Coastal Dynamic, Nitrate (NO3-) Phosphate (PO4-) and Phytoplankton Abundance at Morodemak North Java Sea Indonesia

Muh. Yusuf

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. Especially to coastal current pattern and to nitrate and phosphate variation and ultimately to phytoplankton abundance. Study area focused at 110°52'03.72"E - 110°35'48" E and 06°80.4'75"S - 06°82'72.22"S. The study was conducted for 1 mont in September 2014. Location of this research at Morodemak waters of North Java Sea. Aim of study was to built current spatial model, measure in situ nitrate and phosphate variation and phytoplankton abundance. Coastal current spatial modelling was done using SMS-v8.1 and sampling site based to purposive sampling representative 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. 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. Around 22 genera of phytoplankton were found, with moderate dominance 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/m3. Lowest abundance at offshore coastal site with 17,060,000 cell/m3. 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

I. INTRODUCTION

Coastal water regarded as specific ecosystem with many natural and man made influences from upland areas as well from oceans [1]. Nutrient of phosphate and nitrogen considered as the limiting factor for seawater productivity [2]. The two nutrients has important role for the life of marine organisms such as phytoplankton [3]. Nitrogen compound which can be used are nitrite and nitrate, while phosphorus in the form of ortho phosphat [4].

Semarang, Morodemak and Demak coastal water the main study area was in fact as fishing ground, auction place and fishermen villages with many kinds of pollution 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 in situ nitrate, phosphate variation and phytoplankton abundance, coastal current and built spatial model.

II. METHOD

Primary data of nitrate, phosphate phytoplankton abundance as well as dissolved oxygen (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 [5] 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°35'48"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 Spectrophotometer 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 [6], then analised discriptively [7].

III. 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 brings 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). Coastal 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 [8]. Other implication of the current, temperature – depth interactions. Both water current and depth contribute significantly to the vertical temperature profile of North Moluccas and Halmahera, with the average current velocity was about 2.5 cm/sec respectively 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.

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 moderately high DO concentration arround station 6. Salmin [9] dissolved oxygen as parameter indicator for seine water quality since dissolved oxygen take role important 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 oxidation of organic and inorganic materials into particulate nutrient and will increase primary productivity. Sastrawijaya [2] 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 phosphates from decomposition process.

About 22 genera of phytoplankton was found, with moderate domination by Baccillariophyceae, Dinophyceae and most dominant of Rhizosolenia. Highest abundance of phytoplankton at the mouth of the river with 28,090,000 cell/m3 and lowest at offshore water with 17,060,000 cell/m3 (Table 2). Highest diversity index (H’) was found at this area as well with (H’): 1.660 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 [8] 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 upwell 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 Dinoflagellates. Non-edible phytoplankton was mainly spread over the oceanic waters up to 200 mile to the north (Pacific) water.

**TABLE I.** NITRATE, PHOSPHATE, CURRENT SPEED AND DIRECTION, DO, SALINITY, SST, pH AND TRANSPARENCY

| ST   | NO3- (mg/l) | PO4 (mg/l) | Current 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       | 0.0002                | 150       | 2.51         | 31       | 31.5  | 8.40             | 0.41 |
| 3    | 2.00*      | 0.14       | 0.0008                | 150       | 2.72         | 32       | 32.6  | 8.85             | 0.21 |
| 4    | 1.00       | 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       | 32.0  | 8.95*            | 0.80 |
| 6    | 0.80       | 0.24       | 0.0014                | 152       | 3.22         | 28       | 31.3  | 8.85             | 1.10 |
| 7    | 0.90       | 0.08       | 0.0015                | 150       | 3.91         | 33       | 29.3  | 8.65             | 1.02 |

**Note:** * as the highest value

**TABLE II.** PHYTOPLANKTON ABUNDANCE AT MORODEMAK-DEMAK COASTAL SEAWATER (x100,000 CELL/M3)

| Genera             | ST     | ST2    | ST3    | ST4    | ST5    | ST6    | ST7    | ST8    | ST9    | ST10   | ST11   | ST12   |
|--------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| **BACCILLARIO-**   |        |        |        |        |        |        |        |        |        |        |        |        |
| PHYCEAE            |        |        |        |        |        |        |        |        |        |        |        |        |
| Amphora            | 4      | 4      | 6      | 3      | 9      | 5      | 31     |        |        |        |        |        |
| Bacillarodinum     | 4      | 5      | 6      | 3      | 3      | 11     | 8      | 3      | 4      | 60     |        |        |
| Bolidium           | 6      | 4      | 4      | 6      | 25     | 8      | 9      | 5      | 13     | 86     |        |        |
| Chaeotricha        | 144    | 28     | 42     | 29     | 62     | 41     | 64     | 168    | 83     | 49     | 117    | 67     |
| Coscinodiscus      | 14     | 16     | 10     | 14     | 28     | 24     | 43     | 23     | 12     | 9      | 7      | 11     |
| Dasyacodinium      | 82     | 49     | 46     | 29     | 49     | 62     | 44     | 63     | 31     | 93     | 42     | 96     |
| Eucampia           | 42     | 22     | 8      | 16     | 14     | 6      | 13     | 11     | 8      | 8      | 7      | 160    |
| Hamaplia           | 4      | 22     | 8      | 4      | 46     | 21     | 27     | 19     | 15     | 8      | 9      | 20     |
| Leptocylindrus      | -      | -      | 7      | 14     | -      |        |        |        |        |        |        |        |
| Leurobiidae        | 10     | -      | -      | 4      | 8      | 10     |        |        |        | 5      | 9      | 10     |
| Mesoelsa           | -      | -      | -      | 103    | 42     | 62     | 40     | 32     | 41     | 125    | 52     | 877    |
| Nitzchia           | 46     | 48     | 18     | 69     | 104    | 127    | 27     | 39     | 65     | 103    | 53     | 91     |
| Navicula            | -      | -      | 14     | 14     | 23     | 4      | 8      | 21     | 32     | 12     | 28     | 33     |
| Pensteemus          | 22     | 80     | 44     | 127    | 129    | 189    | 187    | 94     | 66     | 142    | 167    | 151    |
| Pelagodinum         | -      | -      | -      | 45     | 8      | -      |        |        |        | 8      | -      | 15     |
| Rhizosolenia        | 213    | 232    | 148    | 209    | 155    | 151    | 114    | 119    | 107    | 117    | 119    | 181    |
| Thalassiosira       | 25     | 69     | 212    | 49     | 164    | 132    | 58     | 72     | 15     | 79     | -      |        |
| Thalassiosira       | 22     | 74     | 44     | 40     | 82     | 80     | 100    | 63     | 41     | 36     | 74     | 24     |
| Thalassiosira       | -      | -      | -      | 4      | 8      | -      |        |        | 6      | -      | -      | 27     |
| Thalassiosira       | 81     | -      | -      | 48     | 67     | -      |        |        | 25     | 41     | -      | 282    |
| Dinophyceae         |        |        |        |        |        |        |        |        |        |        |        |        |
| Fistulinua          | 66     | 83     | 25     | 47     | 6      | 17     | 4      | 25     | 44     | 18     | 37     | 19     |
| Centricmus          | 4      | 8      | 8      | 6      | 4      | 3      | -      | 4      | 12     | 6      | 5      | 10     |
| Total per station   | 264    | 280    | 182    | 272    | 245    | 250    | 182    | 202    | 172    | 122    | 98     | 276    |

**Note:** * as the highest value
Coastal current. Coastal current spatial model was done using SMS software, where dominant current direction towards South-East to the coastline. For verification, the model’s result then compared by measurement data for prove the validity and accuracy of model. The comparison show around 10.74% MRE (Mean Relative Error) value. This MRE value shows the error/differences value between measurement data and model’s result. Furthermore, the accuracy between those data are around 89.27% and scientifically acceptable. According to Short [10], the value of accepted MRE’s model is about 15% to measurement data.

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 result of the spatial current model are influenced by surface wind, tidal current, bathymetry and coastal profile (Figure 4). Dominantly, the current will flow from open ocean to estuaries/lands due the effect of wind forcing and corresponding to wind direction at that region. Moreover, this condition are strengthened by tidal forcing when high tide condition and vice versa when low tide. 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 [11].

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 [12] stated that the resulted coastal current from field data and spatial model using SMS software would be more affected by tidal current pattern.

IV. CONCLUSION

Nitrate concentration range of 0.60-2.0 mg/l, phosphate range of 0.04 - 0.24 mg/l. Both with high concentration arround the mouth of the river estuary and lowest toward the open coastal seawater. There were 22 genera of phytoplankton with domination of family Ciliariophyceae, Dinophyceae and mostly Rhizosolenia. Highest density of phytoplankton was found the estuary with 28,090,000 individu/m³ and lowest abundance 17,060,000 individu/m³. Maximum coastal current range was 0,0003 - 0,0033 m/sec. The spatial model had resulted that the dominant coastal current direction to the south east direction as well as the validation validation. MRE value of the spatial model was found 10.73 % means that the model accuracy was 89.27 %.

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