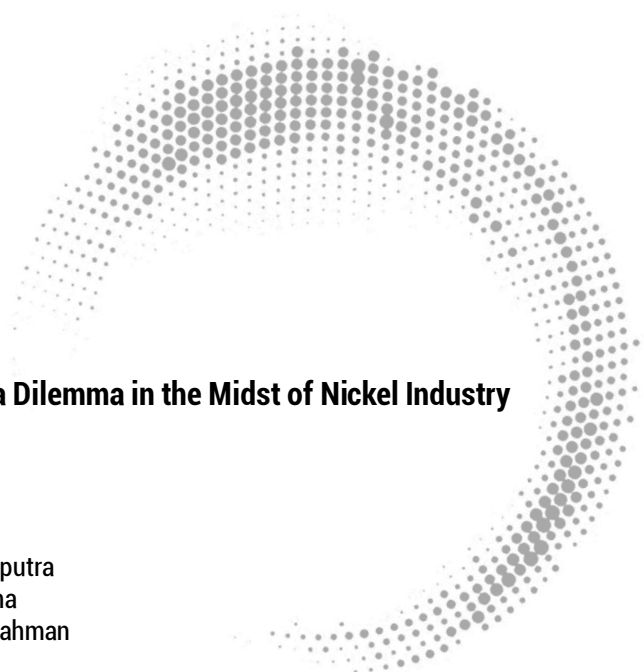


Halmahera Dilemma in the Midst of Nickel Industry





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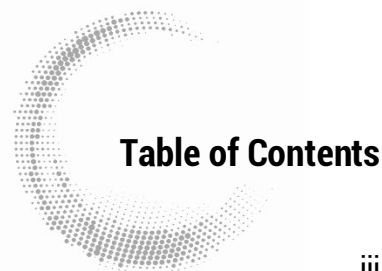


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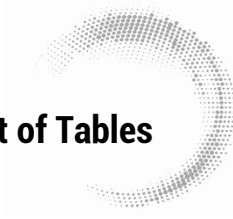
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Executive Summary

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 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 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 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 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 workers of 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 villagers who oppose land clearance. These circumstances leave the workers in a vulnerable and precarious position.

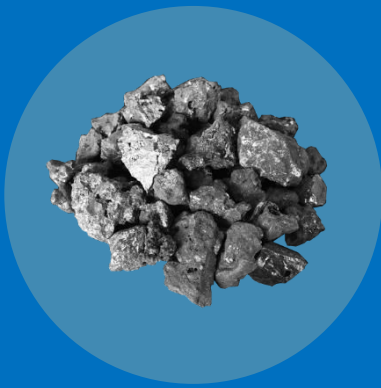
With the ongoing development of the IWIP zone, there have been notable changes in the water quality of rivers and the sea. In fact, certain rivers have been buried, ceasing their flow into the sea. The Wosea River, which has narrowed due to dumping activities on its banks, now contains detectable levels 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 of the coal-fired

steam power plant, the mouth of the Ake Doma River, and Cape 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 alterations in the vicinity of the IWIP zone 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 Lelief 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 IWIP zone 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 villagers. According to the Community Health Center in Lelief, cases of acute respiratory infections (ARI) have surged since the establishment of 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 IWIP zone 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

1.1 Background

Under President Joko Widodo's leadership, his administration oversaw the development of numerous industrial zones beyond Java as part of the National Strategic Project, which was initiated through the revision of Presidential Regulation Number 3 of 2016. The primary goal of this national strategic project was not solely to expedite the improvement of Indonesia's infrastructure quality and accessibility but also to enhance the well-being of local communities and regional economies. Among these industrial zones, some were specifically designated to align with policies for downstream industries based on natural resources, as outlined in the 2020-2024 National Medium-Term Development Plan. Within the context of the burgeoning steel and electric vehicle industry, one particularly promising natural resource is nickel.

As of 2022, Indonesia possesses 21% of the world's nickel reserves and caters to more than 48% of the global demand for nickel ore¹. With a focus on advancing the downstream nickel industry, Indonesia is anticipated to emerge as a key producer. This will be realized through the establishment of ore processing and refining facilities (smelters) strategically located within industrial zones near mining sites. At present, Indonesia already operates Rotary-Kiln Electric Furnace (RKEF) smelters capable of satisfying 74% of the global demand for nickel pig iron (NPI). Additionally, Indonesia operates three High-Pressure Acid Leaching (HPAL) smelters that produce mixed hydroxide precipitate (MHP), a semi-finished product crucial for the production of nickel sulfate used in electric vehicle battery manufacturing. This significant contribution underscores Indonesia's pivotal role in the global battery component supply chain and aligns with the country's commitment to reducing emissions in the transportation sector on a global scale.

¹ Annur, C.M. (2023). *The World's Largest Nickel Producing Country by 2022, Indonesia is Number One!* Databoks. <https://databoks.katadata.co.id/datapublish/2023/03/02/deretan-negara-penghasil-nikel-terbesar-di-dunia-pada-2022-indonesia-nomor-satu>

The diversification of the nickel industry extends beyond electric vehicle battery production to include the significant production of stainless steel, which heavily relies on Nickel Pig Iron (NPI). In 2022, Indonesia achieved the status of the world's second-largest producer of NPI-based stainless steel, following China, by manufacturing 5.7 million tons—an impressive increase of 700 thousand tons within just one year. Much of this growth can be attributed to the establishment of nickel-based industrial zones, notably exemplified by the Indonesia Weda Bay Industrial Park (IWIP) in Central Halmahera Regency, North Maluku Province.

The trajectory of nickel mining in North Maluku has undergone rapid expansion in recent years, in response to the growing global demand for nickel in both the electric vehicle battery and stainless steel sectors. It began with Aneka Tambang Ltd. (ANTAM), which commenced mining operations on Gebe Island in 1997, and mining concessions have since expanded to encompass 156,197.04 hectares, predominantly situated in Central Halmahera². While nickel mining in North Maluku has undeniably brought economic benefits and development opportunities to the local region, it has also produced undeniable negative impacts on social and environmental conditions.

This study aims to provide an initial overview of the current social and environmental situation in the vicinity of the IWIP area. The information and insights generated from this study are valuable to stakeholders, including the government, mining industry, local communities, and environmental organizations. By identifying and comprehending the existing impacts, this report is expected to serve as a foundation for formulating effective policies and mitigation measures in the management of nickel mining in North Maluku. Therefore, negative social and environmental impacts can be prevented or at least minimized, allowing the growth of the nickel industry to align with the vision of sustainable development and genuinely improve the well-being of local communities.

² Abubakar, K.S., & Karim, A.G. (2011). *The Lives of Gebe Island Communities: A Study of the Community's Situation Following the End of Aneka Tambang Ltd.'s Work Contract in Central Halmahera Regency*. Gadjah Mada University.
https://etd.repository.ugm.ac.id/home/detail_pencarian/50850

1.2 Potential Impacts of Nickel Mining Activities

Nickel mining is acknowledged as a pivotal industry in the shift from fossil fuels to renewable energy adoption within the transportation sector. The ongoing global conversation highlights the essential need for a substantial nickel supply in our evolving society, where electric vehicles are becoming increasingly central. Nevertheless, nickel mining operations have a downside, causing unfavorable alterations in both the environment and local communities in their proximity. Frequently, these activities result in a degradation of environmental conditions, with certain community groups being disproportionately affected by these consequences³.

Extractive nickel mining operations invariably require vast resources. Extensive land, adequate transportation access, a significant water volume, and a substantial workforce are always fundamental requirements. Consequently, significant environmental and social changes occur at every stage of the project, from exploration, construction, mining, processing, refining, transportation, to post-mining. These negative impacts are not limited to local communities; they also affect biotic factors (such as flora and fauna) and abiotic environmental elements (such as temperature and surface water chemical composition). For local communities impacted by nickel mining activities, their living space is constrained, both in economic and social contexts. Due to environmental degradation, the overall health quality of local villagers also deteriorates. In terms of the biotic elements in the environment, nickel mining can reduce biodiversity indices. In other words, these endeavors eliminate specific flora and fauna habitats, endangering their survival.

The following are the potential impacts that can occur due to nickel mining:

1. Deforestation

Nickel mining requires vast expanses of land for exploration, mineral extraction, and mining infrastructure development. The extensive land requirements bring a direct impact of deforestation as they result in the loss of forest cover.

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>

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

The construction of mining infrastructure, mineral excavation, and various other activities at mining sites have the potential to generate dust and emissions released into the air. Particulate matter and other compounds can have adverse effects on air quality, causing respiratory issues for humans and ecosystem alterations.

4. Alterations to Livelihood Patterns of Local Communities

Landscape alterations resulting from nickel mining can lead to socio-economic changes among local villagers. This may trigger conflicts of interests over land and resources around nickel mining areas.

5. Destruction of Flora and Fauna Habitat

Nickel mining leads to ecosystem alterations within the adjacent areas, affecting both aquatic and terrestrial ecosystems. These modifications can lead to the disruption of native habitats of flora and fauna, potentially diminishing biodiversity levels in regions where nickel mining operations are active.

1.3 Profile of Indonesia Weda Bay Industrial Park (IWIP)

Indonesia Weda Bay Industrial Park (IWIP) is an industrial area dedicated to advancing the downstream utilization of nickel resources in Central Halmahera, North Maluku. The development of this industrial zone is a national project enshrined in Presidential Regulation No. 18 of 2020, Presidential Regulation No. 109 of 2020, and Presidential Decree No. 62 of 2004⁴. In addition to being the focal point for the development of strategic areas and the processing of nickel resources, IWIP is also a target for enhancing integrated intermodal connectivity through sea, river, land, and air modes. To achieve this objective, road access, ports, and airports in the central industrial area are being constructed.

⁴ About IWIP. <https://iwip.co.id/tentang-iwip/>

Administratively, IWIP industrial zone is located in the districts of Weda Tengah (Central Weda) and Weda Utara (North Weda). Most of its area covers almost the entire coastal region of Lelilef Sawai Village in Weda Tengah. However, its impacts have the potential to spread to three surrounding villages, namely Lelilef Woebulen Village, Gemaf Village, and Sagea Village. The area has reached 5,000 hectares, and according to villagers' estimates, the size of this industrial zone is likely to continue increasing.

The IWIP industrial zone is managed by 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 zone⁵. The total investment amounts to 10 billion US dollars, previously agreed upon between Eramet Group (France) and Tsingshan, along with local partner, ANTAM⁶. 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 IWIP to build and operate nickel ore processing and refining facilities. For example, Youshan Nickel Indonesia, Weda Bay Nickel, and Angel Nickel Industry operate RKEF smelters with various nickel products and capacities. Other tenants, such as Huafei Nickel Cobalt and Sonic Bay, are also conducting feasibility studies for hydrometallurgical smelters using High-Pressure Acid Leach (HPAL) technology. All these smelters obtain nickel ore from Weda Bay Nickel, whose mining concession overlaps with the IWIP zone. In addition to facilitating metal refining activities, the IWIP industrial zone is also open to investors interested in building nickel sulfate (NiSO_4) production facilities, NCM/NCA, precursors, and even lithium-ion batteries for electric vehicles⁷.

⁵ Lia, A. (2023). *IWIP LLC: Company Profile, Vision and Mission, Vacancies, Job Prospects*. <https://blackgarlic.id/pt-iwip/#:~:text=%E2%80%93Sejarah%20PT%20IWIP,Menengah%20Nasional%20Tahun%202020%2D2024>.

⁶ Rafael, E.C. (2018). *Halmahera Industrial Zone worth US\$10 billion officially developed*. Kontan.co.id. <https://nasional.kontan.co.id/news/kawasan-industri-halmahera-senilai-us-10-miliar-resmi-dibangun>

⁷ Directorate General of Customs and Excise, Ministry of Finance. (2020). *Customs Inaugurates New Customs Zone in Central Halmahera*. <https://www.beacukai.go.id/berita/bea-cukai-resmikan-kawasan-pabean-baru-di-halmahera-tengah.html>

1.4 Research Objectives

1. To assess the impacts of IWIP's nickel mining activities on the local communities in four villages in Central Halmahera, North Maluku. The social components studied are land disputes, economic conditions, labor conditions, deterioration in health quality, and women involvement.
2. To assess the impact of IWIP's nickel mining activities on the water and air environment inside and outside the industrial zone. The environmental components studied are 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

2.1 Location

This research was conducted in Central Halmahera Regency, North Maluku Province, specifically in four affected villages: Lelilef Woebulen, Lelilef Sawai, Gemaf, and Sagea. Administratively, the first two villages are located in the Weda Tengah sub-district, and the other two are in the Weda Utara sub-district. Field surveys about the social and environmental aspects in these villages in relation to IWIP's mining activities, were carried out in June 2023. *Figure 2.1* illustrates IWIP's zone spanning 5,000 hectares, marked by the blue line, with the administrative village boundaries highlighted by the yellow lines.



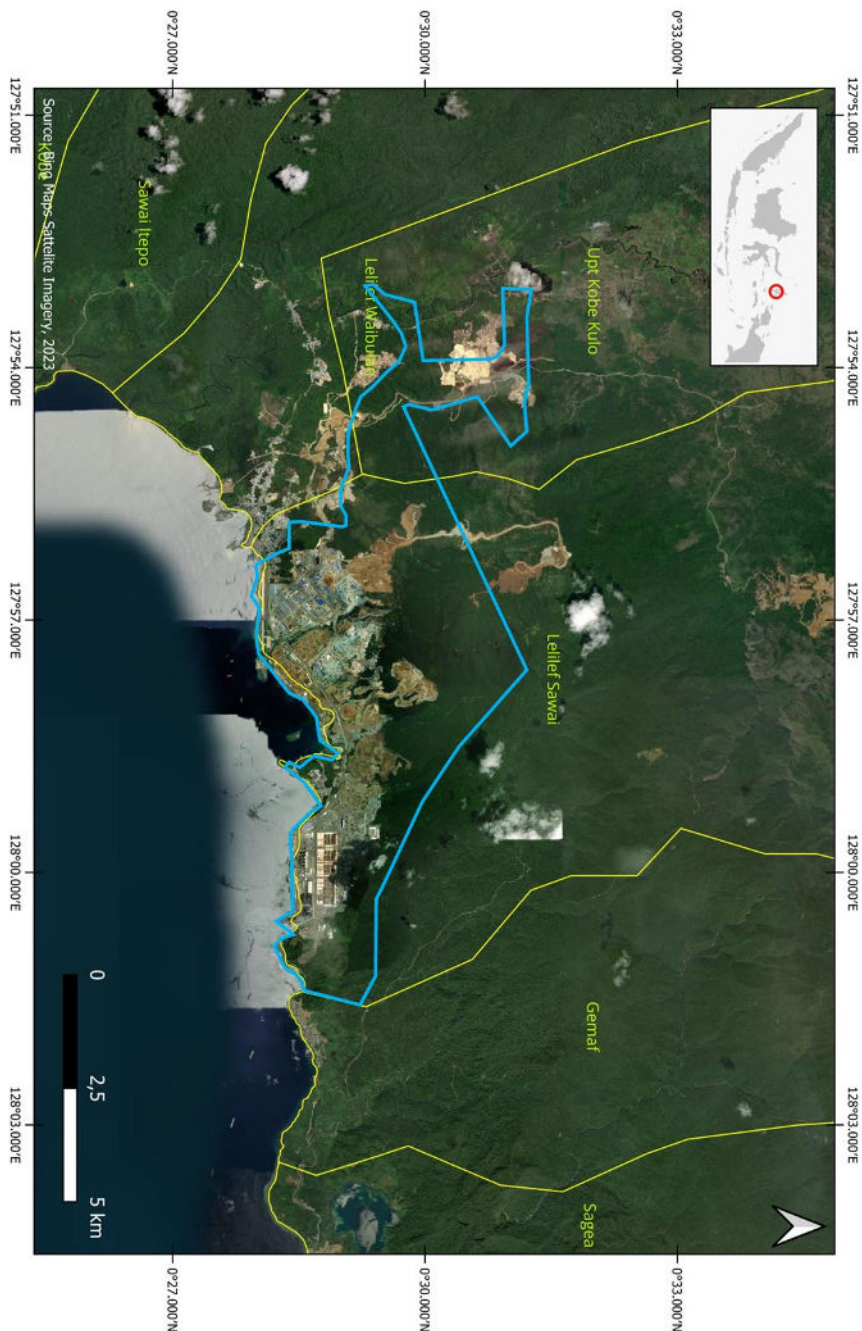


Figure 2.1. Location of IWIP zone (blue line) in Central Halmahera Regency, North Maluku Province

2.2 Data Collection Methods

2.2.1 Social Aspect

In this research, we gathered data on social and economic aspects through in-depth interviews with impacted communities, including the villagers of nearby villages and the employees of IWIP. Additionally, our study involved participatory mapping activities with village villagers concerning the changing landscape context in Central Halmahera Regency, specifically in the four affected villages. These participatory mapping exercises produced sketches of the area that visually highlight the landscape changes before and after IWIP's presence. These dynamic landscape alterations serve as a crucial basis for assessing the impacts on the social and economic conditions of the communities in the proximity of the company's operations.

2.2.2 Environmental Aspects

Data on environmental components were collected using direct measurement methods, interviews, and field observations. The selected environmental components included surface water (rivers and lakes), seawater, and ambient air. Water and air are the environmental components most significantly affected by IWIP mining activities. Digital measuring instruments (portable tools) were used for measurements due to their convenience and effectiveness. For water quality assessment, we utilized a Water Quality Tester and a Chromium VI Low Range Portable Photometer. Additionally, for ambient air quality assessment, we employed an Integrated Air Quality Detector. In specific locations for lake water quality assessment, we also utilized the Pack Test® Hexavalent Chromium Wak-Cr⁶⁺. Prior to the measurements, we conducted the calibration of the Water Quality Tester and Integrated Air Quality Detector. The test using the Chromium VI Low Range Portable Photometer indicated that the sample concentrations were within acceptable ranges.

The selection of measurement locations was based on the observations and reach of the field team. We focused on areas downstream of rivers and coastal regions near IWIP operations. Additionally, in areas where high particulate dust concentrations were anticipated, such as those around coal-fired power plants and visibly dusty zones, we conducted ambient air quality measurements.

In addition to primary data collected through measurements, we also relied on secondary data sources, including interview records and documents such as the Environmental Impact Assessment for IWIP Industrial Zone Development Plan. This supplementary data played a crucial role in enhancing the analysis of measurement results, providing a comprehensive picture of environmental quality during the field assessments.





Chapter III

Results and Analysis of Social Conditions and Potential Social Impacts

3.1 Changes in landscape over time

Main points:

- *The establishment of IWIP's industrial zone in Central Halmahera Regency since 2018 has led to significant transformations in the landscapes of several villages, including Lelilef Woebulen, Lelilef Sawai, and Gemaf villages. Formerly, these areas consisted of plantation lands, mangrove forests, and indigenous settlements. However, they have now been converted into facilities for nickel processing and refining, ports, coal-fired power plants, and other supporting infrastructure.*
- *The profiles of rivers that used to flow through Lelilef Sawai Village have undergone changes. The Wosea River has narrowed due to the dumping of earth materials along its banks, the flow of the Ake Sake River has been redirected for the construction of the coal-fired power plant, and several rivers, such as the Karkar River, the Woebem River, and the Gwondi River, no longer flow into Teluk Weda as they have become fully sedimented, signifying a significant shift in their profiles.*



Since the arrival of IWIP in 2018, these landscape changes have had various effects in the four most closely-affected villages within the company's operational area. The primary change has been the loss of local villagers' plantation areas in Lelilef Sawai, Lelilef Woebulen, and Gemaf villages, along with landscape modifications in Sagea Village. The most substantial transformations have occurred in Lelilef Sawai, Lelilef Woebulen, and Gemaf Villages, where agricultural lands were acquired through land acquisition processes by WBN and IWIP. In the Sagea village area, landscape changes have been less extensive than in the other three villages, but land acquisition by IWIP has already taken place, raising concerns among local villagers about potential future expansions to the north of Sagea Village. These changes are visually represented in *Figures 3.1* and *3.2*, which illustrate the landscape situation before the arrival of IWIP (before 2018) and after its presence (2018 - 2023)⁸.

Before the establishment of IWIP, the local villagers were already aware of Weda Bay Nickel (WBN), which conducted nickel and cobalt mining in Central Halmahera and East Halmahera. WBN was established by Aneka Tambang Ltd. (ANTAM) in partnership with Eramet S.A. (ESA) to implement the 7th generation Work Contract with the Indonesian Government⁹. Their mining operations began after their Environmental Impact Assessment (AMDAL) was approved by the Provincial Government of North Maluku in 2009. The concession area of WBN covers 54,874 hectares, with almost 65% of that area located in protected forests¹⁰. In the IWIP area, WBN has become one of the tenants operating pyrometallurgical smelters, specifically Rotary-Kiln Electric Furnace (RKEF), with a capacity of 30.000 tons of nickel per year¹¹.

⁸ These sketches were created using the participatory mapping method. This means that the sketches depict changes in the village landscape based on the memories of the informants.

⁹ Aneka Tambang Ltd. (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 in conflict with indigenous communities, threatening protected forests*. Mongabay, Environmental News Site. <https://www.mongabay.co.id/2013/06/07/weda-bay-nickel-berkonflik-dengan-masyarakat-adat-hutan-lindung-pun-terancam/>

¹¹ Profile of Weda Bay Nickel as one of the tenants of Indonesia Weda Bay Industrial Park (IWIP). <https://iwip.co.id/pt-weda-bay-nickel/>

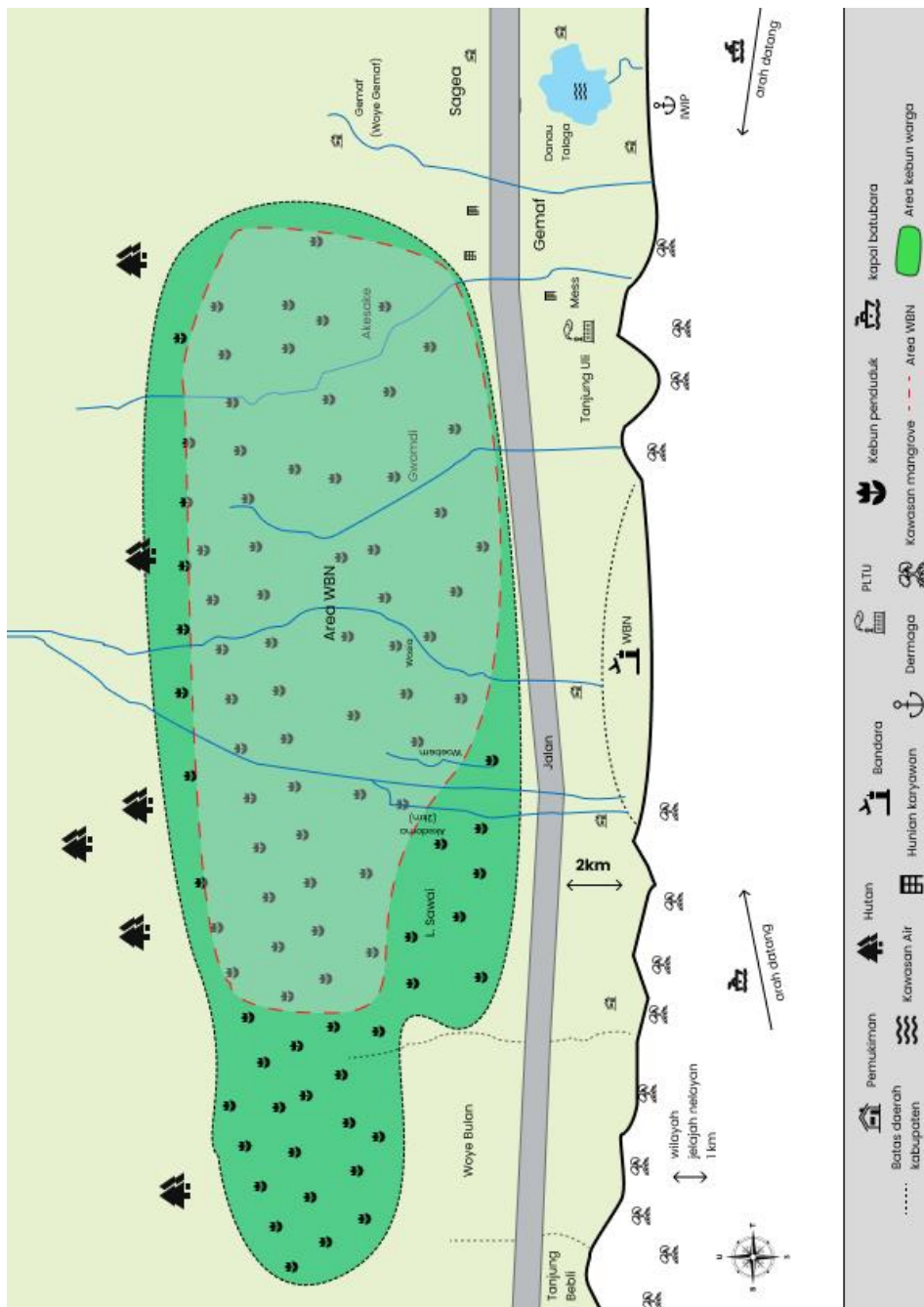


Figure 3.1. Sketches of the area prior to the presence of IWIP (prior to 2018)

Prior to 2018, WBN did not engage in massive land clearance. Most of the residential and agricultural areas of the villagers in Lelilef Woebulen, Lelilef Sawai, and Gemaf villages were within WBN 's concession area, which was close to forested regions. Along the coastal areas, mangrove forests dominated the coastline, starting from Lelilef Woebulen in the west and reaching Sagea in the east. From the coast, fishermen typically ventured out to sea up to one kilometer. Based on the sketches created with several informants, it is evident that compared to WBN 's concession area, which did not cover the coastal region, IWIP expanded its operational area to the coastal region of Lelilef Sawai through reclamation and airport construction.

The presence of IWIP since 2018 significantly altered the landscape, especially in three affected villages: Lelilef Woebulen, Lelilef Sawai, and Gemaf. The farmlands of the villagers were replaced by IWIP's operational areas. Nutmeg and clove trees were felled to make way for mining, offices, employee accommodations, a Coal-Fired Power Plant, and coal stockpiling areas. The coal storage location and the 1,000 MW capacity coal-fired power plant were situated near the Ake Sake River.



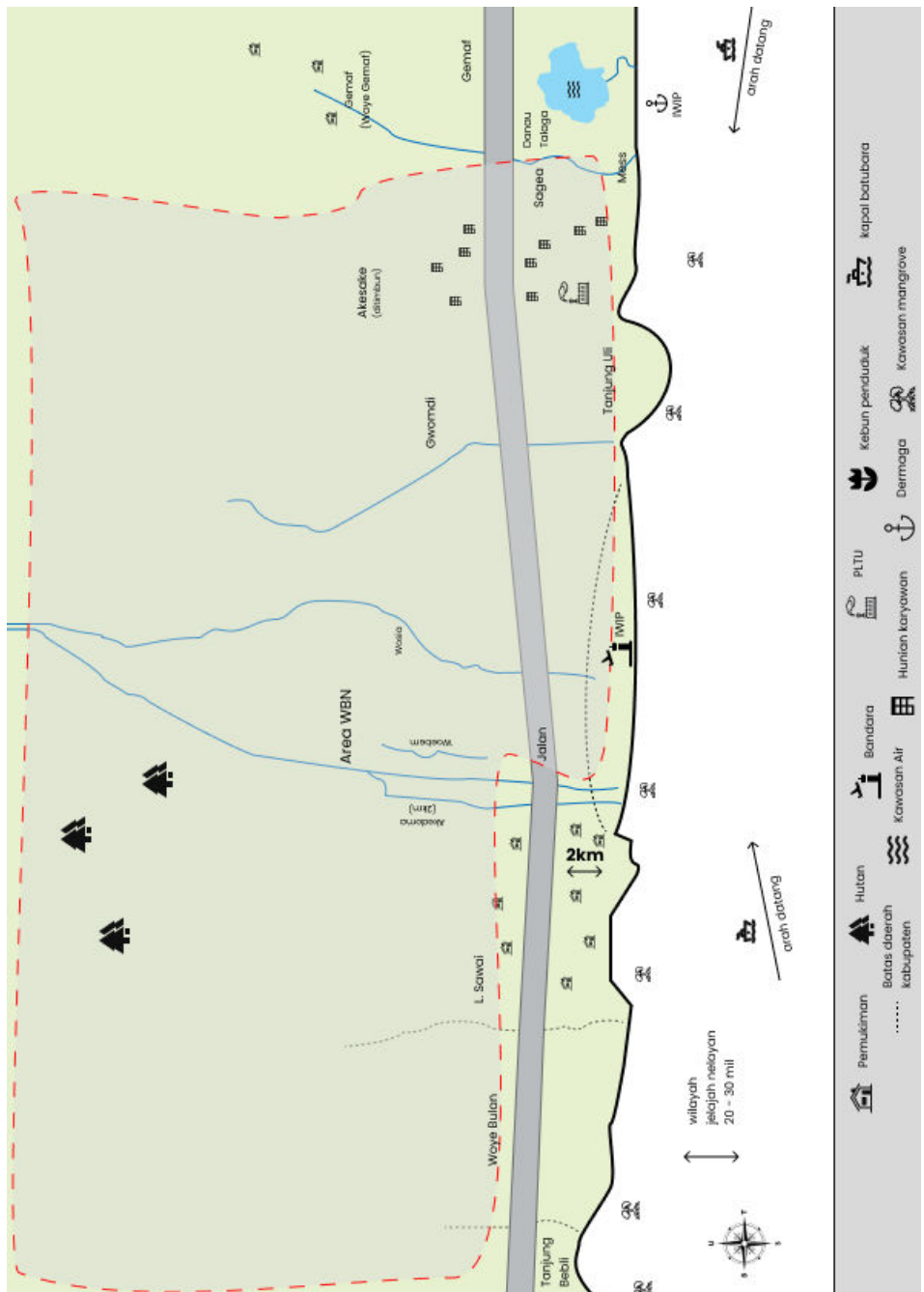


Figure 3.2. Sketches of the area following the presence of IWIP (post 2018)

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 River¹² has been diverted for the construction of the coal-fired power plant, and several rivers have even been filled in and no longer flow into Weda Bay, such as the Karkar River, the Woebem River, and the Gwondi River. The filling, narrowing, and alteration of river courses have reduced access to rivers and fishery resources for villagers. Today, villagers rely solely on the rivers that pass through Lukulamo Village (e.g., the Kobe River), Gemaf Village (e.g., the Woyelo River), and Sagea Village (e.g., the Goa Boki Maruru River).

According to the local community, the development of the IWIP area has been accompanied by a decrease in mangrove forest area. Land reclamation for airport construction, coal stockpile areas, and other facilities has nearly eradicated the mangrove forests along the coastline. The remaining mangrove forest is mainly found in Cape Ulie, some of which has already been converted into a port area.



Figure 3.3. The mangrove forest area in Cape Ulie, Lelilef Woebulen, which has now been repurposed as a storage location for IWIP's goods and materials

¹² The local language refers to rivers, streams, or creeks with two terms: "aki/ake" and "wo/woi/woye". Different dialects cause varying sounds for each term.

The two affected villages, namely Lelilef Sawai Village, have experienced the most concerning landscape changes. Almost the entire residential area of Lelilef Sawai Village has transformed into IWIP's industrial area. The land coverage, which used to be farmland, has drastically reduced, resulting in a significant decrease in vegetation along the county road that passes through these two villages. Meanwhile, although not experiencing landscape changes similar to the previous two villages in settlement areas, Gemaf Village is very close to IWIP's operations. Several houses in Lelilef Sawai and Gemaf Villages are located less than 100 meters from IWIP's area. This also exposes villagers to dust and noise from IWIP's activities.

The county road along the coast of Central Halmahera serves as the primary land transportation route. This land access is used not only by local villagers but also by IWIP employees, meeting the operational needs of IWIP and its tenants. Around the clock, company vehicles (e.g., employee shuttles, Light Vehicles (LV) for patrols, heavy equipment transport trucks) constantly travel along the road, competing for space with local villagers' motorcycles or cars. As a result, traffic congestion has increased in frequency and intensity, and dust pollution has become a daily sight. The presence of IWIP has led to an increase in the number of traffic accidents.

"Since IWIP's presence, dust has been a daily occurrence, especially during hot weather conditions. After the rain, the roads become muddy and slippery, leading to frequent accidents. There is an accident almost every month. IWIP uses the county road as their transportation route for goods and employee traffic. villagers also use the same road to move between Lelilef, Gemaf, and Sagea. Traffic congestion is a daily issue. Collisions or motorcycle accidents occur frequently. villagers' homes are also covered in dust." (Field Notes, June 24, 2023"



3.2 Land Disputes and Shrinking Living Space

3.2.1 Shrinking Livelihood Space and Tenurial Conflicts due to Mining

Main points:

- *The primary triggers for tenure conflicts in Central Halmahera involving WBN, IWIP, and the mining communities in the four affected villages are mainly two-fold: economic impacts experienced when villagers lose their livelihood space and compensation issues that do not align with the economic value of the land for affected villagers.*
- *The shrinking of living space is not limited to plantation farmers who lost their farmlands through the land acquisition process but also affects fishermen whose fishing areas had to shift due to nickel mining activities.*

Large-scale development projects, such as mining, often come hand in hand with land disputes between companies and local communities. The same holds true in the Central Halmahera region, involving WBN, IWIP, and the mining communities in the four affected villages. Tenure conflicts between villagers and the companies had already emerged when WBN was still in the exploration process and carried out gradual land acquisition from 2008 to the 2010s. The situation worsened with the presence of IWIP, which conducted large-scale land acquisition in the three affected villages from 2018 until the present (2023).

These tenure conflicts stem from two main factors: the economic impact experienced by villagers when they lost their plantation areas and the low compensation for land acquisition compared to its economic value for the villagers. The land acquisition processes carried out by both WBN and IWIP have narrowed the livelihood space for the villagers who have depended on annual crop plantations such as cloves, nutmeg, coconuts, and copra for decades. The change in the landscape, as depicted in *Figure 3.2*, illustrates the lost living space for villagers due to IWIP's presence. The villagers lost their livelihood as farmers when their plantation areas were replaced by mining and nickel smelter facilities.

The impact of the loss of plantation areas extends beyond altering the landscape of the affected villages and depriving villagers of their livelihoods as farmers. Another issue that has arisen is the problem of poverty due to the lack of alternative sources of income for the villagers. As of June 2023, villagers of the affected villages are facing a "dead end" in seeking their livelihoods because, in addition to losing their plantations, they are also finding it increasingly challenging to catch fish. Fishermen in Lelilef Sawai, Lelilef Woebulen, and Gemaf are dealing with a similar situation related to the impact of the nickel mining company in their vicinity. The loss of coral reefs and mangroves along the coast due to reclamation around the IWIP area (for airport construction, office areas, and a coal-fired power plant) has led to the fishing areas moving further away for the fishermen.

Before IWIP came into existence, fishermen could catch fish along the coast up to a distance of 1 km from the shoreline. Reclamation activities, company waste disposal, and other operations by IWIP and its various tenants have significantly reduced the fish population near the coast. As a result, fishermen face difficulties in finding fish in their usual fishing areas and now have to venture out to sea at distances of 20-30 km from the shoreline. This situation poses challenges for the fishermen because they are compelled to invest more capital in their fishing trips compared to the time before IWIP's establishment. The difference in required capital is substantial, as fishermen now need a minimum of IDR 3,000.000 to IDR 5,000.000 for a single fishing trip, with no guarantee of catching enough fish to meet their daily needs.

Dullah, a fisherman from Lelilef Woebulen Village, expressed concerns about the lasting effects of 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 IWIP's operations on the local community and the environment.

"Whether it's fishing or farming, we need environmental fertility or freshness. When it's disrupted by waste, how can we talk about economics?"

3.2.2 Land Compensation Issues

Main points:

- *The ongoing tenurial conflicts between IWIP and the local communities are a result of the discrepancy between the compensation offered by the company and the demands of the villagers. 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 villagers, 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 IWIP is still facing resistance from several villagers 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 villagers. Since 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 villagers' 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 IWIP is IDR 9,000/m and the land purchase price by WBN is IDR 8,000/m. These amounts are far different from the standard land prices which, according to the impacted village villagers, range from IDR 30,000 to IDR 220,000/m, depending on the land condition (based on NJOP regulated in agrarian regulations).¹³ However, these regulations are not followed by the company. 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 villagers.

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 (villagers and the company). The land price is unilaterally determined by the company without involving any negotiation process with the landowners. The villagers are asked to accept the offered price by the company without any room for negotiation.

"...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 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 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.

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

"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 IDR 112,260,000 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 Gemaf is IDR 50,000 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 IDR 9,000 per square meter, and in some cases, even as low as IDR 6,000 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, 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 IWIP. Max mentions that he can still access his farmland despite being surrounded by 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, 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 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 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 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 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 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 IDR 15,000,000 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 IWIP, where the salary for such workers ranges from IDR 5,000,000 to IDR 6,500,000 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 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 Changes in Economic Conditions

Main points:

- *The landscape alteration from agricultural areas to mining zones has changed the local society's livelihood patterns. Initially, society members worked as farmers or fishermen, but now they have shifted to occupations such as room rental business owners, merchants, or mining company workers.*
- *This shift in livelihoods is not universally seen as an improvement in the lives of the local society, as it also brings new challenges for farmers who lack the capital to start businesses or fishermen who have no alternative livelihood options.*

"....I'm around 60 years old, and when it's over, it's over for me. But the future generations, those who will be regarded as citizens, where are they going to live tomorrow? We must think about it because the state is responsible for it. If we talk about what this country is about, look at us. We are Indonesian citizens, but who actually benefits when it's not us, the citizens?" (Dullah in Field Notes, June 18, 2023)

Before WBN and IWIP were present in Central Halmahera, the local residents of Lelilef Sawai, Lelilef Woebulen, Gemaf, and Sagea villages used to have their livelihood primarily centered around farming cash crops such as cloves, nutmeg, copra, and coconuts. Their income from each harvest varied, ranging from IDR 15,000.000 per month to as high as IDR 50.000.000 per month for those with one or two hectares of land.¹⁴ The local communities' lives in these impacted areas used to be prosperous before IWIP arrived. When we say that they used to be prosperous before IWIP's presence, we mean that their lives were deemed sufficient to meet their daily needs and to ensure that their children and grandchildren could have a decent livelihood in the future. This was mainly the villagers owned productive plantation land that generated income considered adequate to sustain their needs, which provided them with a sense of security of their present and future livelihoods.

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

For example, a villager from Sagea Village named Jumat, who had just started cultivating nutmeg, could earn IDR 15,000.000 every three months. This income was sufficient to support Jumat and his family. When calculating Jumat's gross income from nutmeg harvest alone, it amounted to IDR 5,000.000 per month. Jumat and other farmers in the affected villages did not solely rely on their livelihoods from the plantation sector but also engaged in supplementary occupations such as fishing or running small shops. That was commonly the situation with other villagers who have been living in the villages around IWIP.



Figure 3.4. Nutmeg plantation area in Sagea Village

The situation was considered to have changed significantly after IWIP began its operations. The impact of the loss of agricultural land due to land acquisition by WBN and 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.

To understand the varying needs of farmers in adapting and sustaining their livelihoods after selling their plantation land, refer to *Table 3.1*.

Table 3.1. Comparison between the proceeds from the sale of land and the cost of constructing a rental property¹⁵

Category	Unit Cost	Price	Information
Income from Sale of Land		IDR 90,000,000 to IDR 180,000,000	(for a land size ranging from 1 to 2 hectares)
Cost of Building a Rental Property Expenses	Land purchase price for the rental property	IDR 250,000,000	(for a 300 m ² land)
	Labor costs (property construction workers)	IDR 10,000,000	per room (1 property of 300 m ² in width can accommodate a maximum of 10 rooms) For one rental property building with 10 rooms, the construction labor cost would be IDR 100,000,000.
	Material costs (if plywood is used)	IDR 100,000,000.	minimum
	Total Cost	IDR 450,000,000	

Based on the table above, the amount of money obtained by farmers from selling their land to 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 they were still engaged in the plantation sector.

¹⁵ This data represents an approximate estimate of the expenses borne by individual farmers in constructing properties if they wish to shift to rental property business. Typically, farmers own 1 to 2 hectares of land although some may own more than 5 hectares. Notably, the predominant demographic among the impacted local residents consists of small-scale farmers who own just 1 to 2 hectares of land. It's important to note that the cost figures presented in the table may fluctuate based on the pricing norms in each village.

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 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 areas surrounding 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 villagers, especially the youth, is to work for IWIP. 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 IWIP. Another issue is the access to job opportunities within IWIP, which becomes increasingly challenging when applicants are known to have relatives in conflict with the company. For instance, there was a 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 villagers in Lelilef Village.

Most of the impacted villagers who eventually find work at 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, even being employed as workers at IWIP is also considered inadequate in bringing prosperity to the affected villagers. These workers face various non-ideal conditions, including excessive working hours, insufficient wages, and substandard employee dormitories.

3.4 Work Conditions of Workers

Main point:

- *The shift in economic activities has altered the livelihoods of the villagers from being farmers and fishermen into mining company workers. However, transitioning to work at IWIP is not seen as an "ideal" alternative. This is mainly because of the perceived inadequate working conditions with low wages, substandard employee accommodations, various cases of what's considered discriminatory terminations, and the high occupational safety risks due to suboptimal implementation of Occupational Health and Safety (OHS) procedures.*



Since around 2018-2019, IWIP's presence in Central Halmahera region has naturally led to labor migration from both within the country and abroad. Most of the native villagers primarily work in field jobs such as construction workers, heavy equipment operators, land surveying teams, and so on. The field research conducted by AEER team identified several issues faced by IWIP workers, especially the local ones, including:

1. Low Worker Wages

IWIP's workers, especially those from the surrounding villages and native people, receive low wages compared to their working hours. On average, monthly salaries of local field workers range between IDR 5,000.000 to IDR 6,000.000. More specifically, wages for certain IWIP field workers such as crawler operators, dump truck operators, loader operators, mobile crane operators, boom truck operators, and forklift operators range from IDR 5,000.000 - IDR 6,000.000 per month, while security jobs earn between IDR 3,000.000 - IDR 3,500.000 per month¹⁶. Even though these wages are higher than the North Maluku Province Minimum Wage (UMP) and the Central Halmahera Regency Minimum Wage in 2023, which is IDR 2,976,720 per month, they are still considered insufficient to cover workers' daily expenses. When comparing their living costs, such as room rent, installments of motorcycle for commuting to work, and basic living expenses such as food and water, the monthly wages are inadequate. The following table lists a breakdown of workers' basic needs compared to their income.

Table 3.2. Comparison between workers' wages and living costs

Item	Amount (in IDR)
IWIP's workers average salary	IDR 5,000,000
Monthly room rent	IDR 1,500,000
Daily food expenses	IDR 2,700,000
Motorcycle installment ¹⁷	IDR 500,000
Money left at the end of the month	IDR 300,000

¹⁶ The worker wage data is generated from the article "2023 Employee Salaries at IWIP, All Positions" available at, <https://www.upahkerja.com/2022/04/gaji-karyawan-pt-iwip.html>, accessed on July 24, 2023.

¹⁷ Motorcycle installment costs may be higher than listed amount in the table, depending on the type of motorcycle purchased. Often, workers spend Rp2,000.000 per month on their motorcycle installments.

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. 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 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 Worker Dormitory

In addition to wages, IWIP's workers are also provided with facilities such as worker dormitories within the IWIP zone. However, many workers choose to rent rooms in the villages around the company, especially local people who work in field jobs or non-skilled jobs such as heavy equipment operators, land surveyors, and construction workers. The main reason is the uninhabitable condition of the worker dormitory.

The worker dormitory at IWIP is considered uninhabitable as it is located in a seemingly slum-like environment. One of the workers describes inconvenience with his expression, "When sleeping, workers would lie down side by side with rats." Additionally, both male and female workers are housed in the same dormitory. One of the issues for the workers is that there are no separate bathroom and toilet facilities for male and female workers. This condition 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.

Workers residing in the dormitory face challenges related to the water quality used for bathing, washing, and sanitation purposes. The water accessible to employees in the dormitory is turbid, leading some to prefer renting accommodations in nearby villages. Opting for rented lodgings in the vicinity provides employees with greater mobility compared to staying in the dormitory. In response to the water quality issues and the dust prevalent in the company's operational area, some employees have chosen accommodations in more distant villages like Sagea, Kobe, and Trans Kobe to secure access to clean water and mitigate environmental concerns.

3. Worker Termination

Workers at IWIP who are found out to have family relations with individuals in conflict with the company face unfavorable situations. In such cases, individuals linked to those involved in land disputes with IWIP may face abrupt termination. When attempting to reapply for a different position with the company, they encounter obstacles, even if they have advanced to the final stages of the recruitment process. One case involves an employee who was terminated after it was revealed that they were the child of Max Sigoro, an individual actively opposing land acquisition by IWIP. Despite submitting job applications multiple times and reaching the final stages of the recruitment process, Max's child remains unable to secure employment with IWIP to date.

Furthermore, employees who commit mild to moderate disciplinary infractions, such as lateness, often receive a Notice of Termination of Employment (SP) without prior warning or the issuance of warning letters from stages 1 to 3. This situation is compounded by the lack of clarity in the regulations set by each field supervisor or foreman. Some workers mention that workplace rules related to Occupational Health and Safety (OHS) and other regulations often change daily, leading to confusion among employees. Instances of employee violations or indiscipline are often related to the erratic changes in regulations, which occur suddenly. Since this company started its operations, there have been several workplace accidents resulting in the deaths of dozens of workers.¹⁸

¹⁸ This information has become a frequently covered news topic in local media, with one example being the coverage provided by Antaranews.com. [Source: <https://ambon.antaranews.com/berita/105630/dua-karyawan-pt-iwip-terlindas-alat-berat-satu-meninggal-dunia-ungkapkan-penyebabnya>.] Accessed on July 24, 2023.

In August 2021, two workers experienced an occupational accident involving heavy machinery, and one of them tragically lost his life.¹⁹ In May 2023, another occupational accident occurred within IWIP's workplace, involving one worker from Ambon and another one from China.²⁰

Various cases of workplace incidents within the IWIP environment are suspected to have occurred due to inadequate and improper implementation of Occupational Health and Safety (OHS) measures. Hayun Maneke, a representative of the National Labor Union (SPN) of Central Halmahera Regency branch, stated that the May Day celebration on May 1, 2023, organized by 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 practices at IWIP. To the letters from the labor union, the company responded with narratives that portrayed the condition of IWIP workers as if it were fine.²¹



¹⁹ *ibid.*

²⁰ The incident has drawn the attention of the National Labor Union of Central Halmahera Regency Branch, which has previously written to IWIP requesting a dialogue between the company and the labor union. [Source: <https://www.posttimur.com/2023/05/15/perihatin-kondisi-karyawan-pt-iwip-ini-harapan-hayun-maneke-ketua-spn-halteng/>, accessed on July 24, 2023.

²¹ *ibid.*

3.5 Environmental Changes and Local Community's Health Conditions

Main points:

- *An indirect consequence of the increased population in the villages surrounding IWIP and mining activities is a change in air quality due to dust pollution. Furthermore, the demographic growth and nickel mining activities are suspected to have an impact on changes in water quality and sanitation in the villages near the mining company. This situation is exacerbated by the increased presence of unmanaged plastic waste in locations close to people's settlement areas.*
- *Following the entry of IWIP in Central Halmahera, there has been an increase in cases of Acute Respiratory Infections (ARI) and diarrheal diseases, which are thought to be the impact of changes in environmental quality (ARI due to decreased air quality and diarrhea due to decreased water quality and sanitation).*

The impact of IWIP's presence on the surrounding villages goes beyond direct consequences such as landscape changes and shifts in residents' livelihoods. IWIP's activities have directly triggered migration from various regions, both domestically and internationally, to Central Halmahera. This migration wave doesn't only bring workers to the mining area but also newcomers who are risking their fortunes in a large-scale development area to engage in trade and other economic activities.

This surge in population has brought several new challenges for the native communities surrounding IWIP, particularly in Lelilef Sawai and Lelilef Woebulen. While the inevitable population increase presents new economic opportunities for those who have lost their farmland, enabling them to establish new businesses like rental spaces, the "positive" economic impacts are short-lived. What are these impacts?

1. Implications of Increased Population: Changes in Water Quality

Since 2022, a new problem has emerged for the villagers of Lelilef Sawai, Lelilef Woebulen, and Gemaf villages, namely changes in groundwater quality. Before the arrival of 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 villagers of Lelilef Woebulen village, mentioned that.

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

Before IWIP's presence, only local residents²² consumed the groundwater. However, with the presence of IWIP and the increasing influx of various newcomers, both workers and non-workers of IWIP, the usage, and demand for groundwater have dramatically increased in the surrounding villages. Since 2022, due to the change in groundwater quality, villagers have had to switch to consuming bottled water sold by water depots around the villages. As a result, they now face a new dependency on clean water, previously freely accessible, thus has now become commercialized

2. Impact of Dust Pollution and Environmental Quality Alterations: Increase in Cases of Diarrhea and Acute Respiratory Infections (ARI)

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

²² The term used to refer to local villagers who were born and raised in the local area or region.

"Yes, typically the highest are ARI, common cold, and diarrhea. We see around 500 or so cases each year. The most common disease we deal with at the Lelilef Community Health Center is ARI. Since the arrival of IWIP, the number of ARI cases has increased. IWIP, if I'm not mistaken, entered the area in 2019 or 2020. Before that, we used to have 300 ARI cases per year, but now it's almost doubled to around 800 or 1000 cases per year." (Field Notes, June 23, 2023)

The increase in diarrhea and ARI cases in the villages around IWIP, according to a healthcare officer at Lelilef Community Health Center, is related to the company's operational activities. The displacement and clearing of farmland by the company, dust pollution that constantly lingers in the settlement areas along the cross-district road, uncontrolled population growth leading to various environmental quality changes such as increased domestic impacts and changes in water quality due to the increased use of groundwater, and the lack of serious efforts from the company to address these issues inevitably affect the health conditions of the surrounding villager communities.

"...Yesterday, we evaluated why our ARI prevalence has increased. It's mainly due to mining, the tropical climate, and the side effects of drought. In Lelilef, we've experienced a lot of land clearances, so naturally, many trees have disappeared. 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 troubling dust pollution, which significantly impacts local residents as it accumulates in their neighborhoods, and the altered groundwater quality, rendering it unsuitable for consumption, there is another concern—escalating domestic waste, with a particular emphasis on plastic waste. Throughout the vicinity of their communities, along roadsides, and even in the rivers, one frequently encounters piles of waste. These include common items such as plastic bags, used bottles, and food packaging, consistently observed in the villages of Lelilef Sawai and Lelilef Woebulen. The surge in population has contributed to the growing volume of plastic waste in these settlement areas.



Figure 3.5. Piles of garbage by the roadside of Lelilef Sawai Village

As per the accounts of residents in Lelilef Sawai and Lelilef Wobulen Villages, the approach taken by IWIP has predominantly been reactive. The company extends assistance in waste removal within the villages upon the villagers' request through the Village Authority. However, concerning issues related to dust and changes in water quality, the residents assert that IWIP has not responded or taken any action. Despite the continuous spread of dust pollution throughout the day in the affected villages, the company has not addressed this concern, even though its trucks, patrol vehicles, and employee vehicles traverse the settlement areas daily, contributing to the scattering of dust around the villagers' settlement areas.

"....Environmentally speaking, it appears that we, Lelilef Village, are susceptible to garbage issues because there is no garbage disposal site. The Village Authority is unable to effectively address this problem, and the company has not offered any assistance. Garbage remains a significant problem." (Field Notes, June 23, 2023)

Efforts have been made to tackle the problem of plastic waste in the villages and rivers by reaching out to the company for support in collecting and managing waste within its premises. In the villages surrounding IWIP, there are no final waste disposal sites capable of handling domestic waste. Consequently, residents, on one hand, depend on the company's assistance for waste management. However, on the other hand, the villagers also assert that the company should take responsibility for addressing the issue of plastic waste in the surrounding villages, including IWIP. This is in addition to addressing the concerns of dust and changes in water quality, as these problems are viewed as indirect consequences of the company's presence and activities in the affected villages.



Figure 3.6. Billboard commemorating the 2023 World Environment Day

3.6 Women's Perspective on Mining-Related Conflicts

Main points:

- *Women, as one of the vulnerable groups, have their own stories to tell about the impacts of nickel mining on their lives. Their experiences are primarily linked to the loss of livelihoods as farmers and the constrained access women face to resources near the rivers within IWIP's operational zone.*
- *Women's voices also highlight their concerns about environmental pollution resulting from nickel mining activities. Inland water bodies such as rivers and lakes, as well as the ocean in the vicinity of nickel mining, are at risk of contamination, potentially leading to a decline in the fish population—a crucial source of livelihood for the local community. Additionally, the activities of local residents, particularly women, heavily rely on access to clean water sourced from the rivers surrounding the village.*

The impact of nickel mining goes beyond economic and health concerns for the communities in its proximity. Women, as one of the vulnerable groups affected, have their own unique stories to share regarding the effects of mining activities in their vicinity. The perspectives of women who are advocating for their rights must be recognized as crucial in understanding the extent of mining's impact on the surrounding communities.

In Lelilef Woebulen Village, there is a prominent female figure actively advocating for her rights to land and clean water resources, known as Farida. Farida, affectionately referred to as Mama Ida, is a 70-year-old woman who was recognized as a traditional women's rights advocate by the National Human Rights Commission in 2015. Around 2013-2014, Mama Ida led demonstrations against IWIP in opposition to land acquisitions. In 2021, Mama Ida led a protest within the IWIP zone regarding the prohibition on collecting riverbed materials, along with her children. The demonstration took place at the Wosea River, driven by the community's belief that the river was "community-owned," granting them access to resources in its vicinity. During the same year, the company imposed a ban on residents gathering stones for construction materials, triggering additional protests. The company clarified that there were no restrictions on "original residents" - a term distinguishing local residents from newcomers - in

collecting these materials. However, Mama Ida asserted that IWIP failed to communicate clearly, causing confusion, and prompting her, along with several other young people and women, to organize a demonstration.

Mama Ida is dedicated to fighting for her rights of access to natural resources in the surrounding villages, particularly agricultural land and river areas. In line with Mama Ida's efforts, in the village of Sagea appears another influential female figure named Maryama, affectionately known as Aunt Ama, who is actively fighting for her farm land, the lands of the villagers, and the sustainability of water sources accessed by the community. For Aunt Ama, the presence of mining companies is poised to impact the availability of clean water resources around villages, especially Sagea Village. This is of particular concern as Sagea hosts a natural spring in Goa Boki Maruru that feeds into the rivers flowing through settlement areas. Aunt Ama shares about her apprehensions 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 gets discharged? Some villagers have chosen to comply and sell their land, but we resist this decision. Consequently, we can no longer source water from the area, as it is contaminated and poses a risk to our community's water source. Currently, residents use bottled water due to the contamination. Since the company's arrival, fishing has become increasingly challenging; previously, we used to catch a considerable amount 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 only 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 settlement 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 IWIP began its operations, the villagers 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 villagers whose daily activities predominantly revolve around their homes, such as women and children. The mining activities conducted by IWIP and its tenants have resulted in changes in the quality of water and air, as well as the loss of livelihood spaces for villagers in the plantation sector. This situation is perceived as detrimental to the village villagers, 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

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 IWIP. Bottled water is produced using distilled and processed groundwater. Every day, the villagers 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 IWIP began its operations, Weda Bay Nickel (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, 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 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, IWIP has not made any efforts to address the problems faced by the community since their mining activities began.



3.7 Comparison between Legal Regulations and IRMA Criteria

The Initiative for Responsible Mining Assurance (IRMA) is a multi-stakeholder coalition in the mining sector established in 2006. Stakeholders involved in IRMA include mining companies, purchasers of mining products, investors, labor, non-governmental organizations (NGOs), and impacted communities. IRMA's mission is to protect communities and the environment from the impacts of mining activities. To achieve this, IRMA has developed standards that can be used as tools to audit the extent of a mining company's compliance with social and environmental requirements. Third-party audit organizations can issue IRMA certification to companies based on their level of compliance.

The IRMA Standard for Responsible Mining, IRMA-STD-001 was published in June 2018²³. The IRMA standard encompasses 26 sections grouped into four principles: business integrity, impact planning and management, social responsibility, and environmental responsibility. The following table outlines the differences between the IRMA standard, specifically in the area of social responsibility, and the applicable legal regulations in Indonesia.



²³ Initiative for Responsible Mining Assurance (IRMA). (2018). *IRMA Standard for Responsible Mining IRMA-STD-001*. https://responsiblemining.net/wp-content/uploads/2018/07/IRMA_STANDARD_v.1.0_FINAL_2018-1.pdf

Table 3.3. Comparison between legislation and IRMA standards

No	Legislation	IRMA Standard
1.	The Law Number 40 of 2007 concerning Limited Liability Companies mandates that every company is required to fulfill social responsibilities related to both 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 are required to possess an Environmental Impact Analysis (AMDAL) document.	Every mining business operator is required to conduct a risk assessment and manage the social, economic, and health impacts of mining activities on affected communities.
3.	Labor Law No. 13 of 2013 stipulates that the minimum wage for employees should be adjusted to the local 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

4.1 River Water

Main points:

- *The Wosea River runs through the industrial area of 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 the Ake Doma River contain high levels of sediment. These sediments are carried by rainwater runoff from deforested land in the upstream area of the rivers. The mining activities of WBN are suspected to have changed the land cover, which was previously a forested area.*
- *The populations of fish in the Kobe River and the 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 the 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 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) the Kobe River, Lukulamo Village; (2) the Ake Doma River, Lelilef Sawai Village; (3) the Wosea River, Lelilef Sawai Village; (4) the Woyelo River, Gemaf Village; (5) the Goa Boki Maruru River, Sagea Village; and (6) the 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 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 IWIP zone, 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. The locations of river water quality measurements are indicated in *Figure 4.1*.



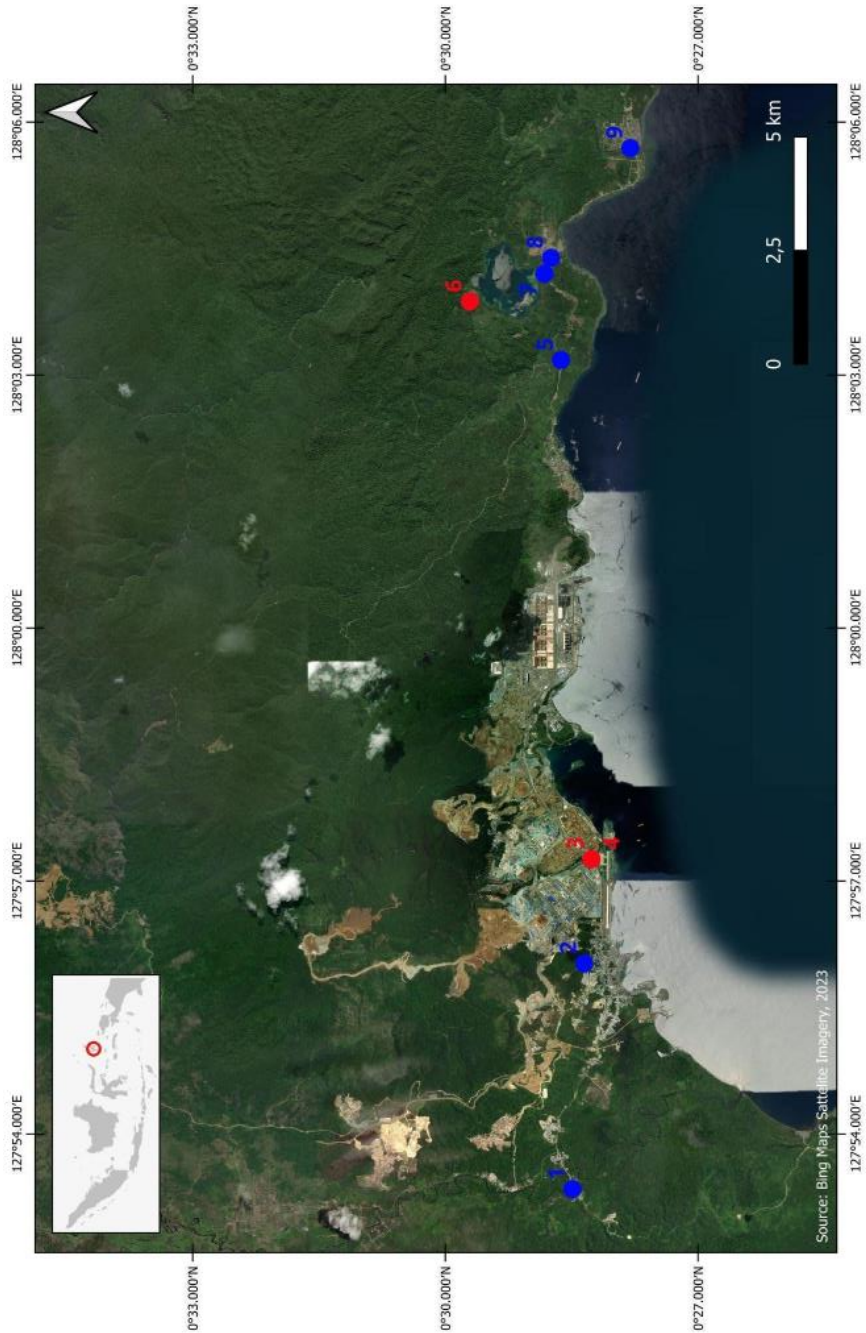


Figure 4.1. Map of river water quality measurement locations in the IWIP zone. Only the Wosea River (measuring points 3 and 4) crosses the industrial zone.

According to local villagers, 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, the Woebem River, and the 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 the 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 WBN at any time.



Table 4.1. Results of river water quality measurements around the IWIP zone

Point	Temp (°C)	pH	TDS (mg/L)	Cr6+ (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
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 villagers 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.
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 the 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 WBN continues to clear forested land. Some villagers 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 villagers bathe and wash their vehicles downstream in that river. Currently, the downstream distance of the Woyelo River to the entrance of 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 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 Huafei Nickel Cobalt and Sonic Bay. Chemical quality measurements of water samples also show that the Wosea River contains hexavalent chromium, Cr^{6+} (approximately 0.016 - 0.017 mg/L). This concentration exceeds the quality standard set by IRMA (0.011 mg/L).



Figure 4.2. 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 IWIP, while the other rivers have the potential for indirect impacts. The measurement locations for the water quality of the Kobe River and the Ake Doma River are on the western side of the industrial area, while the measurement locations for the water quality of the Woyelo River, the Yonelo River, the Goa Boki Maruru River, and the waterfall near Sagea Lake are on the eastern side of the area. In other words, the activities of IWIP do not directly affect the water quality of those rivers. However, the upstream areas of the Ake Doma River, the Woyelo River, and the Goa Boki Maruru River could be directly impacted by the mining activities of 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

Main points:

- *Lake Sagea is the only lake in Central Halmahera Regency. Local villagers also refer to it as Lake Talaga or Lake Legaेल. Administratively, the lake is located in Sagea Village. It is approximately 7 km away from the western boundary of the 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 Zhong Hai Rare Metal Mining and First Pacific Mining Indonesia were suspected to be the main causes. The operating licenses of both companies were revoked by the central government. However, villagers of Sagea and Kiya are concerned about the potential expansion of the IWIP zone 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 & 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, First Pacific Mining Indonesia, and about 7 km from the entrance of the IWIP zone. 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

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 Legaيلول. In the Sawai language, Legaيلول 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 villagers 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 villagers to dry nutmeg.

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 Zhong Hai Rare Metal Mining and First Pacific Mining Indonesia²⁴. 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)²⁵. It means that the indigenous and local communities were not involved in the approval of the mining activities.

²⁴ 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>

²⁵ 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>

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



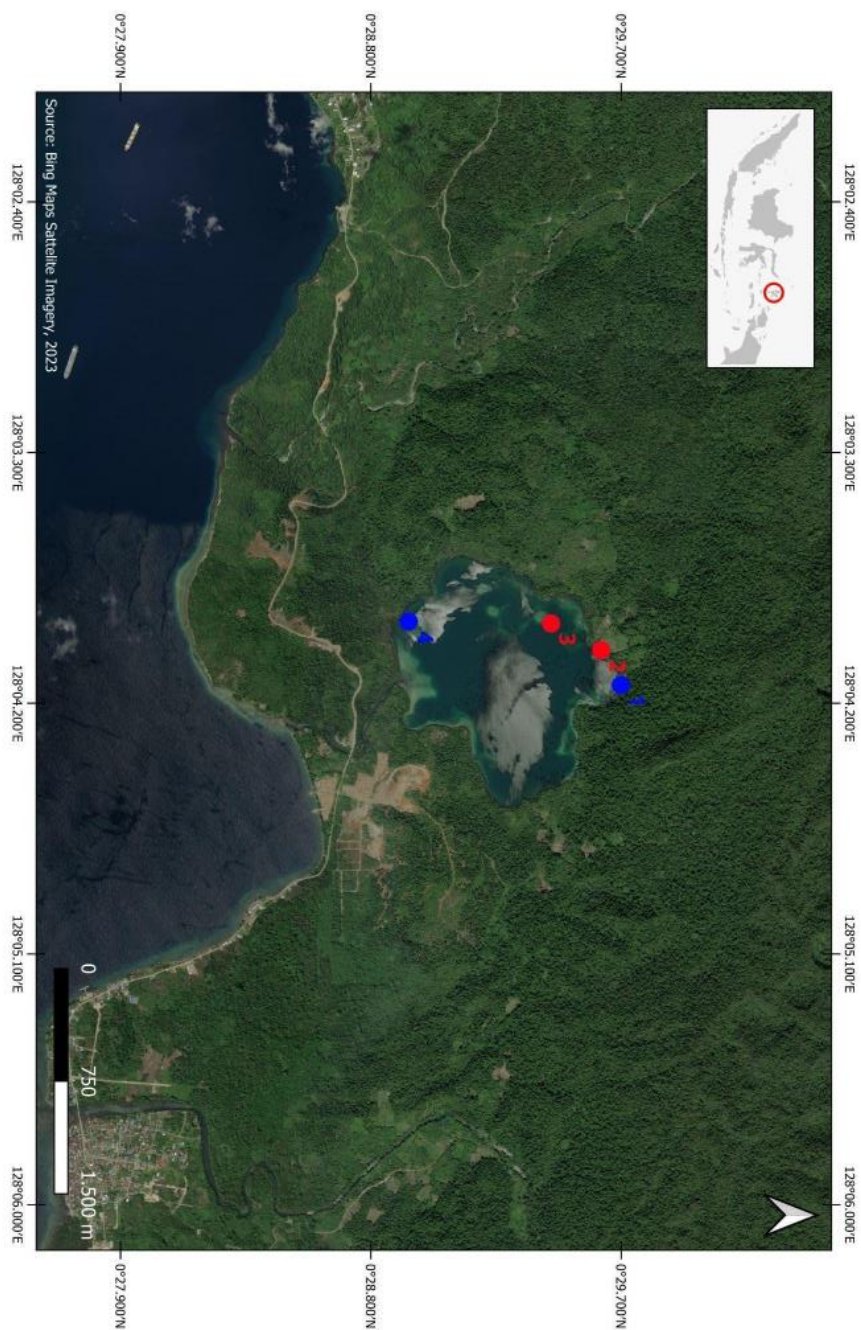


Figure 4.4. Map of the location for measuring the water quality of Lake Sagea, 7 km east of IWIP

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 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 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 villagers also suspect that IWIP intends to expand its area to the coast of Gemaf Village and Sagea Village.



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

Point	Temp (°C)	pH	TDS (mg/L)	Cr ⁶⁺ (mg/L)	Remarks
1	Jeres Springs				
	29.5	8.1	152	< 0.05	Does not exceed quality standards; springs come from the mountains.
2	Kebun Gebang				
	30.5	8.57	7,600	< 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	9,100	< 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 Seawater

Main points:

- *The wastewater discharge point, Cape Ulie waters, and the mouth of Ake Doma River are located in the marine waters bordering the 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 coal plant wastewater from the coal-fired power plant operations. In addition to carrying hexavalent chromium from activities like steel welding and painting, the coal plant wastewater 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.

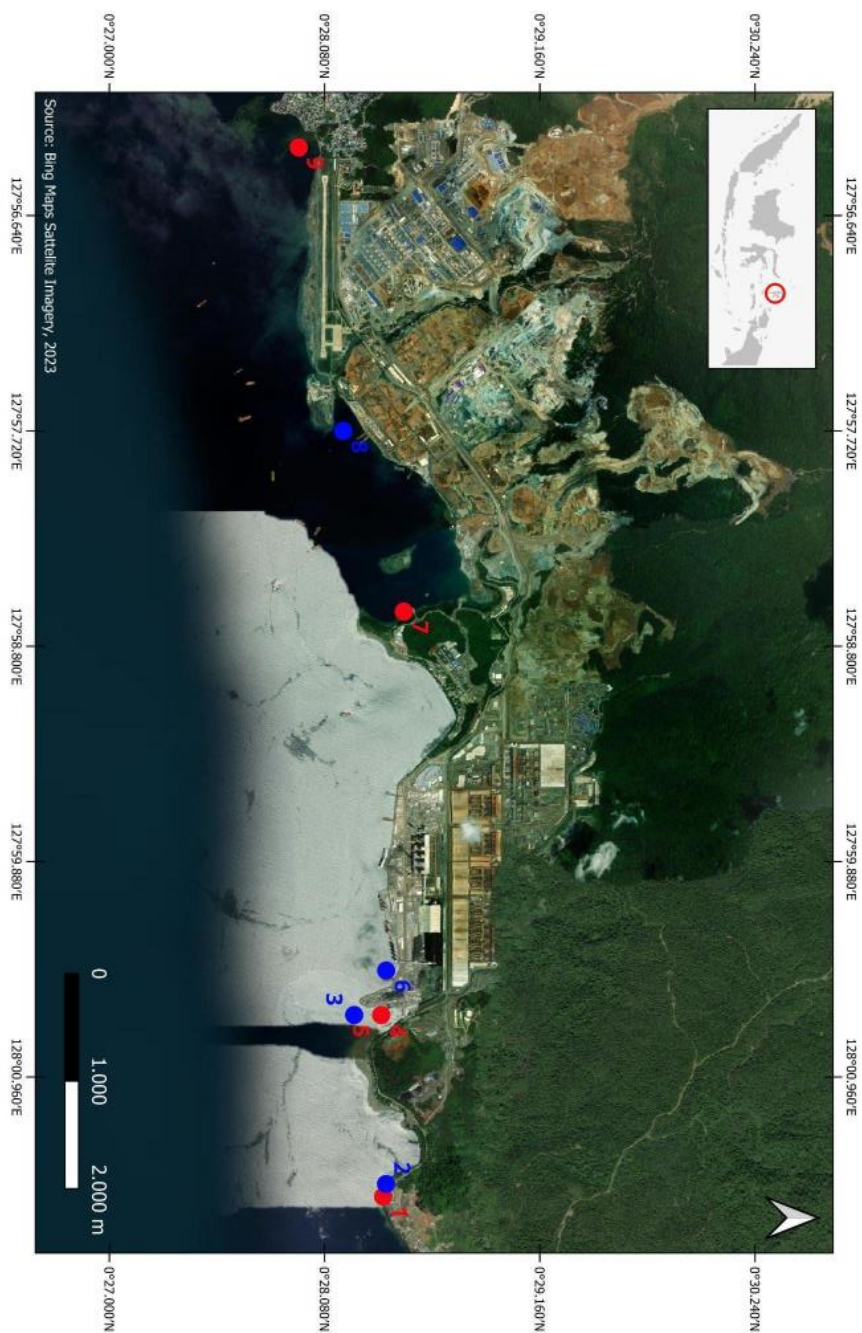


Figure 4.5. Map of seawater quality measurement locations throughout the IWIP zone

The measurement of seawater quality focuses on the marine areas along the IWIP industrial zone. This area stretches from the coastal border of Gemaf Village to Lelilef Sawai Village, all the way to the mouth of the 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) Lolero, Gemaf Village; (3) the mouth of the Ake Sake River; (4) Wastewater discharge point; (5) Port area; (6) Cape Ulie; (7) the mouth of the Wosea River; and (8) the mouth of the Ake Doma River. Measurements are taken twice at the wastewater discharge point. The measurement points from the mouth of the Ake Sake River to the mouth of the Wosea River are located close to 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, Cr^{6+} , 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 (CaCO_3) rocks and chromite rocks (FeCr_2O_3) can each contribute to the alkalinity and the presence of hexavalent chromium ions in the water.

Hexavalent chromium content is also detected in the Cape Ulie area and the mouth of the Ake Doma River. In Cape Ulie, the concentration of hexavalent chromium is 0.003 mg/L, exceeding the marine tourism quality standard, while in the mouth of the Ake Doma River, 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 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 the Ake Doma River's mouth, while the left side was occupied by houses of local villagers. 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. Mouth of the Ake Doma River, brownish in color due to wastewater disposal

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 coal plant wastewater originating from the condenser unit and boiler water supply of the coal-fired power plant. The coal plant wastewater is generated from the condenser unit and boiler water supply operations, which result in high water temperature. According to the Environmental Impact Analysis (AMDAL) document of the IWIP Industrial Zone Development Plan, the estimated amount of coal plant wastewater from the coal-fired power plant is 2,371 m³/day or 865,400 m³/year, and it is discharged into the Ake Sake River, which carries it to the sea²⁶. Its quality refers to the Regulation of the Minister of Environment No. 8 of 2009 concerning the Quality Standards for wastewater from coal-fired power plant operations and/or activities. On a land area of 2,600 hectares within the IWIP zone, a 1,000 MW capacity coal-fired power plant has been operating.

²⁶ Indonesia Weda Bay Industrial Park. (2018). *Environmental Impact Analysis (AMDAL) of the Indonesia Weda Bay Industrial Park Construction Plan*.

In addition to the operational coal-fired power plant, 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 generated by all tenants in 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 the Ake Sake River, which flows towards the sea.²⁷

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.²⁸ Health studies have shown that the presence of hexavalent chromium in drinking water can increase the risk of stomach cancer and reproductive health disorders^{29, 30}. Direct contact with hexavalent chromium can also cause skin rashes in certain individuals³¹. In Central Halmahera, particularly in the villages around IWIP, there hasn't been a specific study on the impact of

²⁷ *Ibid.*

²⁸ Sharma, P., Singh, S.P., Parakh, S.K., & Tong, Y.W. (2022). *Health hazards of hexavalent chromium (Cr (VI)) and its microbial reduction*. *Bioengineered*, 13(3), 4923-4938. <https://doi.org/10.1080/21655979.2022.2037273>

²⁹ 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>

³⁰ Wuri, L., Arosh, J.A., Wu, J.Z. & Banu, S.K. (2022). *Exposure to hexavalent chromium causes infertility through disruption of 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>

³¹ 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/10.1080/10408440701266582>

mining activities on human health. However, the fishermen from Gemaf Village have witnessed the death of coral fish in the area where IWIP disposes its wastewater. The high temperature and elevated concentration of hexavalent chromium can cause coral reef mortality.³² The reduction of coral reef ecosystems, which serve as feeding, breeding, and spawning grounds for coral fish, leads to a decrease in the population of coral fish.

Table 4.3. Results of seawater quality measurements around the IWIP zone

Point	Temp (°C)	pH	Cr ⁶⁺ (mg/L)	Information
1	Botepo, Gemaf			
	31.5	8.62	0.005	The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water); Cr ⁶⁺ concentration exceeds Government Regulation 22/2021 quality standards for marine tourism and IRMA standards.
2	Lolaro, Gemaf			
	29.1	8.28	0	Does not exceed quality standards.
3	Mouth of the Ake Sake River			
	32.2	8.39	0.001	The temperature is high for coral reefs and seagrasses.
4	Near the outlet of the coal plant wastewater discharge			
	32.2	8.6	0.024	Temperatures are high for coral reefs and seagrasses; The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water); Cr ⁶⁺ concentration exceeds Government Regulation 22/2021 and IRMA quality standards.
5	Near the outlet of the coal plant wastewater discharge			
	35	8.6	0.009	The temperature is high for coral reefs, mangroves and sea grasses; The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water); Cr ⁶⁺ concentration exceeds Government Regulation 22/2021 and IRMA quality standards.

³² 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>

Point	Temp (°C)	pH	Cr ⁶⁺ (mg/L)	Information
6	Harbor area			
	32.4	8.71	0.001	Temperatures are high for coral reefs and seagrasses; The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water).
7	Cape Ulie			
	32.6	8.64	0.003	Temperatures are high for coral reefs and seagrasses; The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water); Cr ⁶⁺ concentration exceeds Government Regulation 22/2021 quality standards for marine tourism.
8	Mouth of the Wosea River			
	33.2	8.69	0	Temperatures are high for coral reefs and seagrasses; The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water).
9	Mouth of the Ake Doma River			
	33.9	8.62	0.015	Temperatures are high for coral reefs and seagrasses; The pH level exceeds the permissible range outlined in Government Regulation 22/2021, (indicating an alkaline tendency in the water); Cr ⁶⁺ concentration exceeds Government Regulation 22/2021 and IRMA quality standards.



The detailed results of seawater quality measurements along the coastline of the IWIP zone are shown in *Table 4.3*. Generally, 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 coal plant wastewater discharge from the operation of the coal-fired power plant. 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 humans³³. 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 villagers.

4.4 Ambient Air

Main points:

- *The concentration of particulate matter with a diameter of less than 10 μm (PM_{10}) in the ambient air around the coal-fired power plant measured 54 $\mu\text{g}/\text{m}^3$. This level exceeds the quality standard set by IRMA (50 $\mu\text{g}/\text{m}^3$). However, the measurement duration was shorter than required.*
- *Lelilef Sawai and Lelilef Woebulen are the most affected villages. High dust concentrations on the district road endanger the health of drivers and villagers. The measurement results indicate that PM_{10} concentration reaches 101 $\mu\text{g}/\text{m}^3$, and $\text{PM}_{2.5}$ concentration reaches 82 $\mu\text{g}/\text{m}^3$. Both of these parameters exceed the quality standard set by Government Regulation No. 22/2021 ($\text{PM}_{10} = 75 \mu\text{g}/\text{m}^3$; $\text{PM}_{2.5} = 55 \mu\text{g}/\text{m}^3$).*
- *The deterioration of air quality can cause lung diseases, and respiratory disorders, or hinder lung growth in children. The Community Health Center of Lelilef records an increase in Acute Respiratory Infection (ARI) cases. Before the establishment of IWIP, they handled around 300 cases per year. Now, the number of cases is around 800 to 1,000 per year.*

³³ 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>

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 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 IWIP zone. The public road within the IWIP zone 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 villagers. *Figure 4.7* shows the measurement locations inside the IWIP zone, which is administratively a part of Lelilef Sawai Village.



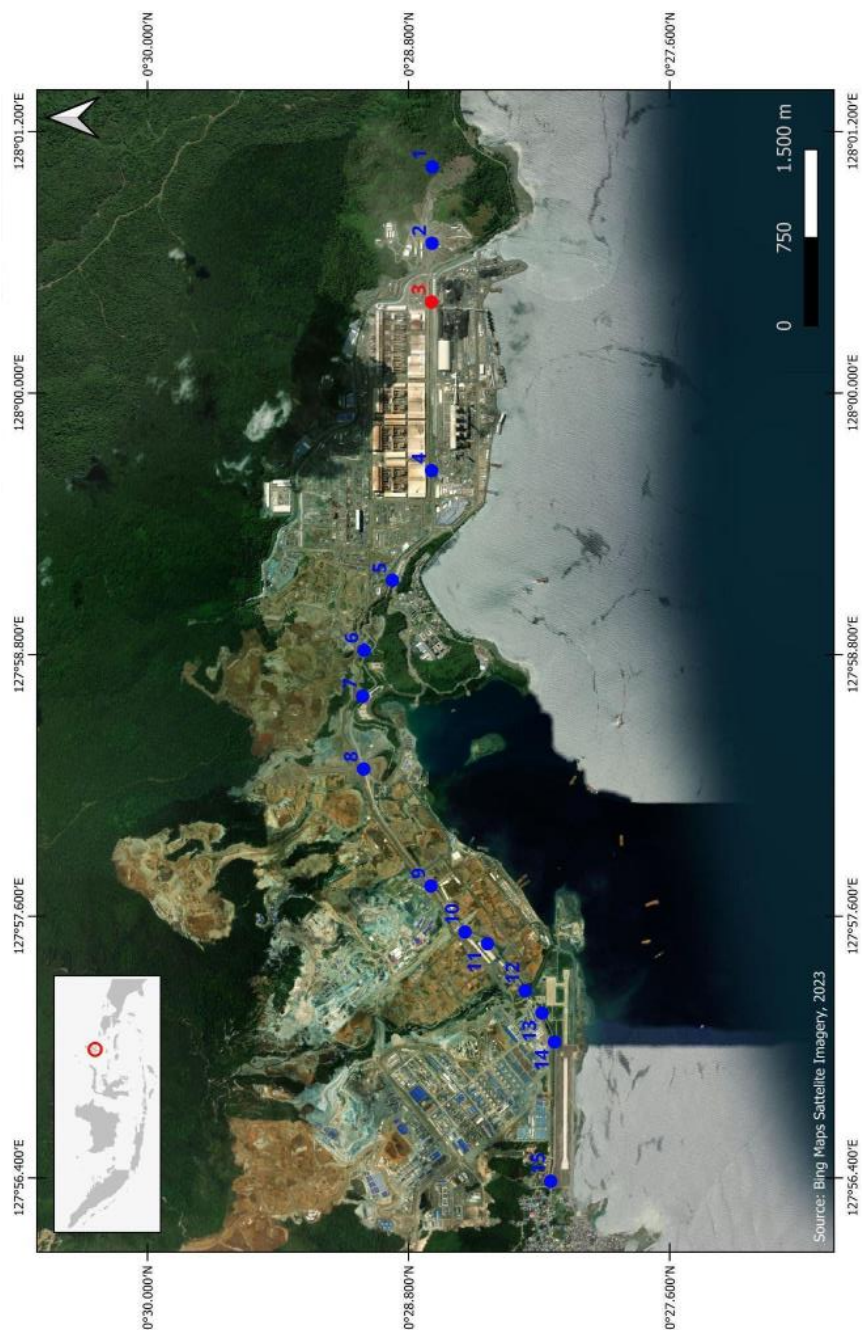


Figure 4.7. Map of ambient air quality measurement locations within the IWIP zone

To assess the impact of IWIP on its surrounding environment, ambient air quality measurements were also conducted in rural areas nearby. The measurement areas included Gemaf Village, Lelilef Sawai Village, and Lelilef Woebulen, each with four measurement points (see *Figure 4.8*). Related mining traffic appeared to be denser in Lelilef Sawai and Lelilef Woebulen compared to Gemaf Village. 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 IWIP. Most of these mobilization and transportation activities pass through Lelilef Woebulen Village and Lelilef Sawai. On the other hand, Gemaf Village, located to the east of IWIP, is generally traversed by local workers who come from North Weda Subdistrict (Gemaf Village, Sagea Village, Kiya Village, Fritu Village, and Waleh Village). 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 $10\text{ }\mu\text{m}$ (PM_{10}) and less than $2.5\text{ }\mu\text{m}$ ($\text{PM}_{2.5}$). For simplicity, these parameters are measured at each point for approximately 10 minutes, unlike the requirement set by Government Regulation No. 22/2021, which specifies measurements for 24 hours or 1 year.



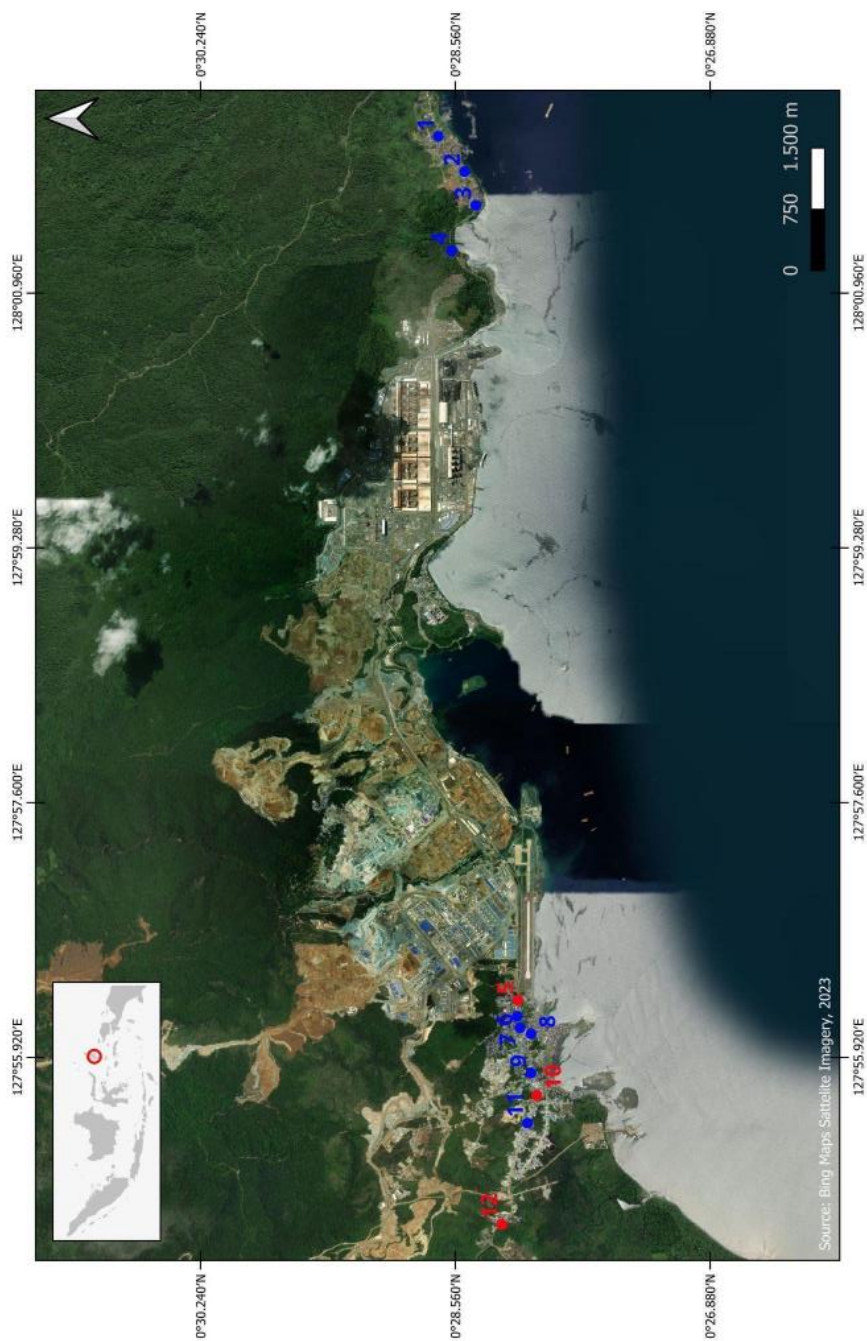


Figure 4.8. Map of ambient air quality measurement locations outside the IWIP zone

When dust concentrations were measured on the road crossing IWIP, several company activities were observed on both sides of the road. These activities include coal storage, coal-fired power plant 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 villagers, construction and coal-fired power plant operations contribute to the increased concentrations of PM₁₀ and PM_{2.5} in the air. The measurement results show that the area near the coal-fired power plant 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 coal-fired power plant'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 PM_{2.5} measurements on the road crossing IWIP. It can be observed that IWIP regularly waters the road using a water truck. This treatment keeps the PM₁₀ and PM_{2.5} concentrations from exceeding the standard in almost all measurement locations, except for the PM₁₀ concentration near the coal-fired power plant. Dust levels at Wosea Bridge 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.

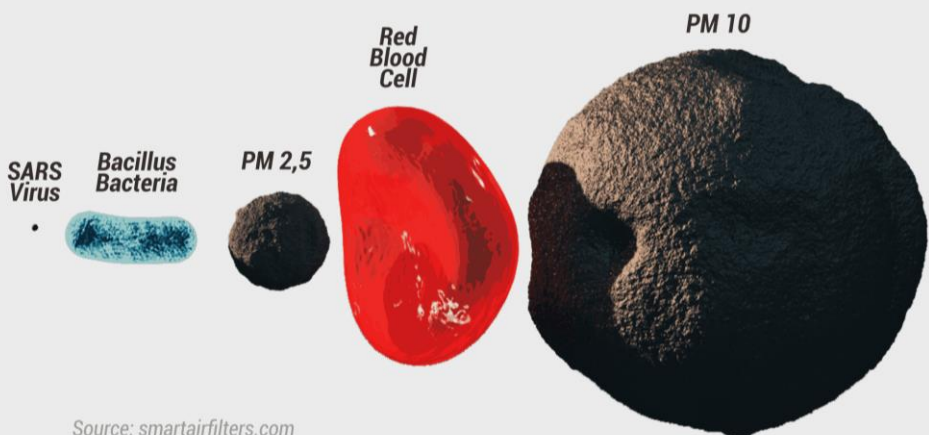


Table 4.4. Results of ambient air water quality measurements in the IWIP zone

Point	Temp (°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	Worker dormitory			
	27	82	34	33
6	Excavation activity			
	25	85	36	32
7	Cape Ulie			
	26	85	5	10
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 PM_{2.5} concentrations in the rural roads around IWIP show significant figures, especially on the west side of 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 PM_{2.5} concentration at that location is detected at 82 µg/m³. About 3 km from the entrance of IWIP towards Kota Weda, there is mining activity by Tekindo Energi. The mining location is not far from the county road. The back-and-forth movement of material transport trucks contributes to PM_{2.5} concentration, which is measured at 58 µg/m³. These particulate dust concentration values exceed the standard set by Government Regulation 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 PM_{2.5} 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 IWIP zone

Point	Village	Temp (°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
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	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 IWIP zone. 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 villagers.

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, settlement areas, and food stalls. This change occurred due to nickel mining, attracting villagers from other districts and even other regencies and cities to work and open businesses in Lelilef. This issue becomes complex because IWIP only sprinkles water on the roads within the industrial area. The rural roads of Lelilef are only watered by some individual villagers. 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 villagers.



Dust with a diameter of less than 10 microns (PM_{10}) can be easily inhaled by humans. If exposure to PM_{10} dust occurs for a prolonged and continuous period, these particles can accumulate in the lungs and cause lung cancer or even death³⁴. For some individuals, exposure to PM_{10} over a short period can result in respiratory tract disorders, such as asthma and Chronic Obstructive Pulmonary Disease (COPD)³⁵. Dust particles with a diameter of less than 2.5 microns ($PM_{2.5}$), smaller than a human hair's diameter, can have even worse impacts on human health. Short-term exposure to $PM_{2.5}$ (lasting up to 24 hours consecutively) can lead to premature death, acute and chronic bronchitis, and asthma attacks³⁶. 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 $PM_{2.5}$ can result in fatalities for individuals who previously had lung or heart problems. Long-term exposure to $PM_{2.5}$ can also hinder lung growth in children³⁷. These health risks can be experienced by local IWIP employees and villagers living and operating businesses in Lelilef Sawai and Lelilef Woebulen villages. Therefore, efforts are needed to reduce dust concentrations in the Lelilef area and restore ambient air quality to its previous state.

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- ³⁴ 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>
- ³⁵ 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>
- ³⁶ 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>
- ³⁷ 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>

4.5 Environmental Impact Potential of Tailing Waste Disposal Activities

Main 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. 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.*
- *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 Sonic Bay and Huafei Nickel Cobalt are situated between the Ake Doma River and the Wosea River, indicating the potential pollution of water sources by tailing waste.*

Currently, several tenants of IWIP operate ferronickel smelters using Rotary-Kiln Electric Furnace (RKEF) technology. As mentioned earlier, these tenants include Youshan Nickel Indonesia with a production capacity of 45,000 tons of nickel matte per year, Weda Bay Nickel with a production capacity of 300,000 tons of nickel pig iron (NPI) per year, and Angel Nickel Industry with a production capacity of 29,000 tons of nickel matte and 207,000 tons of NPI per year. According to the Environmental Impact Analysis document for the Industrial Area Development Plan of IWIP, the cooling phase of slag and the washing of ferronickel use excess water that does not evaporate. Meanwhile, the tailing waste resulting from cooling is transported to temporary storage locations and further management is entrusted to 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 year³⁸.

Two companies are recorded to operate HPAL technology, namely Sonic Bay and Huafei Nickel Cobalt. Their smelter facilities are located west of the IWIP zone, 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 (Cr^{3+}) to hexavalent chromium (Cr^{6+}). If these two types of tailing waste are mixed, the rate of chromium oxidation will be faster. The issue is that hexavalent chromium has a greater potential for environmental damage and human health risks. Therefore, tailing waste is categorized as hazardous waste.

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 then transferred from the trucks to containment ponds for each type of tailing waste. The maximum retention

³⁸ 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>

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. Sonic Bay, as one of 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.³⁹

The transfer, transportation, and storage of tailing waste at TWS have the potential for negative and significant impacts on 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 storage area. Rainwater and runoff can transport toxic chemicals from the containment area to the soil surface. Soil contamination of this nature can affect soil fertility levels and the soil's ability to serve as a planting medium for crops.

2. Groundwater Contamination

If the containment design is inadequate or accidents occur during the transfer and transportation of tailing waste, there is a potential risk of contaminating the groundwater below the surface. Dissolved heavy metals and other pollutants present in the tailing waste can move vertically or horizontally towards the groundwater table (percolation). Groundwater contamination has the potential to jeopardize human health and ecological systems, given that groundwater often serves as a source of drinking water and supports underground wildlife habitats.

³⁹ Indonesia Weda Bay Industrial Park. (2018). *Environmental Impact Analysis (ANDAL) of the Development Plan for Indonesia Weda Bay Industrial Park*.

3. Surface Water Contamination

The HPAL smelters of Sonic Bay and Huafei Nickel Cobalt are located between two rivers, the Ake Doma River and the Wosea River. The tailing waste storage location is near the headwaters of the Ake Doma River. This indicates that surface water has the potential to be impacted by the smelter activities and tailing waste storage at IWIP . If tailing waste is exposed to rainwater, its runoff flows into the nearest river, resulting in a decline in river water quality. This can be followed by the death of aquatic life in the river or even health issues for the local community that uses river water for hygiene and sanitation purposes. As for the water quality of Lake Sagea, no significant impact is anticipated due to the operation of the smelters in the IWIP area. However, significant environmental quality changes in Lake Sagea could occur if the IWIP area is expanded to the eastern part and new smelters are constructed in Gemaf Village. 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 zone. However, significant changes to the environmental quality of Lake Sagea can occur if the IWIP zone is expanded to the east, and new smelters are built in Gemaf Village.

Several mining companies employ different practices for managing their tailing waste. Instead of containing and converting tailings into different forms, tailings are piped for over 100 meters or more to the seafloor. It is expected that the tailing waste will settle at the seafloor or in the deepest parts of the sea, thus not affecting the marine life above. This method is referred to as Deep-Sea Tailing Placement (DSTP) or Deep-Sea Tailings Disposal (DTSD). However, this method has proven to be high-risk. It includes pipe leaks, marine water pollution, damage to marine ecosystems, and even a decrease in the health quality of coastal communities that rely on fish and seafood as their food source.

The practice of Deep-Sea Tailings Placement (DSTP) has been prohibited in several countries, including the Republic of Chile and China. In 2018, the Chilean courts compelled CAP, an iron ore mining company, to cease DSTP operations on the Atacama coast after 40 years of activity⁴⁰. This significant move marked the end of DSTP practices in the country⁴¹. China is among the 51 countries that supported the ban on tailings disposal into the sea at the 2016 International Union for Conservation of Nature Congress. Considering the characteristics of deep-sea environments along coastlines, only 0.14% of global coastal areas have water depths exceeding 1000 meters within 2 km from the shore. Besides the potential environmental damage, the technical challenges of implementing DSTP safely are considerable⁴². Nevertheless, some mining companies in specific countries, including Indonesia, continue to employ this method.

The Buyat case illustrates the negative consequences of the DSTP method. Newmont Minahasa Raya disposed of a total of 4 million tons of gold mining tailings at a depth of 82 meters in Buyat Bay, Minahasa Peninsula, North Sulawesi. This practice occurred over 8 years from 1996 to 2004. During this disposal period, the pipeline experienced multiple leaks, allowing tailing waste to enter the marine water column. Heavy metals, such as arsenic, mercury, and manganese, then contaminated the seawater, damaging marine and coastal ecosystems, and reducing the local population's health. In 2004, local fishermen began complaining of various health issues, including skin conditions, tremors, headaches, and swelling in their necks, calves, wrists, and heads. An investigative team found accumulations of arsenic and mercury in marine organisms, including fish, at concentrations exceeding safe levels⁴³. Following the investigation, local fishermen and villagers were advised not to consume fish and were relocated to other rural areas.

⁴⁰ Baxter, A. (2019). *CAP puts an end to years of marine pollution: disposal of tailings into the sea is terminated*. Oceana. <https://oceana.org/press-releases/cap-puts-end-years-marine-pollution-disposal-tailings-sea-terminated/>

⁴¹ Cacciuttolo, C. & Atencio, E. (2022). *Past, Present, and Future of Copper Mine Tailings Governance in Chile (1905–2022): A Review in One of the Leading Mining Countries in the World*. International Journal of Environmental Research & Public Health, 19, 13060. <https://doi.org/10.3390/ijerph192013060/>

⁴² 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>

⁴³ 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

Media investigations and research also indicate a decline in environmental quality in the waters of Obi Island, North Maluku. According to the investigative team at Narasi, a pioneering journalism company, the seawater can feel very dense and reddish in color⁴⁴. This finding is supported by research conducted by the Aquaculture Study Center of Khairun University, which found heavy metal levels in fish and shellfish exceeding normal limits⁴⁵. These environmental changes, including deterioration of air quality, have affected the health of the local villagers. 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 children⁴⁶.



⁴⁴ Narasi Newsroom. (2022). *Irony of Nickel Factory, Destroying Nature For Greening Cities in China and Europe* | Open Eyes. <https://www.youtube.com/watch?v=Oyoud99LfRs>

⁴⁵ Tamrin & Aris, M. (2022). *Peringatan Pencemaran Logam Berat Berdasarkan Indeks Saprobik Di Perairan Pulau Obi, Maluku Utara*. Jurnal Ilmiah PLATAX, Universitas Sam Ratulangi, 10(1), 55-60. <https://ejournal.unsrat.ac.id/index.php/platax/article/download/37329/34799>

⁴⁶ 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_MupP0KqQ7GGNb0IEFCJ4TA60sTFvwsfzpFeTg

Trimegah Bangun Persada (TBP) Harita Group, the implementer of the nickel industrial zone on Obi Island, initially had permission to dispose of tailings into the sea through Decree No. 502/12/DPMPTSP/VII/2019 approved by the Governor of North Maluku, KH. Abdul Gani Kasuba. However, due to pressure from non-governmental organizations and the local community, the permit was revoked, and the company reapplied for a permit at the end of 2021 related to the operation of the Dry Stack Residue Facility (DSRF)⁴⁷. Along with its partner, Halmahera Persada Lygend, TBP operates one of the first three HPAL smelters built in Indonesia (the other two HPAL smelters are located in the Indonesia Morowali Industrial Park). The production capacity of the HPAL smelter reaches 37 kilotons of mixed hydroxide precipitate (MHP) per year. In response to coverage by *The Washington Post*⁴⁸, TBP stated that they have never discharged tailings into the waters of Obi Island or beyond their DSRF facility area⁴⁹.

Geographically, the IWIP industrial area is located on the coast of Weda Bay. Technically, the smelter operators at 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 visit, the seawater temperature at the wastewater disposal point was found to be high. This increase in seawater temperature is caused by the coal plant wastewater from the operation of the coal-fired power plant. 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.

⁴⁷ Sawal, R. (2022). *Moncer Baterai Kendaraan Listrik, Suram bagi Laut dan Nelayan Pulau Obi* [2]. Mongabay, Situs Berita Lingkungan. <https://www.mongabay.co.id/2022/01/03/moncer-baterai-kendaraan-listrik-suram-bagi-laut-dan-nelayan-pulau-obi-2/>

⁴⁸ Tan, R. (2023). *To meet EV demand, industry turns to technology long deemed hazardous*. The Washington Post. <https://www.washingtonpost.com/world/interactive/2023/ev-nickel-refinery-dangers/>

⁴⁹ Trimegah Bangun Persada. (2023). *Response to The Washington Post Article*. <https://tbpnickel.com/id/investor-relation/disclosure-information/response-to-washington-post-article>

4.6 Comparison between Legal Regulations 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 IWIP zone.



Table 4.6. Comparison of river water quality standards between Government Regulation No. 22 of 2021 and IRMA

No	Unit	Government Regulation 22/2021				IRMA
		Class 1	Class 2	Class 3	Class 4	
1	Temperature					
	°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	-	nd
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	nd
7	Chemical Oxygen Demand (COD)					
	mg/L	10	25	40	80	nd
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	-	nd
16	Fluoride (F)					
	mg/L	1	1.5	1.5	-	1
17	Hydrogen Sulfide as H₂S					
	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	nd
35	Total Detergent					
	mg/L	0.2	0.2	0.2	-	nd
36	Phenol					
	mg/L	0.002	0.005	0.01	0.02	nd
37	Aldrin/Dieldrin					
	µg/L	17	-	-	-	nd
38	BHC					
	µg/L	210	210	210	-	nd
39	Chlordane					
	µg/L	3	-	-	-	nd
40	DDT					
	µg/L	2	2	2	2	nd
41	Endrin					
	µg/L	1	4	4	-	nd
42	Heptachlor					
	µg/L	18	-	-	-	nd
43	Lindane					
	µg/L	56	-	-	-	nd
44	Methoxychlor					
	µg/L	35	-	-	-	nd

45	Toxaphan					
	µg/L	5	-	-	-	nd
46	Fecal Coliform					
	MPN / 100 mL	100	1,000	2,000	2,000	nd
47	Total Coliform					
	MPN / 100 mL	1,000	5,000	10,000	10,000	nd
48	Waste (Trash)					
		None	None	None	None	nd
49	Radioactivity					
	Gross-A					
	Bq/L	0.1	0.1	0.1	0.1	nd
	Gross-B					
	Bq/L	1	1	1	1	nd

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

1. The river water quality standards set in Government Regulation No. 22/2021 are categorized based on their intended use. Class I rivers are designated for raw drinking water and other purposes that require the same water quality, Class II rivers are for water recreational facilities, freshwater fish farming, livestock, irrigation, and other purposes with similar water quality requirements, Class III rivers are for freshwater fish farming, livestock, irrigation, and similar uses, and Class IV rivers are for irrigation and other purposes requiring the same water quality. In contrast, the IRMA criteria apply universally to all types of surface waters, including lakes. IRMA also provides specific criteria for drinking water, agricultural activities, livestock, aquaculture, and recreation. Unlike Government Regulation No. 22/2021, IRMA's criteria are well-defined and distinguishable from one another.

2. The water quality standard set by the Government Regulation No. 22/2021 is a national criteria developed independently by involving experts. In contrast, IRMA's criteria integrate various sources from environmental organizations in different countries, and these sources vary for each parameter. For example, the hexavalent chromium standard is sourced 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. Government Regulation No. 22/2021 tends to establish concentration limits for each parameter, whereas IRMA's criteria do not. In IRMA's criteria, there are several parameters that need to be measured and further analyzed for severity, such as dissolved oxygen and total nitrogen. Some parameters need to be calculated based on hardness levels 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 elements, and radioactivity are regulated in Government Regulation No. 22/2021 but not in the IRMA criteria (i.e., they are not regulated). Conversely, IRMA criteria include a range of metal parameters (such as aluminum, total chromium, and trivalent chromium) and non-metal parameters (like alkalinity and dissolved organic carbon) that are not part of Government Regulation No. 22/2021. This discrepancy arises because Government Regulation No. 22/2021 is designed with the assumption that rivers serve as the receiving bodies for treated wastewater from various activities, including agricultural and domestic activities. IRMA criteria, on the other hand, are designed with parameters relevant to mining activities. In surface water quality monitoring efforts, 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 examined, especially acidity and hexavalent chromium, the IRMA criteria appear to be more stringent than the water quality standards of Government Regulation No. 22/2021. Based on our measurements of river water quality around the IWIP area, the most affected river is the Wosea River, with a pH of around 9.15 and hexavalent chromium concentration reaching 0.017 mg/L.

Table 4.7. Comparison of lake water quality standards between Government Regulation No. 22 of 2021 and IRMA

No	Unit	Government Regulation 22/2021				IRMA
		Class 1	Class 2	Class 3	Class 4	
1	Temperature					
	°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	-	nd
5	Color					
	Pt-Co unit	15	50	100	-	nd
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	nd
8	Chemical Oxygen Demand (COD)					
	mg/L	10	25	40	80	nd
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	-	nd

No	Unit	Government Regulation 22/2021				IRMA
		Class 1	Class 2	Class 3	Class 4	
14	Fluoride (F)					
	mg/L	1	1.5	1.5	-	1
15	Hydrogen Sulfide as H ₂ S					
	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
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	measured
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	measured

No	Unit	Government Regulation 22/2021				IRMA
		Class 1	Class 2	Class 3	Class 4	
28	Dissolved Zinc (Zn)					
	mg/L	0.05	0.05	0.05	2	measured
29	Dissolved Copper (Cu)					
	mg/L	0.02	0.02	0.02	0.2	measured
30	Dissolved Lead (Pb)					
	mg/L	0.03	0.03	0.03	0.5	measured
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	nd
33	Total Detergent					
	mg/L	0.2	0.2	0.2	-	nd
34	Phenol					
	mg/L	0.002	0.005	0.01	0.02	nd
35	Aldrin/Dieldrin					
	µg/L	17	-	-	-	nd
36	BHC (Hexachlorocyclohexane)					
	µg/L	210	210	210	-	nd
37	Chlordane					
	µg/L	3	-	-	-	nd
38	DDT (Dichlorodiphenyltrichloroethane)					
	µg/L	2	2	2	2	nd
39	Endrin					
	µg/L	1	4	4	-	nd
40	Heptachlor					
	µg/L	18	-	-	-	nd
41	Lindane					
	µg/L	56	-	-	-	nd

No	Unit	Government Regulation 22/2021				IRMA
		Class 1	Class 2	Class 3	Class 4	
42	Methoxychlor					
	µg/L	35	-	-	-	nd
43	Toxaphan					
	µg/L	5	-	-	-	nd
44	Fecal Coliform					
	MPN / 100 mL	100	1,000	2,000	2,000	nd
45	Total Coliform					
	MPN / 100 mL	1,000	5,000	10,000	10,000	nd
46	Klorofil-a					
	mg/m ³	10	50	100	200	nd
47	Waste (Trash)					
		none	none	none	none	nd
48	Radioactivity					
	Gross-A					
	Bq/L	0.1	0.1	0.1	0.1	nd
	Gross-B					
	Bq/L	1	1	1	1	nd

Table 4.7 illustrates the distinctions between Government Regulation No. 22/2021 and the Initiative for Responsible Mining Assurance (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, 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. Government Regulation 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 Government Regulation No. 21/2021, such as aluminum, calcium, total chromium, potassium, silver, sodium, thallium, alkalinity as CaCO_3 , and dissolved organic carbon.

Table 4.8. Comparison of seawater quality standards between Government Regulation No. 22 of 2021 and IRMA

No	Unit	Government Regulation 22/2021			IRMA
		Port	Marine Tourism	Marine Biota	
1	Color				
	Pt-Co	-	30	-	nd
2	Brightness				
	m	> 3	> 6	<i>coral</i> : > 5 <i>mangrove</i> : - <i>lamun</i> : > 3	nd
3	Turbidity				
	NTU	-	5	5	nd
4	Odor				
	-	odorless	odorless	natural	nd
5	Total Suspended Solids (TSS)				
	mg/L	80	20	<i>coral</i> : 20 <i>mangrove</i> : 80 <i>lamun</i> : 20	-
6	Waste				
	-	none	none	none	nd
7	Temperature				
	°C	natural	natural	natural <i>coral</i> : 28-30 <i>mangrove</i> : 28-32 <i>lamun</i> : 28-30	-

No	Unit	Government Regulation 22/2021			IRMA
		Port	Marine Tourism	Marine Biota	
8	Oil Layer				
	-	none	none	none	nd
9	pH				
	-	6.5 – 8.5	7 – 8.5	7 – 8.5	6.5 – 8.7
10	Salinity				
	‰	natural	natural	natural coral: 33-34 mangrove: s/d 34 lamun: 33-34	nd
11	Dissolved Oxygen (DO)				
	mg/L	-	> 5	> 5	nd
12	Biochemical Oxygen Demand (BOD ₅)				
	mg/L	-	10	20	nd
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	nd
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 ₂ S)				
	mg/L	0.03	0.002	0.01	measured
18	Total Petroleum Hydrocarbons (TPH)				
	mg/L	1	-	0.02	nd
19	Total Phenolic Compounds				
	mg/L	0.003	0.001	0.002	nd
20	Polycyclic Aromatic Hydrocarbons (PAH)				
	mg/L	-	0.003	0.003	nd

No	Unit	Government Regulation 22/2021			IRMA
		Port	Marine Tourism	Marine Biota	
21	Polychlorinated Biphenyls (PCB)				
	µg/L	0.01	0.005	0.01	nd
22	Surfactants (Detergents) as MBAS (Methylene Blue Active Substances)				
	mg/L	1	0.001	1	nd
23	Oil and Grease				
	mg/L	5	1	1	nd
24	Pesticide				
	a. BHC				
	µg/L	-	210	210	nd
	b. Aldrin / Dieldrin				
	µg/L	-	17	-	nd
	c. Chlordane				
	µg/L	-	3	-	nd
	d. DDT				
	µg/L	-	2	2	nd
	e. Heptachlor				
	µg/L	-	18	-	nd
	f. Lindane				
	µg/L	-	56	-	nd
	g. Methoxychlor				
	µg/L	-	35	-	nd
	h. Endrin				
	µg/L	-	1	4	nd
	i. Toxaphan				
	µg/L	-	5	-	nd
25	TBT (tri butil tin)				
	µg/L	0.01	-	0.01	nd

No	Unit	Government Regulation 22/2021			IRMA
		Port	Marine Tourism	Marine Biota	
26	Mercury (Hg)				
	mg/L	0.003	0.002	0.001	0.0004
27	Hexavalent chromium (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	-	nd
35	Coliform (total)				
	amount / 100 mL	1000	1000	1000	nd
36	Pathogen				
	cell / 100 mL	-	none	none	nd
37	Phytoplankton				
	cell/mL	-	1,000	1,000	nd
38	Radioactivity				
	Bq/L	-	4	4	nd

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

1. The seawater quality standards specified in Government Regulation 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. Government Regulation 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. Government Regulation 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 and then analyzed for its impact on seawater quality.
4. Parameters such as pesticides, biological factors, Persistent Organic Pollutants (POPs), oxygen demand, and several physical parameters are regulated in Government Regulation 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 Government Regulation No. 22/2021. The seawater quality standards in Government Regulation 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 Government Regulation No. 22/2021. Based on water quality measurements around the IWIP zone, the most affected zone is the discharge area of the coal-fired power plant with water temperature reaching 35°C and hexavalent chromium concentration reaching 0.024 mg/L.

Table 4.9. Comparison of ambient air quality standards between Government Regulation No. 22 of 2021 and IRMA

No	Measurement Time	Government Regulation 22/2021	IRMA
1	Sulfur dioxide (SO₂)		
	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	nd
2	Carbon monoxide (CO)		
	1 hour	10000 µg/m ³	nd
	8 hours	4000 µg/m ³	10000 µg/m ³
3	Nitrogen dioxide (NO₂)		
	1 hour	200 µg/m ³	200 µg/m ³
	24 hours	65 µg/m ³	nd
	1 year	50 µg/m ³	40 µg/m ³
4	Photochemical oxidants (O_x) as Ozone (O₃)		
	1 hour	150 µg/m ³	nd
	8 hours	100 µg/m ³	120 µg/m ³
	1 year	35 µg/m ³	nd
5	Non-Methane Hydrocarbons (NMHC)		
	3 hours	160 µg/m ³	nd

No	Measurement Time	Government Regulation 22/2021	IRMA
6	Dust particles		
	Dust particles < 100 µm (TSP)		
	24 hours	230 µg/m ³	nd
	Dust particles < 10 µm (PM₁₀)		
	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	nd
	1 year	15 µg/m ³	25 µg/m ³
7	Lead (Pb)		
	24 hours	2 µg/m ³	nd
	1 year	nd	0.5 µg/m ³
8	Benzene		
	1 year	nd	5 µg/m ³
9	Arsen (As)		
	1 year	nd	6 µg/m ³
10	Cadmium (Cd)		
	1 year	nd	5 µg/m ³
11	Nickel (Ni)		
	1 year	nd	20 µg/m ³
12	Polycyclic Aromatic Hydrocarbons (PAH)		
	1 year	nd	1 ng/m ³ (as Benzo(a)pyrene)

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

1. The air quality standards in Government Regulation 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 Government Regulation No. 22/2021 establish measurement systems for each parameter, whereas IRMA does not. For example, for the parameter sulphur 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 sulphur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), and particulate matter <10 µm (PM₁₀), while Government Regulation 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 Government Regulation 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 Government Regulation No. 22/2021. These differences are also evident in the measurement duration. For example, Government Regulation No. 22/2021 establishes a 24-hour measurement duration for the parameter particulate matter < 2.5 µm (PM_{2.5}), while IRMA does not have such a requirement.

5. For the parameters under study, such as PM_{10} and $PM_{2.5}$ with a 24-hour measurement duration, IRMA imposes stricter standards compared to the ambient air quality standards in Government Regulation No. 22/2021. Based on air quality measurements inside and outside the IWIP zone, the locations most affected are the coal-fired power plant area, Lelilef Sawai Village, and Lelilef Woebulen Village, with PM_{10} concentrations reaching $101 \mu\text{g}/\text{m}^3$ and $PM_{2.5}$ concentrations reaching $82 \mu\text{g}/\text{m}^3$.





Chapter V

Conclusion and Recommendations

5.1 Conclusion

The Indonesia Weda Bay Industrial Park (IWIP), a nickel mining industrial zone 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 zone 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, smelters, offices, and worker accommodations. This change in land use has marginalized the living space of the villagers, 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 zone 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 coal-fired power plant's wastewater, at the mouth of the Ake Doma River, and at Cape Ulie. Particulate dust levels on the roadside near the coal-fired power plant 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 villagers. The Community Health Center of Lelilef has recorded an increase in the number of Acute Respiratory Infections (ARI) complaints each year.

Construction activities, ore excavation, nickel ore processing, and the utilization of steam from coal combustion within the IWIP zone have also had environmental impacts on the surrounding air and water. High concentrations of hexavalent chromium have been detected downstream of the Wosea River, the wastewater discharge outlets of the coal-fired power plants, the mouth of the Ake Doma River, and Cape Ulie. Particle dust levels near the roads close to the coal-fired power plants and at several points in Lelilef Sawai and Lelilef Woebulen Villages also exceed the required air quality standards. These environmental changes can trigger damage to aquatic ecosystems and a decline in the health of villagers. The Community Health Center of Lelilef has recorded an increasing number of Acute Respiratory Infections (ARI) complaints each year.

The development of the IWIP industrial zone 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 Weda Bay Nickel's mining activities, a tenant of 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 suggest the following measures:

1. **Community Involvement:** Engage the community in a participatory and collaborative manner in discussions concerning mining and nickel industry activities that affect their interests, land acquisition processes, and water resource utilization. The company should respect sites or areas that hold vital value for the community. Values of inclusivity and collaboration with the local community should be fostered from the early stages of the project.
2. **Tenure Conflict Resolution:** Address tenure conflicts in a participatory and equitable manner. Fair discussion spaces between the community and the company need to be established. All parties should have a voice to ensure that the agreements reached accommodate all interests.
3. **Inclusive Community Involvement:** Inclusivity in community participation should extend beyond community leaders to include planning and implementing social and economic development programs for communities in the vicinity of mining and nickel industrial zones.
4. **Communication Forums:** Establish communication forums between the community and mining and nickel industrial companies that are active and inclusive. Forum meetings should be held regularly, on a monthly or bi-monthly basis.
5. **Environmental Monitoring:** Regular environmental quality monitoring should occur at specified intervals. This monitoring should involve both the company and the government, covering not only industrial zones but also environmental components in impacted villages. The results of environmental quality monitoring should be accessible to the public, enabling community members and environmental advocates to participate in monitoring efforts. One infrastructure that should be provided by both the company and local government is Air Quality Index (AQI) boards or other relevant technologies to be installed in high-risk areas.

6. **Environmental Outreach:** The company should address environmental issues outside the industrial area, such as in settlement areas. Issues may include, but are not limited to, access to clean water, dust, waste, and coral reef damage. The company should implement environmental programs related to these issues. Regarding waste management, the company should provide infrastructure and organize villagers to minimize waste generation.
7. **Coal-fired Power Plant Transition:** The coal-fired power plant in the industrial area should be discontinued and transitioned to renewable energy sources to avoid air pollution and adverse effects on local community's health.
8. **Transparent Electric Vehicle Industry:** The electric vehicle industry should be transparent about their nickel supply chain and ensure that every aspect of the supply chain adheres to stricter social and environmental standards, such as the Initiative for Responsible Mining Assurance (IRMA), not limited to national regulations.
9. **Further Research:** Conduct further research on the impact of nickel mining activities in the industrial area on social, environmental, economic, and cultural aspects. The preliminary insights in this study can inspire the government, academia, and non-governmental organizations to conduct more extensive and long-term scientific investigations in the same or different research locations. Data and analysis from these studies can serve as a foundation for decision-making toward sustainable development. One potential area for further research is the impact of the nickel mining industry on indigenous communities, such as Tobelo Dalam, who inhabit the forests of Central Halmahera and East Halmahera.



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The phrase *Bahoku tafe* represents a concise sentence in the Bungku language, which is spoken by the Morowali community. It translates to "my water is polluted/damaged." Beyond being a common grievance among local residents, this local expression encapsulates the concept of environmental degradation occurring alongside the expansion of mining and nickel industry enterprises in Morowali.

The nickel industry in Morowali Regency, located in Central Sulawesi Province, has experienced significant growth since the establishment of the Indonesia Morowali Industrial Park (IMIP) in the Bahodopi District in 2015. With production activities spanning three clusters over a vast 4,000-hectare area, the IMIP industrial zone is credited with generating thousands of job opportunities and bolstering the local economy. However, this positive transformation has been paralleled by a deterioration in environmental quality and public health.

Bahoku Tafe: Environmental Impact Study of the Nickel Industry Park in Morowali provides an examination of current data and information concerning the environmental quality of villages affected by the operations of the IMIP industrial zone. The environmental components scrutinized include coastal waters, freshwater, and ambient air. Moreover, this report identifies potential environmental repercussions arising from the development of the three industrial cluster areas, primarily engaged in the production of electric vehicle battery cathodes.

Bahoku Tafe: Environmental Impact Study of the Nickel Industry Park in Morowali serves as a sequel to the policy brief titled *Policy, Risks, and Prevention of Impact of Nickel Mining at Sea in Indonesia*, previously released by **Action for Ecology and People's Emancipation (Aksi Ekologi dan Emansipasi Rakyat)**. The initial policy paper analyzed the outcomes of seawater quality assessments conducted on the coast of Bahodopi in June 2022.

In this latest report, we once again formulate several recommendations intended to provide a framework for all stakeholders involved in policy-making and mitigation strategies. We hope that this report could contribute to advancing environmental justice in Indonesia's pursuits of a sustainable energy transition.



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