Degradation of fishing grounds in the coastal area of Tangerang Regency

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Abstract. Industrial activities, housing and port activities, and fishing have an impact on ecosystems in coastal areas. Tangerang Regency is dominated by small-scale capture fisheries that catch fish as far as four miles from the coastal area. This study used a survey method to determine the degradation level of fishing grounds and spatially map the degradation level of fishing grounds in the coastal area of Tangerang Regency. Data on sea surface temperature, water clarity, odor, plastic waste, salinity, pH, and dissolved oxygen (DO) were collected *in situ*, while chlorophyll information was obtained *ex situ*. Moreover, data on environmentally friendly capture fisheries were collected from literature study. Fishing grounds degradation status was determined through a combined scoring of water quality and environmentally friendly capture fisheries conditions. Water quality, environmentally friendly fishing gear, and fishing grounds degradation status were then spatially mapped by analyzing marine geographic information systems. The results showed a sea surface temperature range of 30.1-32.2°C, water clarity of 0.5-4.3 m, salinity of 31.1-32.3 ppm, chlorophyll-a concentration of 0.67-9, 11 mg L^{-1}, DO of 5.1-10.1 mg L^{-1}, and pH of 8.1-8.4. Furthermore, parameters of water clarity, odor, and plastic waste were lower than seawater quality standards. The water quality condition in the coastal area of Tangerang Regency is lightly polluted, and the fishing gears are not environmentally friendly. These conditions contribute to the degradation of fishing grounds, with a correlation value of 0.77 and a determination value of 58.6%. Therefore, the coastal area of Tangerang Regency has experienced mild fishing grounds degradation.
Key Words: fishing gear, small fisheries, water quality.

Introduction. The coastal area of Tangerang Regency has high natural resource potential that supports economic growth in various sectors. The development supports community needs, including education, tourism, fisheries, marine sectors, and industry. The fisheries and marine sectors are the mainstay of Tangerang Regency, generating regional income, mostly by small-scale fisheries. The fishery commodities produced are used to meet local needs and partly to meet the needs of the people of Jakarta. Additionally, developments in the industrial sector help meet the needs of the wider community. Small-scale fisheries could significantly contribute to the livelihoods, food security, nutrition, and welfare of coastal communities (Stacey et al 2021). Small-scale fisheries are an important dimension of marine resource sustainability (Warren & Steenbergen 2021). Therefore, the management of coastal areas must focus on environmental sustainability to synergize economic and social activities (Trinanda 2017) and not destroy the income of small fishers (Royandi & Keiya 2019). Damage to coastal ecosystems can cause fishing activities to be abandoned by fishermen because they are no longer profitable (Handayani et al 2020).

The environmental sustainability of small-scale fisheries in the Tangerang Regency is influenced by activities on the mainland and government regulations. Damaianto & Masduqi (2014) stated that various waste and pollutants lead to environmental degradation in coastal areas and the surrounding ecosystem. Excessive organic and inorganic substances are reported to negatively impact marine waters and reduce the physical, chemical, and biological seawater quality. Furthermore, microplastic inorganic waste has reached the food chain in the ocean and has been consumed by humans through contaminated seafood (Piyawardhana et al 2021). Plastic waste can affect the life of biota, especially coral reefs (Muhammad et al 2021). According to Gholizadeh et al (2016), changes in vulnerable

ecosystems due to anthropogenic activities endanger the habitat of fish and other water organisms. The quality of the aquatic environment and coastal ecosystem is reduced by pollution from inland activities, such as industry, households, agriculture, and marine transportation (Lasabuda 2013). Moreover, coastal land use for settlements, offices, industry, and trade has damaged this area (Kakisina et al 2015). The presence of the fish, the target of the catch, is getting farther from the coast. The fishermen cannot fish outside the coastal area of Tangerang Regency because of the limited capabilities of their vessels. Ships measuring <5 gross tonnage (GT) cannot reach fishing grounds further away from the coast, causing a decrease in income.

The fishing grounds in the coastal area of Tangerang Regency are degraded by fishery, marine economic activities and coastal land use. According to Simbolon (2019), degradation of fishing grounds could be caused by pollution and commercial capture fishing activities. In line with this, Limbong & Syafrie (2018) found that non-environmentally friendly fishing gear, such as Danish seine and dredge net, directly damages aquatic ecosystems. Low awareness of the negative effects of using non eco-friendly fishing gear is a major problem in coastal areas (Nurdin & Grydehøj 2014). Furthermore, environmental change should be studied with an approach to aquatic oceanographic parameters, such as sea surface temperature, salinity, water clarity, pH, chlorophyll concentration, and dissolved oxygen (DO), to determine the water's quality in Tangerang Regency. Various activities that cause damage to the aquatic environment and degrade fishing grounds should be identified in order to overcome the problems. Proving the fishing grounds degradation would highlight the current condition of the waters on the coast of the Tangerang Regency. Also, studies on the quality of marine waters, including sea surface temperature, water clarity, salinity, pH, DO, could be used as indicators of water pollution (Hamuna et al 2018).

Fishing grounds in the coastal area of Tangerang Regency experience great pressure from socio-economic activities and nature, such as wind, waves, tides, currents, and sediment transport. The pressure received by the aquatic environment must capture the attention of stakeholders in the fisheries business to ensure that the aquatic environment produces resources, especially fish, which meet community needs. Therefore, a study on the degradation of fishing grounds in the coastal area of Tangerang Regency is necessary to ensure sustainable management to increase fishermen income and preserve natural resources; thus, this was established as the aim of this study.

Material and Method

Data collection. This study was conducted for one year in 2021 and consisted of three stages. The first stage was a preliminary survey. The second stage was primary and secondary data collection on the coastal area of Tangerang Regency from April to June 2021. A survey method was used, where primary data on water quality consisted of sea surface temperature, water clarity, odor, plastic waste, salinity, pH, and DO. Specification of analysis and methods of seawater quality data collection can be seen in Table 1. Data on water quality were collected directly (*in situ*) in 50 sampling points selected using purposive sampling by considering the characteristics of Tangerang Regency water. The territorial waters of Tangerang Regency and the sampling point can be seen in Figure 1. In contrast, chlorophyll-a was obtained *ex situ* through remote sensing techniques by downloading the Aqua MODIS image at https://oceancolor.gsfc.nasa.gov/, a properly corrected level 3 data type. Daily image with a spatial resolution of 4 km was adjusted to the study period.

Primary data on eco-friendly fishing gears and fishing grounds degradation status were collected by interviews designed through questionnaires for fishermen. Samples were determined by incidental sampling of ten fishermen at each fish landing area. Furthermore, secondary data on capture fisheries potential were obtained from Ministry of Marine Affairs and Fisheries. Data on eco-friendly fishing gears were obtained from literature studies.

Table 1

Parameters and methods of seawater quality analysis

Parameter	*Collection method*	*Specifications of analysis tools/methods*
Sea surface temperature	*In situ*	Digital thermometer
Water clarity	*In situ*	Secchi disk
Odor	*In situ*	The five senses
Plastic waste	*In situ*	The five senses
Salinity	*In situ*	Refractometer
pH	*In situ*	PH meter
Dissolved oxygen (DO)	*In situ*	DO meter
Chlorophyll-a concentration	Remote sensing	Geographic information System

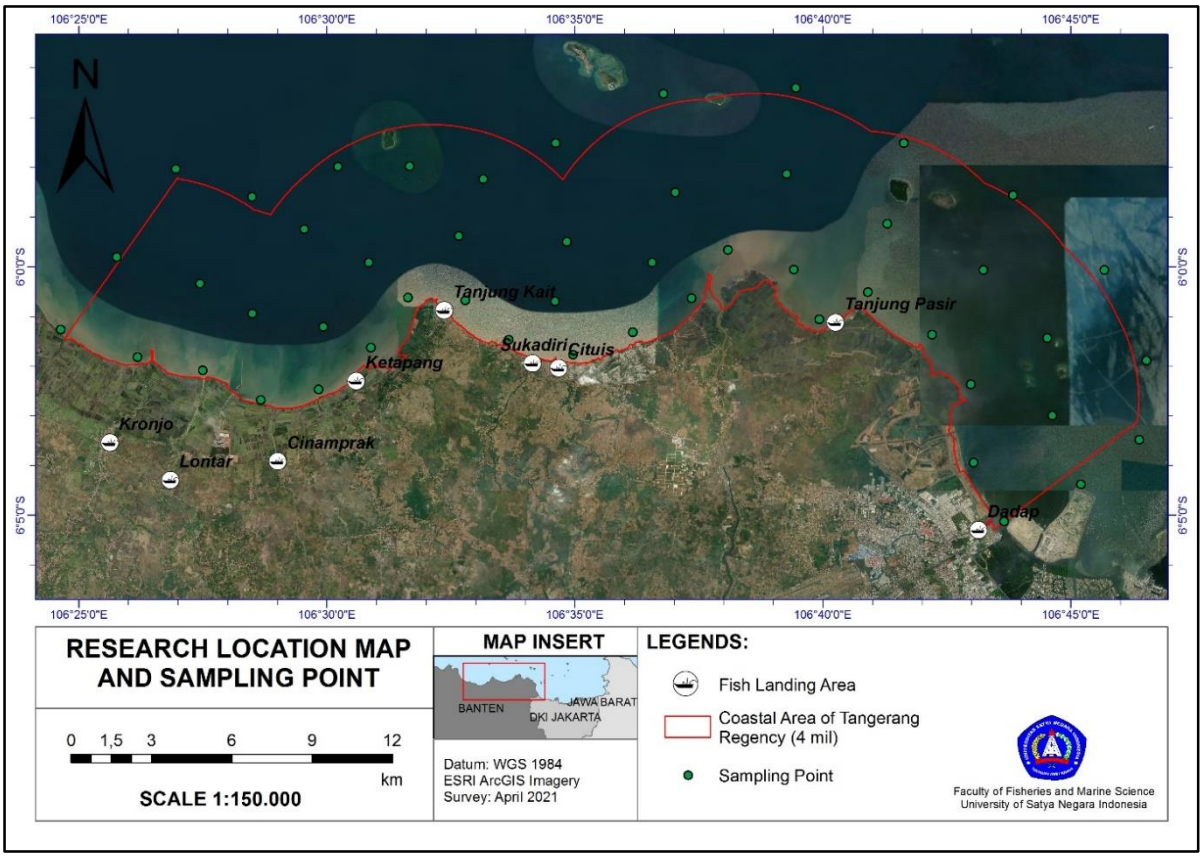

Figure 1. The location of the coastal area of Tangerang Regency.

Data analysis

Water pollution status. Data on *in situ* measurements on water quality parameters were analyzed descriptively. It involved comparing the results with the quality standards of seawater for marine biota based on the Decree of the Minister of the Environment Number 51 of 2004 concerning Sea Water Quality Standards devoted to marine life. Pollution status was determined using the Pollution index according to the Decree of the State Minister of the Environment Number 115 of 2003 (Nemerow & Sumitomo 1970) as follows:

$$PI_j = \sqrt{\frac{\left(\frac{C_i}{L_{ij}}\right)_M^{\ 2} + \left(\frac{C_i}{L_{ij}}\right)_R^{\ 2}}{2}}$$

Where: L_{ij} - the concentration of water quality parameters in water allocation quality standards (j); C_i - concentration of survey water quality parameters; PI_j - pollution index for designation (j); $(C_i/L_{ij})_M$ - maximum Ci/Lij value; $(C_i/L_{ij})_R$ - average Ci/Lij value.

The relationship between the pollution level and the criteria for its index based on the Decree of the State Minister of the Environment Number 115/2003 concerning the Determination of Water Quality Status is as follows: $0 \leq PI_j \leq 1$ - water meets quality standards (good condition); $1 < PI_j \leq 5$ - water is lightly polluted; $5 < PI_j \leq 10$ - medium polluted water; $PI_j > 10$ - heavily polluted water.

Environmentally friendly capture fisheries status. The aspects of environmentally friendly fishing gear were analyzed based on nine criteria according to the Code of Conduct for Responsible Fisheries (CCRF). This is a procedure issued by the Food and Agriculture Organization (FAO) for responsible fishing activities to preserve marine resources. The nine criteria include having high selectivity, do not destroy habitats, producing high-quality fish, do not harm fishermen, production does not harm consumers, low by-catch, low impact on biodiversity, does not harm protected fish, and being socially accepted. The environmental friendliness levels are: damaging the environment ($1 < x \leq 9$); not environmentally friendly ($10 < x \leq 18$); less environmentally friendly ($19 < x \leq 27$); environmentally friendly ($28 < x \leq 36$), where x is the sum of the average values of the nine CCRF criteria.

The study of Limbong & Syafrie (2018) was the reference regarding identifying environmentally friendly fishing gear in the waters of the Tangerang Regency. The dominant fishing gear used is based on the level of environmental friendliness, and includs: gillnets - less environmentally friendly; traps - less environmentally friendly; handline - environmentally friendly; trawler - not environmentally friendly; lift nets - less environmentally friendly; scallop collecting tools - not environmentally friendly.

Fishing grounds degradation status. The determination of fishing grounds degradation in the coastal area of Tangerang Regency was based on water quality parameters and environmentally friendly capture fisheries. Each parameter was analyzed partially with a scoring system, and the evaluation results were used to determine the fishing grounds degradation. The last stage was to group the combined scoring values determined by adding the values of the two parameters (Table 2).

Table 2

The combined scoring value of fishing grounds degradation in Tangerang Regency waters

Parameter	*Category*	*Scoring*
Water quality	Heavily polluted	1
	Medium polluted	2
	Lightly polluted	3
	Meets quality standards (good condition)	4
Environmentally friendly capture fisheries	Damaging the environment	1
	Not environmentally friendly	2
	Less environmentally friendly	3
	Environmentally friendly	4

The status of the combined scoring values of the two parameters are grouped into: 1. a combined scoring value ranging between 2-4 implies a heavy fishing grounds degradation; 2 - a combined scoring value range of 5-6 implies a mild fishing grounds degradation; 3 - a combined scoring value range of 7-8 implies no fishing grounds degradation.

The relationship between fishing grounds degradation with water quality parameters and environmentally friendly capture fisheries was analyzed using multiple linear regression equations, as follows:

$$Y = a + bX_1 + cX_2$$

Where: Y - fishing grounds degradation; X_1 - water quality parameters; X_2 - environmentally friendly capture fisheries parameters; a - intercept; b - water quality coefficient; c - environmentally friendly capture fisheries coefficient.

Correlation analysis was conducted to determine the relationship between fishing grounds degradation with water quality parameters and environmentally friendly capture fisheries using the SPSS 25 software. The degree of relationship is expressed by the correlation coefficient (r), the root of the coefficient of determination (R^2). The range of correlation coefficient values is $-1 \leq r \leq +1$, where the correlation is high when $r \geq 0.7$ and $r \leq -0.6$, while the correlation is low when $-0.6 < r < 0.7$. The t-test was used to test each variable partially.

Spatial mapping of fishing grounds degradation. Spatial mapping was conducted on water quality data, environmentally friendly capture fisheries data, and fishing grounds degradation status in Tangerang Regency waters, using a marine geographic information system (GIS) with ArcGIS 10.8 software. In GIS, the data used has a georeferenced system, and a spatial database is built by considering the allowed error limits to develop a topology correctly. Moreover, the relational data model is used to design a database, and the attribute data fields are defined correctly. Where possible, each attribute data field should be formulated correctly, and each variable for data manipulation purposes must be represented in the database.

Spatial mapping of water quality, environmentally friendly capture fisheries, and fishing grounds degradation status must be supported by the Data Base Management System (DBMS) to function as an information system. DBMS is essential in manipulating, analyzing, and presenting spatial data. Digital thematic maps are made in marine GIS with the following steps:

1. Input Data: The attribute data from the score is entered into the marine GIS analysis (ArcGIS software) to generate a shapefile (*.shp). This corresponds to the position of the data sampling in the waters.
2. Interpolation: Shapefile shape attribute data (*.shp) is interpolated to produce a spatial distribution and turned into raster data. The interpolations used are Inverse Distance Weighted (IDW) and Kriging.
3. Map Layout: Making a spatial distribution map must comply with the requirements of a good map, including conformity, equidistance, equivalence. Therefore, it must have several elements such as title, scale, legend, latitude, longitude, and source.

Results and Discussion

Tangerang Regency water quality. The results showed that the sea surface temperature (SST) values ranged between 30.1-32.2°C, the clarity was 0.5-4.3 m, the salinity was 31.1-32.3 ppm, the chlorophyll-a concentration was 0, 67-9.11 mg L^{-1}, DO was 5.1-10.1 mg L^{-1}, and pH was 8.1-8.4. The odor of water areas close to the coast and estuary was bad, while the plastic waste was found near river mouths. The measurement results are presented in Table 3. Several water quality parameters are classified as good, based on the Decree of the State Minister of the Environment Number 51 of 2004 concerning Seawater Quality Standards.

Table 3

Results of water quality measurements in coastal area of Tangerang Regency

Water quality parameters	*Measurement value*	*Average*	*Quality standards*
SST (°C)	30.1–32.2	30.7	28-32
Clarity (m)	0.5–4.3	1.6	>3
Salinity (ppm)	31.1–32.3	31.5	<34
pH	8.1–8.4	8.3	7-8.5
DO (mg L^{-1})	5.1–10.7	6.9	>5
Chlorophyll concentration (mg L^{-1})	0.67–9.11	4.3	<15
Odor	Smell	-	Natural
Plastic waste	Available	-	Unavailable

Sea surface temperature is a physical parameter of the waters that plays an important role for marine biota and water ecosystems. The survival and growth of water biota have different tolerance limits for temperature. The average value of SST for the waters of Tangerang Regency is 30.7°C, and the SST value is consistent with the temperature parameter quality standard for marine life of 28-32°C. The interviews with fishermen in Kronjo and Kemiri Sub-Districts showed that the construction of the Lontar's electric steam power plant caused changes in fishing locations due to changes in water temperature.

Water quality in Tangerang Regency was categorized as good according to seawater quality standards and lightly polluted. Moreover, water quality in Ketapang and Tanjung Kait villages was classified as good, while others were classified as lightly polluted. The analysis showed that the Tangerang Regency waters are not moderately or heavily polluted. Parameters of clarity, odor, and plastic waste are consistent with seawater quality standards. This consistency with the seawater quality standards for biota is due to the insignificant influence of land activities because the in-flowing river is not big and cannot be used as a mooring for fishing boats. The map of the spatial distribution of water quality in Tangerang Regency can be seen in Figure 2. The area of Tangerang Regency waters that has been lightly polluted is about 231 km^2, while around 70 km^2 are in good condition. This area is four miles from the coastline used by fishermen. About 77% of the waters have been lightly polluted, while 23% are good for marine life.

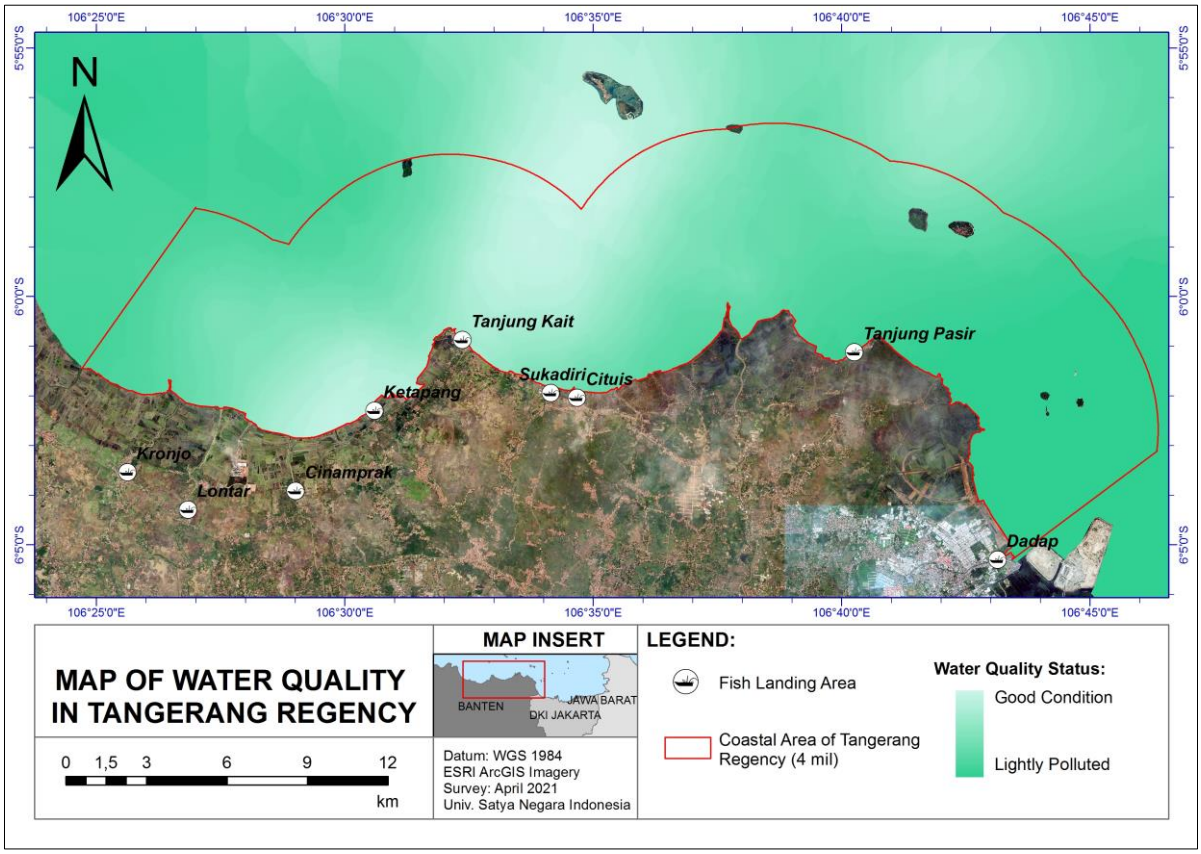

Figure 2. Spatial map of water quality in Tangerang Regency.

Mustikasari et al (2019) stated that the water temperature between 28.6-30.3°C favors the growth and development of various marine life. The SST value in Tangerang Regency waters is consistent with the SST range on the coast of the Java Sea, of 27-31°C (Putra et al 2012) and 30.5-31°C in Kendal waters, Central Java (Agung et al 2018). Furthermore, the SST range in the Java Sea follows the seasonal pattern in Indonesian waters, where the highest SST value occurs during the West-East transition season. Water clarity in the coastal area of Tangerang Regency is about 1.6 m, less than the seawater quality standard for biota. The water clarity represents the transparency level that determines the

photosynthesis level of biota in marine waters (Hamuna et al 2018). The levels of clarity and turbidity of seawater influence the growth of marine life. The low clarity occurs due to the high supply of organic and inorganic sediments and dissolved particles originating from river flows. Farther from the coast, the water clarity is higher. On the contrary, it is lower towards the land because it is dependent on sedimentation from rivers (Patty et al 2020).

The pH value of the Tangerang Regency waters is 8.3 and is in good condition for biota life. Simbolon (2016b) found the pH value of the waters on the coast of Jakarta to be 8, categorized as good for biota life, according to quality standards. The pH and temperature, and DO in the Java Sea are positively correlated. Changes in pH and DO are influenced by algal photosynthesis, respiration, water temperature, and decomposition of organic compounds (Meirinawati & Iskandar 2019). DO is needed by almost all biota for respiration, metabolic processes, or the exchange of substances, producing energy for growth and reproduction. The DO content in Tangerang Regency waters was 6.9 mg L^{-1}, considered good according to seawater quality standards. Simbolon (2016a) noted that the DO value of 7.89 mg L^{-1} in Cituis waters was good and suitable for the life of aquatic biota.

The abundance of phytoplankton is strongly influenced by water parameters such as pH and ammonia, which have a direct impact on the abundance of zooplankton (Pratiwi et al 2016). The observation of chlorophyll-a parameters in Tangerang Regency waters showed an average of about 4.3 mg L^{-1}, classified as good. Therefore, Tangerang Regency waters could be classified as mesotrophic (<5 mg L^{-1}) with moderate chlorophyll-a content. Its coastal area with many rivers carrying nutrients from the mainland results in high chlorophyll-a content. Limbong (2020) stated that chlorophyll-a in Tangerang Regency waters reached 6.10 mg L^{-1}, classified as high, characterizing fertile waters. This is in line with the finding of the chlorophyll-a content in the coastal areas of the northern Java waters such as Kendal, Central Java, which is categorized as high, reaching 4.8 mg L^{-1} (Agung et al 2018). The highest and lowest chlorophyll-a contents in the Java Sea occur in the West monsoon and the East-West transition season, respectively (Putra et al 2012). According to Hermawan et al (2021), chlorophyll can affect fish catches up to 62.2%, so it can be used in predicting fishing grounds. Furthermore, waters in Tangerang Regency located at the river mouth are dominated by the smelly plastic waste. This is because the rivers flowing into the coastal waters are used as moorings for fishing boats. The mooring activities at the mouth of the river produce plastic waste from unloading the catch, cleaning and repairing ships, and the process of buying and selling the catch. The plastic waste in the waters of Tanjung Kait, Tangerang Regency is also reported to negatively impact marine life ecotourism (Setyawan et al 2020). Additionally, Ford et al (2021) stated that plastic pollution in the sea contributes to global warming, occurring in almost all Indonesian waters. According to Hermawan & Sidik (2019), Indonesia is the second-largest contributor to plastic waste in the sea worldwide.

Several studies show that the northern waters of Java Island are lightly or moderately polluted. Cituis waters in the West-East transition season (April) are moderately polluted due to land activities (Argarini 2014). Similarly, Cilincing waters are moderately polluted due to human settlements and activities at sea (Simbolon 2016b). The coastal waters of Cilegon City are polluted by the use of open spaces, such as settlements, agriculture, and industry, affecting the capture fisheries sector (Fransisca 2011). The coast of Brebes Sub-District (Gemilang & Kusumah 2017) and Kartini beach in Jepara, Central Java (Riza et al 2015) are lightly polluted, while Semarang Bay waters are moderately polluted (Gaus et al 2018).

Environmentally friendly fishing gears in Tangerang Regency. The fishing gear most widely used by fishermen in Tangerang Regency waters include traps, gill nets, handline, dredge net, lift net, seine net, and Danish seine. Subsequently, shell collecting tools and Danish seine are not environmentally friendly fishing gears. Gill nets, traps, and lift nets are less environmentally friendly, while handlines are environmentally friendly. Based on the literature, the spatial distribution of environmentally friendly fishing is mapped. Therefore, most of the Tangerang Regency waters are classified as less environmentally friendly.

The status of fishing in the waters of Kronjo and Kemiri Subdistricts is classified as not environmentally friendly. The less environmentally friendly fishing is found in the Sub-Districts of Mauk, Sukadiri, and Kosambi, while Pakuhaji and Teluk Naga Sub-Districts have environmentally friendly fishing (Figure 3). The Regency's water area indicated as non environmentally friendly is 53 km^2, the less environmentally friendly is 115 km^2, and the environmentally friendly area is 133 km^2. 44% of Tangerang Regency's waters are environmentally friendly based on the fishing gear used.

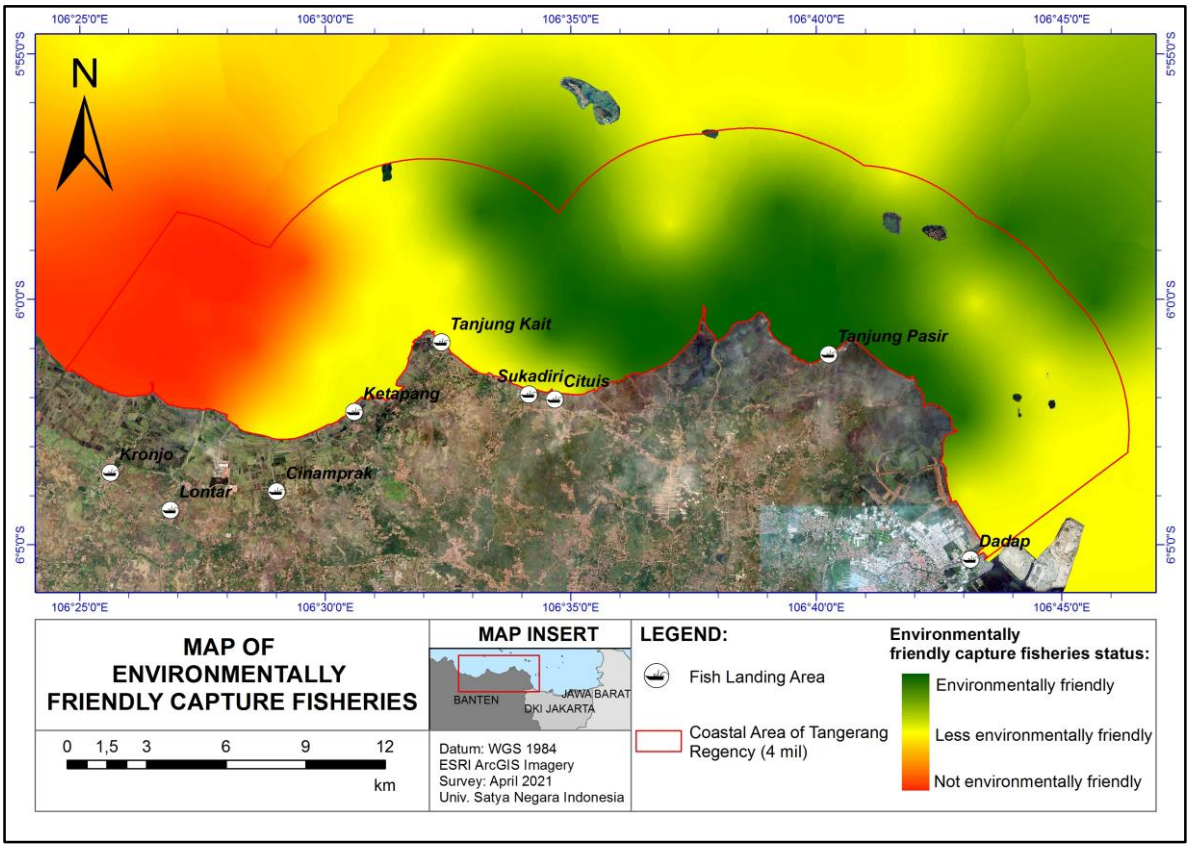

Figure 3. Spatial map of environmentally friendly capture fisheries in Tangerang Regency.

Environmentally friendly fishing status is obtained based on the distribution of the fishing gear used. The use of dredge net and Danish seine is the main cause of ecosystem damage. Testing the escape rate with the 2, 3, and 4-inch square mesh window types has not increased the selectivity level of Danish seine in the Java Sea waters (Hufiadi et al 2014). The dominance of less environmentally friendly fishing in Tangerang Regency waters is due to local government and coastal communities' lack of attention. The local government has not regulated fishing activities, such as providing fishing gear to replace the dredge net and Danish seine. Furthermore, sustainable management of fishery resources in Indonesia has not empowered stakeholders with responsibilities and authority in running the business (Widowati et al 2019). Therefore, the role of the government through village assistants, non-governmental institutions, and academics is needed to apply technology to produce sustainable fisheries (Nawastuti 2018).

Most of the coastal communities of Tangerang Regency are migrant fishermen with no local wisdom to protect fish resources. The Danish seine fishermen at Kronjo come from Central and East Java with no wisdom about the sustainability of water resources in the Tangerang Regency. Local wisdom reduces damage to the water environment, such as overfishing, because it contains religious, cultural, and socio-economic values to support the sustainable management of marine resources (Ambarini et al 2018). Some coastal areas applying local wisdom have the ability to maintain environmental sustainability, especially fish resources. For instance, local wisdom in Situbondo Regency plays a role in

preserving fish resources, especially coastal biota (Ibad 2017), and local wisdom in Bali and Nusa Tenggara has been proven to have a positive impact on sustainable capture fisheries management (Widarmanto 2018).

Fishing grounds degradation level in Tangerang Regency waters. The degradation level of fishing grounds in Tangerang Regency was analyzed using data on water quality and capture fisheries conditions. The analysis showed that the quality of polluted waters and non environmentally friendly fishing gear significantly influence the degradation of fishing grounds. This is seen from the correlation (r) and determination (R^2) values of 0.77 and 58.6%, respectively. Furthermore, the t-test analysis showed that non environmentally friendly fishing degrades fishing grounds, while water quality has no significant effect. Environmentally destructive fishing gear, such as Danish seine and dredge net, damages the marine biota ecosystem in Tangerang Regency. Moreover, the use of the two fishing gears, besides the illegal size of the dominant marine biota caught, damages the basic aquatic ecosystem.

Tangerang Regency has an ocean area of 300 km^2, calculated as four miles from the coastline for fishing vessels <5 GT. People living in coastal areas generally work as fishermen, comprising 3,439 fishing households, fishing vessels, and fishing gear units. One fishing household, vessel, and the fishing unit could utilize about 0.08 km^2 of sea space. The sea space in the Tangerang Regency is highly utilized for capture fisheries and tends to be over-exploited. The coastal fishing degradation reduces the production value, affecting the fishermen welfare.

The Tangerang Regency waters experience degradation of fishing grounds, although the degradation is not yet in the heavy category. In contrast, the waters of Kronjo, Lontar Village in Kemiri Sub-District, Dadap in Kosambi Sub-District, Mauk Sub-District, and Cituis in Sukadiri Sub-District experienced a higher fishing grounds degradation. Conversely, the Pakuhaji Sub-District waters and Tanjung Pasir of Teluk Naga Sub-District have not experienced fishing grounds degradation and are classified as good. The area is close to Seribu Islands, only reached by fishing boats measuring over 25 GT.

The degradation of fishing areas in the northwest of the Tangerang Regency waters is higher compared to the north and northeast directions, as presented in Figure 4. This is due to a large number of dredge net and Danish seine fishing gear operating in the northwest direction. The degradation of fishing grounds towards the northeast of Tangerang Regency waters is high. It is caused by polluted water quality. There is no dredge net and Danish seine fishing gear in Dadap. Water pollution is caused by land residential and industrial activities and marine activities, such as coastal reclamation. The northeastern area of Tangerang Regency is directly adjacent to the Jakarta Province. The mild fishing grounds degradation in the northern waters of Tangerang Regency occurs due to the fewer fishing activities with destructive tools. Coastal communities generally prefer lift net fishing, green mussel cultivation, and sport fishing, and most fishermen rent boats for sport fishing. The area of Tangerang Regency waters that experienced mild fishing grounds degradation is 61% or 184 km^2, while 117 km^2 have not been degraded.

66% of fishing vessels in Tangerang Regency measure <5 GT, operating four miles from the coast (Limbong 2020). Coastal activities with small-scale fisheries are important in maintaining fisheries sustainability (Warren & Steenbergen 2021). The decline in fishing grounds on the coast reduces income as experienced by the entire fishing fleet, such as gill nets, hand lines, traps, and dredge net. Degradation of the aquatic environment directly impacts fishing grounds. Specifically, the coastal areas affected by land activities are vulnerable to environmental pollution. Furthermore, coastal areas would always be a disagreement issue for small fishermen, resulting in overfishing. The waters of Jakarta Bay have experienced degradation of fish resources and the aquatic environment through water pollution and damage to the mangrove ecosystem (Nugraha et al 2020). The status of demersal fish resources around the coast in the Indramayu Regency points to overfishing and resource degradation (Yulianto et al 2016). Several studies on the coast of the Java Sea show that higher environmental degradation results in fishing grounds degradation, impacting fishermen welfare.

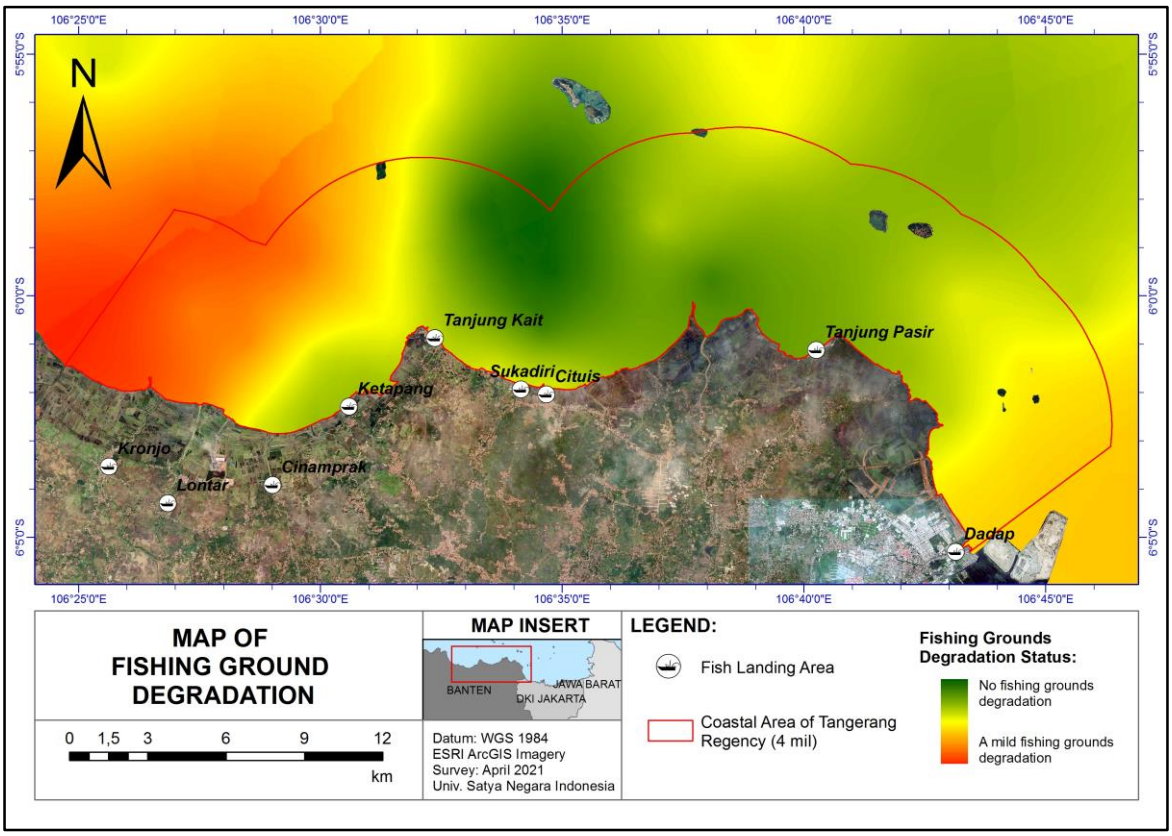

Figure 4. Spatial map of fishing ground degradation in Tangerang Regency.

Fishing grounds degradation needs serious attention from stakeholders such as the government, business enterprises, and academics. Furthermore, the aquatic environment degradation that reduces fishing grounds should be controlled, including land and fishing activities. The fishing gear that damages the environment needs to be limited, such as replacing dredge net and Danish seine with gill nets and handlines. Good aquatic environmental management would positively impact the sustainability of fishery resources in the future. The high fish catch production has a positive impact, but could reduce income and food security in the long term (Wijayanto et al 2020).

Conclusions. The coastal area of Tangerang Regency has experienced light fishing ground degradation of around 61%, covering 184 km^2. The parameters of water temperature, salinity, pH, DO, and chlorophyll-a are in good condition, while clarity, odor, and plastic waste are inconsistent with the seawater quality standards for biota. Furthermore, the waters have been lightly polluted, in a level of 77%, covering 231 km^2. The most influential factor in degrading fishing grounds is the use of non environmentally friendly fishing gear. Furthermore, non environmentally friendly fishing gear is used in 53 km^2 of the waters, less environmentally-friendly fishing gear is used in 115 km^2, while environmentally friendly fishing gear is used in 133 km^2, accounting for 44%.

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Conflict of Interest. The authors declare that there is no conflict of interest.

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