Assessment of Nutrient Availability on Sediment Matang Mangrove Forest, Perak

Ahmad Hanafi Hamzah1, Seca Gandaseca1✎, Ahmad Mustapha Mohamad Pazi1, Usama Mohd Alifa1

[1]Department of Forest Production, Faculty of Forestry, Universiti Putra Malaysia, 43400 Serdang, Selangor Darul Ehsan Malaysia

Abstract: Sediment has a potential in nutrient availability and plays an important for fertility rate at mangroves ecosystem. In mangrove ecosystem sediments were found abundantly in the river bank. Therefore, to prove this statement, macro and micro nutrients were taken on sediment of mangrove forest at Matang mangroves, Perak. The objectives of this study are to provide fundamental information on sediment nutrient availability at the Sungai Sepetang and to compare 3 different zones and 5 different depths. One transect line was established along the river and divided into three zones (Upstream, Middle stream, Downstream). About 75 of sediment samples were collected using peat auger in 5 different depths (0-15 cm, 15-30 cm, and 30-50 cm,). A standard method was used in sediment preparation and laboratory analysis. The obtained data were analyzed using Statistical Analysis System (SAS) Version 9.2 to find mean comparisons between the zones and depths. As a result of fundamental information on sediment physiochemical properties for pH level from (3.17-5.03) which are acidic and the electrical conductivity range from (14.34-23.87[mS/cm]). Whereas, for nutrient availability were showing significant difference with the highest amount of Magnesium 3.93a(±0.092) in middle stream. For available nutrient such as Nitrogen, Potassium, Phosphorus, and manganese were similar. Lastly, depth 1 (0-15 cm) was showing significant difference and recorded the higher amount of nutrient content of Magnesium 3.703a(±0.156) and Potassium 1.541b(±0.079). As a conclusion, sediment is one of the potential for nutrient availability, but more researches are needed to be done to prove that the nutrient availability percentages are encouraged by mangrove zones and depths.

Keywords: Sediment, Factors, Nutrient Availability, Mangrove Forest and Perak

INTRODUCTION

Matang Mangrove Forest is one of the mangrove forests in Malaysia that well known and well management in the world. Sustainable Forest Management has been implemented in Matang Mangrove Forest where they did replanting to maintain the logs production and to achieve a sustainable forest management (Goessens et al, 2014).

Sediments are defined as the organic and inorganic materials found at the bottom of a water body. It includes clay, silt, sand, gravel, decaying organic matter, and shells among other things, but exclude anthropogenic debris, such as vehicle tires. Sediment is the loose sand, clay, silt and other soil particles. Sediment is the amassing of residue such as rock, sand in a stream, lake or other marine environment (Ellison. 1999). They play important roles in nutrient retention and transformation (Richardson 1989; Walbridge and Struthers 1993; Reddy et al. 1999), riverine marshes influence downstream water quality (Whigham et al. 1988; Correll et al. 1992)

✎ Seca Gandaseca (Correspondence)
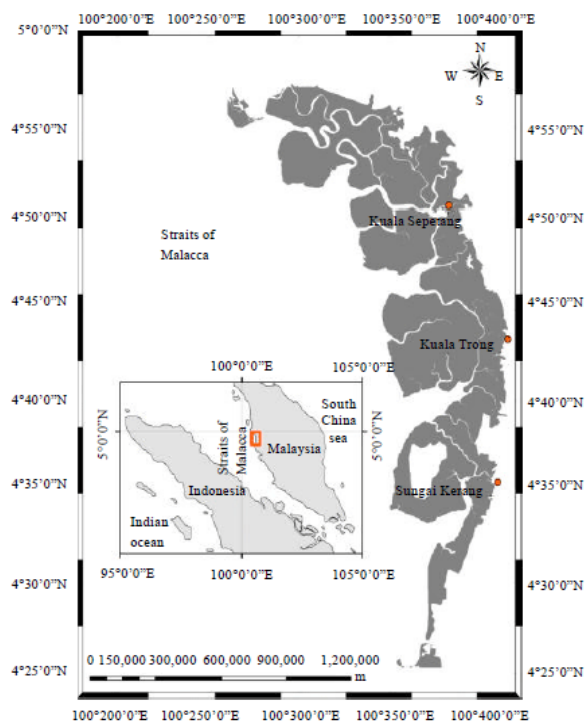
✉ seca@upm.edu.my

☎ +60194830370

Figure 1. Location of research area of Sungai Sepetang in Perak, Malaysia.

From a sullying point of view, we comprehend that silt is critical to the sustenance web and serve as a repository of contaminants for bio-accumulation and tropic exchange. Once the substance sullying fixation achieves a time when it causes antagonistic impacts to biota, it is viewed as contaminated (Thomsen et al, 2004). More activities that happen along Sungai Sepetang such as agricultural, industrial and villager activities that may affect the sediment quality because mangrove forest at Sungai Sepetang provide many services to nearby communities (Goessens et al, 2014). Mangrove roots have a natural affinity for sediment binding; they simultaneously prevent coastal erosion and trap nutrients for utilization by other organisms within an ecosystem (Ellison, 1999). This system allows flora and fauna to thrive, attracting tourists and bringing significant economic benefit to the community. Thus, this study is important to identify the availability of nutrients on the sediment of mangrove forest along Sungai Sepetang.

MATERIAL AND METHODS

Study area
Sediment sample was carried out at river water Matang Mangrove Forest, Perak, Malaysia which lies between latitude 4°51'7.14"N and longitude 100°38'48.50"E (Figure 1).

Sediment collection and preservation
The Sepetang River was divided into three zones: upper stream, middle-stream and downstream as shown in figure 3.4, 3.5 and 3.5. Each zone was divided into five subplots and five different depths such as 0-15 cm, 15-30 cm, 30-50 cm, and 50-10 in each subplot. The sediment was taken in a transect line at the side of the river. Five replications of sediment were taken at the subplot. The sediment was taken in each subplot at five different depths. All soil samples were kept in zip lock plastic to prevent from contamination during transportation to soil laboratory.

Sediment analysis
All soil samples were air-dried, grinded and sieved pass (0.2mm). This process is for the determination of mangrove sediments physical and chemical properties. As for bulk density determination, soil samples that had been taken at different depths put in core oven-dryer at 60^0C (Kauffman and Donato 2012). Apart from that, soil pH was also be determined in water and potassium chloride (KCI) at ratio 1:2.5 using pH meter based on the method of Tan (2005). Total Nitrogen (TN) was determined by using the Kjeldahl method (Jones, 2001) and Total Phosphorus (TP) was determined by using Double acid and blue method (Bray and Kurtz 1945; Salimin *et al.* 2010). Leaching method by Cottenie (1980) and Berg and Gardner (1978) were used for determining micro nutrient such as K, Ca, Mg and Mn.

Data analysis
At the end of this data collection, the obtained results were analysed using SAS version 9.2. The analysis of variance (ANOVA) followed by Tukey's Studentized range test (HSD) at $P \leq 0.05$ was used to evaluate significant differences in mean comparison between differences of zones and depths.

RESULT AND DISCUSSION

Physical and chemical for zone at Sungai Sepetang.
Table 1 presents the pH water, pH KCl and EC for the zones. As for the pH water, it is shown that higher pH was determined at the middle-stream with value 4.20 a(±0.06), and for KCl showed higher pH at middle-stream with value 4.07 a(±0.05). The soil pH showed that it was categorized as strong acidic soil with a pH lower than 5. According to Allen V.B and Pilbeam D.J. (2009), low pH is due to the soil is mainly contains leaching anions produced by microbial break-down activities of organic matter. Whereas, the highest mean value of EC is 23.87 a(±0.14) recorded for the upper-stream and middle-stream.

Table 1. Status of pH and CEC on sediment at different zones of mangrove forest
along Sungai Sepetang

Variable	Upper-stream	Middle-stream	Downstream
pH (H_2O)	$4.772^b(\pm0.045)$	$3.173^c(\pm0.074)$	$5.030^a(\pm0.112)$
pH (KCL)	$4.077^a(\pm0.137)$	$2.844^b(\pm0.137)$	$3.955^a(\pm0.083)$
Electrical Conductivity (EC)	$23.876^a(\pm0.145)$	$23.823^a(\pm0.168)$	$14.346^b(\pm0.303)$

**Different alphabet within the column indicate significant difference using Tukey s test at $P\leq 0.05$

Table 2 shows present the nutrients on the sediment at different zones of mangrove forest along Sungai Sepetang. The phosphorus was ranged from 7.25 to 24.17 mg/L (Table 2). High concentration of phosphorus was because of the nutrient is being transported to the downstream during base flow conditions, which is affected due to the microbial uptake and abiotic sorption (Elwood et al., 1983).

Table 2. Status of nutrients on sediment at different zones of mangrove forest along Sungai Sepetang

Zone	Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Manganese
Upper-stream	0.069^a (±0.006)	14.771^b (±0.794)	1.837^a (±0.012)	3.735^a (±0.017)	2.526^a (±0.251)	0.147^a (±0.007)
Middle-stream	0.055^a (±0.005)	7.252^c (±0.812)	1.1676^b (±0.059)	3.938^a (±0.092)	2.268^a (±0.292)	0.097^{ab} (±0.020)
Down-stream	0.069^a (±0.006)	24.071^a (±0.559)	1.252^a (±0.044)	2.840^b (±0.107)	2.076^a (±0.228)	0.073^a (±0.008)

**Different alphabet within the column indicate significant difference using Tukey s test at $P\leq 0.05$

The magnesium was recorded ranging from 2.84 to 3.93 mg/L (Table 2). Magnesium is an abundant element in the earth, and its properties of being a common constituent of natural water give hardness to water (APHA, 2005). The potassium was ranging from 1.16 to 1.83 mg/L (Table 2). Concentration of K found during this study was in the natural level as the fresh water in mangroves is in combination with the seawater (APHA, 2005). Meanwhile, the manganese has ranged from 2.84 to 3.88 mg/L (Table 2). It is found that the Mn was probably the origin from soil, rock and some decoyed organic matter in the water bodies. (APHA, 2005)

In this study is important to identify the availability of nutrients on the sediment of mangrove forest along Sungai Sepetang. For the zones, middle stream shows the highest value compare to the other because at the middle stream, it was an open area, but it not too open. The activities that happen along Sungai Sepetang such as agricultural, industrial and villagers activities that may affect the nutrient availability. The river flow also plays important role because the nutrient will flow from upstream to downstream and stuck in the middle because of water tidal. Mangrove roots have a natural affinity for sediment binding; they simultaneously prevent coastal erosion and trap nutrients for utilization by other organisms within an ecosystem (Ellison, 1999)

Physical and chemical for depth at Sungai Sepetang.
Table 3 presents the pH water, pH KCl and EC for the depth. For the pH water Showed that higher at depth 1 with value $4.57^a(\pm0.28)$ and for pH KCl showed that higher at depth 1 at value $3.84^a(\pm0.12)$. The result of the soil pH shows that it was strongly acidic soil a pH lower than 5. This is due to the decomposition process of organic matter that occur towards inland since it was occupied with mature tree and have favorable conditions to sustain forest communities (Kusmana et al., 1992). Whereas, the highest mean value of EC of was $21.05^a(\pm1.44)$ at depth 3. The EC can be identified with particular soil properties that influence crop yield, for example, topsoil profundity, pH, salt fixations, and accessible water-holding limit.

Table 3. Status of pH and CEC on sediment at different depth of mangrove forest along Sungai Sepetang

Depth	pH (H_2O)	pH (KCL)	Electrical Conductivity (EC)
0-15	$4.571^a(\pm0.283)$	$3.844^a(\pm0.127)$	$20.190^b(\pm1.739)$
15-30	$4.295^b(\pm0.312)$	$3.588^{ba}(\pm0.242)$	$20.803^{ba}(\pm1.579)$
30-50	$4.108^c(\pm0.285)$	$3.444^a(\pm0.242)$	$21.053^a(\pm1.447)$

**Different alphabet within the column indicate significant difference using Tukey s test at $P\leq 0.05$

Table 4 shows the macro and micro nutrient for the depth. The mean comparison using Tukey's test showed that there was significant different ($p \geq 0.05$) between the depth at Sungai Sepetang. The highest value of nutrient at Sungai Sepetang is at depth 0-15 for magnesium follow by depth 15-30 for magnesium and lastly is depth 30-50 for potassium.

Table 4. Status of nutrients on sediment at different depth of mangrove forest along Sungai Sepetang

Depth	Nitrogen	Phosphorus	Potassium	Magnesium	Calcium	Manganese
0-15	0.062[a] (±0.006)	15.895[a] (±2.523)	1.397[b] (±0.105)	3.579[a] (±0.157)	2.488[a] (±0.159)	0.132[a] (±0.022)
15-30	0.066[a] (±0.006)	15.812[a] (±2.096)	1.541[b] (±0.079)	3.703[a] (±0.156)	2.409[a] (±0.142)	0.091[a] (±0.014)
30-50	0.064[a] (±0.006)	14.387[a] (±2.898)	1.317[a] (±0.135)	3.231[b] (±0.203)	1.972[a] (±0.385)	0.094[a] (±0.008)

**Different alphabet within the column indicate significant difference using Tukey s test at P ≤ 0.05

The range of magnesium is from 3.23 to 3.70 mg/L as shown in Table 4. Magnesium is an abundant element in the earth and a common constituent of natural water, which give the hardness to water. The microbial decomposition of organic matter depends on the presence of electron acceptors, primarily oxygen in the surface sediment, but deeper down when oxygen is depleted these are replaced by nitrate, iron, manganese or sulphate (Thomsen et al., 2004). The range of potassium is from 1.31 to 1.54 mg/L. Meanwhile, K concentration found in this study was in the natural level for fresh water that is the mixing with the seawater. Nutrient retention efficiency indicates the rate at which nutrient cycle between the dissolved states in the water column, benthic sediments, and biota of the stream (Stream Solute Workshop, 1990).

Soil Depths give significant difference in nutrient availability, when the depth is deeper the nutrient availability will be lower. This is because of the nutrient availability will be moved to lower depth and the decomposition process at this level is slower because of the process need appropriate condition for making decomposition process such as light, oxygen and others (Linn & Doran, 1984). Weathering dissolution and atmospheric deposition affect the depth at which nutrient inputs occur (Kirby 1985).

CONCLUSION

There are significant difference show in all depths and zones of nutrient availability. Whereas, for nutrient availability were significant difference with the highest amount of Magnesium 3.93[a](±0.092) in middle stream. For available nutrient such as Nitrogen, Potassium, Phosphorus, and manganese were similar. Lastly, depth 1 (0-15 cm) was significant difference and recorded the higher amount of nutrient content of Magnesium 3.703[a](±0.156) and

Potassium 1.541[b](±0.079). As a recommendation, the sediment is one of the potential for nutrient availability, so more research are needed to be done to prove that the nutrient availability percentage are encourage by mangrove zones and depths.

REFERENCES

1. APHA (2005). Standard Method for the Examination of Water and Wastewater. 21 ed. Washington American Water Works Association, Water Environment Federation.
2. Ellison, J. C. (1999). Impacts of sediment burial on mangroves. Marine Pollution Bulletin, 37(8-12), 420-426.
3. Chou, L. M., Ong, X., Todd, P. A. (2010). Impacts of pollution on marine life in Southeast Asia. Biodiversity and Conservation, 19(4), 1063-1082.
4. Goessens, A., Satyanarayana, B., Stocken, T.V., Quispe, M. Z., Lokman, H.M., Sulong, I. and Farid D.G (2014). Is Matang Mangrove Forest in Malaysia Sustainably Rejuvenating after More than a Century of Conservation and Harvesting Management? Plos One, Vol. 9 (8), 2014.
5. Greaney, K. M. (2005). An Assessment of Heavy Metal. Marine Resource Development and Protection, 1-3.
6. Kirby MJ (1985) A basis for soil profile modelling in a geomorphic context. J. Soil Sci. 36: 97–121.
7. Linn, D. M., & Doran, J. W. (1984). Aerobic and anaerobic microbial populations in no-till and plowed soils. Soil Science Society of America Journal, 48(4), 794-799.
8. Morris J.T. 1991. Effects of nitrogen loading on wetland ecosystems with particular reference to atmospheric deposition. Ann. Rev. Ecol. Syst. 22: 257–279.
9. Stream Solute Workshop. 1990. Concepts and methods for assessing solute dynamics in stream ecosystems. *J. North American Benth. Soc.* 9(2): 95-119.
10. Thomsen, U., Thamdrup, B., Stahl, D.A. & Canfield, D.E. (2004)*:* Pathways of organic carbon oxidation in a deep lacustrine sediment, Lake Michigan. Limnol. Oceanogr. 49: 2046-2057.
11. U.S. EPA (U.S. Environmental Protection Agency). (1995) Policy for risk characterization. Memorandum of Carol M.

Browner, Administrator, March 21, 1995, Washington, DC. Available from: http://www.epa.gov/osp/spc/2riskchr.htm.

12. U.S. EPA (U.S. Environmental Protection Agency). (2005) Supplemental guidance for assessing cancer susceptibility from early-life exposure to carcinogens. Risk Assessment Forum, Washington, DC. Available from: http://www.epa.gov/ncea/raf.

13. Vitousek P.M., Aber J.D., Howarth R.W., Likens G.E., Matson P.A., Schindler D.W., Schlesinger W.H. and Tilman D.G. 1997. Human alteration of the global nitrogen cycle: sources and consequences. Ecol. Appl. 7 (3): 737–750.

14. Whigham D.F., McCormick J., Good R.E. and Simpson R.L. 1978. Biomass and primary production in freshwater tidal wetlands of the Middle Atlantic Coast. In: Good R.E., Whigham D.F. and Simpson R.L. (ed) Freshwater Wetlands: Ecological Processes and Management Potential. Academic Press, New York, NY, pp. 3–20.