RIPARIAN MANAGEMENT AND ITS EFFECT ON AQUATIC MACROINVERTEBRATE COMMUNITIES AT OIL PALM WATERWAYS IN PERAK

NOOR RASHIDAH BINTI NOORDIN

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ABSTRACT

A study on effects of riparian management on aquatic macroinvertebrate communities along three different oil palm waterways in Perak was carried out at Sungai Selinsing, Sungai Johan and Sungai Tumboh. The study aims in classifying riparian management of the study area, assess Biological Water Quality Index (BWQI) and evaluate physical characteristics of water along the oil palm waterways. Comparison of BWQI and physical analysis was conducted to determine their equivalence. Sungai Selinsing, Sungai Johan and Sungai Tumboh were classified as S5 refering to specified as a stream without fish and not in community watershed. For macroinvertebrate analysis, all three rivers shows presence of nymphs. Sungai Selinsing consists of three types of groups namely; nymphs, insects and molluscs. Sungai Johan consist of five types of groups namely; nymphs, insects, crustacea, molluscs and worms, meanwhile Sungai Tumboh consist of four types of groups namely; nymphs, insects, crustacean and molluscs. For Sungai Selinsing and Sungai Tumboh shows Class II a rather clean to clean water river, and Sungai Johan shows Class III a rather dirty water to average river. BWQI and physical characteristics of a river is in equivalent and related to effects of encroachment into the riparian management areas of the rivers, some indicator species are very sensitive to disturbance into their territory and level of pollutants, while others do endure disturbance and pollutants in the river. This shows that riparian management area class S5 with absence in the reserved zone and an encroached riparian management area have a negative impact on aquatic macroinvertebrate communities in rivers along it. This study shows that the future dependence of BWQI in examining water quality along an encroached riparian management area and riparian management area with absence in reserved zone is at stake and aquatic macroinvertebrates are important component used in analyzing environmental quality.

ABSTRAK

Satu kajian mengenai kesan pengurusan riparian terhadap hidupan makroinvertebrata akuatik di tiga sungai berlainan yang terletak di kawasan kelapa sawit di Perak telah dijalankan di Sungai Selinsing, Sungai Johan dan Sungai Tumboh. Kajian ini bertujuan mengklasifikasikan pengurusan riparian, menilai Indeks Kualiti Air Biologi (BWQI) dan menilai ciri-ciri fizikal air di kawasan kajian. Perbandingan antara indeks kualiti air biologi dan analisis fizikal telah dilakukan bagi menentukan kesetaraan mereka. Pengurusan riparian di Sungai Selinsing, Sungai Johan dan Sungai Tumboh diklasifikasikan sebagai klasifikasi S5 yang telah dinyatakan sebagai aliran tanpa ikan dan tidak berada di kawasan tadahan air komuniti. Bagi analisis makroinvertebrata, ketiga-tiga sungai menunjukkan kehadiran nimfa. Di Sungai Selinsing terdapat tiga kumpulan iaitu: nimfa, serangga dan moluska. Di Sungai Johan terdapat lima kumpulan iaitu: nimfa, serangga, krustasia, moluska dan cacing, sementara di Sungai Tumboh terdapat empat kumpulan iaitu nimfa, serangga, krustasia dan moluska. BWQI bagi Sungai Selinsing dan Sungai Tumboh dikategorikan dalam Kelas II iaitu bersih dan Sungai Johan dikategorikan dalam Kelas III iaitu sederhana. Walau bagaimanapun, keputusan ini masih setara antara BWQI dan ciri-ciri fizikal sungai yang berkaitan dengan kesan pencerobohan dalam kawasan pengurusan riparian sungai. Sebahagian spesies makroinvertebrata adalah sangat sensitif kepada gangguan dan tahap pencemaran, manakala ada juga spesies yang mampu bertahan. Ini menunjukkan bahawa pengurusan riparian kelas S5 dengan ketiadaan zon yang dikhaskan dan kawasan pengurusan riparian yang dicerobohi mampu memberi kesan negatif ke atas hidupan makroinvertebrata akuatik di sungai. Kajian ini menunjukkan bahawa pemantauan kualiti sungai menggunakan BWQI di sepanjang kawasan pengurusan riparian yang dicerobohi adalah perlu dan hidupan makroinvertebrata akuatik adalah komponen penting yang digunakan dalam analisis kualiti alam sekitar.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Located in the humid tropics with abundant rainfall, Malaysia has over 150 major rivers, as well a variety of tropical wetland, forest, coastal and marine ecosystems, representing several Global 200 Ecoregions, and it is recognized as one of 17 mega-diverse countries in the world *(http://www.biodiversitya-z.org)*. Its extensive river systems as well as associated riparian, floodplain and catchment forests support an immense diversity of aquatic and terrestrial biodiversity, including more than 600 freshwater fish species. The river systems provide ecosystem services benefiting both rural communities and urban societies, including water supply, artisanal fisheries, aquarium fish industry, transport routes, tourism and recreation. However, the rivers face threats from a wide range of pressures including habitat loss and fragmentation, pollution, over-exploitation and invasive alien species that threaten their biodiversity and ecological stability, with ongoing loss of genetic resources, ecosystem services and national and local socio-economic benefits. (United Nations Development Programme, (UNDP), 2016).

Sustainable agriculture requires that soil and water quality be maintained. Some farm practices have the potential to cause environmental harm, which may affect rural and urban areas alike. Most of the potential negative impacts of farming can be greatly reduced by the use of best management practices. These are agricultural practices that reflect current knowledge about conserving soil and water without sacrificing productivity. Water is continually cycling where the water that we use has been used before. Producers and consumers, rural and urban people and the public and private sectors, all are responsible for using water wisely and ensuring that the resource is maintained for others (Hilliard and Reedyk, 2014).

One of the main contributing factors of riparian zone destruction in Malaysia is the encroachment of river reserves by oil palm plantations (Zainudin *et al.* 2013). Although there are conventional legal mechanisms that deal with the issue, much of the damage has already took place. Pollutants such as fertilizers, pesticides and suspended solids (SS) are freely transported to a river in encroached areas. Riparian Management is the term used in describing how land users look after the margin of a river or a stream, a lakeshore or a swamp. It doesn't entail surveying off a fixed width of land next to a waterway, to create an esplanade reserve for public access. Riparian management is simply something land users undertake themselves, on land which remains under their private ownership (Parkyn 2004).

1.2 Problem Statement

Malaysia is one of the major players in the palm oil industry. Oil palm was first planted commercially in Peninsular Malaysia in 1917, where it replaced rubber plantations and forest. As land became scarce, expansion shifted to Sabah and Sarawak, often in association with logging, and was facilitated by the reclassification of some state forest reserves to allow conversion to plantations. Between 1990 and 2015 the area of oil palm plantation in Malaysia increased by 1.8 million ha to 5.6

million ha (refer Table 1.1), where 1.1 million ha of forest were lost (*http://www.mpob.gov.my)*. It is estimated that at least 1.0 million ha of forest were replaced by oil palm over this period, but this estimations does not consider forest conversion into unproductive land, nor whether oil palm caused or simply followed deforestation. As of 2015, the land area in Perak planted with oil palm exceeded 398,214 ha which is the third largest in Peninsular Malaysia.

Table 1.1:Distribution Of Oil Palm Planted Area By State And Sector In Malaysia for 2015 (Malaysia Palm oil Board (MPOB),2016)

State	SECTOR (Hectare)						Total
	Smallholders	FELDA	FELCRA	RISDA	SEDC/Govt. Agencies	Private Estates	
Johor	207,484	131,958	22,594	3,308	39,598	334,641	739,583
Kedah	24,725	717	858	853	2,409	57,682	87,244
Kelantan	4,996	33,629	2,271	501	20,167	90,409	151,973
Melaka	11,347	2,434	2,463	1,583	304	36,472	54,603
Negeri Sembilan	23,533	47,028	7,402	9,710	521	89,547	177,741
Pahang	45,428	301,102	30,412	23,404	69,391	255,502	725,239
Perak	109,995	23,479	28,125	17,486	20,058	199,171	398,314
Perlis	68	106	120	-	-	-	294
Pulau Pinang	9,019	-	472	-	-	4,956	14,447
Selangor	43,057	7,937	2,850	281	3,256	79,955	137,336
Terengganu	10,851	40,727	19,200	19,029	10,370	72,410	172,587
Peninsular	490,503	589,117	116,767	76,155	166,074	1,220,745	2,659,361
%	18.44	22.15	4.39	2.86	6.24	45.90	100.00
Sabah	217,403	106,087	14,859	-	96,818	1,109,056	1,544,223
%	14.08	6.87	0.96	-	6.27	71.82	100.00
Sarawak	175,098	17,752	43,543	-	85,334	1,117,632	1,439,359
%	12.16	1.23	3.03	-	5.93	77.65	100.00
Malaysia	883,004	712,956	175,169	-	348,226	3,447,433	5,642,943
%	15.65	12.63	3.10	-	6.17	61.09	98.65

Oil palm cultivation is cited as a major threat to tropical biodiversity as it is centred on some of the world's most bio-diverse regions. In the context of global vegetable oil markets, palm oil and soya beans account for over 60% of production but are the subject of less than 10% of research. Much more work need to be done to

establish the impacts of habitat conversion to oil palm plantation on biodiversity. Results are crucial for informing conservation strategies and ensuring sustainable management of plantations. Malaysia currently accounts for 39% of world palm oil production and 44% of world exports. If taken into account of other oils and fats produced in the country, Malaysia accounts for 12% and 27% of the world's total production and exports of oil and fats, thus having a great contribution to its economy. As a result, oil palm plantation can only continue to expand in order to maintain the status quo.

Immediate water bodies and wetlands along plantation areas are the most affected by the cultivation. Direct impacts on aquatic ecosystem from oil palm cultivation include draining and conversion of wetlands into oil palm production areas, clearing of riparian vegetation for palm cultivation, sediment runoff from cleared land, and degraded water quality from pollutants and mill tailings. Therefore, it is essential that riparian areas are managed and the ecosystem is monitored. One of the methods to monitor the ecosystem is through macroinvertebrates and water quality analysis. This study intends to document the management of riparian reserves throughout the study area and its effect on aquatic macroinvertebrates, river water quality and stream integrity.

It is observed that there have been very little studies completed with regard to riparian areas where researchers are focusing more on aquatic microinvertebrates. A better understanding of riparian management and its effect on aquatic macroinvertebrate communities in oil palm waterways is discussed in this study.

1.3 Objectives of Study

The aim of this study is to find out the effect of oil palm plantations along riparian vegetation's on quality of existing waterways. The main purpose of this study is to achieve the following objectives.

a) To classify riparian management area at selected rivers in Perak.

b) To assess aquatic macroinvertebrate communities and Biological Water Quality Index (BWQI).

c) To evaluate the physical characteristics of water along the oil palm waterways.

1.4 Scope of Study

The scope of this study is identify the class of riparian along oil palm waterways by measuring riparian vegetation, stream depth and width throughout the study area in three tributaries in Perak. The selected locations for this study area are Sungai Selinsing, Sungai Johan and Sungai Tumboh.

In this study, different sampling points were selected along the study area. The scope of the study focuses on Biological Water Quality Index (BWQI) developed by Department of Irrigation and Drainage, Malaysia and physical characteristics of water quality. Biological water quality comprises the assessment of aquatic macroinvertebrate community's species and family along the study area and its richness. Physical characteristic of water quality comprises of five parameters which are dissolved oxygen (DO), pH, temperature, conductivity and turbidity.

1.5 Significance of Study

In Malaysia and countries where oil palm domestication is on high rise, the increase in encroachment of oil palm trees into riparian zone is already occurring, replacing riparian plant communities. It has been studied that in Malaysia, one of the major causes of riparian destruction is agricultural activity or more specifically oil palm plantations (Malaysian Environmental Resources Centre (MERC), 2010). As we know, riparian ecosystem is very sensitive to disturbance and encroachment, as water resources become polluted by day due to human activities and poorly agricultural land use practice, weeding becomes the best practice to maximize the nutrients availability to agricultural plantation with negligence or arrogance in knowing the importance of the vegetation to the riparian ecosystem, macroinvertebrate species begin to disappear as chemical water content begins to change with time, physical properties of water becomes deteriorated.

Riparian ecosystem are increasingly threatened by human activities, oil palm tree replacement causes water loss through increase in riparian vegetation clearing which leaves the soil surface bare and increases evaporation (Santos, 2010). In addition, this will increase silt load in the stream as a result of increased surface runoff. Application of fertilizers and pesticides to the replaced riparian vegetation in order to boost its yield along the riparian buffer ends up in the waterways along the riparian thereby polluting the river and having effect on aquatic macroinvertebrate communities. In addition, the importance of this study is to ensure the sustainability of the environment and its vital components. Hopefully, this study will contribute to the future studies of microinvertebrates associated with water quality.

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