IS THERE A RELATIONSHIP BETWEEN PURIFICATION AND CARRYING CAPACITY OF ECOSYSTEM IN COASTAL REGION?

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Abstract

The coast is an area that has very high activity. It is estimated that 60% of the world's population lives in coastal areas. Various types of pollution enter this area. Halogenated hydrocarbons, pesticides, marine biotoxins, synthetic fertilizers, livestock and fisheries waste, heavy metals, hot water waste, and radioactive substances. The coastal area is a natural ecosystem built by a unique ecosystem, including mangrove forests, seagrass beds, and coral reefs. The three ecosystems interact with each other dynamically and are interdependent. One of the characteristics of natural ecosystems is self-purification so that their carrying capacity is optimal. Coastal self-purification capacity is built by the synergy between physical, chemical, and biological components and their morphology-hydrology. Self-purification mechanisms include filtering, transformation, degradation, and decomposition. Self-purification is a coastal ecosystem's ability to accept a certain amount of waste in a complex natural process. Before there are indications of a decline in its designated function, the implementation of self-purification will effectively support the optimization of carrying capacity, namely the ability of ecosystems to support population life. There are three factors related to carrying capacity: the availability of natural resources, population size, and consumption level.

Keywords:

Coastal area, self-purification, and carrying capacity

A. Introductions

Coastal is an area of relatively shallow marine waters. However, it has very high productivity compared to the deep sea, which has a larger area. Coastal areas contribute 60 percent of ocean productivity. This condition is supported by the richness of ecosystems in coastal areas. For example, mangroves, coral reefs, and seagrass fields into dining and spawning grounds for several aquatic fauna species (Bengen, 2002). Besides, coastal areas contain a wealth of non-renewable natural resources, such as oil, gas, minerals, and environmental services (Dahuri et al., 2001). The large potential of coastal natural resources encourages various economic activities in this region.

The development growth in the coastal areas shows higher activity. It is estimated that nearly 60 percent of important cities in the world are located in coastal areas. Then it is estimated that 60 percent of the world's population are in coastal areas. This means 3.4 billion people live on the coast and make the coast as landfills, sewage, and toxic waste. On the other hand, land contamination from all activities through rivers will enter coastal waters. The high activity of coastal areas is in line with the increasingly pressing land on land due to economic activity. The implication is that coastal areas become a new alternative for development.

Coastal areas have a high diversity of natural resources. So that many stakeholders have activities in this area with different interests. The implication is that the utilization of natural resources in coastal regions can eliminate one another. If this condition is neglected, it has the potential to accelerate environmental degradation in coastal areas.

Experience in coastal natural resource management shows an extractive picture. As a result, massive damage to coastal natural resources has occurred in various parts of the world. One indication of degradation in coastal areas is foreign chemical compounds and high sedimentation in the coastal water system. Suppose these chemical compounds and solids are in a certain amount and impact changing the ecological function of coastal waters ecosystems. In that case, it can be said that pollution has occurred.

Coastal areas, as open natural ecosystems, can carry out self-purification or self-purification. The self-purification process is a natural law of an ecosystem capable of neutralizing chemical compounds through a complicated process. Several studies on self-purification in nature have been carried out, including Otsuka et al., (2006) on the efficiency of self-purification, Ostroumov (2004), Kohata et al., (2003) about self-purification in aquatic ecosystems. Boaden (1996) stated that there are many types of research related to the coast because of its high biodiversity and this area, which has significant economic and aesthetic values for humans. The implication is that the beach becomes the densest economic space with its various activities.

Studies on coastal areas' self-purification capacity are becoming increasingly crucial amidst the rapidly growing economic activity in this region. This study can be an indication of the carrying capacity of the coast. Furthermore, information about coastal self-purification about carrying capacity becomes necessary information that is very important in coastal environmental management planning. It is hoped that this essential information will strengthen sustainable coastal development.

This paper aims to discuss the characteristics of typical coastal ecosystems, concepts, and factors that play a role in the self-purification of coastal ecosystems and their relation to their carrying capacity. The system includes:

- The introduction.
- The concept of the coastal ecosystem.
- The characteristics of the typical coastal ecosystem.
- Sources and Types of Pollution in the Coastal Environment
- Self-purification Capacity Relation to Carrying Capacity
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B. Coastal Conceptions and Characteristics of the Ecosystem

1. Coastal Conception

Several kinds of literature provide coastal concepts (Bengen, 2002), (Boaden, 1996), and (Beatly et al., 2002), namely; (1) areas that are still affected by the two regimes are land phenomena such as sedimentation and river flow with oceanic phenomena such as tides, waves, winds, and interference; (2) the meeting area which is influenced by the characteristics of the sea and land while the real coastal boundary does not exist; is an area of the interface where land, atmosphere, and oceans interact in a vulnerable balanced by natural and human influences.

The concept mentioned above illustrates the characteristics of a very dynamic coastal area with varied ecosystems. Besides having great potential, the coastal environment is an area that is vulnerable to development activities. The high vulnerability of the coastal area is due to the dynamic interaction of the two forming regimes. This is in line with (French, 2004) which states that coastal areas and oceans are complex systems; in it there is an interaction of various processes: natural (e.g., hydrology and geomorphology), social, cultural, welfare, and governance. Another view is conveyed by (Turner et al., 1998) that the environmental and socio-economic aspects of the coastal areas provide three economic values, namely (1) direct use values, for example, the value of fishery resources and the value of oil or gas resources; (2) indirect use values such as wave breaks and aberration for coral reefs and mangrove forests; (3). the value is not in order, for example, the value of heritage's existence and value (*Bequest Value*). Some of these views illustrate that socio-economic conditions are one of the factors that determine coastal ecosystems. This means that the higher the activity in coastal areas, the higher the ecosystem's pressure will be. If coastal management ignores its carrying capacity, the ecological function of the coast will be degraded.

2. Types of Coastal Ecosystem

Huang et al., (2010) explain that the coast is an area where the interaction between land and sea takes place intensively. Meanwhile, Dahuri et al., (2001) stated that there are one or more environmental systems (ecosystems) and natural resources in a coastal area. There are natural and artificial coastal ecosystems. Natural ecosystems such as mangrove ecosystems, ecosystem field of seagrass, and coral reef ecosystems. Meanwhile, artificial ecosystems such as ports, tidal fields, and ponds. Bengen (2002) explains these distinct ecosystems and their interdependent interactions, which are briefly described below.

Mangrove Ecosystem

Mangroves or mangrove forests are wetland ecosystems in tidal areas. The word mangrove comes from the Portuguese *mangue* meaning "tree," and the English word *grove* is used for trees and shrubs found in shallow, sandy, or muddy waters. This mangrove forest has a high salinity tolerance or is called euryhaline. Mangrove forests have unequal zoning and associations between species influenced by the dynamics of their physical environment. For example, Rhizophora (red mangrove) is in the zoning directly facing the extreme tides, while Avicennia is in the landward zoning. In general, mangrove vegetation lives in the physical environment of the coast with little waves and sediment. Therefore, the distribution of mangrove forests is determined by factors: water and air temperature, sedimentation, waves, chemical compounds, and tides (Quisthoudt et al., 2012) and (Sheppard et al., 2018).

Mangrove ecosystems are characterized by high primary productivity (ability to produce carbohydrates/food sources through photosynthesis). Many scientific studies have shown that mangroves have an essential role in supporting the quality and sustainability of life in coastal areas and maintaining fisheries resources. Meanwhile, Polidoro et al., (2010) stated that the rate of loss of mangrove forests had increased sharply, so it is estimated that it will not only impact the rapid loss of biodiversity and threaten its ecological function. The further implication is that it hurts human livelihoods, especially in areas where mangrove forests have low biodiversity.

The functions and benefits of mangrove forests are related to the physical topology of the landscape. For example, in the estuary area, in the coastal zone, in the island area, and in the delta area. Some of the functions and benefits of mangrove forests are as follows (Lacerda, 2002); (Twilley et al., 1992); (Kawaroe et al., 2001):

1. Provider of plants; Mangrove forests have a very high diversity of natural plants. These plants are a source of energy because they directly benefit life, such as food, drink, medicine, shell charcoal, and food. Even traditional Nipa tree has long been much used as the roof of the house. However, certain species such as *Rhizophora samoensis*, *Avicenna bicolor* , *Mora oleifera* and *Tabebuia palustris are* threatened with extinction (Polidoro et al., 2010).
2. Providers of fishery and non-fish resources; Mangrove forests naturally have a wealth of fishing and non-fish resources. Such as shrimp and crab. Apart from having high nutritional value, these resources also have essential economic values. Mangroves are a large growing area for several economically important fish, shrimp, and crab species. Martosubroto & Naamin (1977) stated a positive linear relationship between mangrove forest area and shrimp production.
3. Protection from natural disasters (hurricanes and Tsunamis); Mangrove forest vegetation protects the coastline from abrasion and intrusion. Also, mangrove forests protect a tsunami or storm. The damage that occurs can be minimized.
4. Nutrient storage, filter, and recycling; the material cycle process occurs in a complex manner in mangrove forests to be very rich in nutrients. This condition is a factor in the mangrove ecosystem having a high level of productivity. Some biota makes mangroves a habitat because of the abundance of food. Also, the mangrove roots trap sediment particles carried from land flows. These sediment particles often contain nutrients and toxic compounds.
5. Carbon sink and storage; absorption of carbon by mangrove vegetation through a complex photosynthetic process. Thus, mangrove forests can function as a mitigation agent for climate change triggered by carbon emissions into the atmosphere.

Seagrass

Seagrass is a flowering plant (angiosperms) that lives in coastal waters, has one seed, has fruit, flowers, and leaves with rhizome roots. According to (Larkum et al., 2006), Ascherson (1871) was the first researcher to include the term seagrass in the scientific literature. Furthermore, it was also explained that Ascherson (1871) was the first researcher to make a biogeographic map of the world's seagrass. Based on this information, seagrass is found on almost all beaches in the world. For example, along the tropical coast, namely *Thalassia, Halophila, Syringodium, Halodule, Cymodocea, Thalassodendron,* and *Enhalus*. Meanwhile, several seagrass types are found on sub-tropical beaches such as *Zostera, Phyllospadix, Heterozostera, Posidonia,* and *Amphibolis*.

Seagrass can grow on almost any substrate on the coast. Seagrass habitat is marine waters with a slightly sandy substrate, including in coral reef areas. Ecologically, the seagrass habitat is primarily determined by the presence of sunlight for photosynthesis. Then through the photosynthesis process, simple inorganic chemical compounds become complex compounds containing high energy. The continuity of life in the sea is mostly determined by the ecosystem that can convert solar energy through photosynthesis. Therefore seagrass ecosystems have a significant contribution to the coast's productivity in particular and the oceans (Boaden, 1996).

Seagrass is a coastal ecosystem whose existence is strongly influenced by anthropogenic activities—delivered by (Allgeier et al., 2018) that anthropogenic activities from industry and agriculture have supplied phosphate and nitrate compounds for the survival and growth of seagrass. According to Sheppard et al., (2018), generally, seagrass is found in atoll lagoons, behind barrier reefs, or on reef plains protected from fringing coral reefs. The interaction between coral reefs and seagrass is essential in supporting the biota's life associated with it. This interaction also forms this area whose productivity is very high.

Larkum et al., (2006) stated that seagrass vegetation's associated with various faunal organisms that are demersal, benthic, and pelagic. The diversity and abundance of fauna associated with seagrass is higher than in areas without seagrass. It was reported that the density of shrimp, sea urchins (*Echinoidea*), Mollusca, fish and crustaceans was higher in seagrass beds than in the substrate where there was no seagrass bed. It is also essential that the fauna is a commodity with very high economic value.

Randall, (1965); Philips & Menez (1988); Nagelkerken et al., (2001) and (Liu et al., 2015) mention the functions and benefits of the seagrass ecosystem, including:

1. sediment traps brought about by flow movements from rivers and coastal water movements. The trapped sediments carry macro and microelements so that they become nutrients for seagrass growth.
2. water purifier containing suspended solids through leaf traps and their rhizomes. The suspended solids are held by the stretching seagrass vegetation so that the solids fall to the bottom to form a consolidated substrate.

3. a good nursery for invertebrates and juvenile fish such as *Ocyurus chrysurus, Scarus iserti, Haemulon parra, Haemulon sciurus, Lutjanus apodus* and *Lutjanus griseus* . Because food is very abundant.
4. food sources, especially for herbivorous organisms. Besides, seagrass provides litter which is used by detritivore fauna. As reported by Randall , (1965) of the 59 species of herbivorous fish, there are about 30 species of seagrass eating fish. Apart from fish species, there are also other fauna types such as crustaceans, reptiles and mammals whose food source is seagrass.
5. habitat for fauna that lives attached to the leaves, rhizomes (rhizome), and between the canopy. Such as Gastropods, Echinoderms, crustaceans, and several types of fish (Hutomo & Azkab , M , 1987). Including habitat for fish that make seagrass as a food source.

Coral reefs

One ecosystem other that is important in coastal areas of coral reefs. Sheppard et al., (2018) and Odum & Odum (1955) stated that coral reefs are iconic tropical marine ecosystems that have very productive ecological wealth and are biologically an ecosystem with high biodiversity the world. This ecosystem giving a vast range of natural resources and environmental services, are of high economic value. For example, seafood, marine tourism, beach protection, aesthetics, and cultural benefits (Moberg & Folke, 1999). He also conveyed that there are about 100 countries whose beaches have coral reefs. And these coral reefs provide an essential source of protein for people. According to (Jennings & Polunin, 1996) an area of 1 km 2 coral reef can support the protein needs of 300 residents if no other protein source is available.

In general, coral reefs have habitats in shallow tropical marine waters. However, coral reefs were also found that live at depths> 50 meters and even more in cold waters. For example*, Stylasteridae, Scleractinia, Zoonthidae, and Antiphataria* are several corals found in cold ocean waters (Sheppard et al., 2018). Coral reefs related to their ability to produce lime are divided into two types. Coral reefs that are capable of forming limestone structures are called *hermatypic corals*. Meanwhile, coral reefs that are unable to form limestone structures are classified as *ahermatypic corals*. Hermatypic corals are associated with zooxanthellae (a type of algae), which are capable of photosynthesis. The byproduct of the symbiosis is calcium carbonate deposits that form distinctive structures and buildings. This type of coral is a factor of sunlight being a limiting factor because the photosynthesis process's main requirement is the sun's presence (Supriharyono, 2000).

Based on the geomorphology of coral reefs, there are three types. Fringing reefs are coral reefs located along the coast. Barrier reefs are coral reefs that are located far from the beach and separated by lagoons. Atoll is a coral reef that forms around a lagoon (Sheppard et al., 2018). Some organisms associated with coral reefs include Cyanobacteria, Sponge, Microalgae, Mollusca, Echinodermata, Coelenterata, Arthropods, and fish (Gani et al., 2017).

Human activities seriously threaten coral reefs on land and in the oceans. As reported by (Jennings & Polunin, 1996) and (Brown, 1985) damage to coral reefs, for example, occurred; (1) on the coast of the South China Sea, namely the use of corals for industry and the use of live corals for aquariums; (2) Damage to coral reefs in Indonesia occurred in several locations on the coast of Madura, Seribu Islands, Maluku, Java. Sources of damage include sedimentation and pollution from the land, offshore oil exploitation, coral mining, tourism, unsustainable fishing, bombing, and fishing anchors; (3) in the Gulf of Thailand caused by chemical compounds (toxins) in sediment and suspended particles that are underwater flow from the mainland, the use of trawl fishing and mining for commercial activities; (4) In the Philippines, damage to coral reefs occurs due to the use of cyanide in fishing, coral mining for industry and aquariums, and agriculture which is not environmentally friendly. Some of the benefits of coral reefs for life are as follows;

1. habitats for several organisms including phylum Mollusca, Coelenterata, Annelida, Arthropoda, and other fish species;
2. protection against waves, especially for coastal areas to reduce the damage caused;
3. a place to look for food and spawning and care for several types of fish that have essential economic values;
4. function of climate change disaster mitigation through the absorption of carbon dioxide in the photosynthesis process by zooxanthellae.

C. Sources and Types of Pollution in the Coastal Environment

Pollution includes substances, compounds, or energy by humans directly or indirectly into marine waters, including estuaries. It threatens organisms' lives and disrupts ecosystems, and reduces their intended function (Islam, 2004). Pollution began to appear in line with the development of human civilization. For example, the use of chemical compounds in agricultural intensification. Disposal of industrial wastewater, mining exploitation, minerals, oil, and waste from transportation combustion. Matter or substances and mixtures that cause pollution are called pollutants.

One of the areas that have a high level of vulnerability to pollution is the coast. Coastal ecosystems are the final dumps for all activities on land (Dahuri et al., 2001). The high level of economic activity in the coastal area will put higher pressure on it. Threats to coastal ecosystems come from: (1) agriculture based on chemical compounds; (2) industrial waste, domestic and hotel waste, hospital waste entering the coastal water system; (3) transportation waste in the form of oil which has been scattered in the waters; (4) destruction of offshore oil mining exploitation which pollutes the environment; (5) development of extractive coastal and marine tourism which triggers organic waste and plastic to increase; (6) environmental degradation as a result of poverty utilizing extractive use (Palunin, 1986) and (Wu et al., 2020).

The description above provides an explanation of the source of pollution in coastal areas. Based on the coastal ecosystem's origin, pollution sources can be categorized into two main types, namely in situ and ex-situ. The source of ex-situ pollution is outside the coastal ecosystem—for example, the head of the pollution from land ecosystems and marine ecosystems. Examples of contamination originating from terrestrial ecosystems are household waste, textile industry, suspended solids, food industry, and agricultural waste. Meanwhile, examples of pollution from the ocean are waste oil or hydrocarbons. Land waste enters the coastal aquatic ecosystem carried by water flows.

Meanwhile, ocean waste entering the coast is carried by tides, currents and waves and wind. The type of in situ waste is waste originating from within the coastal ecosystem itself. For example, oil spills in ports, organic waste from aquaculture and waste from marine tourism activities. Pollution that occurs in coastal areas is generally anthropogenic. This pollution comes from economic and social activities that take place on land and in the oceans. According to Wu et al., (2020); and (Peixoto et al., (2019), waste that enters the coast in various forms:

1. Solid waste such as inorganic and organic waste.
2. Liquid waste such as chemical compounds originating from industrial, agricultural and offshore oil refineries.
3. Sediments containing toxic chemical compounds carried by water flow from the land.
4. Heavy metals such as Cu, Cd, Hg, and As are very high contributing to cancer risk in adults and children.
5. Residential waste and urban.

The number of organic pollution in the last decade has been reported to increase in coastal areas. One of the main stresses comes from excessive macronutrients (phosphate and nitrate), which causes tropic status changes leading to eutrophication (Meyer-Reil & Koster, 2000). The high levels of these nutrients can trigger high algae growth, including the opportunity for algae blooming, which has a serious negative impact on coastal organisms, including humans. Because several types of algae are classified as *Harmful Algae Bloom* (HAB), such as Ceratium sp, Nitzschia sp, and Dinophysis (Choirun et al., 2015), the blooming of microalgae will reduce the dissolved oxygen content in the waters. The implication is that it will interfere with the aerobic decomposition of organic compounds and interfere with coastal fauna organisms' respiration, including fish.

D. Self-purification Capacity Relation to Carrying Capacity

The coastal area is a unitary coastal life system that has a unique ecosystem. Based on its natural characteristics, the coastal ecosystem has the following main functions:

1. life support service providers because they contain many natural resources that function as energy sources, including for humans;
2. aesthetic service providers that can provide comfort so that many are developed as tourist areas;
3. providers of non-renewable natural resources. For example, sand, minerals, and oil which are very useful for development;
4. environmental service providers describe waste disposed of in coastal areas (Dahuri et al., 2001).

Based on these four functions, the function as a provider of environmental services to dilute waste becomes very important. Because it will affect the function of providing life support services and the role of tourism services, the development of coastal areas must require the functioning of the self-purification or assimilation capacity to be maintained. The quality of the coastal aquatic ecosystem depends on natural self-purification (Otsuka et al., 2006).

Coastal self-purification is the ability of a coastal ecosystem to accept a certain amount of waste in a complex natural process and before there is any indication of decreasing its function. According to Ostroumov (2004), the interaction between physical, chemical, and biological components is an important component in the self-purification process. These interactions are very complex and dynamic in the form of direct and indirect relationships.

Bengen (2002) states that coastal and marine ecosystems can assimilate or self-purify the waste that enters this ecosystem. Self-purification in coastal ecosystems occurs from the interaction of its constituent components. Besides that, self-purification in coastal ecosystems also occurs due to physical dynamics such as tides, currents, waves, and water flow from rivers. However, this self-purification ability has limitations. If the incoming waste exceeds its carrying capacity, damage to the coastal ecosystem will occur.

Dhinakaran & Lipton, (2014) explained that several coastal organisms such as *Holothuria* sp produce bioactive. These chemical compounds are synthesized through secondary metabolism to protect themselves and carry out self-purification in their environment. Besides, coastal ecosystems contain many microbes, which are very important in the self-purification process—for example, *Pseudomonas* and *vibrio's role* in the decomposition process of cellulose and chitin. Meanwhile*, Nitrosomonas, Nitrosocysteine, Nitrosospira, Nitrosolobus bacteria* play a role in the conversion process from ammonia (NH_4^+) to nitrite (NO_2^-). Furthermore, the conversion from nitrite to nitrate (NO_3^-) by bacteria *Nitrobacter, Nitrosococcus, Nitrospina* . The nitrification process tends to lower the pH and denitrification tends to increase the pH, so that the waters' pH becomes neutral (Toorn, 1987).

Li et al., (2015) stated that one of the services and benefits of coastal areas is the ability to naturally carry out self-purification. Several factors that control coastal self-purification include (1) morphological and hydrological characteristics; (2) physical and chemical processes such as sedimentation, accumulation, and nutrient loads; (3) biological aspects include food webs, the dominance of macrophytes or microalgae, decreased biodiversity and trophic status (Schiewer & Schernewski, 2004). Therefore, coastal vegetation is also considered to have an essential function in carrying out the self-purification process. For example, mangrove forest vegetation and fields of seagrass ecosystems that are rich in organic and inorganic materials. This material becomes nutrients for bacteria or other microbes to carry out metabolism. This metabolic activity produces bioactive, which function in self-purification.

On the other hand, mangrove vegetation traps suspended particles from rivers. The seagrass catches the particles with a smaller size than those that settle in the mangrove through its delicate leaves. Thus, the level of water transparency in the ecosystem is still high so that the photosynthesis process runs optimally. The optimal process of photosynthesis means that the reoxygenase process in aquatic ecosystems is optimal. Microbes again use the dissolved oxygen content to decompose organic and inorganic materials.

The description of the self-purification mechanism explains that self-purification is a process that occurs in every natural ecosystem through its two main functions, namely the flow of energy and the flow of matter. Besides, the physical-chemical factors of the coastal environment play a role in the self-purification process. The dynamics of coastal waters in the form of waves, currents and tides cause the self-purification useful. However, not all of the coastal environment can self-purify the same because of many factors, such as mangrove ecosystems, seagrass and coral reefs, and the types of coastal ecosystems. A coast with a complete ecosystem is different from a shore with a whole ecosystem about self-purification.

Seguchi et al., (2002) stated three coastal functions: primary producer, tourism, and natural purification. Self-purification occurs through biological activity by living organisms to absorb or break down chemical compounds in water. For example, the process of denitrification and nitrification by bacteria. Ostroumov (2004); (Schiewer & Schernewski, 2004) explains that the self-purification mechanism in general consists of three aspects, namely:

(1) the activity of filtering or absorption by organisms, for example, all invertebrates that have a filter eating habit, macrophytes which can capture biogas and pollutants that enter the ecosystem, and microorganisms that absorb heavy metals;

(2) the mechanism for the transformation of chemical compounds between ecological compartments, such as from water to sediment, from water to the atmosphere, from coastal waters to land through tidal movements, the movement from water to light through a net feeding mechanism (fish eaten by birds);

(3) The degradation of pollutants, including cellular enzymatic processes, extracellular enzymatic processes in water, and free radical processes involving biological agents of origin. Thus the self-purification ability is influenced by several factors, namely (1) the type of waste entering, (2) the amount of incoming waste, (3) and the activity of organisms, (4) as well as the Physico-chemical conditions of the coastal waters environment. For example, salinity, dissolved oxygen content, and incoming nutrients.

On the other hand, coastal characteristics also influence the self-purification process. Bengen (2002) states that sandy beaches have low primary production. Almost all organic matter is imported and the consumption of organic matter is mostly by bacteria. Meanwhile, rocky shores have a higher level of water clarity and high dissolved oxygen content. The Physico-chemical diversity of the coastal waters' environment will affect the presence of organisms. Then the complex formed conditions work naturally in the self-purification process. However, the ability of coastal self-purification is highly dependent on its carrying capacity.

Meanwhile, the carrying capacity of an ecosystem is minimal. The carrying capacity of the coastal ecosystem will be optimal if the ecosystem is in balance. Conversely, if the coastal ecosystem is in an imbalance of its carrying capacity, the natural self-purification capacity will be disturbed. Carrying capacity is the ability of an ecosystem to support the life of a population. Thus, the optimal population size is one that can be supported by natural resources. Conversely, if the population cannot be supported, the carrying capacity has been exceeded (Inglis et al., 2000). According to Lankford et al., (2005) the concept of carrying capacity can be classified into four types, namely economic, physical, social and ecological aspects. The ecological carrying capacity is the natural resource's ability to provide ecological services to the organisms that live in them—for example, fish life or other living organisms in coastal ecosystems. Coastal ecosystems are said to have their carrying capacity disturbed if organisms' lives in the ecosystem begin to be ecologically depressed. An excellent natural indicator to see the carrying capacity of an ecosystem is living organisms. Three factors affect the carrying capacity of the ecosystem:

1. The amount of available and usable resources in the ecosystem
2. Population size in the ecosystem
3. The amount of consumption of each individual in the population in the ecosystem

Suppose it is related between self-purification and the carrying capacity of its environment. In that case, it can be explained that the carrying capacity of its environment determines an ecosystem's self-purification ability because self-purification is not just a physical-chemical process of the coastal environment its interaction with biological components. Thus, for the ecosystem's ecological function, namely self-purification, to continue, natural resource management must maintain the carrying capacity of the environment.

E. Conclusion

Natural self-purification is a natural occurrence in any natural ecosystem, including the coast. Self-purification is very dependent on the biological activity of the organisms present in the coastal ecosystem and the dynamics of Physico-chemical factors. Self-purification in the process includes three things, namely, filtering or absorption by organisms, the transformation of chemical compounds between ecological compartments, and the decomposition of pollutants and other chemical compounds.

The role of mangrove, coral reef, and seagrass ecosystems is very important in the coast's self-purification process. Because the ecosystem's position acts as a habitat for organisms that play an important role in the self-purification process, each coastal environment will have different self-purification capabilities, depending on the constituents of the ecosystem. Besides that, self-purification with the carrying capacity of the coastal areas interacts in two positive directions. Effective self-purification will keep the ecosystem carrying capacity running optimally. Self-purification is part of the ecosystem's functional processes in the form of the matter cycle and energy flow. Therefore, safeguarding the sustainability of coastal ecosystems' ecological function, including coral reefs, seagrass, and mangroves, is an essential part of the effectiveness of its self-purification capacity.

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