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Mangrove Vegetation Effect of Nutrient Conditions in The Ponds of Sembilang National Park, South Sumatra

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ABSTRACT

Sembilang National Park is one of the national parks which is located in South Sumatra and became the largest mangrove area in western Indonesia. However, most of the mangroves area in the national park has been experiencing over the function to be plots of tidal ponds. This has resulted in concerns mangrove destruction of land in national parks. One of the efforts made to maintain the mangroves area is to do sylvofishery system, which is mangrove planting and cultivation of milkfish simultaneously in the plots of ponds. This study aims to analyze the water quality and nutrient levels (nitrate and phosphate) in the ponds in the area of sylvofishery restoration in Sembilang National Park. This study conducted by purposive method sampling in the restoration ponds, non-restoration ponds, and river water bodies in all area of Sembilang National Park. The analyze include insitu parameters measurement and nutrient (nitrate and phosphate) analysis. The results showed that the presence of mangrove plants in the ponds area is able to improve the content of DO and pH of pond water, mangroves also showed satisfactory results in the capture of nitrate that would indirectly prevent the pond water from pollution. However, based on the phosphate condition, high phosphate in ponds area that have been restored showed that young mangrove plants have not been able to significantly phosphate binder.

Keywords: *mangrove restoration, ponds, insitu parameter, nitrate and phosphate, Sembilang National Park*

INTRODUCTION

Sembilang National Park is located in Banyuasin Regency, South Sumatra and is the largest mangrove area located in the western part of Indonesia (Suwignyo at al, 2005). Mangrove areas in this Sembilang officially became a national park on the recommendation of the Governor of South Sumatra (Letters of Recommendation No. 522/5459/BAPPEDA-IV/1998), and the ministerial decree on March 15, 2001, No. 76/Kpts-II/2001 on Appointment of Forest Area in South Sumatra Province, which also included the designation of the area as a National Park Sembilang. This was then followed up by the Governor of Sumatra (based on no 522/5128/I letter dated October 23, 2001), by requesting the establishment of Sembilang National Park area with an area of 205.750 ha. Determination Sembilang mangrove area in a national park does not mean the problem of mangrove conservation in this region is complete. Determination of the region into a new national park was in 2001, although since the 1990s the surrounding community has many uses in the mangrove areas as land Sembilang breadwinner. Many mangrove areas which have become the pond area. This resulted in most areas of mangrove in Sembilang National Park has experienced over the function and if not treated immediately then it is not impossible mangroves in Sembilang National Park will be completely depleted.

One of the efforts made to restore the mangrove is the approach followed by restoration. The restoration effort has been made in some areas of the ponds, with mangrove planting in the ponds, both farms which have been abandoned and ponds that are still active. Planting using sylvofishery pattern, make the use of mangrove and fish in the same pond. This technique is considered the most suitable for ponds and expected social welfare can be increased while still ensuring proper mangrove forest sustainability. Sylvofishery effort has been going on for the last 4 years and need for a study to determine the level of benefits of the mangroves on the ponds. Therefore this study aimed to analyze the water

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quality and levels of nutrients (nitrate and phosphate) in the ponds in the area of restoration sylvofishery Sembilang National Park Banyuasin district.

METHODS

The study was conducted in October 2013 in Sembilang National Park, South Sumatra. At the park there are three large rivers, i.e. the Solok Buntu River, Barong Kecil River and Barong Besar River. On those three rivers there are ponds that use river water flow as a source of pond water (Figure 1).

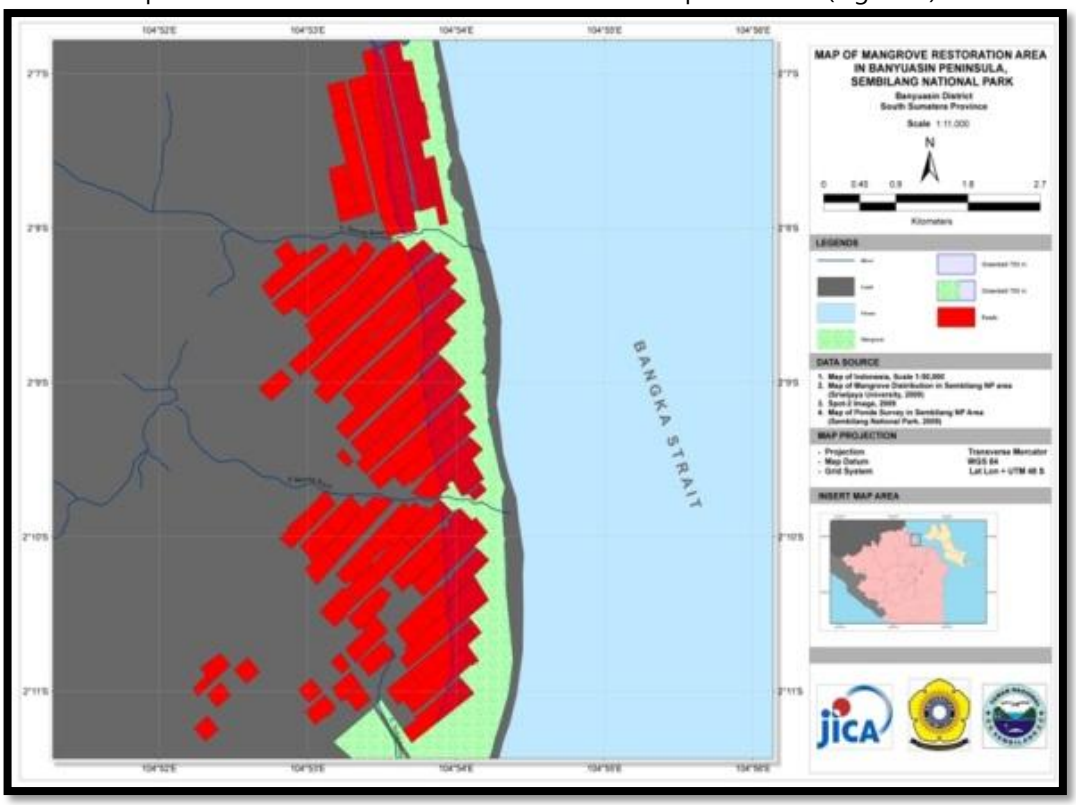


Figure 1. Research map location.

In each region, water sampling and insitu measurements of parameters have been done using purposive sampling method. The sampling areas are restored ponds, natural ponds or restoration has not been done, and the rivers that flow into the pond. At Solok Buntu River and Barong Kecil River there are only 2 mangrove restoration ponds. On Barong Kecil River, taken 3 ponds treated with mangrove restoration. In addition to these ponds, sampling and measurement parameters were also performed on each river stream as a control.

Sampling and measurement of insitu parameters at each sampling station using 3 different points. Sampling was conducted by carried out 50 mL of water which then directly keep in the cool box for nitrate and phosphate concentrations which will be analyzed in the laboratory. Measurement insitu parameters include temperature, salinity, pH, and dissolved oxygen (DO).

RESULTS AND DISCUSSIONS

Insitu Parameters. Parameter measurements insitu was conducted to determine the condition of the water in each pond and river. Insitu parameter measurement results can be seen in Table 1. Table 1 shows the value of pH, DO, temperature, and salinity were different in each pond and river respectively. On Solok Buntu River and Barong Kecil River, pH in the restoration ponds was more alkaline than non-restoration ponds. This is presumably due to low CO_2 content in the pond restoration. At the time the study was conducted, restoration ponds are in post-harvest conditions, where there is no culture of milkfish as culture organism and water conditions in the ponds are also in a little volume.

Tabel 1. Insitu parameter of ponds and rivers in Sembilang National Park

Location		pH	DO (ppm)	Temperature (^{O}C)	Salinity (‰)
Solok Buntu River	Restoration ponds	9.61	7.54	35.53	21.67
	Non-restoration ponds	8.44	5.52	37.37	27.00
	River stream	8.18	3.12	31.49	15.00
Barong Kecil River	Restoration ponds	9.48	6.90	34.07	17.17
	Non-restoration ponds	8.95	5.01	38.72	23.00
	River stream	8.89	4.93	29.30	17.00
Barong Besar River	Restoration ponds	7.50	3.82	28.89	11.58
	Non-restoration ponds	8.94	3.76	29.57	8.67
	River stream	8.66	3.87	29.91	17.00

This resulted in the absence of CO_2 source in the ponds so that the concentration of CO_2 was low. In addition, the mangrove in the restoration ponds also acts as the user CO_2 in water for photosynthesis, resulting lower CO_2. The higher the concentration of CO_2, the water will become more acidic, and so the lower concentration of CO_2,the pH waters will become more alkaline. This is in accordance with equation (Doney, SC, VJ Fabry, RA Feely, and JA Kleypas. 2009) :

$$CO_{2(atmos)} \rightleftarrows CO_{2(aq)} + H_2O \rightleftarrows H_2CO_3 \rightleftarrows H^+ + HCO_3^- \rightleftarrows 2H^+ + CO_3^{2-}.$$

The opposite happens in the ponds in the Barong Besar River, which are the restoration ponds more acidic than non-restoration ponds. This is presumably due to the location of non-restoration ponds which are closer to the river as a water source. In addition, at the time of sampling, the restoration ponds were in dredged condition. It is thought to result in the release of the CO_2 content of the sediment to the water column. Furthermore, for the body of the rivers, the pH of the water bodies is generally lower than the pH of the ponds. The river is a source of CO_2 which then taken from the upstream to the downstream areas, besides respiration which is carried out by the river organism along the river bodies allegedly contributing to the increase in CO_2.

Based on the provisions of Minister of Environment No. 51 of 2004, pH conditions in the ponds that have been restored, natural ponds and river water bodies, tend to exceed the standard. The provisions KepMenLH No.51 of 2004 provides pH for quality standard in the range of 7 to 8.5. However, the condition exceeded standards this does not necessarily indicate the condition of the restoration ponds are not feasible for the growth of milkfish. This is because post-harvest stages that occurring in the restoration ponds. While in the non-restoration ponds, the high pH conditions indicate that pond water conditions are not in accordance with the growth of milkfish. On the non-restoration ponds, people usually do not do water changes during cultivation. This is of course will result in declining of water quality little by little.

Influence of the presence of mangrove restoration in ponds is also seen in the content of DO, where DO in the restoration pond are higher than non-restoration ponds and river water bodies. This is caused by the photosynthetic activity undertaken by mangroves and then transferred to the ponds water column. Conditions restoration ponds which just done harvesting, resulting in oxygen of photosynthesis is not fully utilized.

In addition, a higher pH level in the restoration ponds also affects the content of DO, pH the restoration ponds which are high (alkaline) will result in high dissolved oxygen. The content of DO in the area of the ponds, both restoration and non- restoration , in Solok Buntu River and Barong Kecil River in accordance with the quality standards established by the Minister of Environment No. 51 of 2004, which is above 5 ppm. Whereas DO in ponds in the Barong Besar River lower than the standard. Same thing with pH, low level of DO in the restoration ponds due to dredging stages of post- harvest, while the non-restoration ponds, indicating the need for the change of water to improve water quality.

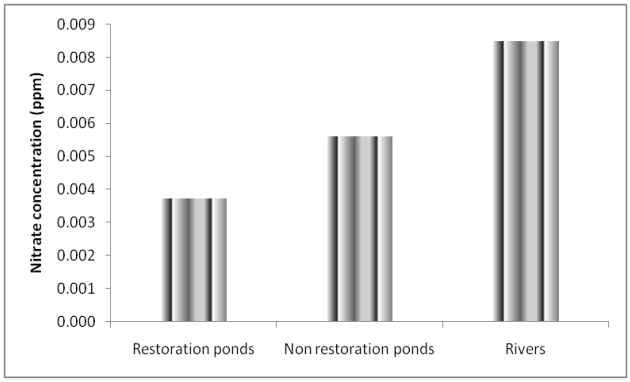
Differences in the temperature parameter in the restoration ponds, non-restoration ponds and river water bodies, due to the difference time measurement parameters. The higher the inclination angle of the sun, then the water temperature will be higher. The ability of water to store heat also led to the temperature difference.

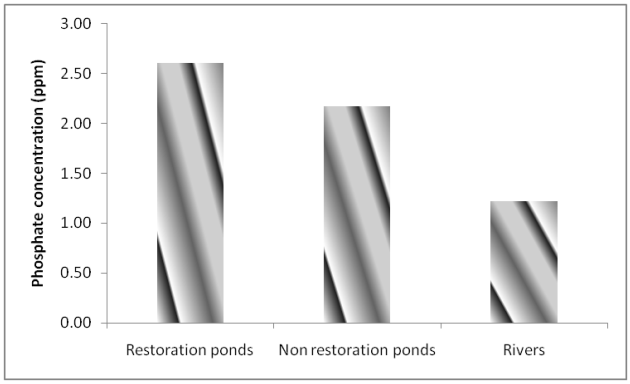
Salinity in the restoration ponds and non-restoration ponds is different generally. This is presumably because of differences in water exchange processes. There are water changes regularly in the restoration ponds every high tide (once a month). But in the non-restoration ponds, water changes happen only once at the beginning of seeding. The process of evaporation that occurs in ponds and the steady of water, resulting in increased salinity non-restoration ponds. The salinity difference also happened between the restoration ponds and non-restoration ponds at Barong Besar River, because at the time of parameter measurement the restoration ponds underwent a water change from the water in the river. The differences of salinity value that occur in the river water bodies affected by different time measurement. In this research, the measurements made not consider tidal waters conditions, which is water salinity will be higher at high tide than at low tide.

Nitrate and Phosphate. Nitrate and phosphate are nutrient which become limiting factor of living organisms. In general, concentrations of nitrate and phosphate in the restoration ponds, non-restoration ponds, and river water bodies are presented in Figure 2. Pond restoration has the lowest nitrate and the highest phosphate concentration. Nitrate and phosphate in waters derived from the internal and external factors. Due to internal factors such as biochemical reactions and organism activity, while external factors such as land fill of waste carried by the flow of the rivers The high oxygen content in the water column of the restoration ponds, resulting in nitrification reaction which is perform by microorganisms that converts ammonia to ammonium which is then converted again into nitrates. On the restoration ponds, nitrate formed is not only utilized by phytoplankton in the water column, it is also used in the mangrove photosynthetic process. In addition, nitrate is a protein that is essential for the growth of mangroves. Mangrove areas contained in the restoration ponds is a growing young mangrove. Same with other plants, the mangrove nitrate required for the formation or growth of vegetative parts of plants, such as leaves, stems and roots, as well as play an important role in the formation of green leaves that useful in the process of photosynthesis (Pustaka Negeri. 2007). The higher the nitrate uptake by plants, then the sooner the synthesis of carbohydrates are converted into protein for growth (Sutedjo and Kartasapoetra, 1990). This resulted in the concentration of nitrate in the restoration ponds remains low despite on going

process of nitrification. Function of mangroves in reducing nitrate concentrations in this habitat is also confirmed by Boto KG, *et al.* (1985) andReef, R et al (2010). The highest nitrate concentration is in the body of the rivers. This is because more sources of nitrate (i.e. the input of additional land) and less use of nitrate.

Phosphate in the restoration ponds is the highest. This is because although phosphate is also one of the supporting elements of mangrove growth, but phosphate is more widely used to support for the formation of flowers and fruit, as well as the cell nucleus and the cell wall. Conditions of mangroves which are still classified in the seedlings category lead the phosphate absorption fewer than nitrate. In addition to mangroves, phosphate is also much used by other organisms. Nurjaya, A Kasno, dan A Rachman. (2009) describes organisms using phosphate as a component of certain enzymes and proteins, adenosine triphosphate (ATP), ribonucleic acid (RNA), deoxyribonucleic acid (DNA), which is more needed by the organism as a source of energy in cellular metabolism. Conditions of restoration ponds which were freshly harvested also resulted in no organisms using phosphate significantly. It is different from the conditions of use of phosphates in the water bodies.





(a) (b)

Figure 2 (a) The average of nitrate concentration (ppm); (b). The average of phosphate concentration (PPM) in the restoration ponds, non-restoration ponds, and river water bodies

In addition to the above, the level of phosphate is also dependent on the pH of the waters in which at low pH, phosphates tend to form insoluble compounds. Sanusi (2009) explains that the compounds are not soluble have tendency of occurrence in the aggregation process which then resulted the flocculants

and settles into the sediment so the concentration in the water will also be low. In detail, the concentration of nitrate and phosphate in all ponds and river water bodies can be seen in Table 2.

Table 2 shows that restoration ponds had the lowest concentrations of nitrate, but in general the non-restoration ponds had higher nitrate concentrations than the river water bodies. Non-restoration ponds are only used for milkfish cultivation, without the presence of plants. This resulted in the use of nitrates only do by a limited number of cultivated organisms. In contrast to river water bodies those have a greater number and variety of organisms. Moreover, judging from the content of DO (Table 1), higher nitrate concentration in the non-restoration ponds indicates that the internal source of nitrate (nitrification reaction) is also much more. This was due to higher DO will trigger the nitrifying microorganisms to perform faster reaction. As for the concentration of phosphate, the concentration of the details in Table 2 is no different from the average phosphate generally in Figure 2, which has the highest concentration of the restoration ponds followed by phosphate concentration on non-restoration ponds and rivers water bodies is the lowest.

Nitrate content in the body of Solok Buntu River is much higher than the nitrates in the restoration ponds and non- restoration ponds (Table 2). This is thought to be due to the influence of high nitrate enter the water bodies. The number of active non-restoration ponds on Solok Buntu River are more than the number of non-restoration ponds on two other rivers. The plots of non-restoration ponds in Solok Buntu River contained different stages of culture. When research is done, there are some of non-restoration ponds were in the post-harvest stages. Conditions that the replacement water of the ponds only in the beginning of seeding, of course resulted in the wastewater pond after harvest contain low DO and high nitrate. When the pond water is discharged into the river, the nitrates in the ponds become one of input for nitrate in water bodies.

Nitrate content contained in the area of non-restoration ponds and restoration ponds is still in standards range of MenLH No. 51 of 2004, i.e. a maximum of 0.008 ppm. Based on these standards, the restoration ponds area have nitrate concentration better for fish than non-restoration pond. Phosphate concentration area for all ponds, generally has exceeded the quality standard of MenLH No. 51 of 2004, i.e. a maximum of 0.015 PPM.

Table 2. Nitrate and phosphate concentration (ppm) in ponds and river water bodies in Sembilang National Park

Location		Nitrate (PPM)	Phosphate (PPM)
Solok Buntu River	Restoration ponds	0.00326	2.84994
	Non-restoration ponds	0.00370	2.46205
	River stream	0.01460	0.05849
Barong Kecil River	Restoration ponds	0.00412	2.34938
	Non-restoration ponds	0.00746	3.44939
	River stream	0.00547	1.93806
Barong Besar River	Restoration ponds	0.00382	2.62299
	Non-restoration ponds	0.00563	0.60671
	River stream	0.00541	1.65658

CONCLUSIONS

Based on the results of the study it can be concluded that in general the existence of mangroves in the area of the ponds can improve the content of DO and pH of water ponds. Although the ponds being in the post-harvest stage, the restoration ponds are still able to be used as a cultivation area. Based from nitrate conditions, the restoration ponds suggest that mangroves in the area of the pond restoration showed satisfactory results in the capture of nitrate that would indirectly prevent the pond water from pollution. While based from phosphate conditions, the high phosphate in the area of the restoration ponds show that young mangrove plants have not been able to significantly phosphate binder.

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