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MORALITY BEFORE KNOWLEDGE

The impact of mining exploitation on community interaction: A social and environmental perspective

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ABSTRACT
Background: Nickel mining activities on Gebe Island in Halmahera Tengah, Maluku Utara, contribute to the national economy by boosting regional income, employment, and infrastructure development. However, the lack of human resources to manage natural resources has led to significant environmental degradation and socio-economic challenges, particularly post-mining. This study analyzes the environmental and socio-economic impacts of nickel mining on the island. **Method:** A qualitative research approach was used to assess the current conditions of Gebe Island's environment and socio-economic landscape. The study focused on two key variables: human interaction and environmental interaction, analyzing their relationship and impacts. **Findings:** The study identified several negative environmental impacts from nickel mining, including landscape alterations, loss of fertile soil, increased critical land, reduced water quality (surface and marine), diminished populations of endemic plants, and disruptions to mangrove and coral reef ecosystems. Additionally, there is a decline in socio-economic life in the post-mining phase, impacting community well-being. **Conclusion:** To mitigate these impacts, the government must involve the community in the management and rehabilitation of the mining areas. Empowering local populations and increasing stakeholder cooperation are critical for ensuring the sustainable application of environmental laws and improving post-mining socio-economic conditions. **Novelty/Originality of this Study:** This research offers a detailed examination of the socio-economic and environmental consequences of nickel mining on Gebe Island. It provides a unique perspective on the need for community involvement and local empowerment to address mining-related challenges and enhance environmental sustainability.

KEYWORDS: community interaction; exploitation; Gebe Island; impact; nickel mining.

1. Introduction

Indonesia is a country with abundant potent and mineral natural resources throughout the islands, from copper and gold in Papua, gold in Nusa Tenggara, nickel in Sulawesi and Eastern Indonesia, to bauxite and coal in Kalimantan (Hadi et al., 2015). According to United States Geological Survey (USGS), world reserves of nickel in 2022 reached more than 100 million tons of nickel. This number is identified as land-based resources approximately 0.5% nickel content or greater with about 60% in laterites and 40% in sulphides deposits. Nickel reserves in Indonesia have approximately 21 million tons of nickel that spread across Sulawesi, Maluku, Halmahera, and Papua (USGS, 2023). The nickel resource in Indonesia was assessed at 6,233.65 million tons in 2016, with a reserve of 3,155.67 million tons (Suherman & Saleh, 2018). Indonesia has a wide range of ultramafic rocks, especially Sulawesi, which has an area of up to 15,400 km^2, and Halmahera, which has an area of about

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4,444 to about 8,000 km^2. The East Celebes Tertiary subduction zone is a thin layer of trench-fed pelagic sediment that is highly deformed, indicating extensive mantle involvement. The same applies to Halmahera and its surrounding smaller islands (Nancy, 2022). Both Sumatera and Halmahera islands also become a main nickel mining site. However, the eastern territory of Indonesia such as Maluku and East Nusa Tenggara are two of the poorest regions despite their function as mining sites. The central government is troubled about the wider geographical interval in the economic growth gains These islands, along with Celebes Island, hold Indonesia's largest reserves of lateritic nickel and iron ore (Asteria, 2021). Nickel is broadly used for infrastructure and buildings, transportation, industrial machinery, appliances and metal products. Nickel's corrosion resistance, strength, and high temperature stability are highly valued in these applications, which often take the form of stainless steels or superalloys (Elshkaki et al., 2017).

Most rural communities depend on a variety of forest products. Each plant species that grows and develops in forests has unique characteristics that are influenced by climate, altitude, and other environmental factors (Irmayanti, 2022). Each ethnic group with different cultures and cultural customs pursues the same goal: the inheritance of the culture of their ancestors, which they believe will have a positive impact on social and environmental aspects.

Nickel mining activities have provided benefits both directly and indirectly for the national economy and development. Negative impacts caused by mining can be reduced by proper planning and implementation so that mining operation management can be more sustainable and environmentally sound. The entire process of developing a mine with the use of ex-mining land in the future is known as sustainable development (Juanda, 2021). The mining sector can contribute to the nation in the form of various sources of financing for the country, such as foreign exchange and royalties, taxes, employment expansion, physical development, etc. On the other hand, it is based on LIPI's research findings (2006), mining activities have caused many social and environmental conflicts. Environmental damage caused by mining activities that intentionally remove vegetation, alter landscapes, and alter soil composition can cause erosion, sedimentation, soil nutrients, and soil compaction, which can lead to land degradation. One of the attempts to improve the environmental conditions in mining areas is through reclamation and post-mining (Herdiansyah et al., 2013). It is also more common in the expansion region (Tuni, 2013).

Gebe Island is located in Halmahera Tengah, Province Maluku Utara. Gebe Island has quite large mining resources, however lack of human resources to manage its natural resources, therefore foreign investors tend to take advantage of the opportunity which was supported by laws issued by the New Order Government regarding foreign investment, mining regulations and domestic investment to protect foreign parties in operating in Indonesia, more specifically in Gebe Island (Beng, 2019). Gebe Island is a small island with an area of ±153 km^2 which is astronomically located at 0°2’24” north latitudes and 0°13’12” south latitudes and 129°16’48” east longitudes and 129°34’48” west longitudes. Gebe Island borders the Pacific Ocean in the north, the Halmahera Ocean in the south, Sorong Regency in the east and Patani District in the west (Wibowo, 2008). Mining exploitation has been started in Gebe Island since 1979. North Maluku, specifically in Halmahera, has quite a large amount of Nickel deposits. INDECO (Indonesia Nickel Development Co. Ltd) conducted survey and exploration on islands around Halmahera in 1969-1975 (Berlianty, 2015).

Mining on Gebe Island is extremely harmful, with just a few of hanfduls benefiting. Shareholders of mining and former army military leaders who sit on executive board to preserve these enterprises’s assets (Naim, 2018). According to Wibowo (2008), nickel mining activities on Gebe Island are apart from providing benefits as a foreign exchange earner for the country, but it also contributes to increase the damaged and unproductive land, as well as changes in the landscape, changes in vegetative structure and composition. The social impacts resulting from nickel mining on Gebe Island include contribution to regional income, increasing employment opportunities, and opening isolated areas, but apart from that there are also negative impacts such as decreasing activity and socio-economic life in the post-mining stage.

The mining company-built support facilities on Gebe Island, some of which were open to the public. The purpose of building such a factory was to support the production of nickel, the main raw material. From building staff quarters to constructing airfields, jobs are allocated bureaucratically based on degree and title. An employee camp complex and a cluttered corporate office were the settlement options. In addition, the company owned a luxury residential complex with 4,444 security stations and entrances. Employees and managers, most of whom were immigrants from other islands, were granted access to various facilities developed by the mining company. Gebe residents worked primarily as farmers or fishermen, but lacked the skills needed to work in the mining industry. As a result, mining company employment opportunities for local residents were limited to positions such as heavy equipment attendants, gardeners, and cleaning service personnel. Therefore, according to the people of Gebe Island, this mining company is one of the companies that must take responsibility for the changes in the landscape and the lives of Gebe residents due to the suspension of operations (Nancy, 2022). Based on the background of the problems above, this research has general and specific objectives. The general objective to be achieved is to determine the existing conditions of the environmental and socio-economic aspects of the Gebe Island community after nickel mining is finished.

2. Methods

This research aims to analyze the existing conditions of the environmental and socio-economic aspects of the Gebe Island community. This research approach uses a qualitative approach with qualitative research methods to determine the existing condition and to determine the relationship between two or more variables. There are two variables studied in this research, namely human interaction and environment interaction variables. The research period was carried out for 2 months starting from November - December 2023. The research location was on Gebe Island, Halmahera Tengah, Maluku Utara. This location was chosen as a research location because the condition of Gebe Island was degraded due to nickel mining activities.

The human interaction variable which includes history, culture, aspects of population, economics, employment of Gebe Island community and government policies related to nickel mining is analysed through secondary data such as population growth, regional income, community livelihoods, and regulations or policies related to nickel mining on Gebe Island.

3. Results and Discussions

3.1 Tradition on Gebe Island

The history of Gebe Island is closely related to the existence of the Tidore Sultanate, one of the kingdoms in North Maluku. Gebe Island first became famous when the Sultan of Tidore's entourage visited the Raja Ampat Islands around 700 AD to expand the territory of the Tidore Sultanate, including the center of Halmahera in the south. Around 1500, the first people to inhabit Gebe Island were the Watehwagya people (Watef in the Gebe language means people who have white magic and Wagya means people who have black magic). The ancestor of the Watehwagya clan named Giafat originally lived in a cave, located on Eleua Hill. The location of the cave on Eleua Hill is difficult to access, perched on a steep cliff in the Gebe Island Forest reserve, so to this day the fossil remains of the ancestors of the Watehwagya clan are still found in the cave (Sulistiono et al., 2016).

Later, the descendants of the Watehwagya clan from Giafat called Wetef moved from the Eleua hills to Watef Cave on the headland of Gebe Island (now known as Tanjung Gebe in the north of Gebe Island). Initially, the ancestors of the Gebe people carried out various activities only in this cave. Over time, as the number of clan members increased, the Gebe people decided to migrate to Koboro (Sulistiono et al., 2016). However, disease outbreaks

continued to occur in the new location, so that within a few months the residents of Gebe decided to move to Sanaf, the first village on Gebe Island. The population of Sanaf has increased rapidly due to the birth of babies from the local Gebe population and the arrival of residents from outside (Sulistiono et al., 2016).

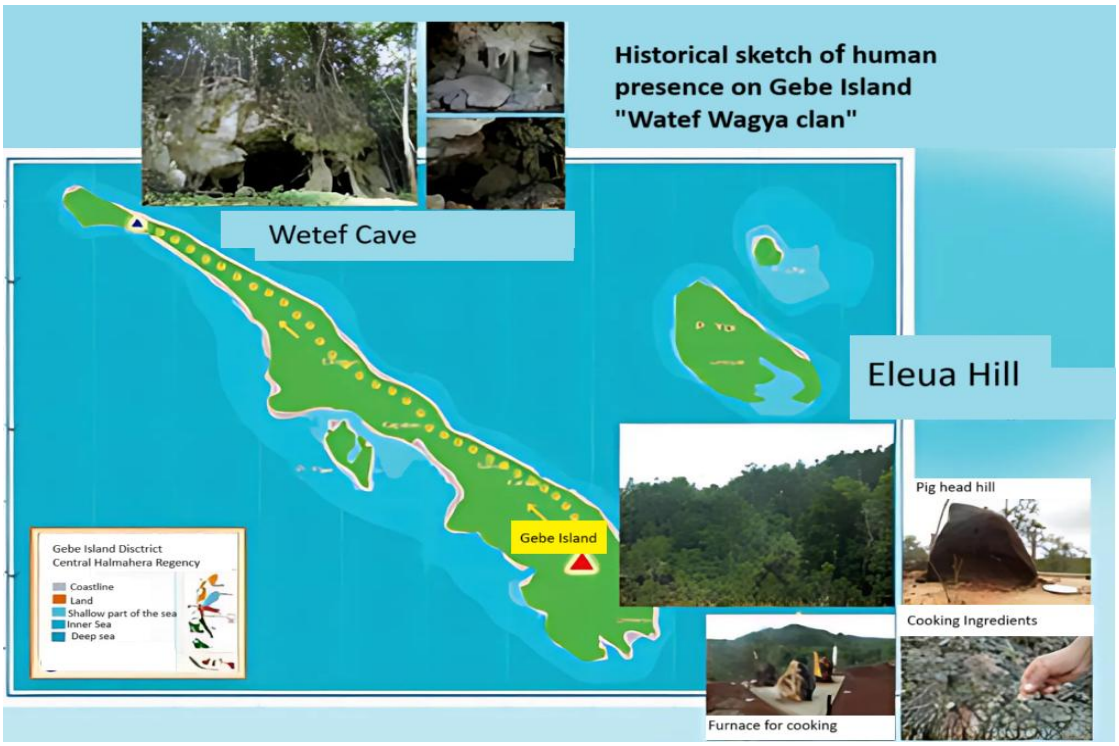

Fig. 1. Cultural history on Gebe Island
(Sulistiono et al., 2016)

This situation encouraged the formation of community groups which ultimately separated themselves to open new villages with the aim of gaining wider access to natural resources to meet their subsistence needs. The Watehwagya clan who lived in Sanaf decided to open new villages such as Sanaf, Kasepo, Yam, Mamin, some also went to Yoi Island, and the former Sanaf village was renamed Sanaf Kasepo. Even though the Watehwagya clan split into several groups, the legacy of Gebe land ownership authority remains strong among the indigenous people of Gebe Island. Land inheritance on Gebe Island, including Yoi and Fao, was based on male descent and was known to the Tidore Sultanate (Sulistiono et al., 2016).

3.2 Geology, hydrology, and climate at Gebe Island

The Gebe Island area consists of an area consisting of several islands. The topography of Gebe Island is hilly, while the other islands are relatively flat and sloping. Gebe Island's hills consist of a combination of lowland forest ecosystems, coastal forests and coastal hill ecosystems. Most of this island is protected forest. Like other islands whose topography is flat and sloping, the coastal ecosystem also includes coastal forests (Sulistiono et al., 2016).

The average rainfall in this area is 1.869.4 mm/year. Gebe Island has two seasons, namely the rainy season and the dry season, which are punctuated by seasonal changes. The rainy season lasts from December to February, and the dry season lasts from August to December, punctuated by the transition season from November to December (Sulistiono et al., 2016).

The weather in the Gebe Island area is influenced by sea breezes depending on the direction of the wind source. The people of Gebe Island recognize two types of winds that influence the weather, namely north winds and south winds. The north wind from the Pacific Ocean blows from the north of Gebe Island, causing 4,444 clouds filled with water which can

cause rain. The south wind blows from the dry direction of Halmahera Island so it is hot but there is no potential for rain (Sulistiono et al., 2016).

Gebe Island's soil is a type of limestone soil that covers almost all of Gebe Island. The soil on Gebe Island has varied development and depth, good drainage, fine soil texture, relatively low fertility, and sparse vegetation. This also has a relative impact on surface erosion, so that soils with low to moderate sun depth and weak to moderate development often occur (Sulistiono et al., 2016).

The soil on Gebe Island is divided into three layers, namely the limestone layer, sand layer and humus layer. The base layer of Gebe Island is a layer of limestone. This layer is composed of hardened limestone and formed on the earth's surface over thousands of years. The sand layer is the second layer, thinner than the lime layer. The soil on Gebe Island contains sand as much as fruit and the groundwater capacity is very high so that water does not flow to the surface of Gebe Island. The top layer of Gebe Island is a layer of humus soil. However, this layer only exists in the north and south of the island. This layer is an area where woody and non-woody plants grow. The layer of soil containing humus is approximately 40 cm thick and is highly eroded (Sulistiono et al., 2016).

Gebe Island has hydrological potential in the form of salt, fresh and brackish water. Gebe Island is a small island in the middle of the Halmahera Strait, and its entire territorial boundaries are surrounded by the waters of the Maluku Sea and the Pacific Ocean, so the potential for salt water is very large (Sulistiono et al., 2016). Gebe Island has fresh water sources in the north because there are still various large and dense tree groups. The existence of these trees can store and maintain the condition of fresh water well. Apart from that, fresh water also comes from rainwater infiltration which infiltrates and is stored in the ground. Fresh water conditions in this area are limited, vulnerable to symptoms of sea water infiltration and liquid waste contamination (Sulistiono et al., 2016). The island has a high potential of fishery resources both for capture and aquaculture fisheries. The community can also harvest and sell the lobster collected from the sea reared for 2-4 months in the floating net cage (Hardinsyah et al., 2016). According to the observation of Insani et al. (2017), the community can rear the humpback grouper fish from 5 cm to 20-25 cm total body length per individual for 12 months (Umera Village), and it was from 5 cm to 10-15 cm total body length per individual for 10 months (Umiyal Village).

Fig. 2. Water resources at Gebe Island
(Sulistiono et al., 2016)

Fresh water is not abundant because not all parts of the island have fresh water. The closer it gets to the coast, fresh water sources will become increasingly difficult to find because the soil layer is limestone and is deep, making it difficult to dig wells. Residents' sources of clean water vary according to the conditions of fresh water in the ground. Communities in the northern part of Gebe Island, namely in the villages of Kapaleo, Elfanun, Kacepi, Yam, and Sanaf Mamin, are unable to obtain clean water for their daily needs (Sulistiono et al., 2016).

3.3 Socio-economy conditions at Gebe Island

Gebe Island District has a population of 4,866 people spread across eight villages. The difference in the population of each village is influenced by the geographical location of each village and the ease of access to the village. The population of Gebe Island District is relatively balanced between men and women, with a sex ratio of 103, meaning that for every 100 female residents there are 103 male residents. The number of male residents was 2,469 and 2,397 females. Kapaleo Village, which is the administrative center of Gebe Island Regency, has the largest population, namely 1,103 people and is the village with the highest population density (Sulistiono et al., 2016).

The people of the Gebe Island area utilize various natural resources in the area to meet their daily needs. Today, most people make a living from gardening. However, there are also people who make their living by raising livestock, raising fish in floating net cages, and utilizing other natural products, especially as fishermen. The development of plantation businesses in the Gebe Island area, especially small-scale coconut plantations, became the main source of income for the area after mining companies stopped operating. In fact, the high level of coconut production makes people believe that building a coconut oil factory on Gebe Island is quite feasible. Other agricultural products grown by the community include cloves, nutmeg and cocoa (Sulistiono et al., 2016).

The people of Gebe Island who make their living as fishermen can utilize the potential and resources of the sea. The coral fish commonly caught by fishermen on Gebe Island include grouper, skipper and snapper. Gebe Island, which is part of the Halmahera Islands region, is also an important fishing spot. The central Halmahera Islands in the Pacific region have great potential for catching skipjack tuna, because skipjack tuna naturally migrates from the Maluku Sea to the Pacific Ocean via the Raja Ampat Islands area. These conditions always encourage people to fish in the waters of Central Halmahera. Capture fishing businesses have great potential to produce extra-regional and market-oriented fishing products such as: Examples: Weda and Ternate. Because the income of the people of Gebe Island comes from fishing, their income is much higher than the income of people in other areas (Sulistiono et al., 2016).

High income is also directly proportional to the cost of living incurred. The prices of various necessities on Gebe Island are very expensive because access to buy these necessities is very far from Weda City and the travel time by boat can take up to 12 hours. Apart from fishing and farming, the Gebe community also farms seaweed and grouper in floating net cages. The community started running this business in 2007. This business has developed in waves, and because it relies on large companies as business partners, sometimes it makes a profit and sometimes it loses (Sulistiono et al., 2016).

Health facilities and personnel in the Gebe Island area are still limited. However, these facilities are sufficient to meet the first aid needs of people in need. Medical services in the Erfanun area (Puskesmas) include doctors. Problems arise when residents require medical treatment for very serious illnesses. The patient needs to be transferred to a hospital in Ternate. This fastest mode of transportation (airplanes) only operates three times a week, every Monday, Wednesday and Friday, and carries a maximum of 11 passengers. Things got worse when the sick person was a resident of Umiyaru village on Yoi Island (Sulistiono et al., 2016).

3.4 Biodiversity at Gebe Island

Gebe Island has a rich flora, which influences evapotranspiration and the amount of fresh water stored in the island's soil (Delinom & Lubis, 2005). The flora of Gebe Island is divided into two groups, namely hillside flora and coastal flora. In the Gebe Island Protected Forest, the vegetation on the hillsides is generally dominated by woody plants. The protected forest on Gebe Island contains several trees including Lasamara, Meranti and Blackwood. These hills, which are quite low and sloping, are usually used by the community

to plant nutmeg trees as a plantation commodity for the people of Gebe Island, especially Umera Village (Sulistiono et al., 2016).

Most animals come from the bird group, including protected birds such as eagles and cockatoos. Apart from that, Gebe Island has an endemic mammal, namely the Gebe cuscus (*Phalanger alexandrae*), which was once found in protected forests in Umera Village. The Gebe Island District area has a sea that is wider than land. Therefore, the potential for animals in the waters is very diverse, such as types of fish (Sulistiono et al., 2016).

Table 1. Fish diversity at Gebe Island

No	Order	Family	Number of species
1	*Myliobatiformes*	*Dasyatidae*	1 species
2	*Mugiliformes*	*Mugilidae*	1 species
3	*Beloniformes*	*Belonidae*	1 species
		Exocoetidae	1 species
4	*Berycuformes*	*Holocentridae*	5 species
5	*Scorpaeniformes*	*Scorpaenidae*	1 species
6	*Perciformes*	*Serranidae*	7 species
		Apogonidae	3 species
		Carangidae	2 species
		Lutjanidae	4 species
		Caesionidae	1 species
		Lethrinidae	4 species
		Mullidae	2 species
		Chaetodontidae	4 species

(Sulistiono et al., 2016)

A total of 6 orders of fish were found in the waters of Gebe Island which were recorded based on the type and catch of local fishermen. The fish family groups that were caught and successfully identified were 14 families for the coastal areas of the island, with a total of 37 fish species from all these families. The family with the highest number of species is the Serranidae family from the order Perciformes. This is because the Serranidae family is a group of coral fish that are often found in coral reef ecosystems. The condition of the coast of Gebe Island, which is found to be quite abundant in coral reef ecosystems, is a factor in the high diversity of species from the Serranidae family (Sulistiono et al., 2016).

Four out of the 18 species (*Pupina laszlowagneri, Taheitia gracilenta, Albersia subsphoerica, Papuina unicolor*) observed on Gebe Island are also noted in New Guinea or nearby islands, including those in Cenderawasih Bay, Raja Ampat, and the Bismarck Archipelago; three species (*Platyrhaphe plicosa, Lamprocystis subangulata, Videna hartmanni*) are part of Moluccan fauna, with two of them restricted to North Moluccas, three species (*Beilania kobelti, Naninia aulica, Planispira kurri*) are found in both Moluccan and West Papuan fauna, while 4 species (*Aphanoconia aprica, Leptopoma gebiensis, Papuina fallax, P. semibrunnea*) have only been documented on Gebe Island. Several common species (N*eritodryas subsulcata, Truncatella guerini, Pythia scarabaeus*) live in coastal regions and can tolerate salt (Greke, 2012).

The diversity of bird species on the mainland of Gebe Island, Fao Island and Yoi Island is very high and has great potential to be developed as a natural tourist attraction on Gebe Island. Every morning and evening you can easily find parrots, water birds and honey birds flying and perching on the coast and protected forest areas on Gebe Island (Sulistiono et al., 2016). The group of mammals on Gebe Island is very interesting as a natural tourist attraction. Gebe Island has an endemic mammal, which means this animal can only be found on Gebe Island, namely the Gebe cuscus (*Phalanger alexandrae*). Gebe cuscus lives in the protected forests of Gebe Island, especially in Umera Village. Gebe cuscus is an endemic animal from Gebe Island, the cuscus is an animal that can be found on small islands and areas very limited distribution. Gebe cuscus lives in the protected forests of Gebe Island at a maximum altitude of 300 meters above sea level. This animal lives in the trees in the protected forest area. The Gebe cuscus population is estimated to be very small, mainly

influenced by decreasing habitat due to the clearing of forest areas for plantations, hunting by the community, and mining on Gebe Island. Now, the Gebe cuscus was classified as Endangered animal by IUCN Red List and must be protected because their population is decreasing (Sulistiono et al., 2016).

Apart from land mammals, on Gebe Island you can also find water mammals such as dolphins and whales which periodically cross the waters of Gebe Island. This group of aquatic mammals can be found in the eastern to southern waters of Gebe Island because these faunae migrate from the Pacific Ocean to the Maluku Sea. Dolphins can easily be seen from the beach in Umera Village because they pass not far from Umera Beach (Sulistiono et al., 2016).

3.5 Mining administrative area at Gebe Island

Gebe Island is a small island located between Halmahera Island and Papua. The geographical location of Gebe Island is located right on the imaginary equator at 0 degrees. Administratively, before becoming a sub-district, Gebe Island previously had village status. In 2001, Gebe Island changed its administrative status to Gebe District with eight village administrative areas. Gabe Island has an island length from northwest to southeast reaching 45 km, and a width of 1-7 km. The total area of Gebe Island is 153 square km (Sulistiono et al., 2016).

The area on Gebe Island consists of nine IUP areas that control mining land activities. The post-mining land will then change its function into a protected area which will then undergo a restoration process by the mining company. Based on the Decree of the Minister of Forestry concerning Amendments to Decree Number 514/KPTS-11/1999 concerning Designation of Maluku Forest and Water Areas, it is known that post-mining land areas will experience changes from production forests to protected forests. The currently active mining area on Gebe Island covers 111.6 square km, or around 70% of the area of Gebe Island. Therefore, if the total area of Gebe Island is compared between the area of the island and the Business Concession Permit, most of the island is used for the mining business sector (Ichi, 2018).

3.6 Mining conditions at Gebe Island

Administratively, Gebe Island is included within the scope of Halmahera Tengah Regency. Before becoming a definitive sub-district, Gebe Island is just a collection of several villages are administratively in the sub-district Patani, but with consideration for shorten the span of control, community services enhancement and speeding up development process, then on April 7 2001 the status of Gebe Village was raised became Gebe Island District with eight definitive villages, which are Umera, Sanafi, Kacepi, Kapaleo, Umiyal, Sanaf Kacepo, Yam, and Elfanun. The life phases of the people on Gebe Island start from living in trees to having houses on stilts. The people live in groups and have a culture with its own characteristics, namely "Babari". Babari culture is a habit of cooperation to help fellow residents and villages. Traditional values are still firmly held and adhered by the people of Gebe Island. The people of Gebe Island adhere to the principles of local wisdom which always want to live together in creating a safe, peaceful, and harmonious atmosphere among the community. This local wisdom is called the *Fagogoru* philosophy which is used as the basis for the people of Gebe Island to always maintain a safe and peaceful climate (Wibowo, 2008).

Every mining company is obligated to maintain all stages of mining operations and the environmental impact in Gebe, but a few mining companies left their mined-out area without any reclamation that caused land degradation in Gebe Island. Many Gebe residents cannot return to their previous jobs namely farmers and fishermen. They have great difficulty opening agricultural land because almost all the strategic land for the community has been used as a mining area. Ex-mining land that is not properly reclaimed also causes a decrease in soil quality so that the land becomes barren and difficult to plant (Wibowo,

2008). Mining with open pit method, the peeled overburden is moved to a disposal area that has no sediment called a waste dump. In mining with open pit method, can leave behind a former mining area in the form of a void. The mining void left at the end of mining without any utilization planning has the potential to cause undesirable impacts on the environment (Nurcahyani, 2011).

Apart from social problems, the negative impacts of nickel mining causing environmental degradation include changes in the landscape, especially in former mining areas, loss of fertile soil layers, increased critical land, decreased quality of surface water and sea water, decreased populations of endemic plants, disruption of mangrove forests and reefs. coral, as well as increased erosion and disruption of slope stability (Wibowo, 2008).

Weak enforcement of environmental law with the principle of sustainable development is caused by a clash between economic interests and environmental preservation. On the one hand, economic interests require the exploitation of nature to gain profits and fulfil human needs, but on the other hand, nature must also receive protection from human activities which are increasingly destroying nature. In this case, the law requires an environmental ethical approach. Environmental ethics helps identify existing problems to determine the direction of policies that will be implemented (Wibowo, 2008).

3.7 Mining impacts on communities and ecosystems at Gebe Island

The indigenous people of Gebe Island relied on dry-land farming and fishing for living. Their coconut farms produce copra and fruit trees that provide the majority of the people's income. Due to lack of finance, some farmers produce nutmeg and cloves (Prematuri et al., 2020). Conditions on Gebe Island, Halmahera, North Maluku, are increasingly worrying due to nickel ore mining activities by several companies in that location. One of the factors that causes problems with environmental conditions and community health conditions is heavy equipment activity. Heavy equipment activities with high intensity produce flying dust, thus disrupting the breathing of local communities. Apart from that, the activity of heavy equipment transporting ore from barges to ships also causes some of the material to fall into the sea, causing damage and pollution to the marine ecosystem (Ichi, 2018).

Fig. 3. Degradation of coral reefs ecosystem at Gebe Island (Ichi, 2018)

The dust problem caused by heavy equipment activities in nickel ore mining companies is still a polemic for the local community. This is because some people experience health problems and ARI. However, the local community feels confused because it is not clear which agency they should convey their aspirations to. Another problem that occurs because of mining activities on Gebe Island is massive damage or degradation of the ecosystem. After mining by the Antam company, there was damage to the ecosystem which formed large pools or holes due to mining, so restoration efforts were carried out by carrying out reforestation or planting trees again as a reforestation effort. However, after the restoration

was carried out, mining was carried out again by company which damaged the results of the restoration and reforestation (Ichi, 2018).

Ecosystem damage does not only occur in land ecosystems, but also has an impact on damage to marine ecosystems. One of the impacts of mining activities on Gebe Island's marine ecosystem is the destruction of coral reefs in the island's coastal areas. Coral reefs provide benefits as habitat for fish, so local people who work as fishermen often use coral reefs as fishing or hunting locations. However, the damage that occurs in the coral reef ecosystem causes the ecosystem to lose its services in providing life support functions for the surrounding community and other living creatures. The location of the coral reef ecosystem that has experienced the most damage due to mining activities is the southern part. The condition of coral reefs in the southern part is currently covered by mud sediment carried by erosion from mining areas. Meanwhile, damage to coral reefs in the northern part of Gebe Island is generally caused by the activities of residents who exploit them as building materials and fish bombing (Ichi, 2018).

Fig. 4. Shores conditions for ship parking at Gebe Island
(Ichi, 2018)

Ecosystem damage due to mining activities also occurs in mangrove forest ecosystems. The condition of the mangrove forests on Gebe Island is currently increasingly worrying because the condition of the forests that previously grew along the coastline is currently experiencing massive damage. The mangrove forest in Tanjung Oeboelie is currently not growing well because its surface is covered in mud sediment carried by erosion from mining and dumping of nickel ore (Ichi, 2018). The number of dissolved particles in a water, whether biological (phytoplankton, zooplankton, and biodegradation) or inorganic (sediment, red soil or clay, and minerals), increases the turbidity rate. This rise in turbidity could have a negative impact on fish habitats and fishing grounds (Sarianto et al., 2016).

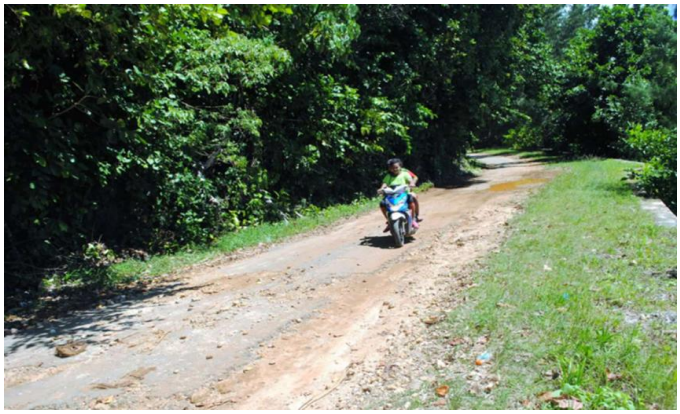

Fig. 5. Road conditions at Gebe Island
(Ichi, 2018)

The condition of ecosystem damage that occurs on Gebe Island can have an impact on the environmental, economic and social conditions of the community. The ecosystem on Gebe Island provides ecosystem services as a provider of habitat and resources, thus providing benefits to the surrounding community and other living creatures. Internal damage can result in a decline in the economic condition of the community, especially communities that rely on coral reef and mangrove ecosystems as a source of livelihood. One of the impacts of damage and degradation of the ecosystem on Gebe Island is the decline in the economy of the people of Gebe Island (Ichi, 2018).

The economic downturn has had an impact on social conditions on Gebe Island, resulting in an increase in people's need for goods and food sources. Apart from that, the high level of dust due to heavy equipment activity which has an impact on public health has triggered an increase in the need for free health facilities on Gebe Island. The condition of heavy equipment activity also has an impact on damage to road access to residential areas on Gebe Island, so that people experience access difficulties. The difficulty of public access connecting settlements with ports on the coast has an impact on the community's economic mobility. Economic activities tend to be hampered and slow due to the damaged roads on Gebe Island. Therefore, environmental damage and degradation on Gebe Island due to nickel mining has an impact on economic and social conditions in society (Ichi, 2018).

3.8 Post-mining solutions at Gebe Island

Mining can be seen as a significant disruption caused by human actions to landscapes. The extent of mining operations dictates the effects on landscapes. Clearly, the influence of mining on changes in the landscape is focused during the development phase, peak phase, and downturn phase. Mining operations cause the most significant disruption to landscapes during the peak phase. Following the end of mining, landscape restoration can occur in two ways: via human intervention or natural recovery. Nonetheless, it will require a considerable amount of time if this occurs through spontaneous recovery (Zhang et al., 2011). Abundant and manageable ecosystem services can sustain the Earth’s life support system. The reaction of ecological storage to the entire process of land use change indicates ecological dynamics. Clearly, the ecological storage comprises two varieties, positive and negative, in this mining community, and their spatial arrangements head in two entirely distinct directions. The overall quantitative balance for offsetting adverse ecological storage is insufficient to support uniform development across all areas. The intense distribution of land use can enlarge ecological or economic disparities and limit sustainable development across multiple industries (Zhang et al., 2010).

Based on the problems that occur in the post-mining environment on Gebe Island. There are several methods or methods that can be used to minimize the impact of nickel mining, such as ecosystem restoration, conservation of flora and fauna, closure of former mining sites, and community empowerment in the surrounding area. Efforts to restore ecosystems and conserve flora and fauna can be focused on returning the services of mangrove plants in coastal areas. The mangrove ecosystem on the coast of Gebe Island, which has been damaged due to pollution from mining waste and massive sedimentation, can be restored by replanting mangrove plants around the coast. Planting mangrove plants can restore mangrove ecosystem services in the area, so that biodiversity in coastal areas increases again. Restoration of the mangrove ecosystem can also increase economic and cultural value for the surrounding community because it can utilize mangrove plants as a source of life and economy for the community (Herdiansyah et al., 2018). Power measurements may be useful in resolving conflicts amongst indigenous peoples and mining companies. Indigenous people's concerns had to be taken seriously and they needed to be involved in the project’s deliberations and negotiations (Gibson, 2006).

Community development is a method of social work whose main objective is to improve the quality of life of the community through the utilization of existing resources and emphasizing the principle of social participation, because coastal communities generally

have heterogeneous characteristics with different backgrounds in terms of education, income and social status (Darmansyah et al., 2016). Local wisdom in the management of forest resources can continue to exist notwithstanding external cultural influences, attributable to certain elements originating from the tribal community itself, specifically the connection between the local community's factors and nature, which is conveyed through the philosophy of living in harmony (Tamalene et al., 2014).

Ecosystem restoration can also be carried out on coral reef ecosystems that have been damaged due to sedimentation. Sustainable coral reef restoration efforts can also restore biodiversity such as coral fish in the coastal area of Gebe Island. The reappearance of coral fish can stimulate the community's economy through the fishing and cultivation sectors, thereby improving community welfare. The government in Gebe District is currently also trying to restore the function of coastal areas as locations for fish and shrimp cultivation, so that coastal areas can again provide benefits to the community. However, obstacles related to ecosystem conditions that have not yet recovered optimally are an obstacle to optimizing fish cultivation on Gebe Island.

Efforts to restore the ecosystem and environment can help restore prosperity and economic conditions on Gebe Island. Community empowerment has also been attempted by the local government through fisheries cultivation efforts in coastal areas and utilization of ecosystem services. Therefore, restoration and community empowerment must continue to be developed to restore and minimize the impact of mining on Gebe Island.

4. Conclusion

Gebe Island is located in Halmahera Tengah, Province Maluku Utara. Gebe Island has quite large mining resources, however there is a lack of human resources to manage its natural resources. The social impacts resulting from nickel mining on Gebe Island include contribution to regional income, increasing employment opportunities, and opening isolated areas, but apart from that there are also negative impacts such as decreasing activity and socio-economic life in the post-mining stage. The negative impacts of nickel mining causing environmental degradation include changes in the landscape, especially in former mining areas, loss of fertile soil layers, increased critical land, decreased quality of surface water and sea water, decreased populations of endemic plants, disruption of mangrove forests and reefs. coral, as well as increased erosion and disruption of slope stability.

The law requires an environmental ethical approach that helps identify existing problems to determine the direction of policies that will be implemented. Apart from that, the implementation and supervision of environmental laws regarding nickel mining must also be carried out strictly. The government needs to involve the community as the figures closest to the impacts caused by mining activities. Coaching, empowering and increasing community participation can increase the synergy between stakeholders so that the application of environmental law can be more effective.

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