Mapping of Nitrate, Phospat And Zooxanthelae With Abundance Of Sea Urchins on Massive Coral Reef in Karimunjawa Island

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Mapping of Nitrate, Phospat And Zooxanthelae With Abundance Of Sea Urchins on Massive Coral Reef in Karimunjawa Island

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Abstract. Coral reefs have high organic productivity because coral reefs can withstand nutrients and accommodate all external inputs. Many factors affect the life of corals, which is nitrate, phosphate and zooxanthellae. The purpose of this study are to know mapping of the content and the relationship between of nitrate, phosphate, zooxanthellae and abundance of sea urchins on massive coral reefs in Karimunjawa Islands. This research was conducted in May - June 2017 in three stations are Karimunjawa, Menjangan Kecil and Cemara Kecil Island. The method used in this research is survey method with quantitative approach. Results of mapping of nitrate contents on massive corals on all three islands showed the highest nitrate content on Cemara Kecil Island and lowest on Karimunjawa island, with a range of values 5.078-212.853 mg/kg. In mapping the distribution of phosphate content in the three islands showed the highest phosphate content in Menjangan Kecil island and the lowest on Karimunjawa island, with a range of values from 6.78–19.35 mg/kg. Zooxanthelae map shows that the highest and lowest distribution of zooxanthela content on Karimunjawa island, with a range of values 2.84–8.88 cell/cm^2. The sea urchins found in Karimunjawa Islands during the study were *Diadema setosum* and *Echinothrix calamaris* with a range of values 5–147. Based on multiple regression analysis showed that the relationship between nitrate, phosphate and zooxanthela with abundance of sea urchins showed a strong correlation result with correlation value (r) is 0.64. These results can be an indicator of coastal environmental health, especially coral reef ecosystems.
Keywords: Nitrate; Phospate; Zooxanthellae; Coral; Sea Urchins

Introduction

Coral reefs are the most diverse of all marine ecosystems. They teem with life, with perhaps one quarter of all ocean species depending on reefs for food and shelter [1]. This is a remarkable statistic when you consider that reefs cover just a tiny fraction (less than one percent) of the earth's surface and less than two percent of the ocean bottom. Because they are so diverse, coral reefs are often called the rainforests of the sea. Coral reefs are also very important to people. The value of coral reefs has been estimated at 30 billion U.S. dollars and perhaps as much as 172 billion U.S. dollars each year, providing food, protection of shorelines, jobs based on tourism, and even medicines [2].

Coral reefs and other coastal marine ecosystems in the tropics, provide rich reservoirs of natural resources. However, terrestrial and climate impacts, and scientific and governance limitations, have resulted in severe degradation of many nearshore tropical ecosystems, and continued threats to many more. In fact, coral reefs might become the first marine ecosystem to be driven to extinction by anthropogenic activity, perhaps within the next century [3]. Unfortunately, people also pose the greatest threat to coral reefs. Overfishing and destructive fishing, pollution, warming, changing ocean chemistry, and invasive species are all taking a huge toll. In some places, reefs have been entirely destroyed, and in many places reefs today are a pale shadow of what they once were.

Indonesia's coral reef resources are among the richest and most diverse in the world. Eastern Indonesia lies at the centre of diversity for corals [4], mollusca, reef fishes and other reef organisms, along with the Philippines and the north coast of Papua New Guinea. This wealth in biodiversity emphasizes Indonesia's importance in global efforts to conserve marine resources and preserve biodiversity [5].

Coral reefs are the only totally biogenic ecosystem, although deep-sea vents and rainforests approach this condition. With the exception of basaltic intrusions in locations such as Hawaii, terrigenous sediments in some reefs near continental coastlines, and exposed underlying bedrock in subtropical locations where coral growth is scant, everything on a coral reef is produced by living organisms. Many Pacific reefs perch on top of thousands of meters of biogenic limestone deposited on a slowly subsiding base over thousands of years. Coral reef formation is tightly constrained by the narrow tolerances of corals and other calcifiers such as calcareous reefbuilding algae [6]. While there are differences among species, corals generally require a firm substratum, depths less than 50m (unless the water is exceptionally clear), oceanic salinity and pH, temperatures between about 18ºC and 35ºC, and minimal pollution or sediment load [7].

Like ecosystem services, the nature and magnitude of threats to coral reefs, mangroves and seagrasses vary considerably among regions. However, there are attributes common to all coral reefs and associated habitats making them especially vulnerable to certain threats and impacts. Many of these attributes also allow them to provide such diverse ecosystem services [8]. The longterm evolution of reef systems that has generated such high ecological complexity and diversity also makes them vulnerable to rapid and irregular changes relative to those experienced over their evolution. Their shallow and nearshore location that allows easy accessibility also places these systems in direct contact with marine, coastal and land-based anthropogenic activity relative to ecosystems in deeper water and further offshore [9]. We address a broad range of threats and impacts, but again without attempting a comprehensive review. For a thorough review of the long-term decline of a reef system and assessment of the primary drivers [10].

Herbivory is an important process shaping natural communities and transferring energy through food webs in autotrophic ecosystems [11]. However, there are significant differences between terrestrial and aquatic systems in the mechanism of energy transfer from primary producers to higher trophic levels [12]. In contrast to terrestrial systems, where large vertebrates still perform an important role as vegetal consumers [13], in marine ecosystems they no longer represent strong trophic links in communities [14]. This is because overfishing in coastal systems has decimated herbivorous megafauna, such as sirenians and turtles [15]. Consequently, fishes and sea urchins are now the most important herbivores in reef ecosystems [16]. However, their relative influence on primary producers differs along a latitudinal gradient [17]. On tropical reefs, fish and sea urchins are both important herbivores, while sea urchins predominate in temperate reef systems [18]. Abundance of sea urchins is found in living corals according to their habitat, so there is a significant difference between the number of sea urchins on coral reefs and seagrass beds [19]. The functional importance of sea urchins in temperate seas is demonstrated by their formation of vast barren areas when at high densities, decreasing habitat complexity and affecting benthic cover and local community dynamics [20].

Located in the middle of the Java Sea, Karimunjawa National Park is one of only seven national marine parks in all of Indonesia. A chain of 27 islands dot the waters, most of them uninhabited. Karimunjawa Islands as one of the districts in the Jepara Regency, lies in the Java Sea about 115 km north of Semarang. The area can be reached by air as well as by sea from Semarang and by sea from Jepara. The islands is composed of 27 islands and cover an area of 7,120 ha with an interior sea of 107.225 ha. The five largest islands are Karimunjawa, Kemujan, Parang, Genting and Nyamuk support permanent settlement [21]. Since 2005 Karimunjawa has been confirmed as Marine National Park which a total area of 111.625 hectares which have 51 genera with more than 90 species of coral biota and 242 species of ornamental fish. Two protected biota species, black coral (*Antiphates* sp) and organ pipe coral (*Tubipora musica*) and divided into 7 zones. Aims for this research were to document coral diseases in Karimunjawa National Park (KJNP) that never recorded in order to develop a species list of corals that are affected by specific disease. Also, to document disease prevalence was compared among coral communities at different sites in KJNP [22].

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Coral reef ecosystems have a very important role in the Karimunjawa Islands. In addition to being used as a marine tourism object, coral reef is one of the coastal ecosystems. The existence of coral reefs in their habitats is influenced by several things such as Nitrate, Phosphate, and one of its natural predators, the sea urchins. The purpose of this study are to know mapping of the content and the relationship between of nitrate, phosphate, zooxanthellae and abundance of sea urchins on massive coral reefs in Karimunjawa Islands.

Materials and methods

The study was conducted in May-July 2017. The study was divided into 3 observation stations consisting of Karimunjawa Island, Menjangan Kecil Island, and Small Pine. Each station is divided into 6 substations that surround the station.

Coral samples in this study were taken using Line Transect sampling. Line intercept transect (LIT) is used to determine the percentage cover of benthic communities. It can be used on its own or in combination with other methods, such as quadrats. The LIT is the standard method recommended by the GCRMN to determine percentage cover and colony size for management level monitoring. Information obtained: Percentage cover of benthic communities e.g. hard coral, soft coral, sponges, algae, rock, dead coral. Medium to detailed information can be collected from growth forms (shape) to family, genus or species level depending on objectives or expertise available. (Hill and Wilkinson, 2004). The content of nitrate, phosphate, and zooxanthellae measured was taken from a sample of masiv coral reef, while the abundance of pig hair was obtained from the number of pigs found at the study site.

The measurement results are then analyzed using Multiple Regression Analysis to know the correlation of all factors. Mapping of nitrate, phospat, zooxanthelae used to software ArcGIS with IDW method.

Result and Discussion

Results of mapping of nitrate contents on massive corals on all three islands showed the highest nitrate content on Cemara Kecil Island and lowest on Karimunjawa island, with a range of values 5.078-212.853 mg/kg. In mapping the distribution of phosphate content in the three islands showed the highest phosphate content in Menjangan Kecil island and the lowest on Karimunjawa island, with a range of values from 6.78–19.35 mg/kg. Zooxanthela map shows that the highest and lowest distribution of zooxanthela content on Karimunjawa island, with a range of values 2.84–8.88 cell/cm^2. The sea urchins found in Karimunjawa Islands during the study were *Diadema setosum* and *Echinothrix calamaris* with a range of values 5–147 .

Based on the results of Nitrate Measurements in Coral Massive at the Study Sites, it can be seen that the highest nitrate concentrations are found in Cemara Kecil Island while the lowest is on Karimunjawa Island. This is allegedly because zooxanthellae conditions on Small Pine Island is better due to the depth of the waters more shallow than in Karimunjawa Island so that sunlight is more optimum. With a better zooxanthellae condition the intake nitrate also works better.

Nitrogen is thereby conserved within the symbiosis and, once assimiliated by the symbiont, may be returned to the host in the form of translocated amino acids [22]. In addition to internal recycling of ammonium, the zooxanthellae have also been shown to be capable of removing net quantities of ammonium and nitarte from seawater, both, in the intact symbiosis [23] and in isolation [24] The capacity for simultaneous net uptake of both nitrate and ammonium is suprising. Nitrate uptake by microalgae is generally supressed in the presence of sgnificant amounts of ammonium [25] and zooxanthellae might be expect to be exposed to elevated tissue ammnoium concentrations due to host excretion. Its possible that uptake by the tartion in the tissue or, as have suggested, reef corals may have evolved low rates catabolism, with little ammonium production [26].

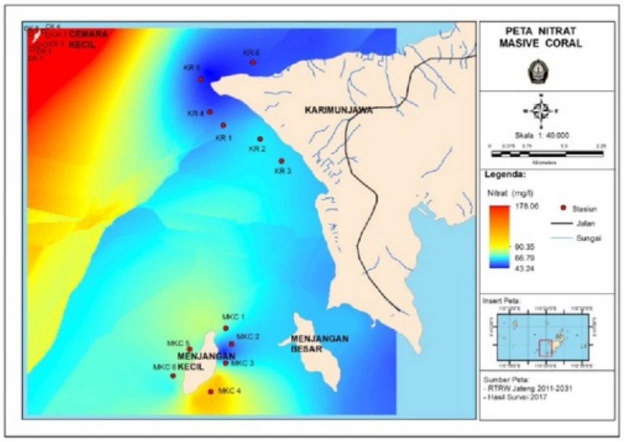

Figure 1. Mapping of Nitrat Distribution

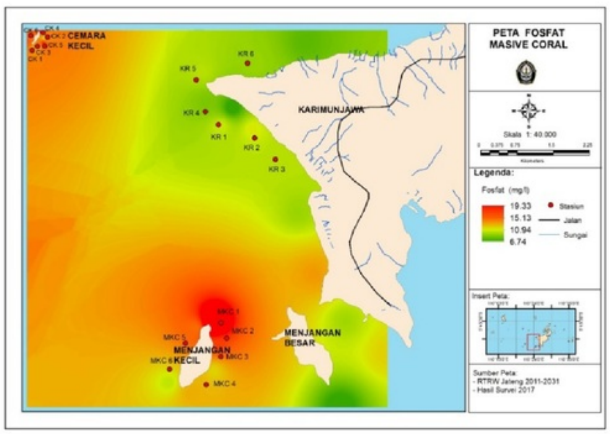

Figure 2. Mapping of Phosphat Distribution

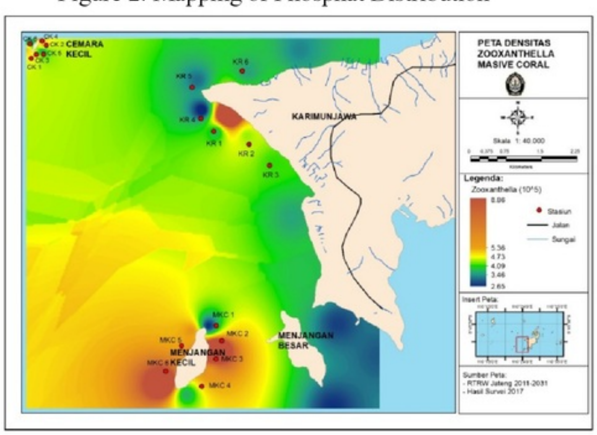

Figure 3. Mapping of Zooxanthelae Distribution

Based on the results of phosphate measurements that have been done, itcan be seen that Menjangan Kecil Island has the average value of the highest phosphate content than other islands. This is presumably due to zooxanthellae on Menjangan Kecil Island is quite higher than other islands.

Zooxanthellae require nutrients (P and N), dissolved inorganic carbon (DIC), and solar radiation for photosynthesis. Hermatypic corals require, minimally, DIC, ATP, and calcium for calcification [27]. Average phosphorus concentrations on natural reefs are generally low (0.01 mg L^{-1}, [28]), but there appears to be a trend towards increasing values in recent years. For example, concentration up to 0.266 mg L^{-1} have been documented on some reefs in the Southern Gulf of Mexico [29]. Elevated phosphate levels are known to affect several aspects of coral health, such as growth rate [30], skeletal density [31], re- production [32], mortality [33], disease susceptibility [34], and zooxanthellae density [31]. Phosphate can stimulate phytoplankton population growth, potentially reducing the availability of light to corals [33], or stimulating growth of benthic filamentous algae that can overgrow corals [35].

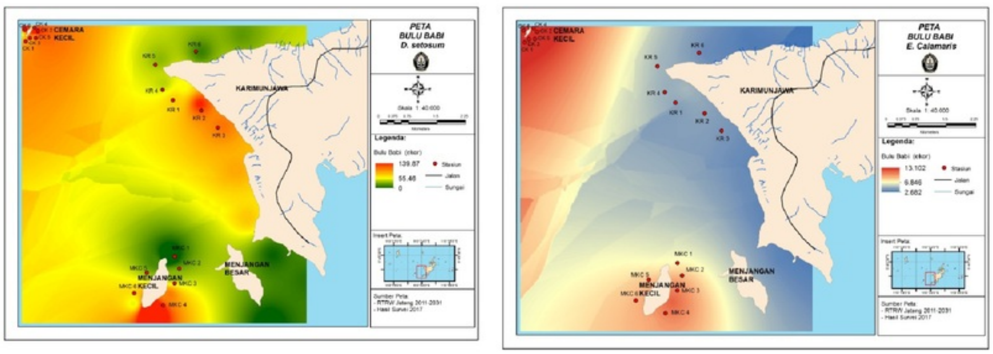

Figure 4. Mapping of Sea Urchin Distribution

Based on the measurements of the number of sea urchins found at the study site, two species of sea urchin are *Diadema setosum* and *Echinotrix calamaris*. The most abundant number of sea urchins is located in Pulau Cemara Kecil.

The presence of *D. setosum* on the coral reef ecosystem has a significant effect on the ecological balance [36]. Suggest that sea urchins are commonly found in coral reef ecosystems, especially species of D. setosum, because the abundance of species popolates is important for coral reefs as a counterweight [37].

The presence of species populations Diadema setosum is important for coral reefs as a counterweight. Diadema population equilibrium will keep the equilibrium of algae and coral populations. Diadema setosum species research is most dominant because the species is one type of sea urchin (Echinoidea) that lives in coral reef and seagrass ecosystems. According to [38], coral reef is a complex ecosystem and has a high aesthetic value, and inhabited by various types fauna, including echinoderms of one of the sea urchins which is a dominant coral reef dweller. Furthermore [39] stated that *D. setosum* has a place to live in the coral reef ecosystem, where this species can occupy the average sand, algae growth areas, coral fragments and dead corals. Pig feathers (Echinoidea) that live in sand-aligned zones, algae growth areas, and coral reefs usually live in clusters in large clusters whereas in coral reefs (Echinoidea) live in small groups or alive life in dead and fractured coral holes coral.

Based on multiple regression analysis showed that the relationship between nitrate, phosphate and zooxanthela with abundance of sea urchins showed a strong correlation result with correlation value (r) is 0.64. These results can be an indicator of coastal environmental health, especially coral reef ecosystems.

Table 1. Result of Multiple Regression Analysis

Regression Statistics	
Multiple R	0,643810756
R Square	0,414492289
Adjusted R Square	0,289026351
Standard Error	30,53351541
Observations	18

Basically the phosphate is occupied in the sediments or is present in coral polyps. On the reef itself, phosphate is required by zooxanthellae as a nutrient and affect the growth of corals. The effects of phosphate on coral condition and/or growth have been studied both in the lab and the field. The results of past studies, however, were not consistent, par-ticularly with respect to coral growth. Growth is often considered an indicator of coral health [40-41] and is com- monly quantified via measurement of linear extension [42] or changes in buoyant weight [43]. Although the buoyant weight technique is attractive because it allows for non-destructive measurement of complete colony growth, it was not used in our study, because it may produce highly variable data [44]. Phosphates have an indirect effect with the abundance of sea urchins. this is due to the phosphate affecting the abundance of zooxanthellae which is the source of food of the sea urchins.

Conclusion

There was interaction between type of fish and body part on moisture, protein, ash and carbohydrate content (P <0,05), but no interaction on fat content and energy (P> 0,05). The body of cultured eel had higher protein than cultured one. The wild eel had higher fat content and energy than cultured one, while the fat content and energy in body and tail were higher than in head.

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