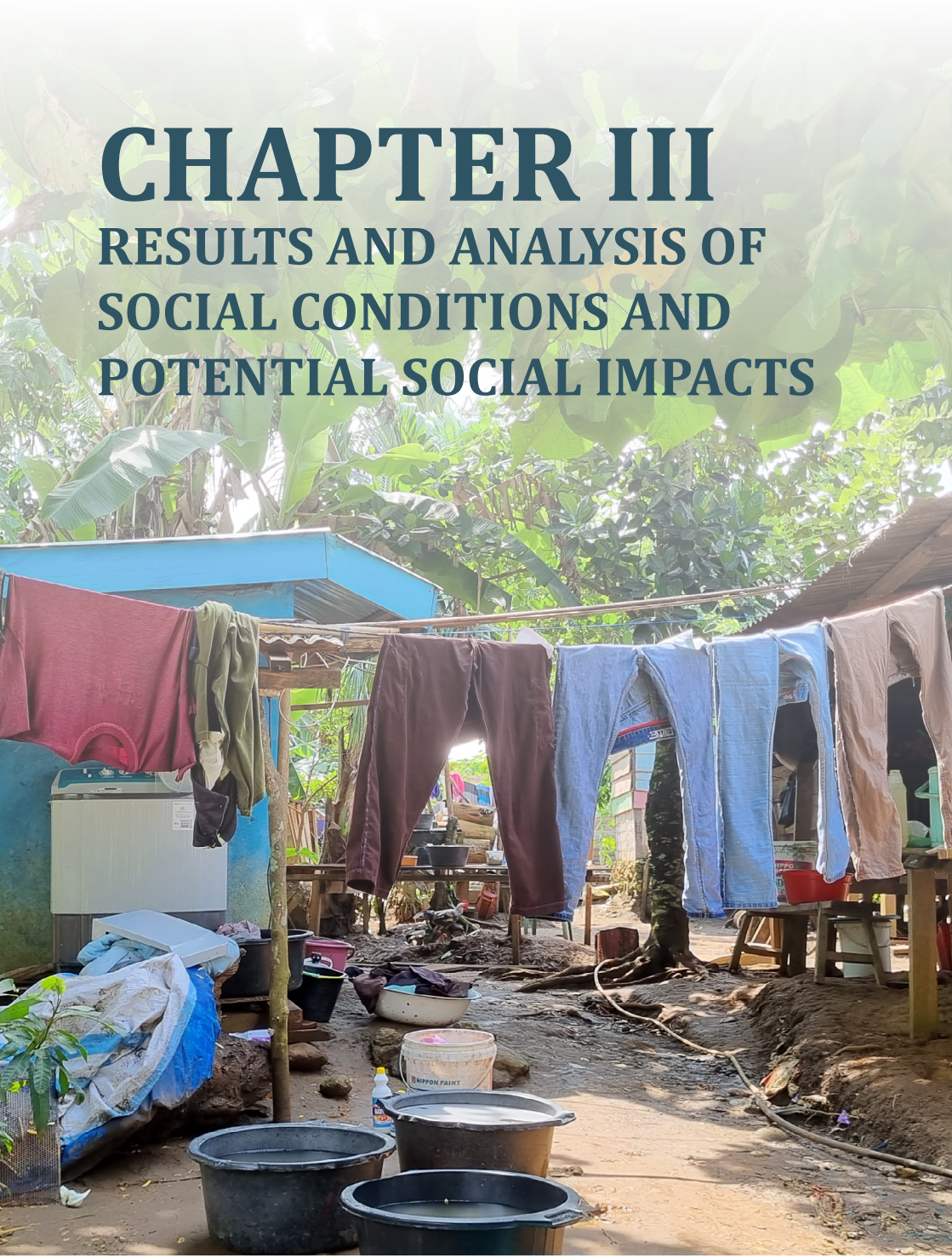
Data collection for environmental components used direct measurement, interviews, and field observations. The selected environmental components were surface water (rivers and lakes), seawater, and ambient air. Water and air are the environmental components most visibly impacted by PT IWIP's mining activities. Portable digital tools were used for measurements due to their convenience and effectiveness. For water quality, we used a Water Quality Tester and Chromium VI Low Range Portable Photometer, while for ambient air, we used an Integrated Air Quality Detector. For several points of lake water quality measurement, we also used the Pack Test® Hexavalent Chromium Wak-Cr6+. Before conducting measurements, we calibrated the Water Quality Tester and Integrated Air Quality Detector. The Chromium VI Low Range Portable Photometer test also indicated that the test sample concentrations were within acceptable ranges.

The measurement locations were chosen based on observations and the field team's reach. We selected downstream areas of rivers and coastal areas close to PT IWIP activities. At locations estimated to

produce high concentrations of particulate dust, such as coal-fired power plants, and visibly dusty areas, we measured ambient air quality.

Interview results and documents, such as the Environmental Impact Analysis (AMDAL) of the IWIP Industrial Area Development Plan, served as secondary data. These data complemented the analysis of measurement results (primary data) in depicting the environmental quality during the field survey.

CHAPTER III
RESULTS AND ANALYSIS OF SOCIAL CONDITIONS AND POTENTIAL SOCIAL IMPACTS



Chapter III
Results and Analysis of Social Conditions and Potential Social Impacts

3.1 Changes in Landscape over Time

Key points:

- *The development of PT IWIP's industrial zone in Central Halmahera Regency since 2018 has transformed the landscapes of Lelilef Woebulen Village, Lelilef Sawai Village, and Gemaf Village. Plantation areas, mangrove forests, and native settlements have been converted into nickel processing and refining facilities, ports, coal-fired steam power plants (PLTU), and other supporting facilities.*
- *The profiles of rivers that previously ran through Lelilef Sawai Village have changed. The Wosea River has narrowed due to the disposal of earth materials along its banks, the flow of the Ake Sake River has been diverted for the construction of the coal-fired power plant, and several rivers have been filled and no longer flow towards Weda Bay, such as the Karkar River, Woebem River, and Gwondi River.*

The presence of PT IWIP since 2018 has led to landscape changes in the four villages closest to the company's operational area. The main form of change observed is the loss of plantation areas owned by the villagers in Lelilef Sawai Village, Lelilef Woebulen Village, and Gemaf Village, as well as landscape alterations in Sagea Village. The most significant landscape changes occurred in Lelilef Sawai Village, Lelilef Woebulen Village, and Gemaf Village, where plantation lands were acquired through land acquisition processes by both PT WBN and PT IWIP. In the area of Sagea Village, the landscape changes have not been as extensive as in the other three villages, but land acquisition by PT IWIP has already taken place, and villagers suspect that in the future, PT IWIP will expand its area to the northern side of Sagea Village. These changes can be observed in Figures 3.1 and 3.2. These two sketches depict the landscape situation before the presence of PT

IWIP (before 2018) and after the presence of PT IWIP (2018 - 2023).[8]

Before the establishment of PT IWIP, the residents were aware of the presence of PT Weda Bay Nickel (PT WBN), which conducted nickel and cobalt mining in Central Halmahera Regency and East Halmahera Regency. PT WBN was established by PT Aneka Tambang Tbk (ANTAM) in collaboration with Eramet S.A. (ESA) to execute the 7th generation Contract of Work (CoW) with the Indonesian Government[9]. The mining operations started after their Environmental Impact Assessment (AMDAL) was approved by the North Maluku Provincial Government in 2009. The total concession area of PT WBN is 54,874 hectares, with nearly 65% of this land located within protected forests[10]. In the PT IWIP area, PT WBN is now one of the tenants operating a pyrometallurgical smelter or Rotary-Kiln Electric Furnace (RKEF) with a capacity of 30,000 tons of nickel per year[11].

8 The sketches were created through the participatory mapping method, representing in the village landscape as recalled by the informants.

9 PT Antam Tambang Tbk. (2021). Associated Entities and Joint Mining Entities. 2021 Annual Report. 452-458. https://www.antam.com/uploads/entitas-asosiasi---pertambangan-patungan.pdf

10 Saturi, S. (2013). *Weda Bay Nickel, Engaging in a Conflict with Indigenous Communities, Endangering Protected Forests. Mongabay, Situs Berita Lingkungan.* https://www.mongabay.co.id/2013/06/07/weda-bay-nickel-berkonflik-dengan-masyarakat-adat-hutan-lindung-pun-terancam/

11 Profile of PT Weda Bay Nickel as a tenant of PT Indonesia Weda Bay Industrial Park (IWIP). https://iwip.co.id/pt-weda-bay-nickel/

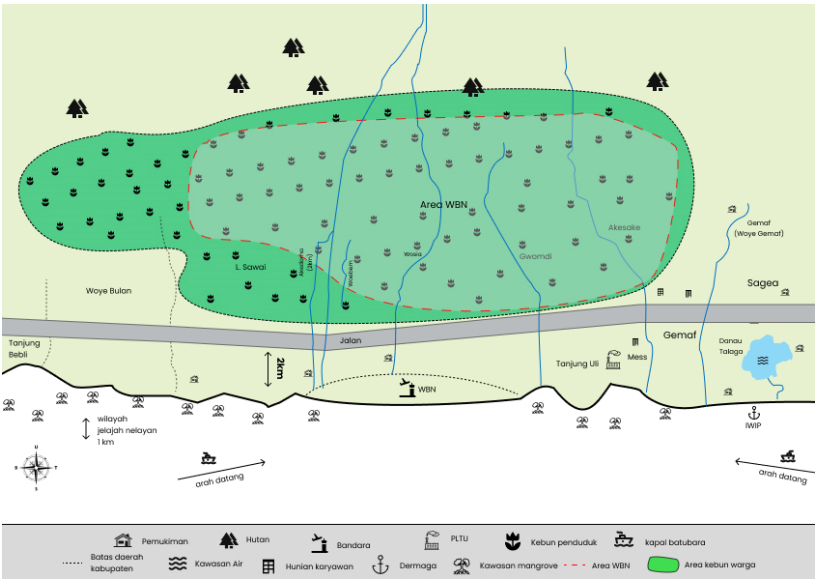


Figure 3.1. Sketch of the Area Before the Establishment of PT IWIP (pre-2018)

Prior to 2018, PT WBN did not carry out massive land clearance. Most of villagers' residential and plantation areas in Lelilef Woebulen Village, Lelilef Sawai Village, and Gemaf Village were included within PT WBN's concession area, and these locations were close to forested areas. Along the coastline, mangrove forests were dominating the coastal region from Lelilef Woebulen Village on the west side to Sagea Village on the east side. From the coast, fishermen usually went out to sea for about one kilometer. Based on the sketch of the area created with several informants, it was observed that, compared to PT WBN's concession area, which did not cover the coastal region, PT IWIP expanded its operational area to the coastal region in Lelilef Sawai Village through land reclamation and the construction of an airport.

Since the presence of PT IWIP in 2018, the landscape has been significantly altered, especially in the three affected villages, namely Lelilef Woebulen Village, Lelilef Sawai Village, and Gemaf Village. The villagers' plantation lands have been replaced by PT IWIP's operational area. Nutmeg and clove trees were cut down to make way for mining areas, offices, employee accommodations, a Steam Power Plant (PLTU),

and coal storage or stockpiles. The coal storage location and the 1,000 MW capacity PLTU are situated close to the Ake Snake River.

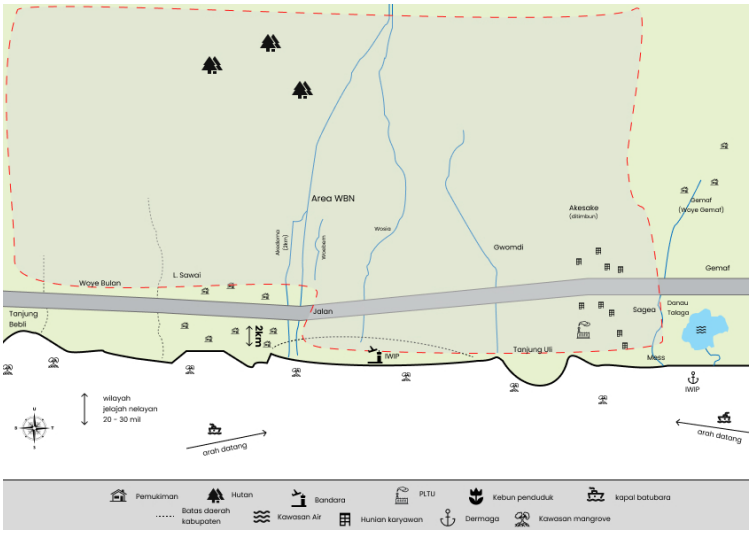


Figure 3.2. Sketch of the Area after the Presence of PT IWIP presence (after 2018)

The profiles of the rivers that previously passed through Lelilef Sawai Village have changed. The Wosea River has narrowed due to the disposal of soil materials on the riverbank, and the flow of the Ake Sake River.[12] The Ake Sake River was diverted for the development of a coal-fired power plant (PLTU batu bara), and some rivers were even filled in and no longer flow into Weda Bay, such as the Karkar River, Woebem River, and Gwondi River. The filling, narrowing, and alteration of the river courses have led to reduced access to rivers and fish resources for the villagers. Currently, the villagers rely only on the rivers that pass through Lukulamo Village (e.g., Kobe River), Gemaf Village (e.g., Woyelo River), and Sagea Village (e.g., Goa Boki Maruru River).

According to the local community, the development of PT IWIP's area is accompanied by a decrease in the mangrove forest area. Land reclamation for the construction of the airport, coal storage area, and other facilities has caused the almost complete disappearance of

12 In the local language, rivers or water catchment areas can be referred to using two terms: "aki/ake" and "wo/woi/woye." The distinct dialects result in variations in pronunciation for each term.

mangrove forests along the coastline. The remaining mangrove forest is only found in Tanjung Ulie, some parts of which have already been converted into a port.

Figure 3.3. The mangrove forest area in Tanjung Ulie, Lelilef Woebulen, now used as a storage site for PT IWIP

Source: AEER Team Documentation, 2023

Two impacted villages, namely Desa Lelilef Sawai, experienced the most concerning landscape changes. Almost the entire residential area of Desa Lelilef Sawai transformed into PT IWIP's industrial zone. The land cover of plantations decreased drastically, leading to a significant reduction in vegetation along the district road in these two villages. Meanwhile, although not experiencing similar landscape changes as the two previous villages in their residential areas, the settlement in Desa Gemaf is located very close to PT IWIP's operations. Several houses in Desa Lelilef Sawai and Desa Gemaf are even located less than 100 meters from PT IWIP's area. This also exposes the residents to dust and noise from PT IWIP's activities.

The district road along the coast of Halmahera Tengah is a major land transportation route. This road is used not only by local residents but

also by PT IWIP employees, fulfilling the operational needs of PT IWIP and its tenants. 24 hours a day, company vehicles (e.g., employee pick-up cars, Light Vehicles (LV) for patrols, heavy equipment transport trucks) always pass along the road, competing for space with motorcycles or private cars of the residents. Consequently, the frequency and intensity of traffic congestion increase, and dust pollution becomes a daily sight. The presence of PT IWIP also triggers an increase in the number of traffic accidents.

> *"Since the establishment of PT IWIP, dust has been present every day, especially during hot weather conditions. After rainfall, the roads become muddy and slippery, causing frequent accidents. In a month, there are always accidents. PT IWIP uses the district road as their transportation route for goods and employee traffic. Residents also use the same road to move from Lelilef to Gemaf or Sagea, and vice versa. Traffic congestion occurs every day. Motorcycle collisions or accidents happen frequently. The residents' houses also become dusty."* (Field Notes, June 24, 2023)

3.2 Disputes over Land and the Consequent Decrease in Livelihood

3.2.1 Shrinking Livelihood Space and Tenurial Conflicts due to Mining

Key points:

- *Tenurial conflicts in Halmahera Tengah between PT WBN, PT IWIP, and the mining-affected communities in four villages mainly stem from two reasons: the economic impact when residents lose their livelihood space and the issue of inadequate compensation compared to the economic value of the affected land.*
- *The reduction of livelihood space is experienced not only by plantation farmers who lost their land through land acquisition but also by fishermen whose fishing areas had to shift due to nickel mining activities.*

Large-scale development projects like mining often come with land

dispute issues between companies and communities. The same happened in the Halmahera Tengah region between PT WBN, PT IWIP, and the mining-affected communities in four villages. Tenurial conflicts between residents and the companies have been ongoing since PT WBN began its exploration and gradual land acquisition process in the 2008s to the 2010s. This situation was exacerbated by the presence of PT IWIP, which conducted large-scale land acquisitions in the three affected villages since 2018 until the present (2023).

The tenurial conflicts are rooted in two factors: the economic impact when residents lose their plantation areas and the issue of compensation for land acquisition, which is significantly lower than the economic value for the affected residents. The land acquisition processes conducted by both PT WBN and PT IWIP have shrunk the livelihood space for the villagers who have depended on plantation agriculture for decades, growing perennial crops such as cloves, nutmeg, coconuts, and copra. The landscape changes depicted in Figure 3.2 show the loss of livelihood space for the residents due to the entry of PT IWIP. The villagers' plantations, replaced by nickel mining areas and smelters, resulted in the loss of their livelihood as farmers.

The impact of the loss of plantation areas goes beyond changing the landscape of the affected villages and the loss of residents' livelihoods as farmers. Another issue that arises is poverty due to the lack of alternative sources of income for the villagers. Currently (June 2023), the affected villages face a "deadlock" in finding a livelihood because, besides losing their plantations, the residents also face difficulties in fishing. Fishermen in Lelilef Sawai, Lelilef Woebulen, and Gemaf face the same situation concerning the impact of the nickel mining company's presence. The loss of coral reefs and mangroves along the coast due to reclamation around PT IWIP's area for airport and office building construction, as well as the power plant (PLTU), has led to the fishermen's fishing grounds moving further away.

Before the presence of PT IWIP, fishermen could catch fish around the coast up to 1 km from the shoreline. Reclamation activities, company waste disposal, and other operations by PT IWIP and its various

tenants have significantly reduced the fish population around the coast. As a result, fishermen struggle to find fish in their usual fishing areas and now have to venture out to sea as far as 20 - 30 km from the shoreline. This situation has made it challenging for fishermen as they are forced to spend more capital to go fishing compared to before PT IWIP's presence. The difference in required capital can reach millions of rupiahs because fishermen now need a minimum capital of Rp 3,000,000 - Rp 5,000,000 for a single fishing trip without any guarantee of catching enough fish to meet their daily needs.

Dullah, a fisherman from Lelilef Woebulen Village, expressed concerns about the lasting effects of PT IWIP's presence. According to him (as mentioned in Field Notes, June 17, 2023), one of the significant long-term impacts is the threat posed to the livelihoods of future generations. The company's operations have resulted in the loss of living space, which could jeopardize the community's economy in the coming years. Additionally, Dullah highlighted the worry of declining land fertility due to the company's mining and nickel smelting activities. These issues raise serious concerns about the lasting implications of PT IWIP's operations on the local community and the environment.

> *"Both fishermen and farmers rely on a fertile and pristine environment. If this environment is already disrupted by waste, how can we even discuss economic sustainability?"*

3.2.2 Land Compensation Issues

Key points:

- *The ongoing tenurial conflicts between PT IWIP and the local communities are a result of the discrepancy between the compensation offered by the company and the demands of the residents. Some landowners feel that the compensation offered is unfair, leading them to refuse selling their land to the company.*
- *The company's land acquisition methods are not limited to direct land purchases from landowners. According to the testimonies of the residents, the company has also been involved in land clearing without proper land acquisition procedures and has blocked access*

to the land owned by the local farmers.

The process of land acquisition by PT IWIP is still facing resistance from several residents in the affected villages. The resistance is mainly due to the low compensation amount offered by the company, which is considered inadequate by the affected residents. Since PT IWIP entered the Halmahera Tengah region, the local mining communities have been opposing the land acquisitions conducted by the company. The main reasons for this opposition, apart from the impact on the narrowing of the residents' living space, are the low prices at which the company purchases the land, which is perceived as disrespectful to the local communities.

> *"... the land prices set by IWIP are unreasonably low. Instead of benefiting the community, it undermines them. Both certified and uncertified lands are appraised at very low values without any distinction."* (Alfonsius, in Field Notes, June 21, 2023))

The land purchase price by PT IWIP is Rp9,000/m and the land purchase price by PT WBN is Rp8,000/m. These amounts are far different from the standard land prices which, according to the impacted village residents, range from Rp30,000 to Rp220,000/m, depending on the land condition (based on NJOP regulated in agrarian regulations).[13] However, these regulations are not followed by the company. PT IWIP only calculates the land area without considering the economic value of the land. Productive agricultural land is not valued differently from non-productive land or land that has never been cultivated for the economic needs of the residents.

Furthermore, there is no differentiation in land prices between land with certificates and land without certificates. The process of determining land prices is not transparent and does not involve both parties (residents and the company). The land price is unilaterally determined by the company without involving any negotiation process with the landowners. The residents are asked to accept the offered price by the company without any room for negotiation.

13 Statement from the interview with Dullah, June 17, 2023.

> *"...The company came with a land measurement team, determined the land area, and then set the land price. We were asked to accept the price determined by IWIP. Is a land price of only nine thousand per meter enough? Cigarettes at the store are much more expensive than the land price. I don't want to sell my land. Even if IWIP has bought land on both sides, I still won't sell it at such a low price."* (Max Sigoro, one of the affected farmers in Gemaf Village, as recorded in the Field Notes, June 19, 2023)

The rejection of land acquisition by PT IWIP is further reinforced by allegations of data manipulation regarding land area by the company's land measurement team. One of the farmers in Gemaf Village stated that he owns a certified garden land with an area of about 1.4 hectares. However, when the measuring team from PT IWIP conducted the land measurement on Max's property, they claimed that the total land area owned by Max was approximately 1.1 hectares. This caused Max to feel that the measurement results by the land measurement team were detrimental and did not match what was stated in his land certificate.

> *"This certificate is issued by the National Land Agency. It is officially issued by the country, why don't they believe in it? My land is more than 14,000 square meters with a certificate from the Land Office. When measured by the company, they claim it's 11,110 square meters, and they offered Rp112,260,000 for that piece of land. I don't want to sell it. This land was surveyed before the company entered. It was already surveyed by the land authorities. They said it's illegal. I asked them, how can this be illegal? This is the emblem of the Garuda bird, it's a national symbol. It was issued by this country, not just some random thing. Why would they call it illegal?"* (Max in Field Notes, June 19, 2023).

However, the minimum price desired by the villagers in Desa Gemaf is Rp50,000 per square meter for both certified and non-certified farmlands (if following the company's policy of not differentiating between certified and non-certified lands). However, the company rejects this and still proposes a price of Rp9,000 per square meter, and in some cases, even as low as Rp6,000 per square meter. These prices

are far below the price requested by the villagers. As a result, some villagers, including Max, still refuse to sell their lands up to this day.

Based on Max Sigoro's account, PT IWIP's response to the villagers' refusal to sell their farmland due to the perceived low land prices is ignored by the company. Max's farmland, which has not been acquired yet, is currently surrounded by lands that have been acquired and opened for nickel mining activities by PT IWIP. Max mentions that he can still access his farmland despite being surrounded by PT IWIP-owned lands. However, there are other villagers who are in the same situation as Max but can no longer access their farmlands. According to Max, PT IWIP will offer lower prices for the farmlands that are constrained by the nickel mining area, compared to the previous offers. This often leads the villagers to feel "forced" to give up their farmlands that they can no longer access..

In addition to offering lower prices to landowners whose lands are constrained by the nickel mining area, there are also cases where landowners whose lands have not been acquired by PT IWIP yet are already being cleared and opened by the company. Melianus, one of the fishermen and landowners in Gemaf Village, mentioned that at least two villagers have approached him and told him that their farmlands, which have not been purchased by PT IWIP, have already been cleared by the company, preventing them from accessing their respective lands. According to Melianus, the company did not provide any explanation regarding this matter, and landowners are struggling to meet with company representatives responsible for land acquisition. The villagers are prohibited from entering PT IWIP's office area by the company's security personnel, so they cannot raise objections or protests regarding the opening of lands that have not been paid for by PT IWIP.

The main reason for the rejection of land acquisition is primarily due to the disparity between the desired purchase price of land by the landowners and the price set by PT IWIP. However, this rejection is also strengthened by the villagers' concerns about their livelihoods in the future. The villagers in the affected villages primarily work as farmers

and fishermen. They can earn at least Rp15,000,000 every three months from the cultivation of crops like nutmeg, cloves, coconuts, and other plants (the income may vary depending on the size of the land and the quantity of the harvest). The income from the agricultural sector is considered higher compared to being an unskilled worker at PT IWIP, where the salary for such workers ranges from Rp5,000,000 to Rp6,500,000 per month.

For the communities around the mining area, ensuring that they have farmland to be inherited by their children and grandchildren is also considered essential. These communities do not have a cultural relationship with the land as seen in indigenous communities or those with a cultural identity as farmers, based on observations and research by the AEER team. However, ensuring that they can provide a sufficient and prosperous life for their offspring through the inheritance of productive agricultural land is a perspective that still exists in the lives of these communities that reject land acquisition. The land acquisition carried out by PT IWIP raises concerns about the future livelihoods of the villagers, coupled with the low and insufficient compensation for their lands, which hinders their ability to transition to adequate livelihoods for their current and future lives.

3.3 Economic Changes

Key points:

- *The landscape transformation from agricultural areas to mining sites has altered the livelihood patterns of the residents. Previously, they were primarily farmers and fishermen, but now they have shifted to become rental property entrepreneurs, traders, or employees in mining companies.*
- *The transition in livelihoods is not always seen as an improvement in the lives of the residents; it also brings new challenges for farmers who lack sufficient capital to start new businesses or for fishermen who have limited alternative livelihood options.*

> *"...when I reach, let's say, 60 years old, that's it, my life is over. But what about the future generations, they are called citizens, where will they go tomorrow? We must consider that because it is the responsibility of the state. When we talk about this country, what do we mean? We are Indonesian citizens, but who benefits from it?"* (Dullah in Field Notes, June 18, 2023)

Before the entry of PT WBN and PT IWIP in Central Halmahera, the livelihood of the communities in the villages of Lelilef Sawai, Lelilef Woebulen, Gemaf, and Sagea was centered around farming crops such as clove, nutmeg, copra, and coconut. The income that could be obtained from each harvest varied, ranging from Rp15,000,000 per month up to Rp50,000,000 per month for one to two hectares of land.[14] The livelihood of the communities in the villages impacted by PT IWIP's activities was prosperous and they felt secure before the company's arrival. The prosperity they experienced before PT IWIP refers to a life considered sufficient for daily needs and ensuring that their children and grandchildren could have a sustainable livelihood.

Being sufficient for the future. This is mainly because the residents owned productive plantations that generated income deemed sufficient to meet their needs, ensuring a sense of security in their current livelihoods and for the future.

One of the residents in Sagea named Jumat, who recently started cultivating nutmeg, could already make Rp15,000,000 every three months. This income was enough to support Jumat and his family. If we calculate Jumat's gross income from nutmeg fruit harvest alone, it amounts to Rp5,000,000 per month. Jumat and other farmers in the affected villages not only relied on their income from the plantation sector but also had side jobs as fishermen or running small shops. Similar situations were experienced by other residents around PT IWIP.

14 This income is solely obtained from harvesting nutmeg every three months. This does not even account for the earnings that can be obtained from harvesting copra and cloves.

Figure 3.4. Friday's nutmeg plantation area in Sagea Village
Source: AEER Team Documentation, 2023

The situation was considered to have changed significantly after PT IWIP began its operations. The impact of the loss of agricultural land due to land acquisition by PT WBN and PT IWIP has resulted in some farmers losing their main source of livelihood. Some farmers with sufficient capital were able to transition to become rental property entrepreneurs. The capital they had came from the money earned by selling their land to the companies. However, with the selling price of the land being lower than the cost of purchasing land to build a rental property, not all farmers were able to switch occupations.

In order to understand the differences in the needs of farmers to adapt and survive after selling their agricultural land, it can be seen through Table 3.1.

Table 3.1. Comparison between Income from Land Sale and Expenses for Constructing a Rental Property[15]

Income from Land Sales	**Cost of Building a Rental Property Expenses**		
	Land Purchase Price for the Rental Property	**Construction Workers' Wages**	**Material Costs (if using plywood)**
IDR 90,000,000 to IDR 180,000,000 (1 to 2 hectares of land)[16]	IDR 250,000,000 (300m2 of land)	IDR 10,000,000/ room (1 rental property with an area of 300m2 can accommodate a maximum of 10 rooms). For 1 rental property with 10 rooms, the labor cost for construc-tion workers amounts to IDR 100,000,000.	IDR 100,000,000. Minimum
	Total Cost: IDR 450,000,000		

Source: AEER Team Field Research Results, 2023

Based on the table above, the amount of money obtained by farmers from selling their land to PT IWIP is far from sufficient to meet the capital needs for building an accommodation facility (indexes) as their main livelihood replacement for the plantation sector. Farmers who lack the capital to build accommodations are forced to work odd jobs or remain unemployed. This situation is vastly different from when

15 This data represents the result of rough cost calculations incurred by each farmer if they want to build a rental property business. On average, farmers have land ranging from 1 to 2 hectares, although some farmers have more than 5 hectares of land. However, the majority of affected residents are small-scale farmers (1 - 2 hectares). The costs listed in the table may vary depending on the price standards in each village.

16 Referring to the price standards set by PT IWIP when purchasing local residents' farmlands.

they were still engaged in the plantation sector.

At the same time, farmers who have alternative livelihoods as fishermen, as well as other villagers whose main livelihood is fishing, face their dilemmas. Coastal areas (within 1 km from the coastline) can no longer serve as fishing locations due to the significant decline in fish populations. Additionally, coastal areas close to PT IWIP's operational areas are no longer safe for fishing activities due to the presence of barges transporting coal for the company, posing risks of accidents around the company's construction (reclamation) area. Presently, fishermen must search for fish in more distant locations with greater capital requirements compared to before. Moreover, Max, one of the fishermen, mentioned that the weather around the sea has become increasingly hot in the past two months, and he suspects it is related to the mining activities in the vicinity of Central Halmahera.

> *"During May and June of this year, a significant number of fish have been found dead in the vicinity of IWIP, near the Power Plant. It has become a recurring issue, with fish deaths being reported almost every year. In the past, before the establishment of IWIP, during the WBN period, it was possible to catch 10 kg of fish in a single day at sea. However, this is no longer the case as the current situation has severely impacted the fish population, making such catches unattainable now."* (Melianus in Field Notes, June 22, 2023)

The alternative chosen by the affected village residents, especially the youth, is to work as employees (laborers) in the company. However, they also have to compete with workers from various other regions in Indonesia as well as immigrant workers from China to secure jobs at PT IWIP. Another issue is the access to job opportunities within PT IWIP, which becomes increasingly challenging when applicants are known to have relatives in conflict with the company. For instance, there was a PT IWIP employee who was fired after it was discovered that he was the son of Max Sigoro, who still refused to sell his farmland to the company. Similar cases have occurred with some residents in Lelilef Village.

Most of the impacted village residents who eventually find work as laborers at PT IWIP are engaged in fieldwork (cargo/logistics handlers, land survey team members, discipline officers, etc.), while others work in the company's office in administrative or Human Resource roles. However, working as laborers at PT IWIP is also considered inadequate in terms of providing prosperity for the affected village residents. These laborers face various non-ideal conditions, including excessive working hours, insufficient wages, and substandard employee accommodation.

3.4 Work Conditions of Workers

Main points:

- *Economic changes have also transformed the livelihoods of the residents from farmers and fishermen to employees in mining companies. However, shifting to work for PT IWIP is not considered an "ideal" alternative. This is primarily due to unfavorable working conditions, perceived low wages, inadequate employee accommodations, various cases of discriminatory dismissals, and high occupational safety risks resulting from suboptimal implementation of Health and Safety at Work (K3).*

Since around 2018 - 2019, the entry of PT IWIP into the Halmahera Tengah region has undoubtedly brought about the migration of labor, both from within the country and abroad. Domestic labor mostly works in field positions such as construction, heavy equipment operators, land surveying teams, and others. The field study conducted by Team AEER revealed several issues faced by the workers at PT IWIP, especially those who are domestic laborers, including:

1. Low Worker Wages Workers at PT IWIP, especially those from the surrounding villages and domestic labor, receive low wages compared to their working hours. The average wage for domestic workers in field positions is around Rp5,000,000 - Rp6,000,000 per month. Specifically, the salary for some PT IWIP field workers, such as crawler operators, dump truck operators,

loader operators, mobile crane operators, boom truck operators, and forklift operators, ranges from Rp5,000,000 - Rp6,000,000 per month, while security positions range from Rp3,000,000 - Rp3,500,000 per month. Although these wages are higher than the North Maluku Provincial Minimum Wage (UMP) and the Central Halmahera District/City Minimum Wage in 2023, which amounts to Rp2,976,720 per month, they are still considered insufficient to cover the daily expenses of the workers. When compared to their living expenses, such as room rentals for boarding, motor vehicle installments, and other daily needs, the wages fall short. "(motorcycle) for commuting to work, living expenses such as food and water, the monthly wage is insufficient. The following table can explain the breakdown of the basic needs of the employees compared to the wages they receive."

Table 3.2. Comparison between Labor Wages and the Cost of Living

Description	Amount (in IDR)
Average salary of PT IWIP workers	IDR 5,000,000
Cost of renting a room	IDR 1,500,000
Daily meal expense	IDR 2,700,000
Motorcycle installment fee	IDR 500,000
Reamining income at the end of the month	IDR 300,000

Source: AEER Team Field Research Results, 2023

The data presented in the table above represents the basic needs of unmarried workers (those without partners and children) who do not have any other dependents besides themselves. The wages received by the employees often do not last until the end of the month. PT IWIP workers often find themselves forced to borrow from grocery stores and food stalls around their rented accommodations because they no longer have any money left starting from the 10th of each month (wages are paid on the 5th). This is illustrated by the account of one of the PT IWIP workers as follows:

"If you look at the employees, they seem strong and confident from the 5th of every month. But once it reaches the 10th until the 15th, we see them struggling, and we feel sorry for them. There was one gentleman (an IWIP worker)

who used a transparent glass for his coffee during payday. But when it's between the 5th and the 10th, and on the 15th, he switches to a cup. But don't judge, whether it's coffee or water (it's just to hide their financial situation that is no longer sufficient)." (Field Note, June 20, 2023).

2. Uninhabitable Employee Housing (Mess) Employees at PT IWIP, in addition to receiving wages, also receive facilities such as employee mess within the PT IWIP area. However, many employees choose to rent rooms in rented accommodations in the villages around the company, especially for local employees who work in field positions or non-skilled roles such as heavy equipment operators, land surveyors, and construction workers. The main reason is the uninhabitable condition of the employee mess at PT IWIP

   The employee mess at PT IWIP is considered uninhabitable as it is located in an area perceived as slum-like. One of the workers describes the unsuitability with the expression, "When sleeping, employees are side by side with rats." Additionally, both male and female employees are housed in the same area. One of the problematic issues for employees is the lack of differentiation between bathroom and toilet facilities for male and female employees. This situation leads to cases of sexual violence against female workers, ranging from male workers peeping at female workers in the bathroom to cases of rape against female workers.

   Another condition faced by workers in the employee mess is the quality of water used for bathing, washing, and toilets (MCK). The water quality accessible to employees in the employee mess is turbid, prompting some employees to choose to stay in rented accommodations in the surrounding villages. Moreover, the mobility of employees is not limited when opting for rented accommodations in nearby villages compared to staying in the employee mess. Some employees have also started moving to accommodations in villages relatively farther from the company's operational area, such as Desa Sagea, Desa Kobe, and Desa Trans Kobe, to access clean water and avoid the dust that spreads around

the company's operational area.

3. Termination of Workers

Workers at PT IWIP who are known to have family relations with individuals in conflict with the company faces unfavorable situations. Often, workers who are related to individuals involved in land disputes with PT IWIP are suddenly terminated by the company. When they try to reapply for different positions within the company, they encounter obstacles even though they have reached the final stage of the recruitment process. One case that occurred was when a worker was terminated after it was discovered that he was the child of Max Sigoro (an individual who still refuses to release the land). Up to now, Max's child has been unable to secure employment at PT IWIP despite applying for job positions multiple times and reaching the final stages of the recruitment process.

Furthermore, workers who commit minor to moderate disciplinary violations, such as tardiness, often receive a Termination Letter without going through the warning mechanism that involves issuing warning letters (WL) from stage 1 to stage 3. This situation is compounded by the ambiguity of the rules set by each supervisor/foreman in the field. Some workers mentioned that regulations related to Occupational Health and Safety (OHS) and other workplace rules often change every day. This situation causes confusion among the workers. Acts of violation or indiscipline of labor are also related to unpredictable changes in regulations and often occur abruptly. Since the company began its operations, there have been several accidents in the workplace resulting in the deaths of dozens of employees.[17] In August 2021, two employees of PT IWIP were involved in a workplace accident where they were run over by heavy machinery, and unfortunately, one of them lost their life.[18] In May 2023, two more workplace accidents occurred

17 This information has been frequently reported in local media. One of the reports was provided by Antaranews.com. https://ambon.antaranews.com/berita/105630/dua-karyawan-pt-iwip-terlindas-alat-berat-satu-meninggal-dunia-ungkapkan-penyebabnya, accessed on July 24, 2023.

18 ibid.

at PT IWIP, involving one worker from Ambon and one worker from China.[19]

Various workplace accident cases within the PT IWIP environment are suspected to have occurred due to inadequate and improper implementation of Occupational Health and Safety (OHS) measures. Hayun Maneke, a representative from the National Workers Union (SPN) branch in Central Halmahera Regency, stated that the May Day celebration on May 1, 2023, organized by PT IWIP, was merely a ceremonial event that invited union representatives as decoration for documentation purposes, without providing space for dialogue so that the labor union could convey their aspirations and demands regarding various labor issues, including the suboptimal implementation of OHS at PT IWIP. The company's response to the letter submitted by the labor union was also perceived as showing a narrative that indicated everything was fine with the workers' conditions at PT IWIP.[20]

3.5 Environmental Changes and Resident Health Conditions

Main points:

- *Indirect consequences of the increased population in the villages surrounding PT IWIP and mining activities include changes in air quality due to dust pollution. Additionally, demographic changes and nickel mining activities are suspected to have an impact on changes in water quality and sanitation in the villages around the mining company. This situation is exacerbated by the increase in poorly managed plastic waste in the settlements.*

- *After the entry of PT IWIP in Central Halmahera, there has been an increase in cases of respiratory diseases (ISPA) and diarrhea, which are believed to be the result of changes in environmental quality (ISPA due to decreased air quality and diarrhea due to decreased water quality and sanitation).*

19 The incident has drawn the attention of the National Workers' Union branch of Halmahera Tengah Regency, which previously sent a letter to PT IWIP, urging them to initiate a dialogue between the company and the workers' union. https://www.posttimur.com/2023/05/15/perihatin-kondisi-karyawan-pt-iwip-ini-harapan-hayun-maneke-ketua-spn-halteng/, accessed on July 24, 2023.

20 ibid.

The impact of PT IWIP on the surrounding villages is not only direct, such as changes in the landscape and livelihoods of the residents. The activities of PT IWIP directly trigger migration from various regions, both from within the country and from abroad, to Central Halmahera. This migration wave not only brings workers to the mining area but also newcomers who are risking their fate in the large-scale development area to engage in trading and other economic activities.

This influx of population brings several new issues for the residents of the villages around PT IWIP, especially in the villages of Lelilef Sawai and Lelilef Woebulen. The unavoidable increase in population does offer new economic potential for those who have lost their farmland, as they can build new businesses such as rental propertys. However, the "positive" economic impacts are short-lived. What are the impacts?

1. Implications of the Increasing Population: Changes in Air Quality
   Since 2022, a new problem has emerged for the residents of Lelilef Sawai, Lelilef Woebulen, and Gemaf villages, namely changes in groundwater quality. Before the arrival of PT IWIP, the groundwater quality in these villages was clear and suitable for daily needs. However, currently, the groundwater has become turbid and salty. This change in water quality is even affecting those who used to live near the coast and could still access fresh groundwater. Jovis, one of the residents of Lelilef Woebulen village, mentioned that.

   "...the most likely reason for the water becoming salty is the excessive use of water by the residents, causing a depletion of groundwater and allowing salty water to infiltrate the soil."

   Before the existence of PT IWIP, there were only residents21 Previously, only residents used groundwater. However, with the presence of PT IWIP and the increasing influx of various newcomers, both workers and non-workers of PT IWIP, the usage, and demand for groundwater have dramatically increased in the surrounding villages. Since 2022, due to the change in groundwater quality, residents have had to switch to using bottled water sold

21 The term used to refer to local residents who were born and raised in a specific location or region.

by water depots around the villages. As a result, they now face a new dependency on clean water, which was previously free and accessible, but has now become commercialized.

2. Impact of Dust Pollution and Environmental Quality Changes: Increase in Cases of Diarrhea and Respiratory Infections (ISPA)

   Besides the emergence of new dependencies due to changes in water quality, the villages affected by PT IWIP's activities, both directly and indirectly, face other issues, namely health problems. Two health problems that have been increasing since the presence of PT IWIP are the rising cases of diarrhea (due to declining water sanitation quality) and respiratory infections (ISPA) caused by deteriorating air quality. Based on the findings from AEER team interviews with one of the personnel at Lelilef Community Health Center (Puskesmas), there has been an increase of up to 500 cases of diarrhea and 800-1000 cases of ISPA per year, compared to the previous 300 cases per year.

   > *"Yes, usually the highest cases are ISPA, common cold, and diarrhea. The cases are around 500 every year. The highest disease at Lelilef Community Health Center is ISPA. The cases of ISPA have increased since the arrival of IWIP. IWIP, if I'm not mistaken, entered in 2019 or 2020. We used to have 300 cases of ISPA per year, but now it's almost doubled, around 800 to 1000 cases per year."* (Field Notes, 23 June 2023)

   The increase in cases of diarrhea and ISPA in the villages surrounding PT IWIP, according to the personnel at Lelilef Community Health Center, is related to the company's operational activities. Land eviction and clearance by the company, dust pollution continuously spreading throughout the residential areas along the district road, uncontrolled population growth leading to changes in environmental quality such as increased domestic impacts and changes in water quality due to increased groundwater usage, and the lack of serious efforts from the

company to help address these issues have inevitable impacts on the health conditions of the residents.

> *"Yesterday, we evaluated why our ISPA coverage is increasing because it is one of the impacts of the mine, tropical climate, and side effects of drought. Here in Lelilef, we have experienced many evictions, so naturally, there are not many trees left. You can see for yourself that there is more dust on the road here. We only have two seasons here, either the dusty season or the muddy season."* (Field Notes, 23 June 2023)

3. Plastic Waste

In addition to the dust pollution, which is considered very disruptive to the residents due to the accumulation of dust in the settlements, and the changing quality of groundwater rendering it unfit for consumption, another issue is the increasing domestic waste, especially plastic waste. In the vicinity of the settlements, along the roadsides, and even in the river streams, piles of waste, ranging from plastic bags, used bottles, to food packaging, are always a common sight in the villages of Lelilef Sawai and Lelilef Woebulen. The rising population has contributed to the increase of plastic waste in the residential areas.

Figure 3.5. Piles of garbage on the side of the road in Lelilef Sawai Village
Source: AEER Team Documentation, 2023

According to the residents of Lelilef Sawai and Lelilef Woebulen villages, since the beginning and up to the time of the AEER field study, the response from PT IWIP has been only reactive. PT IWIP assists in removing waste around the villages when contacted by the Village Government. However, concerning the issues of dust pollution and the changes in water quality, the residents claim that there has been no response or action from PT IWIP. The dust pollution, which persists throughout the day in the affected villages, is not addressed by the company, despite trucks, patrol cars, and employees' vehicles passing through the residential areas daily, causing dust to spread around the settlements.

> *"...when looking at the environment, Lelilef is now prone to waste because there is no waste disposal site, and the Village Government cannot handle the waste issue. The company has not provided any assistance for it. Waste is still a significant problem."* (Field Notes, June 23, 2023)

Efforts to address the plastic waste issue in the settlements and rivers have been undertaken by the village residents by contacting the company to help transport and manage the waste in the company's area. In the villages around PT IWIP, there is no final disposal site (TPA) to accommodate domestic waste around the villages, so the residents depend on the company's assistance for waste management. However, on the other hand, the villagers also believe that plastic waste is one of the problems that the company, including PT IWIP, should address in the villages, along with dust pollution and changes in water quality. This is because all these problems are indirect consequences of the company's presence and activities in the affected villages.

Figure 3.6. Billboard for World Environment Day 2023
Source: AEER Team Documentation, 2023

3.6 Perspective of Women in Mining Conflicts

Main points:

- *Women, as one of the vulnerable groups, have their own stories about*

the impact of nickel mining on them. The impact they experience is mainly related to the loss of their livelihood as farmers and the restricted access of women to the resources around the rivers within the PT IWIP operational area.

- *Women's perspectives also emphasize their concerns about environmental pollution due to nickel mining activities. Inland water areas such as rivers and lakes, as well as the ocean, have the potential to be contaminated due to nickel mining in the surrounding areas, which can lead to a decline in the fish population, a significant source of livelihood for the residents. Moreover, the activities of the residents, especially women, rely on access to clean water obtained from the rivers around the villages.*

The impact of nickel mining is not solely about economic and health issues for the communities around it. Women, as one of the vulnerable groups affected, have their own stories about the impact of mining activities around them. The perspectives of these women, fighting for their rights, should be seen as essential in understanding the magnitude of the mining impact on the communities around it.

In the village of Lelilef Woebulen, there is a prominent woman figure named Farida who actively fights for her rights to land and clean water resources. Farida, affectionately known as Mama Ida, is a 70-year-old woman who was appointed as a champion of indigenous women's rights by the National Commission on Human Rights (Komnas HAM) in 2015. Around 2013-2014, Mama Ida led demonstrations against PT IWIP concerning the rejection of land acquisition. In 2021, Mama Ida also staged a demonstration in the PT IWIP area regarding the prohibition of taking river materials along with her children. The demonstration took place at the Wosia River. The cause was that the residents of the villages around the company understood that the river was considered "community property," meaning that the community could access the resources around the river. In the same year, the company prohibited the residents from taking stones for construction materials. This prohibition triggered the residents' demonstration. The company claimed that there was no restriction for the "original

inhabitants" – a term used to distinguish between residents and newcomers – to take stones from around the river as construction materials. According to Mama Ida's account, PT IWIP did not specify that only newcomers were not allowed to take the materials, which led Mama Ida and several other young people and women to stage the demonstration.

Mama Ida is striving to fight for her rights regarding access to natural resources around the village, especially agricultural land and river areas. In line with Mama Ida, there is a prominent woman figure named Maryama in the village of Sagea, affectionately known as Bibi Ama, who is actively involved in advocating for her own agricultural land, communal land, and the preservation of water resources accessed by the villagers. For Bibi Ama, the presence of the mining company will affect the condition of clean water resources around the village. Particularly in the village of Sagea, there is a spring source in Goa Boki Maruru that flows into the river passing through the residential area. Bibi Ama expresses her concerns about this situation.

"..because I'm afraid that there might be waste, you know, they (the mining company) are making this, what is it, waste disposal. The concern is, what will happen to us, the people of Sagea when the waste is disposed of? But we (I) want to reject it, while other people have already sold their land. So we can't get water from there anymore, it might be contaminated waste, why would we take it from there again? (worried that we won't be able to get water from there anymore, for example, if the water is already contaminated with waste, why should we take it from there again). Currently, they (the villagers) use water gallons because the water is dusty (contaminated). Since the company arrived, it has become difficult to catch fish. It wasn't like that before, when we went fishing, we brought back a lot of fish. When I have to travel to Weda and pass through the location of the IWIP company, tears roll down my cheeks. I feel sorry for the people of Gemaf, even though they are our village neighbors, our blood is the same. Every time it rains, the excavator on the mountain dislodges and the runoff reaches the gardens and residential areas. Muddy and sludgy, reaching the houses of the villagers. I said, restrain yourselves, people of German, don't sell the

remaining land anymore, let's see the impact of this. I said while tears rolled down my cheeks, we will suffer greatly in the future." (Maryama in Field Notes, June 22, 2023)

For women, farmland and clean water sources are crucial. The activities of women in the affected villages are undeniably tied to their access to clean water and agricultural land, which are essential for the livelihood of their families. Before PT IWIP began its operations, the residents of the affected villages could still grow various vegetables that not only served their consumption but also provided an additional source of income besides their main income from nutmeg and clove plantations. For women engaged in fishing activities, clean rivers ensured that they could meet their daily household consumption needs with an adequate supply of consumable fish.

Furthermore, clean air conditions that do not fill homes with dust throughout the day are vital for the overall health of residents whose daily activities predominantly revolve around their homes, such as women and children. The mining activities conducted by PT IWIP and its tenants have resulted in changes in the quality of water and air, as well as the loss of livelihood spaces for residents in the plantation sector. This situation is perceived as detrimental to the village residents, particularly women. As mentioned earlier, there has been an increase in cases of diarrhea and respiratory tract infections in the affected villages, which concerns women significantly.

Figure 3.7. Appearance of the Kobe River in Lukulamo Village which can no longer be consumed
Source: AEER Team Documentation, 2023

The worrisome conditions for women are not only limited to the quality of river water but also extend to groundwater. Mama Ida expressed her concerns about the quality of bottled water sold in the villages surrounding PT IWIP. Bottled water is produced using distilled and processed groundwater. Every day, the residents consume this water because the condition of groundwater in their wells is no longer suitable for consumption. Efforts to address these concerns have been initiated by the Lelilef Woebulen Health Center through inspections and water quality tests at bottled water depots around the health center's working area. However, the results of the inspection and water quality tests have not been disseminated to the community or to the health center itself as of the time the AEER team conducted their field study. Moreover, according to Mama Ida, these efforts need to be strengthened with support from the mining company to ensure access to clean water for the affected communities.

This concern is also shared by Yulius, one of the elders in the village of Lelilef Sawai. Yulius mentioned that before PT IWIP began its operations, PT Weda Bay Nickel (PT WBN), which exploited nickel in Central Halmahera, collaborated with the Saloi Foundation to provide large water tanks as facilities to supply clean water to the villagers. Additionally, PT WBN regularly checked the condition of river water and other water sources accessed by the villagers to ensure that these water sources were still suitable for use by the surrounding villages. However, the situation changed after PT IWIP entered the area. The provision of clean water facilities was no longer managed, and there were changes in the quality of river water and groundwater. Based on the knowledge of the affected villagers, PT IWIP has not made any efforts to address the problems faced by the community since their mining activities began.

3.7 Comparison between Legislation and IRMA Criteria

The Initiative for Responsible Mining Assurance (IRMA) is a multi-stakeholder coalition in the mining sector formed in 2006. The stakeholders involved in IRMA include mining companies, purchasers of mined products, investors, labor force, non-governmental organizations (NGOs), and affected communities. Its mission is to protect communities and the environment from the impacts of mining activities. To achieve this, IRMA has developed standards that serve as tools to assess the level of social and environmental compliance carried out by mining companies. As a third-party audit institution, IRMA can issue certifications to companies based on their level of compliance.

The IRMA Standard for Responsible Mining, IRMA-STD-001 was published in June 2018. The IRMA standards encompass 26 sections grouped under four principles: business integrity, impact planning and management, social responsibility, and environmental responsibility. The following table illustrates the differences between IRMA standards, specifically the social responsibility principle, and the prevailing legislative regulations in Indonesia.

Table 3.3. A Comparison of Laws and Regulations with IRMA Standards

No.	Legislation	IRMA Standard
1.	The Law Number 40 of 2007 concerning Limited Liability Companies stipulates that every company is obligated to carry out social responsibilities in the form of economic and social development.	The company is also required to fulfill its social responsibilities to ensure that the health and safety of communities affected by mining activities are guaranteed both during mining operations and after mining activities ceased.
2.	Regulation of the Minister of Environment and Forestry (Permen LHK) No. 4 of 2021. Article 3, Paragraph 2 states that businesses or activities that impact the environment, social environment, and cultural environment must possess an Environmental Impact Analysis (AMDAL) document.	Every mining business operator must conduct an assessment and risk management of the mining impact on social, economic, and community health aspects of the affected communities.
3.	Labor Law No. 13 of 2013 stipulates that the minimum wage for employees must be adjustable to the needs of each region.	On the other hand, the IRMA standards specify that companies must provide wages that exceed the minimum living requirements for every worker.

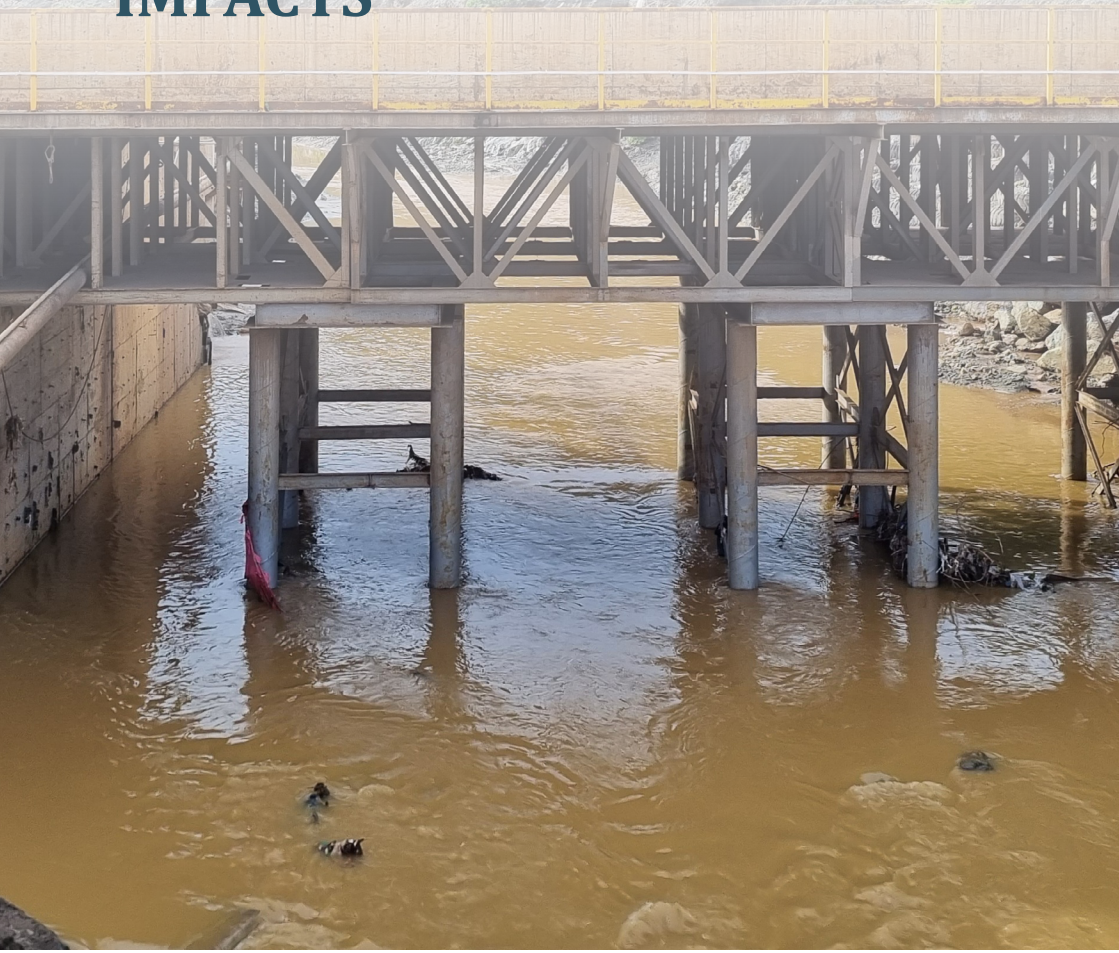
Based on the comparison between IRMA standards and the legislative regulations in Indonesia, it is observable that:

1. IRMA standards emphasize the importance for companies to ensure the safety and health aspects of the communities affected around the company's area as part of their social responsibility. This responsibility is applicable during mining operations and after the cessation of mining activities. On the other hand, Indonesian legislative regulations stipulate that every company (including mining companies) is obliged to contribute to the economic and social development of the communities in their vicinity.

2. Both Indonesian legislative regulations and IRMA standards require every mining company planning to operate to conduct assessments regarding the environmental, social, economic, and cultural impacts of mining activities in the surrounding areas of the company's operations.

3. The provision concerning fair wages that meet the basic living needs of every worker is regulated in both Indonesian legislative regulations and IRMA standards.

CHAPTER IV
RESULTS AND ANALYSIS OF ENVIRONMENTAL QUALITY AND POTENTIAL ENVIRONMENTAL IMPACTS



Chapter IV
Results and Analysis of Environmental Quality and Potential Environmental Impacts

4.1 River Water Quality

Main points:

- *The Wosea River runs through the industrial area of PT IWIP. Downstream of the river, hexavalent chromium with a concentration of 0.017 mg/L was detected, which exceeds the quality standard set by IRMA (0.011 mg/L).*
- *The Kobe River and Ake Doma River contain high levels of sediment. These sediments are carried by runoff from deforested land in the upstream area of the rivers. The mining activities of PT WBN are suspected to have changed the land cover, which was previously a forested area.*
- *The populations of fish in the Kobe River and Ake Doma River have decreased. These rivers also receive domestic wastewater discharge. Additionally, piles of garbage can be seen in the river. The increase in the population also puts pressure on the carrying capacity of the river water.*
- *The Woyelo River and Goa Boki Maruru River, located on the eastern side of the industrial area, tend to have better water quality. The downstream part of the Woyelo River is even used for bathing and washing vehicles.*

Based on Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, particularly Annex VI on River and Similar Water Quality Standards, this study focuses on four parameters: (1) temperature (°C); (2) acidity level, pH; (3) total dissolved solids or Total Dissolved Solid (TDS) (mg/L); and (4) hexavalent chromium, Cr6+ (mg/L). Besides these quality standards, the surface water quality criteria set by the

Initiative for Responsible Mining Assurance (IRMA) are also used as a measurement tool for the analysis.

The water quality measurements were taken in the downstream areas of the rivers flowing around the PT IWIP industrial area. There are six rivers that we studied, and the measurement locations of these river water qualities are within specific administrative regions. They are (1) Kobe River, Lukulamo Village; (2) Ake Doma River, Lelilef Sawai Village; (3) Wosea River, Lelilef Sawai Village; (4) Woyelo River, Gemaf Village; (5) Goa Boki Maruru River, Sagea Village; and (6) Yonelo River, Sagea Village. We also measured the water quality at the waterfalls in the hills of Sagea Lake, Sagea Village. Among these rivers, only the Wosea River still flows through the PT IWIP industrial area. During the measurements, dumping activities of soil materials were observed on both sides downstream of the Wosea River. Unlike the other rivers outside the PT IWIP area, the water quality measurements of the Wosea River were conducted twice. Measurements were also taken twice at the Yonelo River, approximately 500 meters apart. Multiple measurements like this are conducted at locations that are potentially polluted.

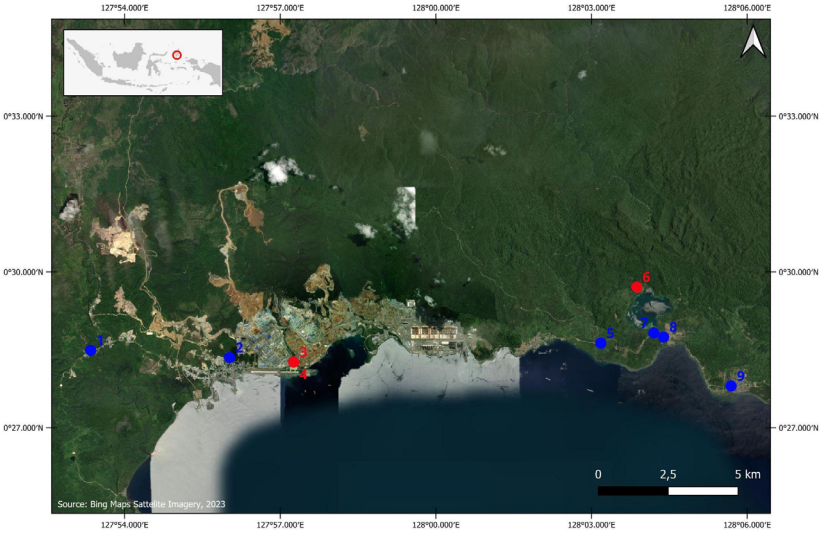


Figure 4.1. Map of river water quality measurement locations in the PT IWIP area. Only the Wosea River (measuring points 3 and 4) crosses the industrial area.

According to local residents, there are other rivers that used to flow through the area as well. However, mining activities, dumping, and the development of industrial infrastructure have covered the flow of rivers, such as the Karkar River, Woebem River, and Gwondi River.

The results of the river water quality measurements are shown in Table 4.1. At least four parameters were measured, and the downstream water quality of the Kobe River and Ake Doma River appears to be normal. The Kobe River is one of the water sources for the company's cooling water system. During the measurements, the river was observed to be contaminated by domestic waste. Meanwhile, the downstream of the Ake Doma River tends to narrow due to residential area expansion. The upstream of the river is potentially affected by the construction and mining activities of PT WBN at any time.

Table 4.1. Hasil pengukuran kualitas air sungai di sekitar kawasan PT IWIP

Point	Measurement Location	Temp (^{0}C)	pH	TDS (mg/L)	Cr^{6+} (mg/L)	Information
1	Kobe River	26,5	8,39	108	0.01	Does not exceed quality standards; polluted by sediment and domestic waste
2	Ake Doma River	29,1	8,57	288	0.003	Does not exceed quality standards; polluted by sediment and domestic waste
3	Wosea River	32	9,14	235	0.017	The pH is above the quality standard range, the Cr6+ concentration exceeds the IRMA quality standard

Point	Measurement Location	Temp (^{0}C)	pH	TDS (mg/L)	Cr^{6+} (mg/L)	Information
4	Wosea River	31.8	9,16	171	0.016	The pH is above the quality standard range, the Cr6+ concentration exceeds the IRMA quality standard
5	Woelo River	28,5	8,42	114	0.007	Does not exceed quality standards; The water is clear enough to be used by residents for bathing and washing vehicles
6	Sagea Lake Waterfall	31.5	9,14	173	0.004	pH is above the quality standard range; the basicity of water occurs naturally (due to the presence of karst rocks)
7	Yonelo River	33,1	8,44	9175	< 0.05	The TDS concentration exceeds the quality standard due to the high content of ions from the sea. The Yonelo River is the inflow and outflow channel of Lake Sagea. The water comes from the sea.

Point	Measurement Location	Temp (^{0}C)	pH	TDS (mg/L)	Cr^{6+} (mg/L)	Information
8	Yonelo River	33,9	8,69	9625	< 0.05	The TDS concentration exceeds the quality standard due to the high content of ions from the sea.
9	Goa Boki Maruru River	31.9	8,26	1486	0.002	The concentration of TDS exceeds the quality standard due to high tides from the sea; polluted by sediment

The Kobe River and Ake Doma River appear to be very turbid. This is caused by the high sediment content carried by rainwater runoff. The concentration of sediment in these rivers will increase as PT WBN continues to clear forested land. Some residents living along the Kobe River have reported that finding fish in the river has become more difficult. On the other hand, the Woyelo River appears clear. Many residents bathe and wash their vehicles downstream in that river. Currently, the downstream distance of the Woyelo River to the entrance of PT IWIP is approximately 4.5 km. However, there is a possibility that this river may become turbid and polluted due to the mining activities of PT WBN in the upstream area.

Other measurement locations include one waterfall flowing through the hills of Sagea Lake, and the Yonelo River, which serves as the inflow and outflow channel for Sagea Lake. Measurements were taken at one point on the waterfall and at two points on the Yonelo River. The results show that the waterfall has a basic nature with a pH of 9.14 (due to the presence of carbonate and bicarbonate anions from karst rocks in Sagea Village). The TDS concentration in the waterfall is very low (173 mg/L), while the water in the Yonelo River contains more than 9,000 mg/L of TDS. The high TDS concentration indicates the input of seawater into Sagea Lake through this river.

Similar to the waterfall in the hills of Sagea Lake, the water in the

Wosea River is also basic. The pH levels of two water samples taken from downstream of the river range from 9.14 to 9.16. The alkaline nature of the Wosea River is caused by the exposure of limestone and other carbonate rocks (such as karst rocks) due to mining and construction activities on the river's side. The downstream of the Wosea River tends to narrow, and its water discharge decreases due to the projects of PT Huafei Nickel Cobalt and PT Sonic Bay. Chemical quality measurements of water samples also show that the Wosea River contains hexavalent chromium, Cr6+ (approximately 0.016 - 0.017 mg/L). This concentration exceeds the quality standard set by IRMA (0.011 mg/L).

Figure 4.2. The location of the waterfall in the hills of Sagea Lake.

In general, the results indicate that the Wosea River is directly impacted by the mining activities of PT IWIP, while the other rivers have the potential for indirect impacts. The measurement locations for the water quality of the Kobe River and Ake Doma River are on the

western side of the industrial area, while the measurement locations for the water quality of the Woyelo River, Yonelo River, Goa Boki Maruru River, and the waterfall near Sagea Lake are on the eastern side of the area. In other words, the activities of PT IWIP do not directly affect the water quality of those rivers. However, the upstream areas of the Ake Doma River, Woyelo River, and Goa Boki Maruru River could be directly impacted by the mining activities of PT WBN if the company's mining area expands into East Halmahera and the forested areas of Gemaf Village and Sagea Village.

4.2 Lake Water

PMain points:

- *Lake Sagea is the only lake in Central Halmahera Regency. Local residents also refer to it as Lake Talaga or Lake Legaelol. Administratively, the lake is located in Sagea Village. It is approximately 7 km away from the western boundary of the PT IWIP industrial area via a district road. Based on measurements, the water quality of Lake Sagea can be considered normal.*

- *Lake Sagea holds ecological, cultural, social, and economic values. Its shores provide habitat for several endemic bird species of Halmahera. The people of Sagea and Kiya have a cultural connection to ancient graves located right at the edge of the lake. Moreover, nutmeg farmers and fishermen from these two villages depend on the sustainability of the lake's ecosystem for their livelihoods.*

- *In 2021, the water of Lake Sagea appeared turbid. The activities of forest clearance by PT Zhong Hai Rare Metal Mining and PT First Pacific Mining Indonesia were suspected to be the main causes. The operating licenses of both companies were revoked by the central government. However, residents of Sagea and Kiya are concerned about the potential expansion of the PT IWIP area or the arrival of new nickel mining players in their villages.*

Similar to the water quality standards for rivers, the water quality standards for lakes refer to Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, particularly Annex VI on Lake and Similar Water Quality Standards. Additionally, the surface water quality criteria set by IRMA are also used in the analysis. The parameters measured are the same as those used for river water quality measurements.

Lake Sagea is the focus of the lake water quality measurements. It is the only lake in Central Halmahera, located approximately 500 meters from the nearest mining area, PT First Pacific Mining Indonesia, and about 7 km from the entrance of the PT IWIP area. Considering the location and chemical characteristics of Lake Sagea, it is classified as a marine lake. The lake receives water inflow from Weda Bay, which is only 1 km away from its shore. Seawater flows through the Yonelo River and underground channels, filling the lake basin. This results in a high level of salinity in the lake water.

Figure 4.3. Lake Sagea which is one of the sources of springs and fishing spots
Source: AEER Team Documentation, 2023

Lake Sagea plays an ecological, cultural, social, and economic role for the communities of Sagea Village and Kiya Village. The local people refer to this lake as Lake Talaga or Lake Legaelol. In the Sawai language, Legaelol means "wise and venerable elder." There is an ancient grave on the lake's side, believed by the community to be the tomb of a child of Sultan Jailolo. Next to it, there flows a clear spring called Jere. When residents and visitors come to pay their respects at the tomb of Sultan Jailolo's child, they usually wash their faces or even bathe with the water from the spring. Additionally, the trees in the hills surrounding the lake serve as a habitat for endemic birds, such as the Halmahera Pitta (Lala Geaurea) and the Halmahera Crow (Corvusvalidus).

Several fishermen regularly search for fish, clams, and crabs when they are not at sea. Some farmers from Sagea Village and Kiya Village also have nutmeg, clove, and coconut plantations on the lake's edge. These fishermen and farmers enter the lake area through the Yonelo River, using motorized boats. The lake is also a tourist destination, especially for local tourists. The lake's landscape can be enjoyed from Kawinet Hill, which is now designed as a gathering and dining spot. An Australian visitor once developed Lake Sagea as a resting place for international tourists. He collaborated with the locals to build several gazebos in the nutmeg and coconut plantations area on the lake's side. However, the COVID-19 pandemic halted the project. Currently, these gazebos are not maintained, and some are used by the residents to dry nutmeg.

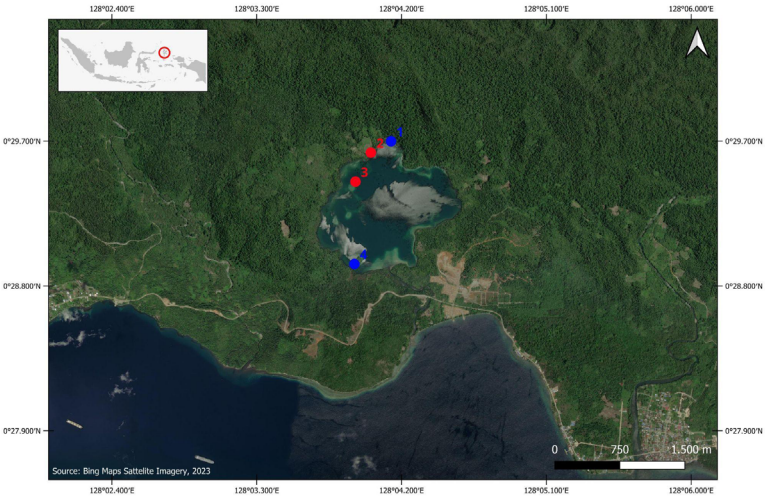


Figure 4.4. Map of the location for measuring the water quality of Lake Sagea, 7km east of PT IWIP

In 2021, the shores of Lake Sagea experienced pollution. The water appeared turbid due to sediment originating from the forest areas owned by two mining companies, namely PT Zhong Hai Rare Metal Mining and PT First Pacific Mining Indonesia[22]. The mining areas of both companies are located at a distance of only about 500 meters to 1 km from the lake. The concentration of sediment in Lake Sagea increased as a result of the land-clearing activities carried out by these two companies. After the local community filed a lawsuit, the permits of both companies were revoked by the central government. Apart from environmental issues, the community also considers that the companies did not fulfill the principles of Free, Prior, and Informed Consent (FPIC)[23]. It means that the indigenous and local communities were not involved in the approval of the mining activities.

In this research, water quality measurements in the lake were conducted

22 Wicaksono, R.A. (2021). Nickel Mining Activities Threaten Lake Yonelo, North Maluku. Betahita. https://betahita.id/news/detail/6244/aktivitas-tambang-nikel-ancam-danau-yonelo-maluku-utara.html.html

23 Laia, K. (2022). Those Who Resist and are Displaced Due to Nickel. Betahita. https://betahita.id/news/detail/7992/mereka-yang-melawan-dan-tersingkir-lantaran-nikel.html?v=1664358309

at four points. These measurement locations are scattered on the left side of Lake Sagea, namely Kebun Gebang, Jere spring, the middle of the lake, and the Yefi Island side. Kebun Gebang serves as one of the docks for farmers who have nutmeg and clove plantations on the side of Lake Sagea, while Jere spring is the water source located right next to the ancient tomb of Sultan Jailolo's child. Yefi Island itself is situated on the southern part of the lake. The island is covered with mangrove vegetation, providing shade around the island. Geographically, the measurement locations are indicated in Figure 4.4.

The measurement results show that Lake Sagea has not experienced significant environmental deterioration. At least, this is what was observed during the measurements. The high concentration of TDS (Total Dissolved Solids) at Kebun Gebang and in the middle of the lake occurs naturally (the input of seawater increases the concentration of chloride and sodium ions in the lake water, and this is considered as part of the total dissolved solids). The water temperature in the middle of the lake is relatively stable and suitable for various activities. The lake's temperature is also higher compared to other measurement points due to the intense exposure to sunlight. Meanwhile, the water around Yefi Island has a normal temperature (due to the shading from mangrove vegetation) and lower TDS concentration (due to the ability of mangrove roots to bind heavy metals in the water). The detailed measurement results can be found in Table 4.2.

However, Lake Sagea is susceptible to being affected by mining activities, as observed in 2021. The concession area of PT WBN covers the northern part of Sagea Village. If this forest area is opened for mining activities, bird habitats will be disturbed, and the high sediment concentration will threaten the clarity of Lake Sagea. Some employees of PT First Pacific Mining Indonesia are still seen working at the coastal area of Sagea Village, indicating that the company has not completely left Central Halmahera. Local residents also suspect that PT IWIP intends to expand its area to the coast of Gemaf Village and Sagea Village.

Tabel 4.2. Results of water quality measurements of Lake Sagea (also known as Lake Talaga or Lake Lagaelol)

Point	Measurement Location	Temp (^{0}C)	pH	TDS (mg/L)	Cr^{6+} (mg/L)	Information
1	Jeres Springs	29,5	8,1	152	< 0.05	Does not exceed quality standards; springs come from the mountains.
2	Gebang Garden	30.5	8,57	7600	< 0.05	The concentration of TDS is very high because the main inflow comes from Weda Bay.
3	Middle of the lake	35,9	8,87	9100	< 0.05	The water temperature is relatively high as a result of sun exposure; TDS concentration is very high because the main inflow comes from Weda Bay.
4	Near Yefi Island	30.8	8,55	797	< 0.05	Does not exceed quality standards; close to mangrove forest vegetation.

4.3 Sea Water.

Main points:

- *The wastewater discharge point, Tanjung Ulie waters, and the mouth of Ake Doma River are located in the marine waters bordering the PT IWIP industrial area. The seawater at these points contains hexavalent chromium, with concentrations reaching up to 0.024 mg/L. This level exceeds the quality standard set by IRMA criteria (0.0044) and Government Regulation No. 22/2021 for marine tourism and marine biota.*
- *The wastewater discharge channel carries hot water from the coal-fired power plant operations. In addition to carrying hexavalent chromium from activities like steel welding and painting, the hot*

water also has a high temperature. This poses a threat to coral reef ecosystems, ultimately leading to a decline in fish populations along the coast. Fishermen now have to venture farther out to sea for their catch.

- *The high concentration of hexavalent chromium can pose health risks to humans. This metal can accumulate in fish bodies, which are later consumed by the population. Besides causing skin rashes, its toxic nature can increase the risk of stomach cancer and disrupt reproductive health.*

Similar to the analysis of surface water quality, the analysis of seawater quality refers to Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, specifically Annex VIII on Seawater Quality Standards. According to this regulation, seawater quality standards are differentiated based on their purposes, which are port, marine tourism, and marine biota (coral reefs, mangroves, and seagrass beds). This study also considers the water quality criteria for marine environments set by IRMA. Unlike surface water quality measurements, seawater quality measurements only involve three parameters, namely (1) temperature (°C); (2) acidity level, pH; and (3) hexavalent chromium, Cr6+ (mg/L). Total Dissolved Solids (TDS) is not included in the list of seawater quality parameters because it is not relevant. Usually, ions in seawater (sodium, chloride, magnesium, and sulfate) are measured as TDS, and their concentration levels range from 10,000 to 100,000 mg/L.

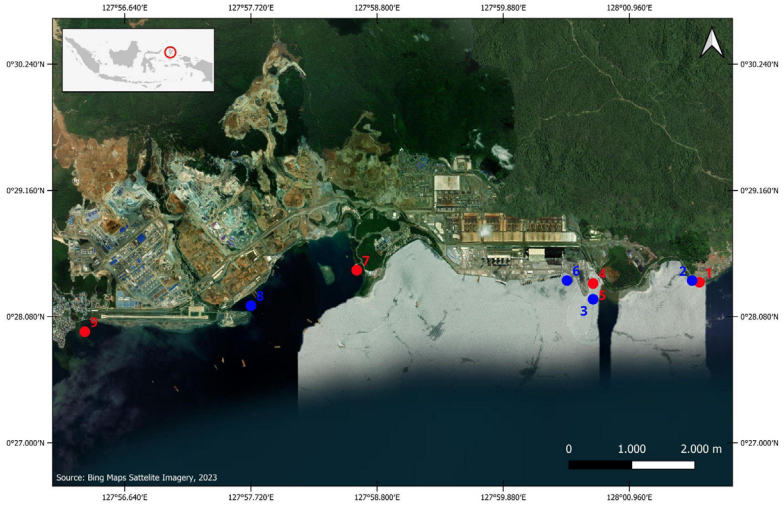


Figure 4.5. Map of seawater quality measurement locations throughout the PT IWIP area

The measurement of seawater quality focuses on the marine areas along the PT IWIP industrial zone. This area stretches from the coastal border of Gemaf Village to Lelilef Sawai Village, all the way to the mouth of Ake Doma River, downstream of Lelilef Sawai Village. The coastline spans 12 km. The seawater quality measurements cover eight points: (1) Botepo, Gemaf Village; (2) Lolaro, Gemaf Village; (3) Ake Sake River Estuary; (4) Wastewater discharge point; (5) Port area; (6) Tanjung Ulie; (7) Wosea River Estuary; and (8) Ake Doma River Estuary. Measurements are taken twice at the wastewater discharge point. The measurement points from Ake Sake River Estuary to Wosea River Estuary are located close to PT IWIP activities, such as dumping of sand and coal, wastewater discharge from the coal-fired power plant, and port operations. The locations of seawater quality measurements are indicated in Figure 4.5.

At least from the three measured parameters, the seawater quality in the Lolero area, Gemaf Village, is in normal condition. However, the seawater in the Botepo area, Gemaf Village, is alkaline and contains hexavalent chromium, Cr6+, at a concentration of 0.005 mg/L, exceeding the marine tourism quality standard of Government

Regulation No. 22/2021. This is likely caused by the weathering of rocks and soil. Calcium carbonate (CaCO3) rocks and chromite rocks (FeCr2O) can each contribute to the alkalinity and the presence of hexavalent chromium ions in the water.

Hexavalent chromium content is also detected in the Tanjung Ulie area and Ake Doma River Estuary. In Tanjung Ulie, the concentration of hexavalent chromium is 0.003 mg/L, exceeding the marine tourism quality standard, while in the Ake Doma River Estuary, it reaches 0.015 mg/L, exceeding all quality standards (Government Regulation No. 22/2021 and IRMA criteria). The presence of these metal ions is related to PT IWIP activities. Although there are no tailings discharged into this area, mining and disposal activities of rock and soil materials can accelerate the weathering process. Mining activities may expose chromite rocks to rainfall, leading to an increased concentration of hexavalent chromium in the seawater. During the measurements, coal dumping activities were observed on the right side of Ake Doma River Estuary, while the left side was occupied by houses of local residents. This area is still used as a fishing ground by local fishermen. This indicates the potential for bioaccumulation of hexavalent chromium ions in the bodies of fish and humans who consume them.

Figure 4.6. Appearance of the mouth of the Ake Doma River which is brown in color due to the disposal of wastewater
Source: AEER Documentation 2023

High seawater temperature and a high concentration of hexavalent chromium are also found in the wastewater discharge point. The water temperature reaches 35°C, and the hexavalent chromium content reaches 0.024 mg/L based on two measurements conducted. This temperature threatens the survival of corals, mangroves, and seagrass beds. The concentration of hexavalent chromium exceeds the quality standards set by IRMA and Government Regulation No. 22/2021 for marine tourism and marine biota. The wastewater is actually hot water originating from the condenser unit and boiler water supply of the coal-fired captive Power Plant (PLTU). The hot water is generated from the condenser unit and boiler water supply operations, which result in high water temperature. According to the Environmental Impact Analysis (ANDAL) document of the IWIP Industrial Zone Development Plan, the estimated amount of hot water from the PLTU is 2,371 m3/day or 865,400 m3/year, and it is discharged into Ake Sake River, which carries it to the sea[24]. Its quality refers to the Minister of Environment Regulation No. 8 of 2009 concerning the Quality Standards for Wastewater from Thermal Power Plant Businesses and/or Activities. On a land area of 2,600 hectares within the PT IWIP zone, a 1,000 MW capacity Thermal Power Plant (PLTU) has been operated.

In addition to the operational Thermal Power Plant (PLTU), wastewater can be generated from other activities. First, domestic wastewater from office, residential, canteen, and clinic activities. This wastewater is estimated to be around 1,079 m3/day or 393,762 m3/year. Second, wastewater from port activities with an estimated discharge of 104 m3/day or 38,000 m3/year. Besides these sources, wastewater is also produced from factory activities (such as stainless steel, carbon iron, and coke factories). The planned ferrochrome smelter using flash smelting technology will also produce wastewater at a rate of 493 m3/day or 180,000 m3/year. However, the hydrometallurgical process through High-Pressure Acid Leach (HPAL) smelter technology contributes the most significant amount of wastewater generation. This technology is estimated to produce 90% of the total wastewater

24 PT Indonesia Weda Bay Industrial Park. (2018). Environmental Impact Analysis (AMDAL) of the Indonesia Weda Bay Industrial Park Construction Plan.

generated by all tenants in PT IWIP. This percentage includes 88,723 m3/day or around 32 million m3/year. All wastewater, except for hot water, is planned to be directed to the wastewater treatment plant (WWTP) unit. The treated water from the WWTP unit will be discharged into receiving water bodies, such as Ake Sake River, which flows towards the sea.[25]

Hexavalent chromium can occur not only naturally but also be generated through industrial processes, such as nickel ore processing, steel welding, painting, as well as cutting, grinding, and sandblasting activities. This ion is a heavy metal that is highly toxic to humans and not easily decomposed in the environment.[26]. Health studies have shown that the presence of hexavalent chromium in drinking water can increase the risk of stomach cancer and reproductive health disorders[27; 28]. Direct contact with hexavalent chromium can also cause skin rashes in certain individuals[29]. In Central Halmahera, particularly in the villages around PT IWIP, there hasn't been a specific study on the impact of mining activities on human health. However, the fishermen from Gemaf Village have witnessed the death of coral fish in the area where PT IWIP disposes its wastewater. The high temperature and elevated concentration of hexavalent chromium can cause coral reef mortality.[30]. The reduction of coral reef ecosystems, which serve as feeding, breeding, and spawning grounds for coral fish, leads to a

25 Ibid.

26 Sharma, P., Singh, S.P., Parakh, S.K., & Tong, Y.W. (2022). Health hazards of hexavalent chromium (Cr (VII)) and its microbial reduction. Bioengineered, 13(3), 4923-4938. https://doi.org/10.1080/21655979.2022.2037273

27 Suh, M., Wikoff, D., Lipworth, L., Goodman, M., Fitch, S., Mittal, L., Ring, C., & Proctor, D. (2019). Hexavalent chromium and stomach cancer: a systematic review and meta-analysis. Critical Reviews in Toxicology. 49(2), 140-159. https://doi.org/10.1080/10408444.2019.1578730

28 Wuri, L., Arosh, J.A., Wu, J.Z. & Banu, S.K. (2022). Exposure to hexavalent chromium causes infertility by disrupting cytoskeletal machinery and mitochondrial function of the metaphase II oocytes in superovulated rats. Toxicology Reports, 9, 219-229. https://doi.org/10.1016/j.toxrep.2022.02.002

29 Shelnutt, S.R., Goad, P., & Belsito, D.V. (2007). Dermatological toxicity of hexavalent chromium. Critical reviews in toxicology, 37(5), 375-387. https://doi.org/10.10408440701266582

30 Schoepf, V., Stat, M., Falter, J.L., & McCulloch, M.T. (2015). Limits to the thermal tolerance of corals adapted to a highly fluctuating, naturally extreme temperature environment. Scientific Reports, 5:17639. https://doi.org/10.1038/srep17639

decrease in the population of coral fish.

Table 4.3. Results of seawater quality measurements around the PT IWIP area

Point	Measurement Location	Temp (^{0}C)	pH	Cr^{6+} (mg/L)	Information
1	Botepo, Gemaf	31.5	8,62	0.005	The pH is above the PP 22/2021 quality standard range (water tends to be alkaline); Cr6+ concentration exceeds PP 22/2021 quality standards for marine tourism and IRMA standards.
2	Lolaro, Gemaf	29,1	8,28	0	Does not exceed quality standards.
3	Estuary of the Ake Sake River	32,2	8,39	0.001	The temperature is high for coral reefs and seagrasses.
4	Wastewater disposal estuary	32,2	8,6	0.024	Temperatures are high for coral reefs and seagrasses; The pH is above the PP 22/2021 quality standard range (water tends to be alkaline); Cr6+ concentration exceeds PP 22/2021 and IRMA quality standards.
5	Wastewater disposal estuary	35	8,6	0.009	The temperature is high for coral reefs, mangroves and sea grasses; The pH is above the PP 22/2021 quality standard range (water tends to be alkaline); Cr6+ concentration exceeds PP 22/2021 and IRMA quality standards.
6	Harbor area	32,4	8,71	0.001	Temperatures are high for coral reefs and seagrasses; The pH is above the range of PP 22/2021 and IRMA quality standards (water tends to be alkaline).

Point	Measurement Location	Temp (^{0}C)	pH	Cr^{6+} (mg/L)	Information
7	Tanjung Ulie	32,6	8,64	0.003	Temperatures are high for coral reefs and seagrasses; The pH is above the PP 22/2021 quality standard range (water tends to be alkaline); Cr6+ concentration exceeds PP 22/2021 quality standards for marine tourism.
8	The mouth of the Wosea River	33,2	8,69	0	Temperatures are high for coral reefs and seagrasses; The pH is above the PP 22/2021 quality standard range (water tends to be alkaline).
9	Estuary of the Ake Doma River	33,9	8,62	0.015	Temperatures are high for coral reefs and seagrasses; The pH is above the PP 22/2021 quality standard range (water tends to be alkaline); Cr6+ concentration exceeds PP 22/2021 and IRMA quality standards.

The detailed results of seawater quality measurements along the coastline of the PT IWIP area are shown in Table 4.3. Generally, the seawater is alkaline (basic) and its temperature tends to be high. The alkaline nature of seawater is due to the weathering of carbonate rocks, which is likely accelerated by soil excavation activities. The warm sensation of seawater is not only caused by sunlight exposure but also by the hot water discharge from the operation of the coal-fired power plant (PLTU). This wastewater may carry hexavalent chromium into the seawater, leading to coral reef death followed by a decline in coral fish populations. Additionally, this heavy metal is also toxic to

the hematology and immune response of both fish and humans[31]. This indicates that the presence of hexavalent chromium can pose a health threat to humans if the process of bioaccumulation occurs in fish that are later consumed by the residents.

4.4 Ambient Air

Key points:

- *The concentration of particulate matter with a diameter of less than 10 µm (PM10) in the ambient air around the coal-fired power plant (PLTU) measured 54 µg/m3. This level exceeds the quality standard set by IRMA (50 µg/m3). However, the measurement duration was shorter than required.*
- *Desa Lelilef Sawai and Desa Lelilef Woebulen are the most affected villages. High dust concentrations on the district road endanger the health of drivers and residents. The measurement results indicate that PM10 concentration reaches 101 µg/m3, and PM2.5 concentration reaches 82 µg/m3. Both of these parameters exceed the quality standard set by PP No. 22/2021 (PM10 = 75 µg/m3; PM2.5 = 55 µg/m3).*
- *The deterioration of air quality can cause lung diseases, and respiratory disorders, or hinder lung growth in children. The Lelilef Community Health Center records an increase in Acute Respiratory Tract Infection (ARTI) cases. Before the establishment of PT IWIP, they handled around 300 cases per year. Now, the number of cases is around 800 to 1,000 per year.*

Ambient air refers to the air freely present at the earth's surface that is required and influences human health, living organisms, and other environmental elements. Unlike emission air released by emission sources, such as heavy vehicles or power plant chimneys, ambient air passively receives such emissions. When emissions are released

31 Kamila, S, Shaw, P., Islam, S., & Chattopadhyay, A. (2023). Ecotoxicology of hexavalent chromium in fish: An updated review. Science of The Total Environment, 890:164395. https://doi.org/10.1016/j.scitotenv.2023.164395

into the ambient air, the air composition can undergo physical and chemical changes. In this study, ambient air quality measurements were conducted along the district road that divides Central Halmahera within and outside the PT IWIP area. The public road within the PT IWIP area stretches approximately 9.5 km, located 1 km to 2 km from the coastline. Along this public road, 15 measurement locations were selected based on daytime field observations when traffic was filled with Light Vehicles (LV) from mining companies, soil material transport trucks, heavy equipment, and private vehicles of residents. Figure 4.7 shows the measurement locations inside the PT IWIP area, which is administratively **part of Desa Lelilef Sawai.**

Figure 4.7. Map of ambient air quality measurement locations within the PT IWIP area.

To assess the impact of PT IWIP on its surrounding environment, ambient air quality measurements were also conducted in rural areas nearby. The measurement areas included Desa Gemaf, Desa Lelilef Sawai, and Lelilef Woebulen, each with four measurement points (see Figure 4.8). Related mining traffic appeared to be denser in Desa Lelilef Sawai and Lelilef Woebulen compared to Desa Gemaf. This is due to the mobilization of labor, transportation of heavy equipment, and provision of operational needs originating from Kota Weda, the

capital of the district, and Kota Ternate, the provincial capital, located to the west of PT IWIP. Most of these mobilization and transportation activities pass through Desa Lelilef Woebulen and Lelilef Sawai. On the other hand, Desa Gemaf, located to the east of PT IWIP, is generally traversed by local laborers who come from Kecamatan Weda Utara (Desa Gemaf, Desa Sagea, Desa Kiya, Desa Fritu, and Desa Waleh). Occasionally, heavy equipment transportation is seen passing through Gemaf Road heading to other mining projects or timber logging areas in Kecamatan Weda Timur and Kabupaten Halmahera Timur.

The ambient air quality standards refer to Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management, especially Annex VII on Ambient Air Quality Standards. The IRMA criteria, adopting the EU standards, are also considered. This ambient air quality measurement involves particulate matter with diameters less than 10 μm (PM10) and less than 2.5 μm (PM2.5). For simplicity, these parameters are measured at each point for approximately 10 minutes, unlike the requirement set by PP No. 22/2021, which specifies measurements for 24 hours or 1 year.

Figure 4.8. Map of ambient air quality measurement locations outside the PT IWIP area

When dust concentrations were measured on the road crossing PT

IWIP, several company activities were observed on both sides of the road. These activities include coal storage, PLTU operations, culvert construction, excavation, road boundary construction, and earth transportation. In addition to the back and forth movement of motor vehicles of employees and local residents, construction and PLTU operational activities contribute to the increased concentrations of PM10 and PM2.5 in the air. The measurement results show that the area near the coal-fired PLTU is the most affected region. The PM10 concentration in that area is 54 µg/m3, exceeding the IRMA criteria (50 µg/m3). The high PM10 dust is caused by the black smoke emitted from the PLTU's chimneys. Although the chimneys are tall, the particulates from the black smoke can fall on the road crossing due to wind direction or high particulate density. This is exacerbated by the back and forth movement of coal transport trucks heading to the storage area.

Table 4.4 shows the detailed results of PM10 and PM2.5 measurements on the road crossing PT IWIP. It can be observed that PT IWIP regularly waters the road using a water truck. This treatment keeps the PM10 and PM2.5 concentrations from exceeding the standard in almost all measurement locations, except for the PM10 concentration near the coal-fired PLTU. Dust levels at Jembatan Wosea and the side road of the IWIP airport are also relatively high according to IRMA criteria, although they do not exceed the standard. The lack of vegetation on the roadside and high traffic intensity are contributing factors.

Table 4.4. Results of ambient air water quality measurements in the PT IWIP area

Point	Measurement Location	temp (^{0}C)	Hum (%)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
1	Coal stockpile	29	68	15	12
2	Construction of culverts	30	68	3	4
3	Coal power plant	32	66	54	41
4	Coal power plant	28	74	21	17
5	Employee Mess	27	82	34	33
6	Excavation activity	25	85	36	32
7	Tanjung Ulie	26	85	5	10

Point	Measurement Location	temp (^{0}C)	Hum (%)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
8	Sand transport route	25	85	38	29
9	Ulie Bridge	31	69	6	4
10	Coal dumping area	24	91	30	26
11	Sand stockpile	33	66	17	17
12	Wosea Bridge	34	64	48	41
13	IWIP airport	27	83	23	20
14	IWIP airport	27	79	41	32
15	Motorcycle Parking Only	27	80	3	4

The measurements of PM10 and PM2.5 concentrations in the rural roads around PT IWIP show significant figures, especially on the west side of PT IWIP. The PM10 concentration near the entrance of IWIP in Lelilef Sawai Village is 69 µg/m3, exceeding the IRMA criteria. In Lelilef Woebulen Village, right in front of Al-Maqdis Mosque, the PM10 concentration even reaches 101 µg/m3. In addition, the PM2.5 concentration at that location is detected at 82 µg/m3. About 3 km from the entrance of PT IWIP towards Kota Weda, there is mining activity by PT Tekindo Energi. The mining location is not far from the county road. The back-and-forth movement of material transport trucks contributes to the PM2.5 concentration, which is measured at 58 µg/m3. These particulate dust concentration values exceed the standard set by PP No. 22/2021. The measurement results confirm what everyone can see, the roads in Lelilef Sawai Village and Lelilef Woebulen Village are very dusty. Meanwhile, the roads in Gemaf Village are relatively safe. The PM10 and PM2.5 concentrations in Gemaf Village do not exceed 21 µg/m3. Detailed measurement results can be seen in Table 4.5.

Table 4.5. Results of ambient air water quality measurements outside the PT IWIP area

Point	Sampling Location	Village	Temp (^{0}C)	Hum (%)	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)
1	Gethsemane Church	Gemaf	30	73	6	4
2	Meylanus Talam's house	Gemaf	36	80	21	19

Point	Sampling Location	Village	Temp (^{0}C)	Hum (%)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
3	Diaspora Church	Gemaf	34	58	5	4
4	IWIP entry post	Gemaf	30	75	12	10
5	IWIP entry post	Lelilef Sawai	27	80	69	52
6	Ake Lelilef Bridge	Lelilef Sawai	32	64	5	4
7	Soccer field	Lelilef Sawai	34	59	36	29
8	SD GMIH	Lelilef Sawai	35	57	10	10
9	Elif's Fruit Shop	Lelilef Woebulen	34	53	28	24
10	Al-Maqdis Mosque	Lelilef Woebulen	33	64	101	82
11	Lelilef Health Center	Lelilef Woebulen	35	59	34	41
12	PT Tekindo Energi	Lelilef Woebulen	35	59	48	58

The air quality in Lelilef Sawai and Lelilef Woebulen Villages is highly problematic. Dust disturbs road users from the early morning when local employees start heading to the PT IWIP area. Most of them use motorcycles and depart from Lelilef Woebulen Village and Lukulamo Village. Almost all of them wear masks and protective glasses to avoid dust irritation on their faces and eyes. Health and food hygiene issues are also found in Lelilef Sawai and Woebulen Villages. Food and food ingredients sold along the road are potentially contaminated by dust, lowering the health quality of residents.

The local community is aware of the declining air quality in the Lelilef area. Compared to Gemaf Village or Sagea Village, which still have green land cover along the road, the Lelilef area has been filled with commercial buildings, residential areas, and food stalls. This change occurred due to nickel mining, attracting residents from other districts and even other regencies and cities to work and open businesses in Lelilef. This issue becomes complex because PT IWIP only sprinkles water on the roads within the industrial area. The rural roads of Lelilef

are only watered by some individual residents. The frequency and scale of watering are not regular and massive. So far, local government programs related to improving air quality have not been evident. Therefore, dust concentrations remain high and pose a threat to the health of residents.

Dust with a diameter of less than 10 microns (PM10) can be easily inhaled by humans. If exposure to PM10 dust occurs for a prolonged and continuous period, these particles can accumulate in the lungs and cause lung cancer or even death[32]. For some individuals, exposure to PM10 over a short period can result in respiratory tract disorders, such as asthma and Chronic Obstructive Pulmonary Disease (COPD)[33]. Dust particles with a diameter of less than 2.5 microns (PM2.5), smaller than a human hair's diameter, can have even worse impacts on human health. Short-term exposure to PM2.5 (lasting up to 24 hours consecutively) can lead to premature death, acute and chronic bronchitis, and asthma attacks[34]. If the decline in health quality affects the workforce, there will be an increase in the number of hospitalization days and a decrease in the number of productive working days. These symptoms are not only experienced by adults but also by infants and children. Prolonged exposure to PM2.5 can result in fatalities for individuals who previously had lung or heart problems. Long-term exposure to PM2.5 can also hinder lung growth in children[35]. The health risks mentioned above can be experienced by the local workforce of PT IWIP and residents who live and operate businesses in Desa Lelilef Sawai and Lelilef Woebulen. Therefore, efforts are needed to reduce the dust concentration in the Lelilef area and restore the ambient air

32 Consonni, D., Carugno, M., De Matteis, S., Nordio, F., Randi, G., Bazzano, M., et al. (2018). Outdoor particulate matter (PM_{10}) exposure and lung cancer risk in the EAGLE study. PLoS ONE 13 (9): e0203539. https://doi.org/10.1371/journal.pone.0203539

33 Lee, Y.M., Lee, J.H., Kim, H., & Ha, E. (2020). Effects of PM_{10} on mortality in pure COPD and asthma-COPD overlap: difference in exposure duration, gender, and smoking status. Scientific Reports, 10:2402. https://doi.org/10.1038/s41598-020-59246-2

34 Thangavel, P., Park, D., Lee, Y. (2022). Recent Insights into Particulate Matter ($PM_{2.5}$)-Mediated Toxicity in Humans: An Overview. International Journal of Environmental Research Public Health, 19, 7511. https://doi.org/10.3390/ijerph19127511

35 Li, S., Cao, S., Duan, X., Zhang, Y., et al. (2020). Long-term exposure to $PM_{2.5}$ and Children's lung function: a dose-based association analysis. Journal of Thoracic Disease, 12(10), 6379-6395. https://doi.org/10.21037/jtd-19-crh-aq-007

quality to its original state.

4.5 Environmental Impact Potential of Tailing Waste Disposal Activities

Key points:

- *Tailing waste is generated by 30 ferronickel smelters using the RKEF technology with a capacity of 500 kilotons of nickel metal per year. The waste is transported from each smelter to the Temporary Waste Stockpile (TWS) site where it is stored for a maximum of one year. PT IWIP plans to utilize the tailing waste for construction materials, while the remainder is managed by third parties. The estimated tailing waste production from ferronickel smelters is 5.5 million tons per year.*
- *PT IWIP plans to construct ferrochrome smelters using flash smelting technology and hydro-metallurgical smelters using High-Pressure Acid Leach (HPAL) technology. The total capacity of each smelter is 300 kilotons per year and 100 kilotons per year, respectively. Similar to the tailing waste from ferronickel smelters, tailing waste from ferrochrome and HPAL smelters will be stored in containment ponds at the TWS. The estimated tailing waste production from these two types of smelters is 450 thousand tons and 10.35 million tons per year.*
- *Potential pollution can occur during the handling, transportation, storage, and processing stages. The environmental components at risk are soil and groundwater. If the TWS or smelters are located near rivers, tailing waste may spill into the water bodies and flow into the sea. The planned HPAL smelters by PT Sonic Bay and PT Huafei Nickel Cobalt are situated between Ake Doma River and Wosea River, indicating the potential pollution of water sources by tailing waste.*

Currently, several tenants of PT IWIP operate ferronickel smelters using the Rotary-Kiln Electric Furnace (RKEF) technology. As mentioned earlier, these tenants are PT Youshan Nickel Indonesia with a production capacity of 45 kilotons of nickel matte per year, PT Weda Bay Nickel with a production capacity of 300 kilotons of nickel pig iron (NPI) per year, and PT Angel Nickel Industry with a production

capacity of 29 kilotons of nickel-matte and 207 kilotons of NPI per year. According to the Environmental Impact Analysis (ANDAL) document for the Industrial Area Development Plan of PT IWIP, the cooling and washing stages of ferronickel slag use residual water that does not evaporate. Meanwhile, the tailing waste from the cooling process is transported to a temporary storage area and further managed by third parties.

Tailing waste will also be generated by the ferrochrome smelter using flash smelting technology and the hydro-metallurgical smelter using High-Pressure Acid Leach (HPAL) technology. The planned capacity for the ferrochrome smelter is 300 kilotons per year, while the hydro-metallurgical smelter is designed with a total capacity of 100 kilotons of nickel hydroxide and cobalt hydroxide per year[36].

Two companies are recorded to operate HPAL technology, namely PT Sonic Bay and PT Huafei Nickel Cobalt. Their smelter facilities are located west of the PT IWIP area, and their location is intersected by the Wosea River. Unlike the ferrochrome smelter, which generates one type of tailing waste from the smelting process, the hydro-metallurgical smelter produces two types of tailing waste: iron residue from the leaching process and manganese residue from the cobalt processing process. Iron and manganese minerals, such as iron oxide and manganese oxide, contained in the tailing waste can act as catalysts for the oxidation of trivalent chromium (Cr3+) to hexavalent chromium (Cr6+). If both types of tailing waste are mixed, the rate of chromium oxidation will be faster. The issue is that hexavalent chromium has greater potential for environmental and human health damage. Therefore, the tailing waste is categorized as Hazardous and Toxic Waste (B3).

PT IWIP plans to store all tailing waste in the Temporary Waste Stockpile (TWS). The tailing waste is transported from each smelter to the TWS location using dump trucks or closed containers. The waste is

36 Rini, A.S. (2018). Melihat Kepak Sayap Tsingshan Group (Viewing the Expanding Wings of Tsingshan Group). https://koran.bisnis.com/read/20181105/447/856440/ekspansi-perusahaan-china-melihat-kepak-sayap-tsingshan-group

then transferred from the trucks to containment ponds for each type of tailing waste. The maximum retention period for tailing waste is one year before it is utilized as raw material for other activities, such as building materials, and the rest is managed by third parties. The storage capacity of IWIP's tailing waste reaches 3 million tons per year. PT Sonic Bay, as one of PT IWIP's tenants, plans to have a Dry Stack Residue Facility (DSRF). This facility functions to transport, thicken, filter, and dispose of tailing waste into containment ponds. DSRF consists of a dry stack, bypass cell, manganese cell, contact, and runoff water ponds. The production of solid residue or tailing waste from the ferrochrome smelter, ferrochrome smelter, and HPAL smelter is estimated to be 5.5 million tons per year, 450 thousand tons per year, and 10.35 million tons per year, respectively. The production of tailing waste from all smelters contributes 87.6% of the total solid residue to be stored in TWS, and almost two-thirds of this tailing waste comes from the HPAL smelter.[37]

The movement, transportation, and containment of tailing waste in the TWS have the potential for significant negative impacts on the soil, groundwater, and surface water (especially rivers). The potential impacts are as follows:

1. Soil Contamination: Heavy metal compounds have the potential to contaminate the soil around the tailing waste containment area. Rainwater and runoff can carry toxic chemicals from the containment area to the soil surface. Such soil contamination can affect soil fertility and its ability to support plant growth.

2. Groundwater Contamination: If the containment design is not appropriate or accidents occur during the movement and transportation of tailing waste, it can potentially contaminate the groundwater below the surface. Dissolved heavy metals and other pollutants contained in the tailing waste may move vertically or horizontally toward the water table (percolation). Groundwater contamination can pose risks to human health and ecological systems, considering that groundwater is often a source of drinking water and supports underground fauna

37 PT Indonesia Weda Bay Industrial Park. (2018). Environmental Impact Analysis (ANDAL) of the Development Plan for Indonesia Weda Bay Industrial Park.

habitats.

3. Surface Water Contamination: The HPAL smelters of PT Sonic Bay and PT Huafei Nickel Cobalt are located between two rivers, namely the Ake Doma River and the Wosea River. The tailing waste containment location is near the headwaters of the Ake Doma River. This indicates that surface water is potentially impacted by the smelter activities and tailing waste containment at PT IWIP. If tailing waste is exposed to rainfall, the runoff flows into the nearby rivers and results in a decrease in water quality in the river.This can be followed by the death of river biota or even health issues for the local community who use the river water as their raw water supply for hygiene and sanitation purposes. As for the water quality of Lake Sagea, it is estimated that there will be no significant impact due to the operation of smelters in the IWIP area. However, significant changes to the environmental quality of Lake Sagea can occur if the IWIP area is expanded to the east, and new smelters are built in Gemaf Village.

Several mining companies have different practices in managing their tailings waste. Instead of containing and utilizing the tailings in different forms, the tailings are discharged through pipelines extending 100 meters or more to the seabed. The tailings are expected to settle at the seabed or in the deepest parts of the sea, so they won't affect the marine biota above them. This method is called Deep-Sea Tailing Placement (DSTP) or Deep-Sea Tailings Disposal (DTSD). However, this method has proven to have high risks, including pipe leaks, pollution of the seawater, damage to marine ecosystems, and even a decline in the health quality of coastal communities who rely on fish and seafood as their food source."

The DSTP practice has been prohibited in many countries, including Papua New Guinea and Norway. In 2019, the Papua New Guinea government banned the disposal of tailings waste into the sea from the Wafi-Golpu gold and copper mining[38], Meanwhile, the Norwegian government, in the same year, completely banned DSTP through

38 Radio New Zealand. (2020). PNG opposition grows to dumping mine waste at sea. https://www.rnz.co.nz/international/pacific-news/425575/png-opposition-grows-to-dumping-mine-waste-at-sea

regulations related to the disposal of industrial waste into the sea[39]. China is also among the 51 countries that agreed to ban the practice of tailings disposal into the sea at the International Union for Conservation of Nature Congress in 2016. Looking at the characteristics of deep-sea areas near the coast, only 0.14% of the world's coastlines have water depths greater than 1000 meters within 2 km from the shore. Besides the potential environmental damage, technically, the DSTP method is also challenging to carry out safely[40]. However, this method is still being practiced by several mining companies in certain countries, including Indonesia.

The Buyat case recorded the negative impact of the DSTP method. PT Newmont Minahasa Raya disposed of a total of 4 million tons of gold mine tailings at a depth of 82 meters in Buyat Bay, Minahasa Peninsula, North Sulawesi. This practice took place for 8 years from 1996 to 2004. During the disposal period, the pipeline suffered multiple leaks, resulting in tailings entering the marine water column. Heavy metals such as arsenic, mercury, and manganese then contaminated the seawater, damaging marine and coastal ecosystems, and reducing the quality of local public health. In 2004, local fishermen started to complain about strange illnesses they experienced, such as skin diseases, tremors, headaches, and swelling in the neck, calves, wrists, and head. Investigative teams found an accumulation of arsenic and mercury in marine biota, including fish, with concentrations exceeding permissible limits[41]. After the investigation, fishermen and local communities were advised not to consume fish and were relocated to other rural areas.

39 Ramirez-Llodra, E., Trannum, H.C., Evenset, A., Levin, L.A., et al. (2015). Submarine and deep-sea mine tailing placements: A review of current practices, environmental issues, natural analogs and knowledge gaps in Norway and internationally. Marine Pollution Bulletin, 97(1-2). http://dx.doi.org/10.1016/j.marpolbul.2015.05.062

40 Kwong, Y.T.J., Apte, S.C., Asmund, G. et al. (2019). Comparison of Environmental Impacts of Deep-sea Tailings Placement Versus On-land Disposal. Water, Air, and Soil Pollution, 230. 287. https://doi.org/10.1007/s11270-019-4336-1

41 Friends of the Earth Indonesia (WALHI), Indonesian Mining Advocacy Network (JATAM), & Indonesian Center for Environmental Law (ICEL). (2004). Buyat Bay is polluted and a risk to the community: Highlights of the official joint investigation of Buyat Bay. https://earthworks.org/wp-content/uploads/2021/09/20041110_SummaryTechTeamFindings.pdf

Currently, the waters of Pulau Obi, North Maluku, are experiencing a decline in environmental quality due to the practice of DSTP. The seawater has changed to a dark red color, and the fish population around Kawasi village has decreased. Fishermen have to travel long distances to the open sea to catch fish. Research conducted by the Aquaculture Study Center at Khairun University also found heavy metal levels in fish and clams that exceed normal limits[42]. In addition, high levels of hexavalent chromium have also been detected in drinking water. These environmental changes have affected the health of the local residents. Since mining activities began, they have been falling sick more frequently, with respiratory infections being a clear concern. Local clinics have reported 900 cases of fatal acute respiratory disorders, with many of the victims being infants and children[43].

The DTSP practice on Obi Island is part of the operational activities of the High-Pressure Acid Leach (HPAL) smelter run by PT Halmahera Persada Lygend, a business unit of Harita Nickel. This HPAL smelter is one of the three first HPAL smelters built in Indonesia (the other two are located in the industrial area of PT Indonesia Morowali Industrial Park). With a production capacity of 37 kilotons per year of mixed hydroxide precipitate (MHP), the HPAL smelter is suspected to dispose of its waste into the deep sea. The permit for tailing waste disposal was approved by the Governor of North Maluku, KH. Abdul Gani Kasuba, through Decree No. 502/12/DPMPTSP/VII/2019.

Geographically, the PT IWIP industrial area is located on the coast of Weda Bay. Technically, the smelter operators at PT IWIP can consider the DTSP method to reduce operational costs and increase the nickel production value. However, field facts indicate that the social and environmental costs incurred can be detrimental to all parties, including the community, government, and company. During our field

42 Tamrin & Aris, M. (2022). Warning of Heavy Metal Pollution Based on Saprobic Index in the Waters of Obi Island, North Maluku. PLATAX Scientific Journal, Sam Ratulangi University, 10(1), 55-60. https://ejournal.unsrat.ac.id/index.php/platax/article/download/37329/34799

43 Firdaus, F. & Levitt, T. (2022). 'We are afraid': Erin Brockovich pollutant linked to global electric car boom. The Gurdian. https://www.theguardian.com/global-development/2022/feb/19/we-are-afraid-erin-brockovich-pollutant-linked-to-global-electric-car-boom?fbclid=IwAR06F1x0Xq6Cy8qfXs26n_MupP0Kqq7GGNb0lEFCJ4TA60sTFvwsfzpFeTg

visit, the seawater temperature at the wastewater disposal point was found to be high. This increase in seawater temperature is caused by the hot water from the operation of the coal-fired power plant (PLTU). The marine biota community is most affected by these environmental changes. The diversity of phytoplankton and macrozoobenthos species has decreased, coral reefs are damaged, and the population of reef fish has also declined. As a result, fishermen from Lelilef and Gemaf have to search for fish in the open sea, requiring larger capital investment.

4.6 Comparison between Legislation and IRMA Criteria

Environmental responsibility is the fourth principle in the IRMA Standard for Responsible Mining, IRMA-STD-001. The IRMA standards assist companies in planning and conducting mining activities, including mineral ore extraction, processing, and waste management, with environmental values in mind, aiming to minimize the impacts on the environment and communities. Resource management of water and air quality is among the aspects considered in the IRMA standards.

The criteria for ambient water and air quality set by IRMA have some differences compared to the quality standards established by the legislative regulations in Indonesia. These differences can be observed in the number and type of parameters, as well as the permissible concentration levels. The following tables illustrate these variations for each environmental component under our study focus. It is important to note that several parameters within the quality standards of both types serve as analytical instruments to assess the environmental conditions around the PT IWIP area.

Table 4.6. A Comparison of River Water Quality Standards between Government Regulation No. 22 of 2021 (PP No. 22/2021) and IRMA

No.	Parameter	Unit	PP 22/2021				IRMA
			Class 1	Class 2	Class 3	Class 4	
1	Temperature	^{0}C	Dev 3	Dev 3	Dev 3	Dev 3	Dev 3
2	Total Dissolved Solids (TDS)	mg/L	1,000	1,000	1,000	2,000	-
3	Total Suspended Solids (TSS)	mg/L	40	50	100	400	40
4	Color	Pt-Co unit	15	50	100	-	unregulated
5	Degree of Acidity (pH)		6 – 9	6 - 9	6 - 9	6 - 9	6,5 – 9,0
6	Biochemical Oxygen Demand (BOD)	mg/L	2	3	6	12	unregulated
7	Chemical Oxygen Demand (COD)	mg/L	10	25	40	80	unregulated
8	Dissolved Oxygen (DO)	mg/L	6	4	3	1	measured
9	Sulfate (SO_4^{2-})	mg/L	300	300	300	400	-
10	Chloride (Cl^-)	mg/L	300	300	300	600	230
11	Nitrate (as N)	mg/L	10	10	20	20	13
12	Nitrite (as N)	mg/L	0.06	0.06	0.06	-	-
13	Ammonia (as N)	mg/L	0.1	0.2	0.5	-	calculated
14	Total Nitrogen	mg/L	15	15	25	-	measured
15	Total Phosphate (as P)	mg/L	0.2	0.2	1.0	-	unregulated

No.	Parameter	Unit	PP 22/2021				IRMA
			Class 1	Class 2	Class 3	Class 4	
16	Fluoride (F)	mg/L	1	1.5	1.5	-	1
17	Hydrogen Sulfide as H_2S	mg/L	0.002	0.002	0.002	-	-
18	Cyanide (CN)	mg/L	0.02	0.02	0.02	-	0.022
19	Free Chlorine	mg/L	0.03	0.03	0.03	-	0.003
20	Dissolved Barium (Ba)	mg/L	1.0	-	-	-	-
21	Dissolved Boron (B)	mg/L	1.0	1.0	1.0	1.0	0.75
22	Dissolved Mercury (Hg) Dissolved Arsenic (As) Dissolved Selenium (Se)	mg/L	0.001	0.002	0.002	0.005	0.0001
23	Dissolved Arsenic (As)	mg/L	0.05	0.05	0.05	0.10	0.024
24	Dissolved Selenium (Se)	mg/L	0.01	0.05	0.05	0.05	0.005
25	Dissolved Iron (Fe)	mg/L	0.3	-	-	-	1
26	Cadmium (Cd)	mg/L	0.01	0.01	0.01	0.01	calculated
27	Dissolved Cobalt (Co)	mg/L	0.2	0.2	0.2	0.2	-
28	Dissolved Manganese (Mn)	mg/L	0.1	-	-	-	0.37
29	Dissolved Nickel (Ni)	mg/L	0.05	0.05	0.05	0.1	calculated
30	Dissolved Zinc (Zn)	mg/L	0.05	0.05	0.05	2	calculated
31	Dissolved Copper (Cu)	mg/L	0.02	0.02	0.02	0.2	calculated
32	Dissolved Lead (Pb)	mg/L	0.03	0.03	0.03	0.5	calculated
33	Hexavalent Chromium (Cr(VI))	mg/L	0.05	0.05	0.05	1	0.011
34	Oil and Grease	mg/L	1	1	1	10	unregulated
35	Total Detergent	mg/L	0.2	0.2	0.2	-	unregulated

No.	Parameter	Unit	PP 22/2021				IRMA
			Class 1	Class 2	Class 3	Class 4	
36	Phenol	mg/L	0.002	0.005	0.01	0.02	unregulated
37	Aldrin/Dieldrin	µg/L	17	-	-	-	unregulated
38	BHC	µg/L	210	210	210	-	unregulated
39	Chlordane	µg/L	3	-	-	-	unregulated
40	DDT	µg/L	2	2	2	2	unregulated
41	Endrin	µg/L	1	4	4	-	unregulated
42	Heptachlor	µg/L	18	-	-	-	unregulated
43	Lindane	µg/L	56	-	-	-	unregulated
44	Methoxychlor	µg/L	35	-	-	-	unregulated
45	Toxaphan	µg/L	5	-	-	-	unregulated
46	Fecal Coliform	MPN / 100 mL	100	1,000	2,000	2,000	unregulated
47	Total Coliform	MPN / 100 mL	1,000	5,000	10,000	10,000	unregulated
48	Waste (Trash)		None	none	none	none	unregulated
49	Radioactivity						
	Gross-A	Bq/L	0.1	0.1	0.1	0.1	unregulated
	Gross-B	Bq/L	1	1	1	1	unregulated

Table 4.6 shows the differences between Government Regulation No. 22 of 2021 (PP No. 22/2021) and IRMA criteria regarding river water quality standards, as follows:

1. River water quality standards according to PP No. 22/2021 are categorized based on their designated use. Class 1 rivers are used for raw drinking water and/or other purposes requiring the same water quality, Class 2 rivers are designated for recreational water facilities, freshwater fish farming, livestock watering, irrigation of crops, and/or other purposes requiring the same water quality, Class 3 rivers are designated for freshwater fish farming, livestock watering, irrigation of crops, and/or other purposes requiring the same water quality, and Class 4 rivers are designated for irrigation of crops and/or other purposes requiring the same water quality. On the other hand, IRMA criteria apply universally to all types of surface water, including lakes. IRMA also has specific criteria for drinking water, agricultural activities, livestock activities, aquaculture, and recreation. Unlike PP No. 22/2021. IRMA's criteria are clearly separated and distinguishable from one another (clear-cut).

2. PP No. 22/2021 water quality standards are national criteria independently formulated involving experts, while IRMA criteria combine various sources from environmental organizations in several countries. These sources vary for each parameter. For example, the hexavalent chromium standard is derived from the US Environmental Protection Agency and the Peru Ministry of Environment, while the temperature standard is sourced from the International Finance Corporation (IFC).

3. PP No. 22/2021 tends to set concentration limits for each parameter, whereas IRMA criteria do not. In the IRMA criteria, some parameters need to be further measured and analyzed for their severity, such as dissolved oxygen and total nitrogen. Some parameters need to be calculated based on hardness or the Biotic Ligand Model (BLM), such as cadmium, copper, and nickel, and based on temperature and pH for ammonia. This means that the

concentration of certain metal and ammonia parameters depends on the values of other parameters.

4. Parameters related to oxygen demand, pesticides, microbiological, and radioactivity are regulated in the water quality standards of PP No. 22/2021 but not in the IRMA criteria (i.e., not regulated). Conversely, certain metal parameters (such as aluminum, total chromium, and trivalent chromium) and non-metal parameters (such as alkalinity and dissolved organic carbon) are regulated in the IRMA criteria but not in PP No. 22/2021. This difference arises because PP No. 22/2021 is designed assuming that rivers serve as receiving bodies for treated wastewater from all types of activities, including agricultural and domestic activities. The IRMA criteria are designed with parameters relevant to mining activities. In the effort to monitor surface water quality, mining companies need to adhere to stricter parameters. However, they are not required to monitor parameters unrelated to their operational activities.

5. For the parameters studied, especially pH and hexavalent chromium, it appears that IRMA criteria are stricter compared to PP No. 22/2021 water quality standards. From the measurement results of river water quality around the PT IWIP area, the most impacted river is the Wosea River with a pH of around 9.15 and a hexavalent chromium concentration of 0.017 mg/L.

Table 4.7. A Comparison of Lake Water Quality Standards between Government Regulation No. 22 of 2021 (PP No. 22/2021) and IRMA

No.	Paramete	Unit	PP 22/2021				IRMA
			Class 1	Class 2	Class 3	Class 4	
1	Temperature	^{0}C	Dev 3	Dev 3	Dev 3	Dev 3	Dev 3
2	Total Dissolved Solids (TDS)	mg/L	1,000	1,000	1,000	1,000	-
3	Total Suspended Solids (TSS)	mg/L	25	50	100	400	40
4	Transparency	M	10	4	2,5	-	unregulated
5	Color	Pt-Co unit	15	50	100	-	unregulated
6	pH (Degree of Acidity)		6 - 9	6 - 9	6 - 9	6 – 9	6,5 – 9,0
7	Biochemical Oxygen Demand (BOD)	mg/L	2	3	6	12	unregulated
8	Chemical Oxygen Demand (COD)	mg/L	10	25	40	80	unregulated
9	Dissolved Oxygen (DO)	mg/L	6	4	3	1	measured
10	Sulfate (SO_4^{2-})	mg/L	300	300	300	400	-
11	Chloride (Cl-)	mg/L	300	300	300	600	230
12	Total Nitrogen	mg/L	0.65	0.75	0.75	1.90	measured
13	Total Phosphate (as P)	mg/L	0.01	0.03	0.1	-	unregulated
14	Fluoride (F)	mg/L	1	1.5	1.5	-	1
15	Hydrogen Sulfide as H_2S	mg/L	0.002	0.002	0.002	-	-
16	Cyanide (CN)	mg/L	0.02	0.02	0.02	-	0.022
17	Free Chlorine	mg/L	0.03	0.03	0.03	-	0.003

No.	Paramete	Unit	PP 22/2021				IRMA
			Class 1	Class 2	Class 3	Class 4	
18	Dissolved Barium (Ba)	mg/L	1.0	-	-	-	-
19	Dissolved Boron (B)	mg/L	1.0	1.0	1.0	1.0	0.75
20	Dissolved Mercury (Hg)	mg/L	0.001	0.002	0.002	0.005	0.0001
21	Dissolved Arsenic (As)	mg/L	0.05	0.05	0.05	0.10	0.024
22	Dissolved Selenium (Se)	mg/L	0.01	0.05	0.05	0.05	0.005
23	Dissolved Iron (Fe)	mg/L	0.3	-	-	-	1
24	Cadmium (Cd)	mg/L	0.01	0.01	0.01	0.01	calculated
25	Dissolved Cobalt (Co)	mg/L	0.2	0.2	0.2	0.2	-
26	Dissolved Manganese (Mn)	mg/L	0.4	0.4	0.5	1.0	0.37
27	Dissolved Nickel (Ni)	mg/L	0.05	0.05	0.05	0.1	calculated
28	Dissolved Zinc (Zn)	mg/L	0.05	0.05	0.05	2	calculated
29	Dissolved Copper (Cu)	mg/L	0.02	0.02	0.02	0.2	calculated
30	Dissolved Lead (Pb)	mg/L	0.03	0.03	0.03	0.5	calculated
31	Hexavalent Chromium (Cr(VI))	mg/L	0.05	0.05	0.05	1	0.011
32	Oil and Grease	mg/L	1	1	1	10	unregulated
33	Total Detergent	mg/L	0.2	0.2	0.2	-	unregulated
34	Phenol	mg/L	0.002	0.005	0.01	0.02	unregulated
35	Aldrin/Dieldrin	µg/L	17	-	-	-	unregulated
36	BHC (Hexachlorocyclohexane)	µg/L	210	210	210	-	unregulated
37	Chlordane	µg/L	3	-	-	-	unregulated

No.	Paramete	Unit	PP 22/2021				IRMA
			Class 1	Class 2	Class 3	Class 4	
38	DDT (Dichlorodiphenyltrichloroethane)	µg/L	2	2	2	2	unregulated
39	Endrin	µg/L	1	4	4	-	unregulated
40	Heptachlor	µg/L	18	-	-	-	unregulated
41	Lindane	µg/L	56	-	-	-	unregulated
42	Methoxychlor	µg/L	35	-	-	-	unregulated
43	Toxaphan	µg/L	5	-	-	-	unregulated
44	Fecal Coliform	MPN / 100 mL	100	1,000	2,000	2,000	unregulated
45	Total Coliform	MPN / 100 mL	1,000	5,000	10,000	10,000	unregulated
46	Klorofil-a	mg/m^3	10	50	100	200	unregulated
47	Waste (Trash)		none	none	none	none	unregulated
48	Radioactivity						
	Gross-A	Bq/L	0.1	0.1	0.1	0.1	unregulated
	Gross-B	Bq/L	1	1	1	1	unregulated

Table 4.7 illustrates the distinctions between Government Regulation No. 22/2021 (GR No. 22/2021) and the Indonesian River and Lake Water Quality Standards (IRMA) concerning the standards for lake water quality. Essentially, the classification of quality standards and the parameters that are regulated mirror those established for river water quality. The factors that set it apart from the IRMA criteria are not significantly divergent from the previous comparison made for river water quality standards. It is essential to take note of the following:

1. Unlike Government Regulation No. 21/2021 (PP No. 21/2021), which includes water quality standards for both rivers and lakes, the IRMA criteria only address surface water quality in general. In other words, the IRMA criteria are intended to apply to all types of surface water, including rivers, lakes, and reservoirs.

2. PP No. 21/2021 includes specific water quality standards for lakes, regulating parameters such as transparency and chlorophyll-a, which are not covered in the IRMA criteria. On the other hand, the IRMA criteria include certain parameters not found in PP No. 21/2021, such as aluminum, calcium, total chromium, potassium, silver, sodium, thallium, alkalinity as CaCO3, and dissolved organic carbon.

Table 4.8. A Comparison of Seawater Quality Standards between Government Regulation No. 22/2021 and IRMA Criteria

No.	Parameter	Unit	PP 22/2021			IRMA
			Port	Marine Tourism	Marine Biota	
1	Color	PT Co	-	30	-	unregulated
2	Brightness	m	> 3	> 6	*coral*: > 5 *mangrove*: - lamun: > 3	unregulated
3	Turbidity	NTU	-	5	5	unregulated
4	Odor	-	odorless	odorless	natural	unregulated
5	Total Suspended Solids (TSS)	mg/L	80	20	*coral*: 20 *mangrove*: 80 lamun: 20	-
6	Waste	-	none	none	none	unregulated
7	Temperature	^{0}C	natural	natural	alami *coral*: 28-30 *mangrove*: 28-32 lamun: 28-30	-
8	Oil Layer	-	none	none	none	unregulated
9	pH	-	6,5 – 8,5	7 – 8,5	7 – 8,5	6.5 – 8.7
10	Salinity	‰	natural	natural	alami *coral*: 33-34 *mangrove*: s/d 34 lamun: 33-34	unregulated
11	Dissolved Oxygen (DO)	mg/L	-	> 5	> 5	unregulated

No.	Parameter	Unit	PP 22/2021			IRMA
			Port	Marine Tourism	Marine Biota	
12	Biochemical Oxygen Demand (BOD_5)	mg/L	-	10	20	unregulated
13	Total Ammonia (NH_3-N)	mg/L	0.3	0.02	0.3	calculated
14	Orthophosphate (PO_4-P)	mg/L	-	0.015	0.015	unregulated
15	Nitrate (NO_3-N)	mg/L	-	0.06	0.06	13
16	Cyanide (CN^-)	mg/L	-	-	0.5	0.004
17	Hydrogen Sulfide (H_2S)	mg/L	0.03	0.002	0.01	measured
18	Total Petroleum Hydrocarbons (TPH)	mg/L	1	-	0.02	unregulated
19	Total Phenolic Compounds	mg/L	0.003	0.001	0.002	unregulated
20	Polycyclic Aromatic Hydrocarbons (PAH)	mg/L	-	0.003	0.003	unregulated
21	Polychlorinated Biphenyls (PCB)	µg/L	0.01	0.005	0.01	unregulated
22	Surfactants (Detergents) as MBAS (Methylene Blue Active Substances)	mg/L	1	0.001	1	unregulated
23	Oil and Grease	mg/L	5	1	1	unregulated

No.	Parameter	Unit	PP 22/2021			IRMA
			Port	Marine Tourism	Marine Biota	
24	Pesticide					
	a. BHC	µg/L	-	210	210	unregulated
	b. Aldrin / Dieldrin	µg/L	-	17	-	unregulated
	c. Chlordane	µg/L	-	3	-	unregulated
	d. DDT	µg/L	-	2	2	unregulated
	e. Heptachlor	µg/L	-	18	-	unregulated
	f. Lindane	µg/L	-	56	-	unregulated
	g. Methoxychlor	µg/L	-	35	-	unregulated
	h. Endrin	µg/L	-	1	4	unregulated
	i. Toxaphan	µg/L	-	5	-	unregulated
25	TBT (tri butil tin)	µg/L	0.01	-	0.01	unregulated
26	Mercury (Hg)	mg/L	0.003	0.002	0.001	0.0004
27	Kromium heksavalen (Cr(VI))	mg/L	-	0.002	0.005	0.0044
28	Arsen (As)	mg/L	-	0.025	0.012	0.0125
29	Cadmium (Cd)	mg/L	0.01	0.002	0.001	0.004
30	Copper (Cu)	mg/L	0.05	0.05	0.008	0.0031
31	Lead (Pb)	mg/L	0.05	0.005	0.008	0.0081
32	Zinc (Zn)	mg/L	0.1	0.095	0.05	0.015
33	Nickel (Ni)	mg/L	-	0.075	0.05	0.07
34	Fecal Coliform	mg/L	-	200	-	unregulated
35	Coliform (total)	jml / 100 mL	1000	1000	1000	unregulated

No.	Parameter	Unit	PP 22/2021			IRMA
			Port	Marine Tourism	Marine Biota	
36	Patogen	sel / 100 mL	-	none	none	unregulated
37	Fitoplankton	sel/mL	-	1,000	1,000	unregulated
38	Radioactivity	Bq/L	-	4	4	unregulated

Table 4.8 presents a comparison between Government Regulation No. 22 of 2021 (PP No. 22/2021) and theInitiative for Responsible Mining Assurance (IRMA) regarding the standards for seawater quality:

1. The seawater quality standards specified in PP No. 22/2021 are categorized based on the intended use of marine waters, such as ports, marine tourism areas, or marine biota habitats, while the IRMA criteria apply generally.

2. PP No. 22/2021 takes into account the natural conditions for parameters such as odor, temperature, and salinity, whereas IRMA does not use such concepts. In other words, the normal limits for these parameters depend on the characteristics of the monitored marine environment. There are allowable variations in temperature and salinity from their natural conditions. However, the IRMA criteria do not even regulate odor and salinity parameters.

3. PP No. 22/2021 tends to set concentration limits for each parameter, whereas IRMA does not. Under the IRMA criteria, the concentration of ammonia needs to be calculated based on temperature and pH, and the concentration of sulfide needs to be measured for further analysis of the severity of seawater quality.

4. Parameters such as pesticides, biological factors, Persistent Organic Pollutants (POPs), oxygen demand, and several physical parameters are regulated in PP No. 22/2021 but not in the IRMA criteria (i.e., not regulated). Conversely, IRMA regulates metal parameters (such as total trivalent chromium, selenium, silver, and vanadium) and chlorine parameters but not in PP No. 22/2021. The seawater quality standards in PP No. 22/2021 are designed to address marine water pollution from all forms of activities in Indonesia, including domestic, industrial, or agricultural activities. On the other hand, IRMA criteria are designed with parameters relevant to mining activities. In efforts to monitor surface water quality, mining companies need to adhere to stricter parameters. However, companies are not required to monitor parameters unrelated to their operational activities.

5. For the parameters we have studied, particularly acidity levels and hexavalent chromium, the IRMA criteria are stricter than the seawater quality standards in PP No. 22/2021. Based on water quality measurements around the PT IWIP area, the most affected zone is the discharge area of the coal-fired power plant (PLTU) with water temperature reaching 35°C and hexavalent chromium concentration reaching 0.024 mg/L.

Table 4.9. A Comparison of Ambient Air Quality Standards between Government Regulation No. 22 of 2021

No.	Parameter	Measurement Time	PP 22/2021	IRMA
1	Sulfur dioxide (SO_2)	1 hour	150 µg/m^3	350 µg/m^3
		24 hours	75 µg/m^3	125 µg/m^3
		1 year	45 µg/m^3	unregulated
2	Carbon monoxide (CO)	1 hour	10000 µg/m^3	unregulated
		8 hours	4000 µg/m^3	10000 µg/m^3
3	Nitrogen dioxide (NO_2)	1 hour	200 µg/m^3	200 µg/m^3
		24 hours	65 µg/m^3	unregulated
		1 year	50 µg/m^3	40 µg/m^3
4	Photochemical oxidants (O_x) as Ozone (O_3)	1 hour	150 µg/m^3	unregulated
		8 hours	100 µg/m^3	120 µg/m^3
		1 year	35 µg/m^3	unregulated
5	Non-Methane Hydrocarbons (NMHC)	3 hours	160 µg/m^3	unregulated
6	Dust particles < 100 µm (TSP)	24 hours	230 µg/m^3	unregulated
	Dust particles < 10 µm (PM_{10})	24 hours	75 µg/m^3	50 µg/m^3
		1 year	40 µg/m^3	40 µg/m^3
	Dust particles < 2,5 µm ($PM_{2,5}$)	24 hours	55 µg/m^3	unregulated
		1 year	15 µg/m^3	25 µg/m^3
7	Lead (Pb)	24 hours	2 µg/m^3	unregulated
		1 year	unregulated	0.5 µg/m^3
8	Benzene	1 year	unregulated	5 µg/m^3

No.	Parameter	Measurement Time	PP 22/2021	IRMA
9	Arsen (As)	1 year	unregulated	6 µg/m^3
10	Cadmium (Cd)	1 year	unregulated	5 µg/m^3
11	Nickel (Ni)	1 year	unregulated	20 µg/m^3
12	Polycyclic Aromatic Hydrocarbons (PAH)	1 year	unregulated	1 ng/m^3 (as Benzo(a) pyrene)

Table 4.9 presents a comparison between Government Regulation No. 22 of 2021 (PP No. 22/2021) and theInitiative for Responsible Mining Assurance (IRMA) regarding ambient air quality standards, as follows:

1. The air quality standards in PP No. 22/2021 are national criteria formulated independently with the involvement of experts, while IRMA adopts the air quality standards of the European Union.

2. The ambient air quality standards specified in PP No. 22/2021 establish measurement systems for each parameter, whereas IRMA does not. For example, for the parameter sulfur dioxide (SO2), the required measurement method is continuous active monitoring for 24 hours, and manual active monitoring may be chosen for 1 hour. (Active method involves air being drawn into the measurement instrument, continuous means the measurement instrument is placed at specific points and continuously measures air quality within a certain time frame, while manual means measurements are taken at specific intervals and conducted by analysts).

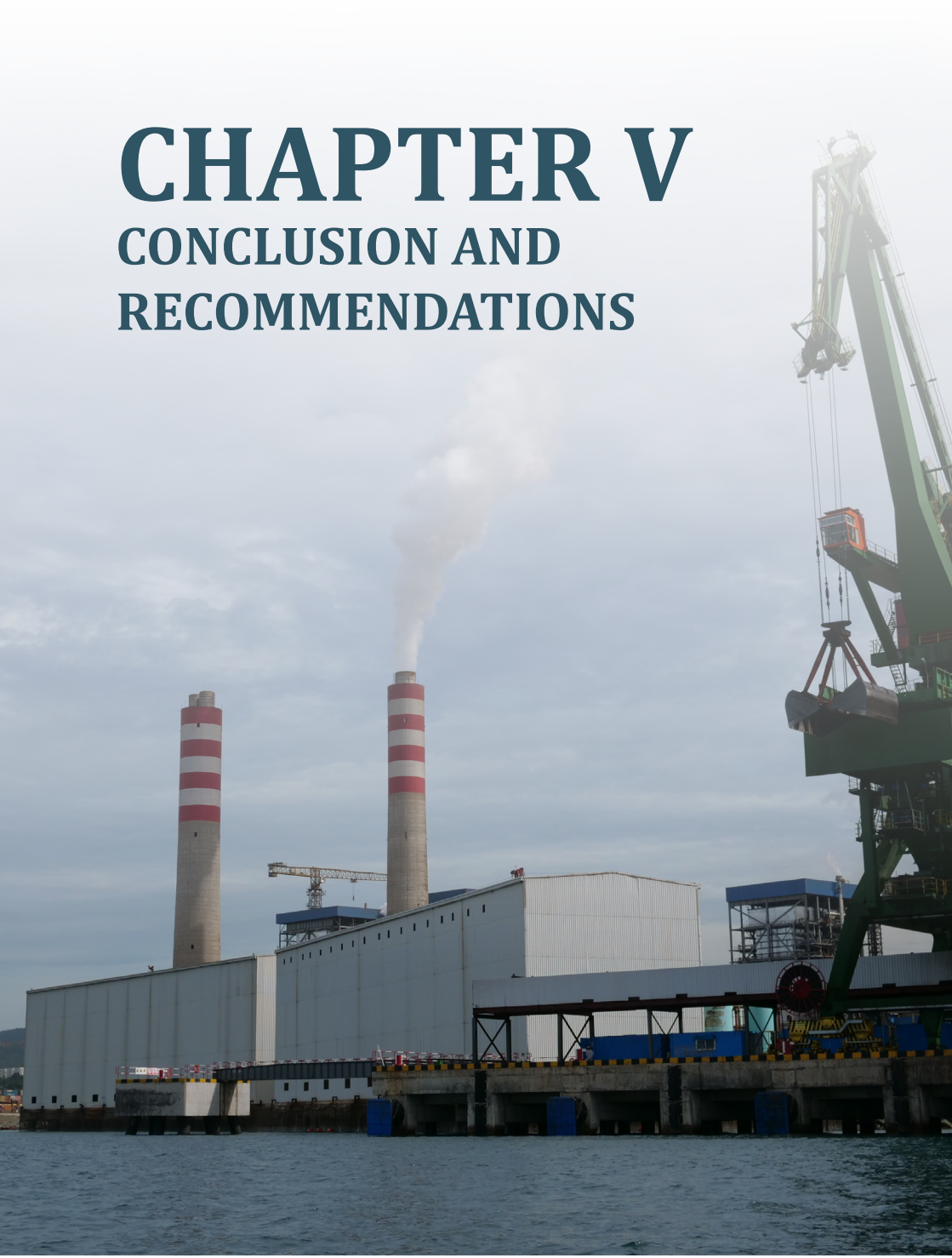
3. IRMA sets permitted exceedances per year for parameters such as sulfur dioxide (SO2), nitrogen dioxide (NO2), ozone (O3), and particulate matter < 10 µm (PM10), while PP No. 22/2021 does not define such permitted exceedances. Permitted exceedance per year refers to the limit of how many times the concentration of a specific parameter can exceed the standard limit each year.

4. Parameters like non-methane hydrocarbons (NMHC) and total suspended particles < 100 µm (TSP) are regulated in PP No. 22/2021 but not in IRMA criteria. On the other hand, parameters such as arsenic (As), cadmium (Cd), nickel (Ni), and Polycyclic

Aromatic Hydrocarbons (PAH) are regulated by IRMA but not in PP No. 22/2021. These differences are also evident in the measurement duration. For example, PP No. 22/2021 establishes a 24-hour measurement duration for the parameter particulate matter < 2.5 μm (PM2.5), while IRMA does not have such a requirement.

5. For the parameters under study, such as PM10 and PM2.5 with a 24-hour measurement duration, IRMA imposes stricter standards compared to the ambient air quality standards in PP No. 22/2021. Based on air quality measurements inside and outside the PT IWIP area, the locations most affected are the coal-fired power plant (PLTU) area, Lelilef Sawai Village, and Lelilef Woebulen Village, with PM10 concentrations reaching 101 μg/m3 and PM2.5 concentrations reaching 82 μg/m3.

CHAPTER V
CONCLUSION AND RECOMMENDATIONS



Chapter V
Conclusion and Recommendations

5.1. Conclusion

The Indonesian Weda Bay Industrial Park (IWIP), a nickel mining industrial area located in Central Halmahera Regency, North Maluku Province, has undergone development along with changes in social and environmental conditions in the four affected villages surrounding the industrial zone. These villages include Lelilef Sawai Village, Lelilef Woebulen Village, Gemaf Village, and Sagea Village. Each village has experienced different levels of impact, with Lelilef Sawai and Lelilef Woebulen currently being the most affected in terms of social structure and environmental conditions.

The development of the IWIP area has transformed the coastal landscape of Lelilef Sawai Village. Previously, the village was covered with mangrove forests, plantations, and settlements. Currently, almost the entire coastline of Lelilef Sawai Village has been converted into a nickel industrial zone with various facilities such as coal-fired Steam Power Plants (PLTU), smelters, offices, and worker accommodations. This change in land use has marginalized the living space of the residents, including farmers who no longer have arable land and fishermen who must seek fish far from the shore. As a result, some farmers and fishermen have switched professions or even become unemployed. They consider the compensation process carried out by the company to be inadequate and unfair. This narrowing of living space is accompanied by other social issues such as poor working conditions, an increasing number of migrants, and reduced access to clean water.

The construction, excavation, nickel ore processing, and utilization of steam from coal burning in the IWIP area also have an impact on the surrounding water and air environments. High concentrations

of hexavalent chromium were detected downstream of the Wosea River, at the discharge point of the PLTU's wastewater, at the mouth of the Ake Doma River, and at Tanjung Ulie. Particulate dust levels on the roadside near the PLTU area and at several points in Lelilef Sawai Village and Lelilef Woebulen Village also exceeded the required standards. These changes in environmental quality can lead to damage to aquatic ecosystems and a decline in the health of the residents. The Lelilef Community Health Center (Puskesmas Lelilef) has recorded an increase in the number of Acute Respiratory Tract Infections (ARTIs) complaints each year.

The development of the IWIP industrial area has been ongoing for five years, and the ferrochrome smelter and High-Pressure Acid Leach (HPAL) will be built in the coming years. The location of PT Weda Bay Nickel's mining activities, a tenant of PT IWIP, is also expanding towards East Halmahera. The expansion of these business activities has the potential for negative impacts on social and environmental aspects. Therefore, all stakeholders involved need to formulate policies and mitigation strategies by understanding the current conditions related to social and environmental aspects as described in this study.

5.2. Recommendations

To reduce the impact of nickel mining and industrial activities on social and environmental aspects, we propose the following steps:

1. Involvement of the community in a participatory and collaborative manner in discussions concerning aspects of mining and nickel industry activities that affect their interests, such as land acquisition processes and the utilization of water resources. The company should respect sites or areas that hold vital value for the community. Inclusivity and collaboration with the local community should be fostered from the early stages of the project.

2. Efforts to resolve tenure conflicts in a participatory and equitable manner. A fair discussion space should be established between the community and the company. Each party should have a voice to

ensure that the decisions made accommodate all interests.

3. Inclusive community involvement should extend beyond community leaders in the planning and implementation of social and economic development programs for the communities surrounding mining and nickel industrial areas.

4. Establish a communication forum between the community and the mining and nickel industrial companies that is active and inclusive. Forum meetings can be held regularly on a monthly or at least bi-monthly basis.

5. Regular environmental quality monitoring should be conducted at specific intervals. Monitoring should be done by both the company and the government, not only within the industrial area but also in the environmental components of the affected villages. The results of environmental quality monitoring should be made accessible to the public, allowing communities and environmental observers to participate in monitoring. One infrastructure that should be provided by the company and the local government is the Air Pollution Standard Index (ISPU) board or other technologies that can be installed in high-risk areas.

6. Companies should also address environmental issues outside the industrial area, such as residential areas. These issues include but are not limited to access to clean water, dust, waste, and coral reef damage. Companies need to implement environmental programs related to these issues. Regarding waste issues, companies should provide infrastructure and organize communities to reduce waste generation.

7. Coal-fired Steam Power Plants (PLTU) in the industrial area should be discontinued and shifted to renewable energy sources to avoid air pollution and deterioration of community health.

8. Electric vehicle industries should openly explain the nickel supply chain they use and ensure that all activities within the supply chain comply with stricter social and environmental criteria or

regulations, such as the Initiative for Responsible Mining Assurance (IRMA), not just national regulations.

9. Further research should be conducted on the impact of nickel mining activities in the industrial area on social, environmental, economic, and cultural aspects. The preliminary findings from this study can inspire government bodies, academics, and non-governmental organizations to conduct scientific investigations on a broader scale and for a longer duration, either in the same or different research locations. The data and analysis from these studies can serve as a basis for decision-making towards sustainable development. One potential topic for further research is the impact of nickel mining industries on indigenous communities, such as Tobelo Dalam, residing in the forests of Central Halmahera and East Halmahera.

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