REPORT

Sato Umi Application and the Environmental Assessment of Jakarta Bay for Regional Indonesian Sustainable Coastal Management

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1. Introduction

Indonesia is the largest archipelago country in the world with an area of ± 7.8 million km^2, where the sea area is 5.8 million km^2 with the number of islands 17,504 where 92 islands are the leading islands of Indonesia. Indonesia has also 1.2 million ha of brackishwaterpond area, but only 37.5% of them are used for aquaculture activities. The low utilization of brackishwater pond is generally caused by environmental damage due to the excessive exploitation by intensive aquaculture activities during the period of 1980s. In line with the growing global paradigm in the face of change and good environmental damage caused by excessive exploitation of natural resources and the consequences of climate change and global warming, it is time for Indonesia to implement the concept of management and utilization of natural resources taking into account the balance and stability of the natural resources and the environment, such as in the concept of SATO-UMI as promoted by Yanagi (2008). To support those paradigm, it is necessary to develop a management and utilization concept of fishery, coastal and marine resources wisely, balanced, harmonious, integrated and more productive by actively involving the community. To implement the SATO-UMI concept and to improve the productivity of the marginal brackishwater pond in the coastal area, a sustainable aquaculture model should be developed. An integrated and environmental friendly farming technology model such as the Integrated Multi-Trophic Aquaculture (IMTA), can be applied to improve the productivity of marginal brackishwater pond by increasing the diversity product through biorecycle system to ensure the sustainable utilization of brackishwater pond in the coastal area.

On the other hand, Jakarta Bay, a semi enclose estuary in the northern coastal area of Jakarta has faced serious environmental degradation due to human and industrial activities. The environment of the rivers surround Jakarta was polluted due to the increasing of the domestics and industrial waste as response to the rapid development of the anthropogenic activities within the city since the decades. As consequence, the carrying capacity of the water ecosystem was degraded including Jakarta Bay as the estuary of the passing rivers of the Jakarta City..This led to ecosystem disturbance including loss of biodiversity due to for example mass mortality of fish as a result of oxygen depletion (hypoxia). It was supposed that the upwelling of oxygen depleted water (hypoxic water mass) would induced the massive fish kill (Sachoemar and Wahjono, 2007).

II. Aim/Objective

This report briefly discusses the Sato Umi concept and its implementation to support the sustainable aquaculture development, and also discusses the pollution problem within the Jakarta Bay to understand the formation mechanism of hypoxic water mass.

III. Method

3.1. Sato Umi and IMTA

An experiment to clarify the sustainable model of Integrated Multi Tropical Aquaculture (IMTA) as a model of Sato Umi Concept was conducted during 4 months from June to September 2010 in the marginal brackishwater pond area of the northern coastal area of Karawang, West Java, Indonesia (Fig.1). The experiment used four (4) aquaculture models using 500 m^2 pond of each with three (3) replications (Fig.1).

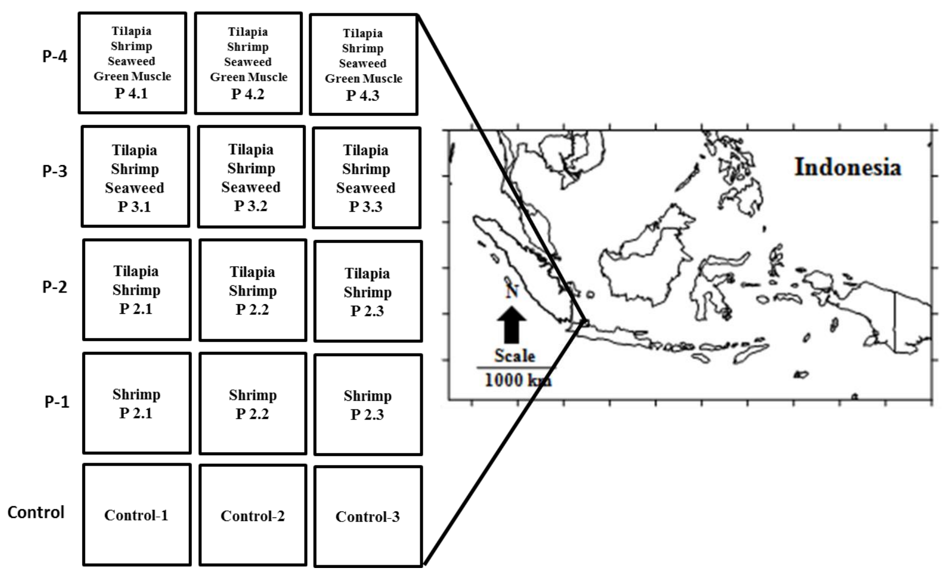

Fig 1. Location and experimental design of IMTA, as a Sato Umi Concept at the northern coastal area of Karawang

3.2. The assessment of Jakarta Bay environment

As for the assessment of Jakarta Bay environment, surveys of the water quality distribution was conducted 3 times (May, September and December) and a survey for the sampling of macrobenthos and bottom sediment (September) during a year. The continuous observation using a mooring system conducted from April 2017 was finished in May 2018. The locations of the stations are shown in Fig.2. During these surveys, the water sampling for the analysis of nutrients and chlorophyll a with a Van-Dorn sampler was conducted at 8 stations in May (Stn. 8, 14, 18, 20, 30, 44, 46, 47) and 5 stations in September and December (Stn. 6, 18, 29, 30, 32).

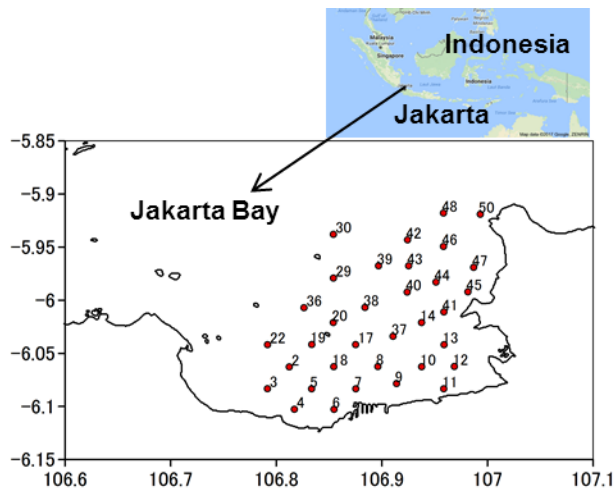

Figure 2. Map of Jakarta Bay and locations of the water quality observation stations.

IV. Result and Discussion

3.1. Sato Umi and IMTA

Based on the data shown in Fig.3, the DIN concentration of P-4 is the lowest even compared to the control. This situation indicates that P-4 containing green muscle as the organic consumer organism and seaweed as an inorganic consumer has contributed on the reduction of DIN concentration through the biorecycle system. In this system, organic material derived from residual feed, fish waste and other sources will be used for the growth of seaweed and green muscle. As the result, water quality and ecosystem of P-4 to be more stable compare to the other models.

The result of experiment has shown that P-4 containing 4 cultivated organism as an integrated multi trophic aquaculture model was the most productive aquaculture system with the most stable water quality compared to monoculture and polyculture non integrated multi trophic aquaculture system (Fig 4.). This result indicates that the aquaculture system with integrated multi trophic polyculture will be more benefit to sustain the aquaculture system in the coastal area and more productive to provide finacial benefits for the society compared to monoculture and polyculture non integrated multi trophic aquaculture system without algae and benthic organism as shown in P-1, P-2 and P-3. With integrated multi trophic aquaculture models, the risk of failure aquaculture business is expected to be reduced, because at least one or more cultivation organisms are still expected to be harvested. The farmer can also reduce the risk of capital farming and maintain the coastal area to sustain aquaculture activities with the natural balance.

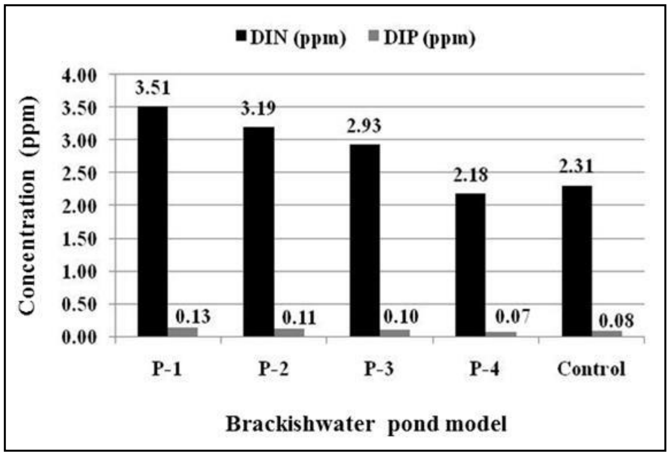

Fig. 3. Mean average of DIN (Dissolve Inorganic Nitrogen) and DIP (Dissolve Inorganic Phosphorus) of each brackish water pond model.

The result of experiment has shown that P-4 containing 4 cultivated organism (tilapia, shrimp, seaweed and shellfish) that are cultured integrity in one pond as an integrated multi trophic aquaculture model was the most productive aquaculture system with the most stable water quality compared to monoculture and polyculture non integrated multi trophic aquaculture system (Fig 4.). This result indicates that the aquaculture system with integrated multi trophic polyculture will be more benefit to sustain the aquaculture system in the coastal area and more productive to provide finacial benefits for the society compared to monoculture and polyculture non integrated multi trophic aquaculture system without algae and benthic organism as shown in P-1, P-2 and P-3. With integrated multi trophic aquaculture models, the risk of failure aquaculture business is expected to be reduced, because at least one or more cultivation organisms are still expected to be harvested. The farmer can also reduce the risk of capital farming and maintain the coastal area to sustain aquaculture activities with the natural balance.

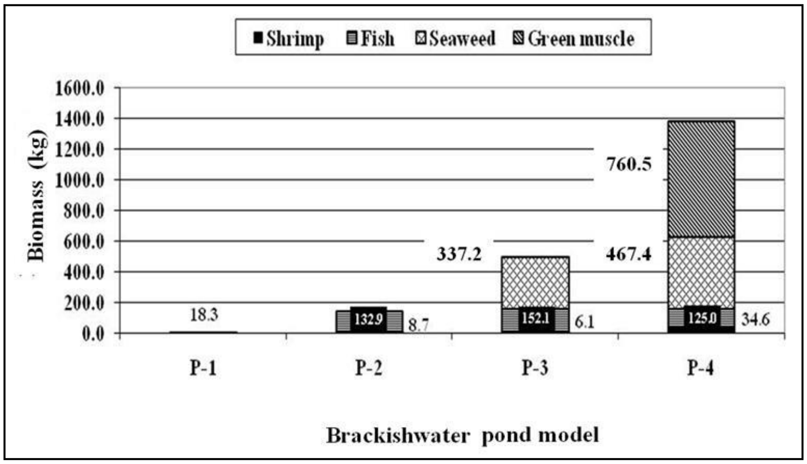

Fig.4. Productivity profile of each brackish water pond model

4.2. The assessment of Jakarta Bay environment

The distributions of temperature, salinity and chlorophyll a fluorescence in the surface layer (0.5 m depth) and the distribution of temperature, salinity and DO in the bottom layer (0.5 m above bottom) in May were shown in Figures 4. The same ones in September and December were shown in Figure 5 and 6. Figure 7 shows the relationship between chlorophyll fluorescence and chlorophyll a observed in the 3 surveys. The nutrient samples are under analysis. In May, surface temperature was higher in the inner most of the bay. There was a low salinity water mass distributed at the south east end of the bay. The chlorophyll fluorescence was high in the coastal area especially south eastern area. However, such structure was not observed in the bottom layer. The water with temperature lower than 30.1 °C and salinity higher than 31.8 distributed wide area of the bay. Bottom temperature was low along the eastern coast. Temperature was high and salinity was low in the southern coastal area. The bottom water DO was in low the eastern Jakarta Bay. The hypoxic water mass which had DO lower than 3 mg/L was formed in the south eastern area. The minimum DO was 0.3 mg/L which was observed at Stn. 10 just above the bottom. In September, the surface temperature was higher in the coastal area. Low salinity water distributed in the inner most of the bay. The chlorophyll fluorescence was relatively high in the coastal area where the salinity was low. It was especially high in the south eastern area. Compare to the surface salinity, the bottom water salinity was homogeneous. The water with high temperature and low salinity distributed along the southern coast. The bottom DO was lower in the eastern area. The minimum DO was 1.6 mg/L which was observed at Stn. 13 just above the bottom. In December, the surface temperature was high in the inner most of the bay. A low salinity water mass was distributed in the central area. The chlorophyll fluorescence was high in the southern coastal area. The bottom temperature and salinity were relatively homogeneous. The high temperature and low salinity water distributed along the coast. The bottom DO was low in the eastern area. The minimum DO was 0.3 mg/L which was observed at Stn. 9 just above the bottom.

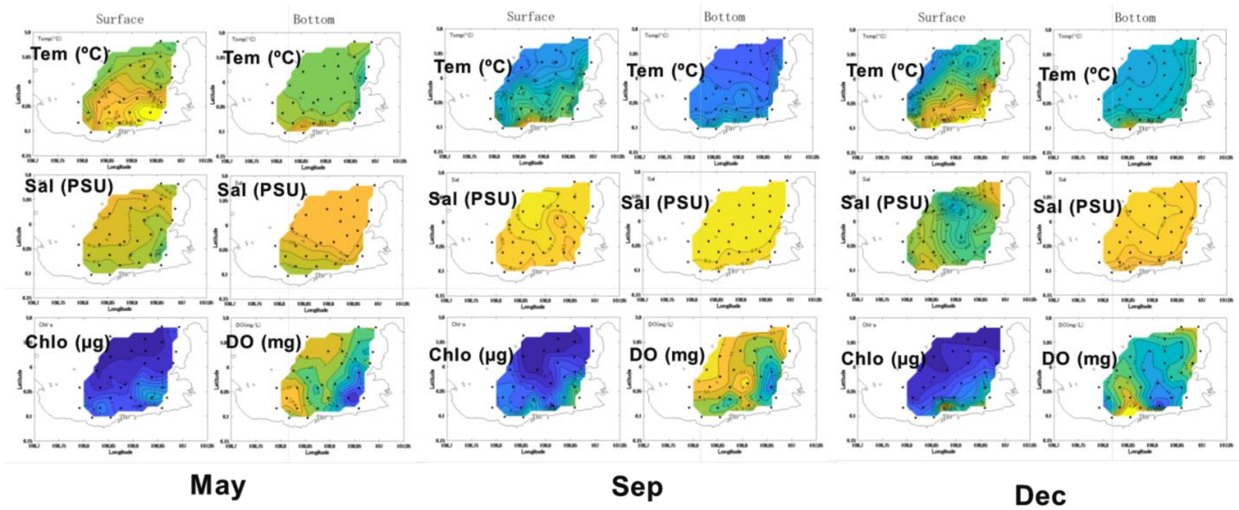

Figure 4. Horizontal distribution of temperature, salinity and chlorophyll a fluorescence in the surface layer (0.5 m) and temperature, salinity and DO in the bottom layer (0.5 m above the bottom) in May, September and December 2018.

V. Conclusion Remark

1. An Integrated Multi Tropic Aquaculture (IMTA) by using tilapia, shrimp, seaweed and shellfish as a model of Sato Umi Concept has demonstrated high productivity and environmental stability compared to the monoculture.
2. In Jakarta Bay, the hypoxic water mass was formed almost throughout the year.

Reference

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Sachoemar, S.I. and H.D. Wahjono (2007) Kondisi Pencemaran Lingkungan Perairan Teluk Jakarta. Jurnal Air Indonesia (Indonesian Water Journal) Vol.3, No. 1: 1-14.

Publication/conference presentation,

1. International symposium on coastal ecosystem change in Asia. LaMer-Center for Marine Environmental Studies (CMES), Ehime University, Matsuyama, Japan 14-16 November 2019. Presentation Topic : The environmental study to understand the hypoxia behavior in Jakarta Bay.
2. The 2nd International Conference on the Environment Managemen of the Enclosed Coasta Seas (EMEC12). Cooperative stewardship for Integrated management toward resilient coastal seas. Pattaya. Thailand. 4-8 November 2018. Presentation Topic : Sato Umi Movement in Indonesia
3. The North Pacific Marine Science Organization (PICES)-2018 Annual Meeting. Oct, 30 – Nov 2, 2018, Yokohama, Japan. Presentation Topic : Development of Sustainable Integrated Multi Tropic Aquaculture (IMTA) as a Model of Sato Umi Concept in the Coastal Area of Indonesia
4. Japan Society for Promotion of Science (JSPS)-CCore-RENSEA Second Joint Seminar on Coastal Ecosystems in Southeast Asia. University of the Philippines Visayas (UPV), Iloilo City Campus. 27 February–1 March, 2018. Presentation Topic : Sato Umi Application and the Environmental Assessment of Jakarta Bay for Regional Indonesian Sustainable Coastal Management.
5. The 85th Anniversary-Commemorative International Symposium of The Japanese Society for Fisheries Science (JSFS). Fisheries Science for Future Generations Abstract Submission Secretariat. “Fisheries Science for Future Generations”. Tokyo University of Marine Science and Technology. Tokyo, Japan, on 22–24 September, 2017. Presentation Topic :Development of sustainable aquaculture model base on sato umi concept in the coastal area of Indonesia.

Perspectives in future

Sato Umi Application and the Environmental Assessment of Jakarta Bay are useful to support the sustainable development of the environment and fisheries resources in the coastal area. The result can be used as a fundamental scientific research data base for developing an advance research of the Sato Umi and the environmental research of the coastal area in the future.