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CHARACTERISTIC AND THE DISTRIBUTTION OF SPASIO – TEMPORAL MACRONUTRIENT IN THE LAGOON AREA OF SEGARA ANAKAN

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ABSTRACT

Lagoon Area of Segara Anakan (SAL) have influence of natural and anthropogenic factors impacting on the increasing of macronutrient, ecologically SAL is downstream from several rivers watershed Citanduy. SAL is tropically moist and influenced monsoon wind, causing the fluctuated waters. The purpose of this research is to recognise the characteristic spatio-temporal makronutrien lagoon. The measurements of macronutrient, include: TN (Total of Nitrogen), NH_3 (Ammonia), NO_3^- (Nitrate), TP (Total of Phosphate), and PO_4^{3-} (Orthophospat), using methods of spectrophotometric and micro-kjeldahl. The spatial approach is done on 7 stations (S) with representations: (S) natural factors and (S) the presence of anthropogenic activities. The temporal approach (*time series*) for a year refers to the monsoon wind pattern (west, transition I, east and transition II) season. The results of laboratory tests are discussed descriptively and adapted to the Indonesian standart of waters quality. To facilitate spatio-temporal interpretation, the data is presented formingly a thematic map. Temporal results show in the west season, the highest macronutrient content is dominated by TN (0.587 ± 0.223) mg / L, NH_3 (0.875 ± 1.290) mg / L and PO_4^{3-} (0.390 ± 0.909) mg / L, while NO3- (0.185 ± 0.015) mg / L and TP (0.155 ± 0.026) mg / L highest during transitional season II. In the spatial approach, (S) with anthropogenic characteristics contribute to the whole height of the macronutrients. The effects of rainfall, anthropogenic pressure, aquatic hydrodynamics and the contribution of metabolic waste discharged from organisms, are thought to cause in the increasing of SAL macronutrients. Management and lagoon management strategies are required by the local government, stakeholders and communities to prevent the phenomenon of eutrophication of the lagoon.

Key words: Macronutrient, Nitrogen, Phospate, lagoon of Segara Anakan

INTRODUCTION

Segara Anakan Lagoon (SAL) is located in the southern coastal area of Java Island, starting from a bay, and the island of Nusa Kambangan as a barrier separeting (SAL) the Ocean Indies. The lagoon is linked by two streams; Pelawangan Timur (Eastern outlet), east of Nusakambangan Island and Pelawangan Barat (Western outlet). The geographical location of SAL is 7º35 "- 7º46" LS and 108º45 "-109º01" BT covering 14.221,8 ha, Subdistrict of Kampung Laut, Cilacap Regency, Central Java.

The presence of natural and anthropogenic factors in the western part of the lagoon, affecting ecological, changes (Ardli and Wolff, 2009; Carolita, 2005; Dewi, *et al.*, 2016). Sediments of land use (anthropogenic activity) containing of strongly sticked macronutrients with water molecules, result in high concentrations in sediments (Kennish, 1992; Jennerjahn, *et al*., 2009).

The ecological threat of western SAL with high sedimentation rate, supported by the growth of population, degradation of mangrove forest area, and change of lagoon usage is for variative anthropogenic activities. This resulted in the excess nutrient waste, especially the macronutrient nitrogen (N) and phosphate (P). The existence of anthropogenic activity around the River Basin also flows to the lagoon and sea (Kennish, 1992; Patty, 2014; Zaaboub, *et al*., 2014). SAL area as S. Citanduy estuary is the main and largest river in Citanduy catchment beside S.Cimeneng, S.Cikonde, S.Cibereum (Jennerjahn, *et al*., 2007).

The river flow brings continuous supply of macronutrient materials leading to consolidation of coastal sediments, both as a source of nutrients and the formation of physical structures of sediments. The coastal waters are euphotic zones continuously dynamically placing the supporting Conditions for the complexity of physical, chemical and microbiological contacts, which will trigger the availability of macronutrient concentrations of N and P. The levels are generally higher than the open seas, resulting in higher productivity (Dahuri *et al.*, 1996). If the accumulation of macronutrients (N) and (P) occurs continuously, it is feared that it will cause the phenomenon of "eutrophication" that resulted in degradation of ecological waters of lagoon. Makronutrien (N) and (P) are very important chemical compounds for supporting the life of aquatic organisms. Especially in growth process and metabolism of phytoplankton, the organism is an indicator for evaluating the quality and level of water fertility. Both of these compounds also play an important role against living tissue cells of living organisms and in the process of photosynthesis (Raymont, 1980; Ferianita-Fachrul *et al*., 2005).

Parslow, *et al*., (2008) and Jennerjahn, *et al*., (2009) suggest that the high macronutrient is to be the limiting factor of distribution, the quantity of chlorophyll-a and the abundance of phytoplankton. It is added by Pednekar, (2012) that in the tropics, the condition is affected by the rainy season. Based on Meteorology and Oceanography data, Indonesian waters are influenced by monsoon winds. SAL is tropically moist and influenced monsoon wind, resulting in fluctuating waters (Nontji, 2008; Ardli and Wolff, 2009).

Furthermore, the purpose of this research is to recognise spatial distribution based on spatial natural and anthropogenic factor and temporal (monsoon wind) to macronutrient content of Western SAL region.

MATERIAL AND METHOD

Sampling for analyzing the content of macronutrient is done by in-situ at temporal period (time series) for a year in 2016, based on representation of monsoon. It is matched with what is stated by Nontji (2008), that, based on the data served by Meteorology and Oseanography, Indoneisa waters is influenced by *monsoon,* consisting of *;*

- **western season** : December - February (in representaion of February dan December).
- **The transitional season I**: March– May (in representation of May).
- **Eastern season** : June – August (in representation of July)
- **The transitional season II**: September - November (in representation of October).

Then, the influence of *monsoon* is used as the reference for time of Sampling on the content of macronutrient with in-situ samppling as many as 7 stations having spatially different characteristic (Table. 1). The spatial evaluation impacts on natural factors (S) : 2, 3, 4, 6, and station with anthropogenic activities (S) : 1, 5, 7.

Figure 1. Research Station Map at the area of lagoon of Segara Anakan

Table 1. The Characteristic of Spatial Approach of sampling on the macronutrient content at the area of lagoon of Segara Anakan

Station	Characteristic	Ordinate	
1	TPI dan Majingklak port	108°48'02.4"BT	07°40'27.6"LS
2	The border of gate (west pelewangan) of SAL directly bordering with Hindia cean	108°46'56.7"BT	07°41'59.0"LS
3	The mouth of Cikonde and Cimeneng river	108°49'47.9"BT	07°40'34.6"LS
4	The area of Mangrove	108°51'36.5"BT	07°41'44.9"LS
5	Kampung Laut settlement	108°52'14.0"BT	07°42'19.5"LS
6	Conservative tourism “Mina” ”Ujung Alang, district of Kampung Laut	108°52'45.4"BT	07°42'55.4"LS
7	Cultivating place by using floating net	108°48'56.0"BT	07°41'01.0"LS

Makronutrient (N) and (P) area of the analyzed SAL during the research are: TN (Total of Nitrogen), NO_3^- (Nitrate), NH_3 (Amonia), TP (Total of Phosphate), dan PO_4^3 (Orthophosphate). Sampled water taken from each ordinating point of sampling, it is then entered into sample container to be analyzed laboratorically.

The determination of the phophate content is done by using the method of spectrometer ascorbat-acidly (SNI 06-6989.31-2005); The determination of the amonia content is done by using the method of spectrometer fenatly (SNI 06-6989.30-2005); The determination of the nitrate content is done by using the method of spectrometer brucin-sulphately (SNI 06-2480-1991); The determination of the TN is done by using the method of microkjeldahl and TP done by using spectrophotometer (APHA, 2005).

The obtained data, the result of measurement of Ex-situ with the laboratorically test, is then arranged into table and analyzed descriptively, reviewed in according to literature studies. (Sugiyono, 2007). Then, To make the analysis easier, the result of the measurement of makronutrient content is represented in forming of thematic map, both spatial and temporal approach.

RESULT AND DISCUSSION

The result shows the temporally contribution pattern of macronutrient in the area of SAL is giving influence on rainfall pattern. This can be recognized from the result of analysis of the height of NO_3 Macronutrient content, the occured TP in the transitional season II (October) whereas TN, NH_3, PO_4^{3-} in western season (December) during the period of a year observation 2016 (Table.2) and (Figure.2). In this season, wind blows from west to east to be signal of rainy season. In according to data served by BMKG, Cilacap district is susceptible for this rany season estimated between 483 – 958 mm.

In according to Livingston (2001), the influence of weather, mainly, rainfall pattern, is a significantly controlling factor of accumulated nutrient influencing to the fluctuation of (N) dan (P). It is also added by Yunev *et al.,* (2007) that the change of rainy and dry season will give influence on the concentration of nutrient, chlorophyll and oxygen, that is dissolved, mainly, in euphothic. Furthermore, it is also explained by Panggabean (1994) that in tropical areas, euthrofication is possible to occur in rainy season.

On spatial approach at research station, it shows that (S) with the characteristic of Anthropogenic is S1, S5 and S7 playing a role in the whole height of macronutrient unsure. This goes with the statement by Pintado, *et al.,* (2007) that 50% of dissolved unorganic nitrogen derives from agriculture activities, whereas 70% of total phosphate is coming from domestic settlement. Then, This accumulated conditions can be categorized to be an euthrofication.

Macronutrient of Nitrogen

Inorganic nitrogen is consisting of nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4), ammonia (NH_3), nitrogen molecule forming gas (N_2), oxide nitrogen (N_2O^-), oxide nitric (NO), dioxide nitrogen (NO_2), whereas, organic nutrient is protein and amino acid

Wilkinson and Salvat (2012) state that Nitrogen coming from the decomposition of organic material is brought out by river stream, counted as 65 % will enter in the waters of costal. Then costal unorganic nitrogen can be explained through variative values from the river. Whereas the reast is influeced by other waters factors (Lee *et al*., 2008).

The lower and height (N) is influenced by the supply of organic waste from anthropogenic domestically, most will donate unorganic nitrogen to waters. (Nielsen, 2004).

Total of Nitrogen (TN)

Based on temporal approach, the highest TN occurs in western season (December) as much as 0,587 ± 0,223 mg/L, while, the lowest in western season (February) is 0,264 ± 0,037 mg/L. then , the result of spatial analysis shows that (S1) is station with the highest TN: 0,431 ± 0,155 mg/L**,** and the lowest is (S2) 0,270 ± 0,090 mg/L.

Table.2 The Content of Makronutrien (TN, NH3, NO3-, TP, PO43-) in The Lagoon Area of Segara Anakan, Using a Spatio Temporal Approach

	Macronutrient (mg/L)										
	Spatial Approach (Station)						**Temporal Approach (Season)**				
	TN	**NO_3^-**	**NH_3**	**TP**	**PO_4^{3-}**		**TN**	**NO_3^-**	**NH_3**	**TP**	**PO_4^{3-}**
1	0.431 ± 0.155	0.162 ± 0.063	0.031 ± 0.010	0.198 ± 0.137	0.094 ± 0.018	**1**	0.264 ± 0.037	0.149± 0. 038	0. 020 ± 0.004	0.106 ±0.020	0.076 ± 0.009
2	0.270 ± 0.090	0.140 ± 0.062	0.096 ± 0.153	0.120 ± 0.070	0.092 ± 0.019	**2**	0.3 04 ± 0.035	0.155 ± 0.031	0.031 ± 0.008	0.130 ± 0.022	0.095 ± 0.018
3	0.362 ± 0.133	0.140 ± 0.042	0.255 ± 0.506	0.102 ± 0.054	0.073 ± 0.041	**3**	0.318 ± 0.052	0.160 ± 0.024	0.031 ± 0.004	0.120 ± 0.014	0.091 ± 0.009
4	0.377 ± 0.182	0.156 ± 0.066	0.096 ± 0.125	0.111 ± 0.062	0.090 ± 0.029	**4**	0.327 ± 0.018	0.185 ± 0.015	0.046 ± 0.011	0.155 ± 0.026	0.107 ± 0.008
5	0.352 ± 0.143	0.143 ± 0.062	0.084 ± 0.131	0.107 ± 0.060	0.573 ± 1.049	**5**	0.587 ± 0.223	0.045 ± 0.022	0.875 ± 1.290	0.071 ± 0.162	0.390 ± 0.909
6	0.336 ± 0.152	0.108 ± 0.051	0.077 ± 0.096	0.094 ± 0.047	0.072 ± 0.041						
7	0.392 ± 0.231	0.121 ± 0.050	0.765 ± 1.635	0.082 ± 0.039	0.070 ± 0.029						

Based on Setiapermana (2006), the content of (TN) is addition of organic and unorganic nitrogen; nitrate (NO_3), nitrite (NO_2), ammonium (NH_4), oxide nitrous (N_2O^-), dimolecular nitrogen (N_2 dissolved), dead organic materials, (particulate matter), dissolved dead organic materials, microbiotic biomass, animal biomass, plant biomass. The fluctuation of number of TN is influenced by the number of organic nitrogen and anorganic waters..

The increasing of TN on (S1) is expected to be estuary of the entering streams on rivershed of Citanduy to SAL, so it causes accumulation of nutrient. On other side, there is an excretion of metabolic waste from organism, functioning waters nutrient to donate waste of organic nitrogen. Whereas, there is the lowness of TN (S2) being expected to be reducing function of TN in waters (organic and anorganic nitrogen) of waters microorganism, because this station is supported by condition of hydrodinamic of fluctuated waters.

This goes with the statement by (Coutinho, *et al,*. (2012); Nielsen *et al.,* (2004) that there is the height of nutrient supply from land through river water stream and tend to go down on coastal area (S2). The total of whole nitrogen can be reduced by the existance of nutrient removal by phytoplankton on the process of denitrification (Pintado, *et al.,* 2007).

NO_3^- (Nitrate)

Based on temporal approach, the highest NO_3^- (Nitrat) is happened in the transitional season II (October) 0,185 ± 0,015 mg/L, while the lowest is in the western season (December) : 0,045 ± 0,022 mg/L. The result of spatial analysis shows that S1 is station with the highest NO_3^- : 0,162 ± 0,063 mg/L, the lowest is (S6) 0,108 ± 0,051 mg/L. The height of NO_3^- (S1) is expected to be causing the existance of Anthropogenic activities in auctioning fish and majingklak port. This station is estuary of the entering domestic waste brought through rivers on rivershed of Citanduy.

This condition is expected to be causing the accumulation of NO_3^-. This goes with the statement by Boyd (1990), that urban people activities (Anthroopogenic) contribute organic materials containing of NO_3^- compound, besides, the existance of influence of upwelling factor that can lift (NO_3^-) from bottom of the water column, mainly, in shallow waters.

Then, Based on Anggoro *et al.,* (2013) that the lowness of NO_3^- on (S6) is caused by the high capability of phytoplanton in absorbing nitrate content. Futhermore, Harvey (1926) dan Redfield (1934) *in* Basmi (1999) state that the saving of N and P is all taken. more or less at the same time as the growth of phytoplankton. The content of nitrate-nitrogen exceeding 0,2 mg/L can cause of eutrofication of waters. stimulating the growth of *blooming* algae (Effendi *dalam* Simanjuntak, 2012). Based on Millero dan Shon (1992), that the content of nitrate in the sea is estimated between 0,0001 - 0,5000 mg/L.

Based on the ministrial desicion KLH, no.51, 2004, on seawater quality standards for marine biota, establishing a standard NO_3-compound for biota by 0.008 mg /L based on this, it is recognised that the content of NO_3^- in SAL is above the threshold of Nitrate compound. So it is needed to do an attempt in managing lagoon to prevent from waters eutrofication.

NH_3 (Ammonia)

Based on temporal approach, the content of the highest NH_3 (Ammonia) is in the western (December) 0,875 ± 1,290 mg/L, the lowest is in the western season (February) : 0,019 ± 0,004 mg/L. Spatially the height of the content of NH_3 on (S7) : 0,7652 ± 1,635 mg/L, dan the lowest is (S1) 0,031 ± 0,010 mg/L.

An increase in the quantity of inorganic nitrogen content (ammonia and urea) is caused by the increasing in residual biota metabolism contributing to other inorganic nitrogenous waste than organic nitrogen (pseudofeces). Organic nitrogen waste resulted by the cultivating activities derive from fases and remaining feeding, while anorganic waste results ammonia (NH_3) dan H_2S (Effendie, 2003).

Herbeck, *et al,*. (2013) state that the weakness of fishpond happened if it does not have standarization of producting pattern of feeding or water circulation system. This causes the height of anorganic nitrogen concentrarion, phospate, chlorophyll a showing level of eutrofication of waters, mainly, costal area. .

In the condition of anareobic, Nitrate is changed by bacteria into nitrite and then changed into ammonia. The height of value on ammonia content is caused by organic material decomposition by bacteria and other microorganisme, so it forms compound of ammonia reacting with water.froming amonium (Goldman dan Horne, 1983).

On (S1) as the rivers entering estuary on rivershed of Citandui to SAL causes the height of the content of TN, including NO_3^-, after the step of nitrogen nutrient functioning, the next process is decomposition by bacteria and other mikroorganism forming NH_3 compound. It is excepted to happen on the decomposition step inorganik nitrogen waste on S1 is distributed to other station, both entering lagoon or delivered to sea because it is supported by factor of hydrodinamic of waters and rainfall. This condition leads to the lowness of NH_3 on S1.

On the other hand, the reduced supply of macronutrients originating from the land carried by river runoff is affected by the decreasing in rainfall (Coutinho, *et al*., 2012; Nielsen *et al*., 2004).

Macronutrient of Phospahate (P)

In waters, phosphorus is existed as a phosphate compound (P). According to Ferianita-Fachrul, *et. al*., (2005) phosphate is very important metabolic macronutrient for the growth and metabolism of phytoplankton. In addition to nitrogen, phosphate is an indicator to evaluate the quality and level of water fertility. The presence of phosphate often affects on the productivity of public waters, as well as being one of the essential elements of protein formation and the metabolism of organisms.

Total of Phosphate (TP)

Based on the temporal approach, the highest total of phosphate (TP) occurs in the transition period II (October): 0.155 ± 0.026 mg /L, and in the western season (December) is : 0.071 ± 0.162 mg / L. Furthermore, spatial approach shows that there is the content of highest TP: 0.197 ± 0.137 mg /L, the lowest on (S7) is : 0.082 ± 0.039 mg /L.

TP in waters comprises organic phosphates (phytoplankton and organic compound bodies) and inorganic (orthophosphate, metaphosphate or polyphosphate). TP describes the sum of all forms of phosphate compounds causing eutrophication of waters. TP fluctuations are influenced by the amount of organic phosphate and inorganic waters (Milne, 2012). According to the Minister of Environment Regulation. No.28, 2009, about the capacity of pollution load of lake water and or reservoir, selected water quality to fulfill trophic status ie phosphate content as Total P.

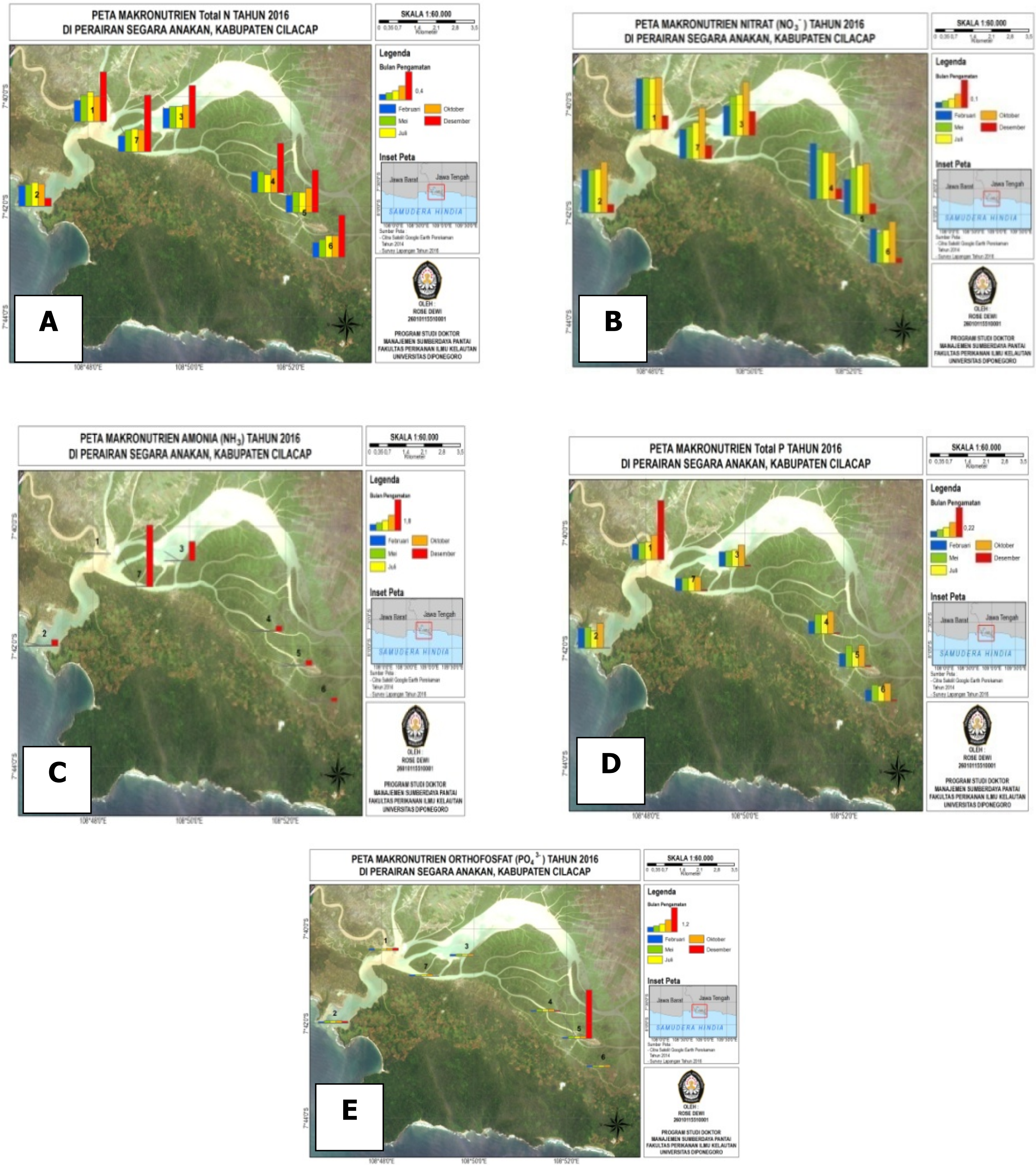

Figure 2. Thematic map of macronutrient content of Segara Anakan Lagoon.: (A). TN (Total of Nitrogen); (B). NH_3 (Amonia); (C). NO_3^- (Nitrate); (D). TP (Total of Phosphate), dan (E). PO_4^{3-} (Orthophospate) spacio Temporal lagoon area of Segara anakan in 2016.

The decreasing of the quantity of TP on (S7) is caused by the utilization of water TP (organic and inorganic) by the cultivation biota. Whereas, the high quantity of TP on (S1) is suspected to be caused by the accumulation of nutrients including TP. These conditions go with the high content of macronutrient TN, and NO_3-. This goes with Pintado's statement, *et al*. (2007) that 50% of inorganic dissolved nitrogen comes from agricultural activities, while 70% of total phosphates come from a varietive anthropogenic activities. These conditions resulted in larger TP concentrations in the lagoon than open ocean (Zaaboub, *et al*., 2014).

Orthophospate (PO_4^{3-})

The result of the content analysis of Orthophospate (PO_4^{3-}) with temporal approach showed that the highest PO_4^{3-}occurred in western season (December): 0.390 ± 0.909 mg / L, while the lowest is in west monsoon season (February) : 0.076 ± 0.009 mg / L. Furthermore the result of spatial analysis (S5) is the highest orthophospatic station: 0.573 ± 1.04 mg / L, the lowest is on (S7): 0.070 ± 0.029 mg / L.

Inorganic phosphate forming metaphosphate or polyphosphate, is often existed in waters containing of dissolved organic phosphorus. However, it is only forming dissolved orthophosphate that (PO_4^{3-}) can be well-absorbed by phytoplankton (Zaaboub, *et al*. 2014; Onandia, *et al*., 2014). It is suspected to be the cause of low PO_4^{3-} (S7), it is in addition to the utilization of phosphate (organic and inorganic) by biota cultivation.

The high content of PO_4^{3-} (S5) which is in the district area of Kampung Laut people goes with the statement by Pintado, *et al*. (2007) that there is the increasing of PO_4^{3-} quantity as a result of variative anthropogenic activities including domestic settlements.

Furthermore, Sonjaya (2007) stated that the area of SAL is 400 ha, inhabited area is as many as 15,278 people where it is ideally only about 8.000 people, it is hoped that the environmental carrying capacity will not have too heavy pressure (Monografi Kampung Laut, 2008 in Mumpuni, 2012). This condition subsequently is increased to 17,181 people (Kampung laut in number 2015).

The greater the population is along with the high pressure of the waters. The contribution of organic pollutants in the liquid waste derived from anthropogenic activity reaches 75% of total of wastewater (Putnam, *et al*, 2010).

Inorganic materials (PO_4^{3-}) are usually simply referred to as phosphates. This water quality parameter is selected as a trophic status limiting factor. Based on the Decree of the Minister of Environment No. 51/2004 on seawater quality standards for biota, the standard quality standard of $PO_4^{3-}$for marine biota is 0,015 mg / L. In line with the Goldman and Horne (1983) assertion that generally the PO_4^{3-} natural water content is not more than 0.1 mg / L. This level can increase with the inclusion of domestic waste. This is like what happened in the SAL area, it is feared that if the phosphate content is high enough to exceed the needs of plant-based organisms, the accumulation will lead to eutrophication phenomena.

CONCLUSION

Overall the SAL region's macronutrients show an increase in the transition period II (October) to the west season (December). So it is concluded that the characteristics of SAL nutrient accumulation influenced rainfall pattern. Based on BMKG data, there is high rainfall at SAL during 2016 from 2nd (October) to west (December) transition season ranging from 483-958 mm.

Weather factors, especially rainfall patterns, anthropogenic pressure, hydrodynamic waters and the contribution of metabolic waste discharges from organisms are controlling fluctuations and accumulation of macronutrients (N) and (P), SAL regions.

The accumulation of macronutrient quantities exceeds the needs of plant-based organisms, it is feared to trigger eutrophication of waters. It is therefore necessary to prepare a lagoon management strategy to reduce anthropogenic pressure by local government, stakeholders and surrounding communities to maintain the ecological stability of the lagoon area.

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