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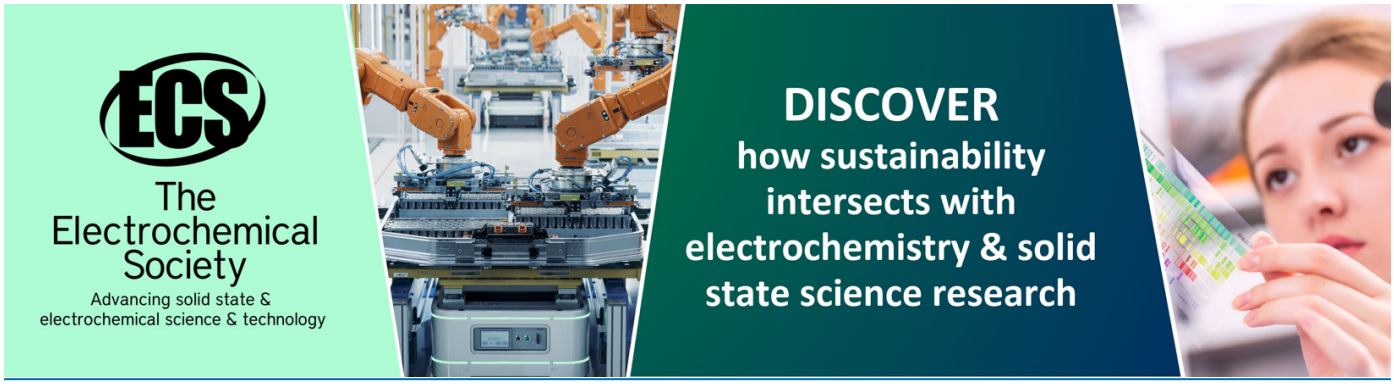

Primary Productivity in Estuary Mangrove Kurau, Bangka Tengah

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Abstract. Ocean primary production is an important factor for determining the ocean's role in global carbon cycle. Primary production is the process whereby inorganic carbon is fixed in the sunlit (euphotic) zone of the upper ocean and forms the base of the marine food pyramid. It occurs when marine phytoplankton use sunlight energy and dissolved nutrients to convert inorganic carbon to organic material, thereby releasing oxygen. The objective of this study was to analyze primary productivity in estuary mangrove area in Kurau, Bangka Tengah, Indonesia. The study area was carried out in mangrove area, specifically in Kurau mangrove, Bangka Tengah, Indonesia. The physicochemical sea water parameters were recorded for all stations. The area was divided into four research stations. Based on the data, value of GPP was between 98.95 mg/L – 114.58 mg/L, NPP between 10.42 - 72.92 mg/L, R between 41.67 - 104.17 mg/L. In general, the mean value of temperature, pH, salinity, sea water current, brightness, phosphate were 29.5 ± 0.5 °C ; 6.75 ± 0.83 ; 15 ± 12.74 ppm ; 0.075 ± 0.032 m/second ; 0.21 ± 0.15 m ; 0.74 ± 0.52 mg/L. GPP rates still in typical state range for estuary of equator. Based on nitrate data, the sampling area was eutrophic, so that respiration rates was higher than NPP rates. Moreover, it is because higher recycling of labeled organic matter in brackish part of the estuary as well.

1. Introduction

Ocean primary productivity refers to the production of organic compound by phytoplankton and has important role for global carbon cycle. Phytoplankton are microorganisms, plants suspended in ocean, most of which are single celled. This microorganisms are photoautotrophs that has ability to absorb light for photosynthesis process. Photosynthesis is a natural process that transfers absorbed photon light energy to organic matters [1]. This process is to change inorganic carbon become organic carbon. Photosynthesis plays a significant process in the global carbon cycle as well as provides the food to support all the heterotroph organisms.

In the marine ecosystem, phytoplankton are the primary photosynthesizers for supporting the ocean's food web. During photosynthesis, the productions of organic carbon are defined as primary productivity [2-4]. Photosynthesis by phytoplankton hold responsible for most marine primary productivity, however,

synthesis of organic carbon from CO_2 by other photoautotroph organisms such as microphytobenthos, symbiotic association, chemosynthetic microbes, seagrass and seaweed can be locally important. These organisms are further categorized by obtaining their elemental requirements from inorganic sources, e.g. nitrogen from ammonium, nitrate and for some dinitrogen, carbon from inorganic carbon such as carbon dioxide and bicarbonate and phosphate from inorganic phosphate.

The organism form the basis of marine food webs and supporting all organisms at higher trophic level [5]. There are three components of primary production that can be estimated: 1. Gross primary production is the rate of all photosynthesis process, not reduced for losses to excretion or to respiration in its various forms; 2. Net primary production is gross primary production less losses to respiration by phytoplankton; 3. Net community production is net primary production less losses to respiration by all heterotrophic organisms and metazoans. In spite of half of global primary production being mediated by the activity of microscopic algae called phytoplankton, the effect of phytoplankton species richness on marine primary productivity lacks a mechanistic understanding [6].

Variability of primary productivity depend on physicochemical water parameters, depth, time of day, region and season. Measurement of primary production can use different approaches. One of primary production determining approaches is oxygen method or light-dependent change in dissolved oxygen. The light-dark oxygen method is a principal method and standard approach for measuring primary production in aquatic environment. Accumulation of oxygen in a clear container (light bottle) represents net primary production by the enclosed community and the consumption of oxygen in a dark bottle is a measure of respiration of phytoplankton. Gross primary productivity is estimated by subtracting the dark bottle result from that for the light bottle. It is assumed that phytoplankton respiration in the light bottle equals that in the dark bottle. Estuaries form transition zones are connecting between freshwater and marine environment. Due to mixing of both distinct water bodies, they are characterized by pronounced gradients of physical and chemical components of water parameters [7].

The phytoplankton community structure and other microbial eukaryote are strongly influenced by all environmental factors along the resulting continuum. Estuaries are usually divided into three types based on their longitudinal salinity distribution and flow of water characteristics: i) highly stratified or salt wedge, ii) partially mixed, and iii) well mixed [8]. These environmental characteristics will cause a shift in species composition of phytoplankton in brackish water [9]. However, phytoplankton communities maintain a high diversity in homogeneous environment as well [10]. All the approach can be used to analyze primary productivity in estuary mangrove area.

2. Material and Method

2.1. Description of study area

The study area was carried out in mangrove area, specifically in Kurau mangrove, Bangka Tengah, Indonesia. This location is one of estuary area in Bangka Belitung Province, Indonesia. Mangrove Kurau is located southeastern part of Bangka Island and bordered by Natuna Sea to the north. This area has some function as fishing ground, spawning ground and feeding ground for some species of fish and prawn. The site research was divided into four research stations which are mouth of River Kurau, near mangrove area, mouth of Munjang Mangrove stream, and transition zone between estuary and maritime environments. The location position of site research is 2°18'26.886" LS and 105°98'158" BT.

2.2. Sampling for Primary Productivity

Primary productivity was determined using light-dark oxygen method. Seawater was taken from estuary area. Samples of seawater were incubated in situ under simulated in situ conditions. Advantages of this incubations is best simulation because incubation in the natural field of light and temperature. Incubation

in situ ensures the best possible simulation of natural conditions at the same depths of sampling. Water samples were collected by placing in three bottle which are light bottle, dark bottle and initial bottle. Water were collected 10 cm below surface water and then immediately incubated for 6 hours. Exposure of samples to turbulence during sampling can damage the phytoplankton and other microbes as well as altering measured rates.

2.3. Environmental physicochemical water parameter

Physicochemical profiles are important for analyzing primary productivity. Those environmental factors can effect to phytoplankton and primary productivity. The characteristics of physicochemical sea water parameters were recorded for all research stations. Parameters of estuary environmental that be taken were temperature (ºC), pH, salinity (ppt), sea water current (m/sec), brightness (m), phosphate (mg/L).

3. Result and Discussion

Overall, data of primary productivity revealed fluctuate value in all sampling research area. Three elements of primary production that measured were gross primary production (GPP), net primary production (NPP) and value of respiration (R). Based on the data, value of GPP was between 98.95 mg/L – 114.58 mg/L, NPP between 10.42 - 72.92 mg/L, R between 41.67 - 104.17 mg/L. Primary production is the synthesis of organic compounds from inorganic chemical compounds through the process of photosynthesis which use light as its source of energy. Furthermore, these simple molecules may be then used to further synthesize more complicated molecules such as proteins, lipids, nucleic acid and complex carbohydrate.

Gross primary production (GPP) is the amount of chemical energy from photosynthesis, typically formed as carbon biomass. This structure that primary producers create in a given period of time. In marine ecosystem, almost all photosynthesis is performed by phytoplankton. Net primary production (NPP) is the rate of photosynthetic carbon fixation without the fraction of carbon used for cellular respiration and maintenance by autotrophic planktonic microbes and benthic plants. Environmental factors of NPP include light, temperature, nutrients, and micronutrients. Marine photosynthetic plankton are responsible for approximately 50 petagrams of carbon per year of net primary production, an amount equivalent to that on land [11]. Net primary production supports essentially all life in the oceans and profoundly affects global biogeochemical cycles and climate. Data on marine primary production have yielded information that has been centrally important to our understanding of marine ecology and biogeochemical cycling.

Since the sampling area is estuary, the flow regime of the estuary mangrove Kurau is generally get impact from freshwater from Kurau River and characterized by daily tidal water. Estuaries are incredibly dynamic systems, where temperature, salinity, water transparency, depth and water current will change daily in response to the tides. The dynamism makes estuaries highly productive habitat. High flows in the rainy season and followed by low flows in the dry season with periodic pulses. Sampling area is a semi enclosed coastal body of water, which has a free connection with open sea and within which sea water is measurably diluted with freshwater derived from land drainage.

The Kurau estuary water is diluted by the freshwater flowing from Kurau Rivers and Munjang stream. The pattern of dilution in this area depends on the volume of fresh water, tidal range and extent of evaporation of the water in the Mangrove Kurau estuary. The mixing between fresh water and marine water provide high levels of nutrients in the water column, making estuaries among the richest natural habitats in the environment. Parameters of physicochemical sea water in Kurau estuary area are: temperature, pH, salinity, sea water current, brightness, phosphate were 29.5 ± 0.5 °C ; 6.75 ± 0.83 ; 15 ± 12.74 ppt ; 0.075 ± 0.032 m/second ; 0.21 ± 0.15 m ; 0.74 ± 0.52 mg/L (Table 1).

Surface salinity of the estuary was significantly different between each research sampling stations. On sampling date in April 2019, surface salinity in transition zone is higher, 30 ppt, than at the mouth of River Kurau dropped to 0 ppt. Photic depth generally increased with distance from the mouth of the estuary with

the mesohaline zone having significantly greater light penetration than the rest of system [12]. Based on data, photic depth in mouth of River Kurau 0 m and 100% light transparency in transition zone. Lack of light transparency in mouth of Kurau River presumably this was due to increased sediment transport from tin mining in alongside River Kurau since as ecosystem, estuaries are also under threat from human activities such as sediments. Photic depths in the oligohaline because of sediments dilution from river flow. Surface water column exchange of dissolved oxygen was measured during these sampling date and found to contribute to the system of primary productivity [13]. GPP rates in mangrove Kurau estuary has positive value since the research is located in equator area.

Table 1. Mean of physicochemical water parameters of Mangrove Kurau estuary

Parameters	Mean
Temperature	29.5 ± 0.5 °C
pH	6.75 ± 0.83
Salinity	15 ± 12.74 ppt
Sea water current	0.075 ± 0.032 m/second
Brightness	0.21 ± 0.15 m
Phosphate	0.74 ± 0.52 mg/L

Comparing of GPP rates of estuary in temperate and equator, temperate estuary area has positive as well as negative rates of GPP depend on time of the research and depth [14]. Due to lack of light availability, this condition could create negative GPP rates.

Based on phosphate element, the sampling area was eutrophic. Estuaries tend to be naturally eutrophic because land run off discharges nutrients into this area. All the physicochemical parameters of estuary water may have affected biological process of the estuary system due to phytoplankton as a primary source of food can produce organic compound by photosynthesis process. In estuary, phytoplankton are key primary producers. This organisms move alongside the water bodies and can be flushed in and out with the tides. Their productivity is mostly dependent upon the phytoplankton, light, temperature, oxygen, turbidity of water and nutrients. Hence, measurements of marine primary production are useful and important for understanding the ocean.

4. Conclusions

This study was to determine the primary production in estuary area in Mangrove Kurau as well as its physicochemical water parameters. The results showed that:

1. Primary productivity of estuary area in Kurau, Bangka Tengah is GPP was between 98.95 mg/L – 114.58 mg/L, NPP between 10.42 - 72.92 mg/L, R between 41.67 - 104.17 mg/L.
2. The parameters of physicochemical sea water in estuary area are temperature, pH, salinity, sea water current, brightness, phosphate were 29.5 ± 0.5 °C ; 6.75 ± 0.83 ; 15 ± 12.74 ppm ; 0.075 ± 0.032 m/second ; 0.21 ± 0.15 m ; 0.74 ± 0.52 mg/L.

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