Coastal Dynamic, Nitrate (NO_3^-) Phosphate (PO_4^-) and Phytoplankton Abundance at Morodemak North Java Sea Indonesia

[a]Muh. Yusuf

[a]Marine Science Department, Faculty of Fisheries and Marine Sciences, Diponegoro University, Prof. Sudarto, SH Street, Tembalang, Semarang. 50275. Central Java & University of Bangka Belitung - Indonesia.

Abstract

Coastal dynamic of North Java sea was the influence of the west and east monsoon as well as interseasonal effect during April-June and October-December. Espescialy to coastal current patern and to nitrate and phosphate variation and ultimately to phytoplankton. Study area focused at 110°52'03.72''E - 110°54'68'' E and 06°80.4'75''S - 06°82'72.22''S. Aim of study was to built current spatial model, measure insitu nitrate and phosphate variation and phytoplankton abundance. Coastal current spatial modelling was done using SMS-v8.1 and sampling site based to purposive sampling represetative to the estuary and coastal system. Spatial modelling using Arc.GIS 10 software. The study revealed that nitrate concentration ranged at 0.60-2.0 mg/l, phosphate 0.04-0.24 mg/l and current speed 0.0003-0.0033 m/sec to southeast direction. About 22 genera of phytoplankton were found, with moderate dominancy of Baccilariophyceae, Dinophyceae and most dominance of Rhizosolenia. Most abundance of phytoplankton was at the mouth of the river or the estuary with 28,090,000 cell/m^3. Lowest abundance at offshore coastal site with 17,060,000 cell/m^3. The highest diversity index (H') was 1.606 at the estuary and the lowest was 0.8730 at coastal offshore.

Keywords

Coastal current, nitrate, phosphate, phytoplankton, North-java sea

1. Introduction

Coastal water regarded as specific ecosystem with many natural and man made influences from upland areas as well from oceans (Dahuri *et.al*, 2004). Nutrient of phosphate and nitrogen considered as the limiting factor for sewater productivity (Sastrawijaya, 2009). The two nutrients has important role for the life of marine organisms such as phytoplankton (Fachrul *et.al*. 2005). Nitrogen compound which can be used are nitrite and nitrate, while phosphorus in the form of ortho phosphat (Jones-Lee and Lee, 2005).

Semarang, Morodemak and Demak coastal water the main study area was in fact as fishing gound, auction place and fishermen villages with many kinds of polution to the adjacent water and effect to water quality. More specifically are house hold organic sewage and detergent, which will affect the concentration of nitrate and phosphate in the seawater. Coastal current will have the influence to the distribution of nitrate, phosphate and phytoplankton. Aim of study was to measure insitu nitrate, phosphate variation and phytoplankton abundance, coastal current and built spatial model.

2. Method

Primary data of nitrate, phosphate phytoplankton abundance as well as dissolved oxygon (DO), pH, salinity, sea surface temperature (SST) and water transparency. Supporting data are digital map of Semarang and Demak coastal water in a scale of 1 : 250,000. Sampling coordinates were based on Purposive Sampling Method as refered to the aim of the research (Sudjana, 1996) using GPS (*Global Positioning System*). Total of 12 station were sampled, where station-1 represent for river mouth estuary. Station 2, 3, 4, and 5 represent for the coastal water and station 6, 7, 8 and 9 represent as the fishing ground and station 10, 11, and 12 more offshore water. Precisely in the coordinate of 110°52'03.72''E - 110°54'68''E and 06°80.4'75''S - 06°82'72.22''S. Seawater samples were taken with volume of 500 ml and immediately store in a cool box. Seawater quality parameters such as dissolved oxygen, temperature, pH, salinity and transparency were measured insitu*.* Phytoplankton were sampled using 0.25 micron mesh plankton net and preserve in 4 % formaline. Coastal current measured using current meter.

Nitrate measurement in the laboratory using Specthrophotometer after filtered with 1μm mesh, while absorbance reading using 220nm and 275nm wavelength of standard metode SNI 06-688.31-2005. Phosphate measurement using standard SNI 06-2480-1991*.* Field data and coordinate were the processed into spatial model using Arc.GIS-10 software (Education license). Spatial model of coastal current was processed using *SMS 8.1* software, as multilayer concept of seawater parameters had been developed by Hartoko and Helmi (2004), then analised discriptively (Suryabrata, 1983).

3. Result and Discussion

Nitrate concentration at Morodemak-Demak coastal water ranged of 0.60-2.0 mg/l. Highest concentration found at station-3 and lowest at station-11 as presented in Tabel 1 and Figure 1. This was assumed that river water bringss high concentration of nitrate. Phosphate range from 0.08 – 0.24 mg/l with highest concentration at station-1 or at mouth of the river (Figure 2). Coasatal current speed range from 0.0003 – 0.0033 m/s with dominant of southeast direction. Which is considered as the tidal current pattern. In comparison to concentration at the north Papua deepsea water nitrate concentration range of 0.2-0.6 mg/l and phosphate concentration range of 0.02 – 0.2 mg/l (Hartoko and Subiyanto, 2009). Other implication of the current, temperature – depth interactions. Both water current and depth contribute significantly to the vertical temperature profile of North Molucas and Halmahera, with the average current velocity was about 2.5 cm/sec respectively (Robertson and Field, 2005) which is much higher than coastal current of Demak. Related to the productivity processes at coastal water the important parameter is water transparency or turbidity. Where water transparency range of 0.21 – 1.2 m should be relative to the coastal depth.

Tabel 1. Nitrate, phosphate, current speed and direction, DO, salinity, SST, pH and transparency

St	NO_3^- mg/l	PO_4 mg/l	Current (m/s)	Direction (°)	DO mg/l	Salinity (‰)	SST (°C)	pH	Transparency (m)
1	1.20	0.24*	0.0003	225	0.61	18	29.2	7.50	0.21
2	1.50	0.13	0.0006	150	2.51	31	31.5	8.40	0.41
3	2.00*	0.14	0.0008	135	2.72	32	30.0	8.85	0.21
4	1.10	0.08	0.0011	150	2.00	33	29.2	8.95	0.42
5	1.00	0.12	0.0013	140	6.80	33	30.2	8.95*	0.80
6	0.80	0.24*	0.0014	152	3.22	28	31.3	8.85	1.04
7	0.90	0.08	0.0015	150	3.91	33	29.3	8.65	1.02
8	1.10	0.10	0.0022	170	5.00	33	31.7	8.73	0.95
9	0.90	0.15	0.0025	130	6.52	33	32.2	8.72	1.20*
10	0.90	0.04	0.0027	140	6.42	32	30.4	8.76	1.10
11	0.60	0.11	0.0030	254	6.00	33*	29.5	8.64	1.10
12	0.70	0.13	0.0033*	150	7.72*	32	32.5*	8.82	1.05

Note : * as the hishest value

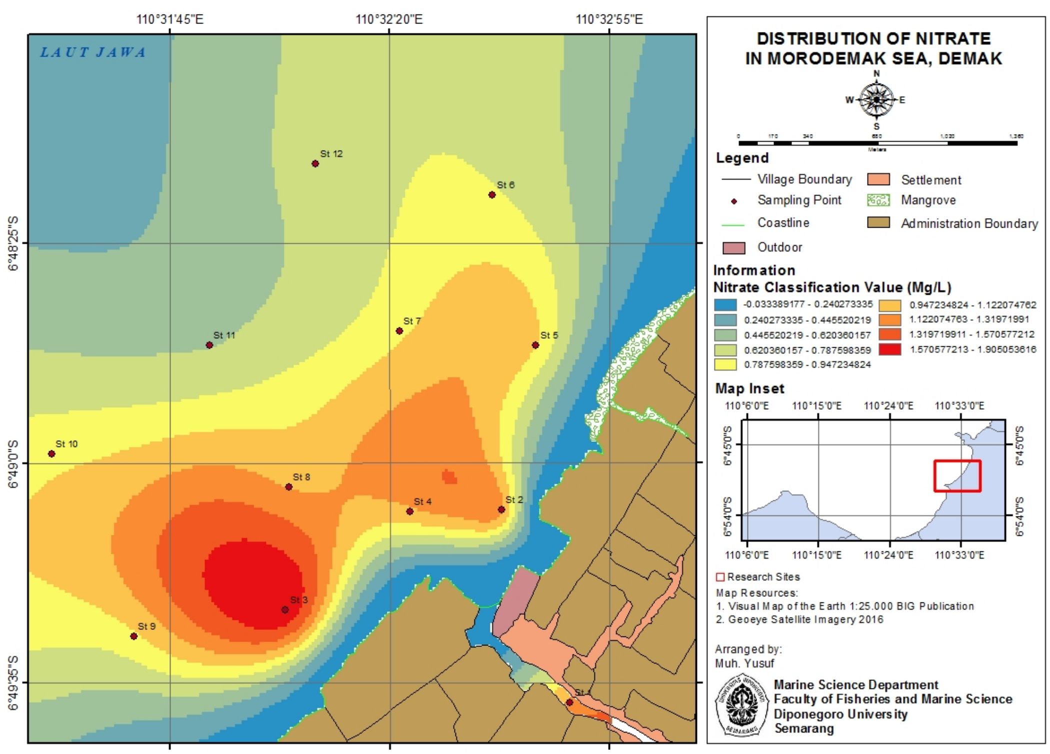

Figure 1. Spatial distribution of nitrate at Morodemak-Demak

Odum (1993) mention that countinus high nutrient concentration of river water flows into coastal water will support the primary productivity. Low concentration of nitrate at station 11 and 12 which the most far station from the mouth of the river. Organic nitrate as mainly come from marine organic metabolism and decomposition. While particulate ones come from sediment degradation (Koesoebiono, 1980).

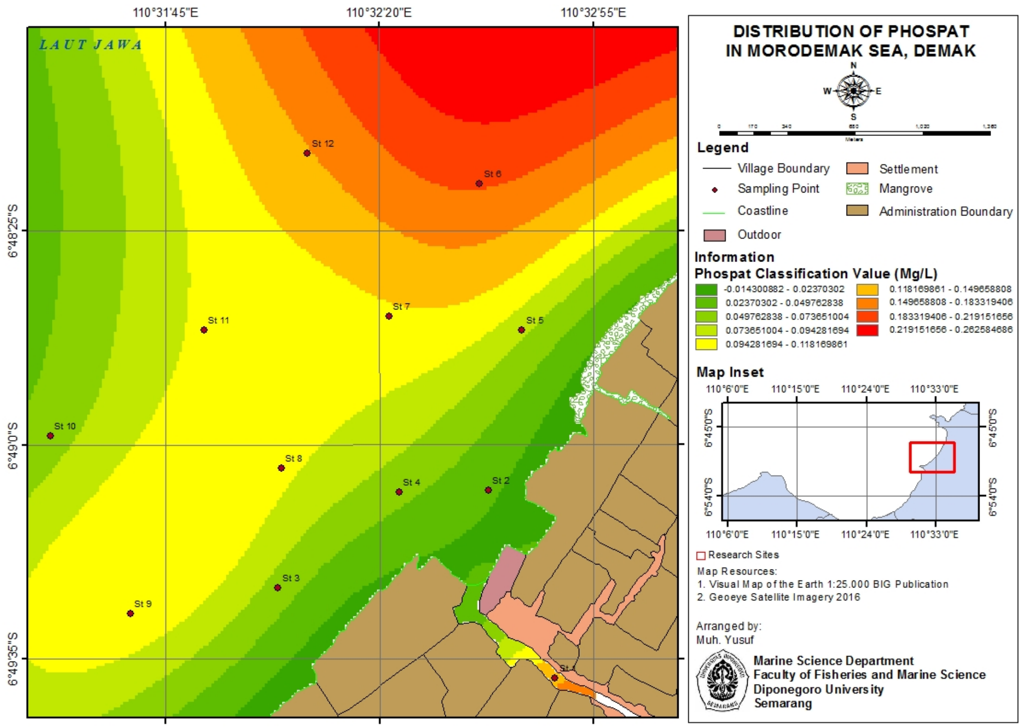

Figure 2. Spatial distribution of phosphate at Morodemak-Demak

High phosphate concentration at station 6 and 12, this kind of spatial distribution pattern was due to the pattern of existing coastal current. As well as moderatively high DO concentration arroind station 6. Salmin (2005) dissolved oxygen as parameter indicator for seawater quality since dissolved oxygen take important role in the process of organic materials oxidation into inorganic particles. Dissolved oxygen also define the biological reaction of aerobic organism in the seawater. In a aerobic condition dissolved oxygen will take role for oxydation of organic and inorganic materials into particulate nutrient and will increase primary productivity. Sastrawijaya (2009) explain that in seawater ecosystem consist of three type of phosphorus substances that is organic phosphorus such as orthophosphate, organic material inside in the protoplasm and dissolved organic phosphate from decomposition process.

About 22 genera of phytoplankton was found, with moderaate domination by Baccilariophyceae, Dinophyceae and most dominant of Rhizosolenia. Highest abundance of phytoplankton at the mouth of the river with 28,090,000 cell/m^3 and lowest at offshore water with 17,060,000 cell/m^3 (Table 2). Highest diversity index (H') was found at this area as well with (H') : 1.606 and lowest of 0.8730 at offshore position. Spatial phytoplankton distribution as presented in Figure 3. In comparison to a deep oceanic water of Papua, Hartoko and Subiyanto (2009) found mainly two groups of phytoplankton had been found in the north Papua deep sea water, that are edible phytoplankton and non-edible phytoplankton groups. The edible phytoplankton with chlorophyll content was found in the upwelling region in the Halmahera and Papua corridor. Non-edible phytoplankton group were characterized with a non-chlorophyll content, having a spiny-silica cell walls (Radiolarians) and some of them were belongs to the toxic Dinoflagelates. Non-edible phytoplankton was mainly spread over the oceanic waters up to 200 mile to the north (Pacific) water.

Coastal current. Coastal current spatial model was done using *SMS* software, where dominant current direction towards south-east to the coastline. Comparison of field current data to the result of current spatial model the value of MRE (*Mean Relative Error*) or meaning that error of field and simulation model is 10.74 %. Meaning that the value of accuracy of the simulated coastal current spatial model is 89.27 %, and scientifically acceptable. This was in accordance with Short (1987) that the value of accepted MRE is about 15%. This specific spatial current model considered as unique for this geographical position of Morodemak as combination effect of an open bay with estuary or mouth of the river.

The spatial current model of the area that estuary or mouth of the river has a unique spatial coastal current pattern as also stated by Wibisono (2011). Result of the spatial current model is considered as the interaction of surface wind, tidal current, bathymetry and coastal land elevation (Figure 4).

Table 2. Phytoplankton abundance at Morodemak-Demak coastal seawater (x000,000 cell/m^3)

NO	Genera	ST1	ST2	ST3	ST4	ST5	ST-6	ST-7	ST-8	ST-9	ST-10	ST-11	ST-12	TOTAL
	BACCILARIO-PHYCEAE													
1	Amphora	-	4	-	4	6	-	3	-	-	9	-	5	**31**
2	Bacteriastrum	-	4	-	6	6	3	3	8	11	8	7	4	**60**
3	Biddulphia	-	6	4	4	6	-	25	8	6	9	5	13	**86**
4	Chaetoceros	144	28	42	29	62	41	64	168	83	49	117	67	**894**
5	Coscinodiscus	14	16	10	14	28	24	43	23	12	9	7	11	**211**
6	Dactyliosolen	82	49	46	29	69	42	64	43	31	93	42	96	**686**
7	Eucampia	42	22	8	16	14	-	6	13	11	8	13	7	**160**
8	Hemiaulus	4	22	8	4	46	-	21	27	19	15	8	29	**203**
9	Leptocylindrus	-	-	-	7	14	-	-	-	-	-	-	-	**21**
10	Lauderia	10	-	-	-	4	8	10	-	-	5	9	10	**56**
11	Melosira	-	-	-	-	103	424	62	40	32	41	123	52	**877**
12	Nitzschia	16	48	18	69	104	127	27	39	65	103	53	91	**760**
13	Navicula	-	18	14	14	23	4	8	21	32	12	28	33	**207**
14	Pleurosigma	22	80	44	127	268	129	189	187	94	66	142	167	**1515**
15	Pelagothrix	-	-	-	-	4	-	3	-	-	8	-	-	**15**
16	Rhizosolenia	2138	2322	1482	2092	1552	1512	1142	1191	1072	1153	1981	2003	**19640***
17	Thalasionema		25	69	213	-	-	49	164	132	58	72	15	**797**
18	Thallassiotrix	22	74	44	40	82	80	100	63	41	36	74	24	**680**
19	Triceratium	-	-	-	-	4	8	-	-	6	-	-	9	**27**
20	Thalassiosira	81	-	-	-	48	87	-	-	25	-	41	-	**282**
	DINOPHYCEAE													
21	Peridinium	66	83	25	47	6	17	4	23	44	18	37	19	**389**
22	Ceratium	4	8	8	6	4	3	-	4	12	6	5	10	**70**
	Total per station	2645	2809	1822	2721	2453	2509	1823	2022	1728	1706	2764	2665	27667

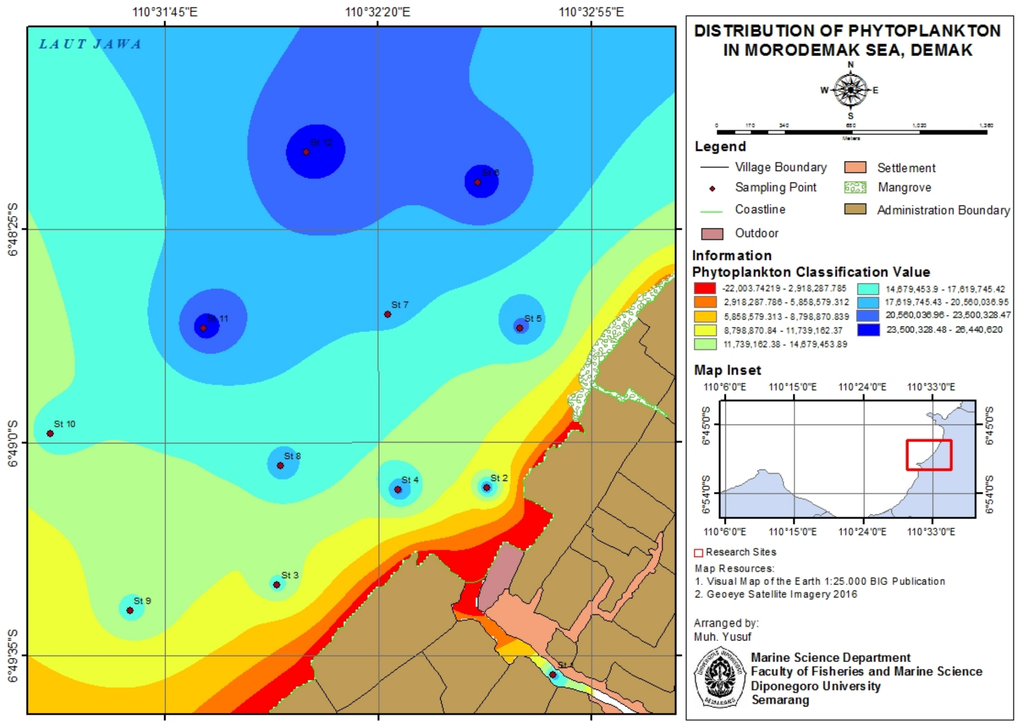

Figure 3. Spatial distribution of phytoplankton at Morodemak-Demak

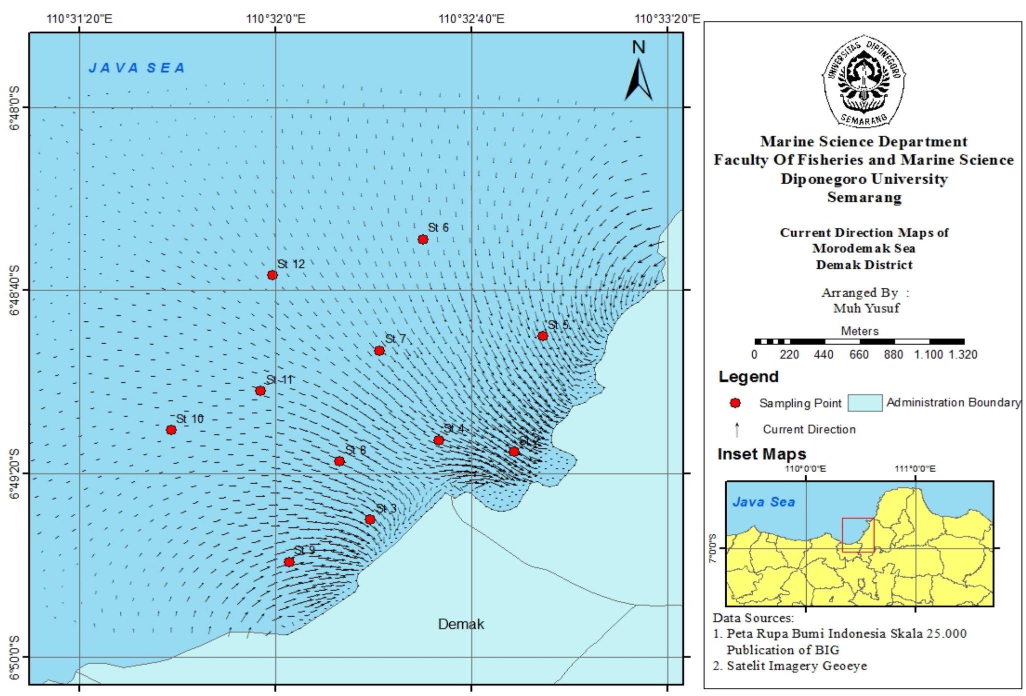

Figure 4. Spatial distribution of phytoplankton at Morodemak-Demak

The study revealed that nutrient distribution in this shallow coastal water was mainly affected by coastal current that is tidal current (Figure 4). Meaning that their spatial distribution pattern was mainly governed by low tide and high tide current. That is towards and offward the coastal water, and ultimately producing a unique spatial distribution of phytoplankton at this area. Jalil (2013) stated that the resulted coastal current from field data and spatial model using *SMS* software would be more affected by tidal current pattern.

Acknowledgements

The author would like to thanks to Riandi for helping the current spatial model, to all staff of Marine Science Department Undip for seawater quality and phytoplankton analysis. Special thanks to University of Bangka Belitung for supporting find to attend the IJJSS 2016 at Chiba University – Japan. A sincere thanks to Prof. A. Hartoko for the English language help of the manuscript.

REFERENCE

Dahuri, R., J. Rais, S.P. Ginting, and M.J. Sitepu. 2004. Pengelolaan Sumber Daya Wilayah Pesisir dan Lautan Secara Terpadu (Integrated Coastal Resources Management). PT. Pradnya Paramita, Jakarta, 328 pp.

Fachrul, F.M., H. Haeruman, and L.C. Sitepu. 2005. Komunitas fitoplankton sebagai bio-indikator kualitas perairan Teluk Jakarta. (Phytoplankton Community as Bioindicator of Jakarta Bay). Seminar Nasional MIPA 2005. FMIPA-Universitas Indonesia, 24-26 November 2005, Jakarta.

Hartoko,A and M.Helmi (2004). Development of Multilayer Ecosystem Parameters Model . Journal of Coastal Development. ISSN : 1410-5217Vol.7,No.3,June 2004. pp 129-136.

Hartoko,A and Subiyanto (2009). Spatial Distribution of Phytoplankton, Zooplankton and Larvae at North Papua Deepsea Water. A paper submited to the Oceanography, USA.

Jalil, A. R. 2013. Distribusi Kecepatan Arus Pasang Surut Pada Muson Peralihan Barat-Timur Terkait Hasil Tangkapan Ikan Pelagis Kecil di Perairan Spermonde. (Variations of Coastal Tidal Current and its Effect to Pelagic Fish Catch at Spermonde). *Depik,* 2 (1):26-32

Jones-Lee, A., & G.F. Lee. 2005. Eutrophication (Excessive Fertilization).Water Encyclopedia: Surface and Agricultural Water. Wiley, Hoboken, NJ. p 107-114.

Koesoebiono. 1980. Dasar Ekologi Umum, bagian IV. Ekologi Perairan. Sekolah Pasca Sarjana. (Basic Ecology. IV. Aquatic Ecology). Jurusan Pengelolaan Sumber Daya Alam dan Lingkungan. Institut Pertanian Bogor.

Odum, E.P. 1993. Translated (Srigandono. Ed). Fundamental of Ecology. Gajah Mada Press. Yogyakarta.

Salmin. 2005. Oksigen Terlarut dan Kebutuhan Oksigen Biologi Sebagai Salah satu Indikator untuk Menentukan Kualitas Perairan. (Dissolved oxygon as Indicator for Water Quality). Oseana.30: 21-26.

Sastrawijaya, T. 2009. Pencemaran Lingkungan (Environmental Pollution). PT. Rineka Cipta. Jakarta

Short, F.T.,1987. Effects of sediment nutrients on seagrasses: literature review and mesocosm experiment. Aquat. Bot., 27: 41-57.

Sudjana. 1996. Metode Statistik (Statistic Methodology). Jakarta : Erlangga

Suryabrata, S, (1983), Metodologi Penelitian (Research Methodology). PT Rajagrafindo Persada, Jakarta.

Wibisono, M.S. 2011. Pengantar Ilmu Kelautan (Introduction of Marine Science) Edisi 2. UI-Press. Jakarta