PRELIMINARY STUDY ON IMPACT OF LAND USE ON FISH FAUNA AT KENYANA RIVER AND ITS TRIBUTARIES, MUKAH, SARAWAK

Hasanaliza Binti Bujang Abdillah

Master of Environmental Science
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<table>
<thead>
<tr>
<th>Acknowledgements</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Tables</td>
<td>IV</td>
</tr>
<tr>
<td>List of Figures</td>
<td>V</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>VI</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>VII</td>
</tr>
<tr>
<td>Abstract</td>
<td>VIII</td>
</tr>
</tbody>
</table>

### INTRODUCTION

1.1 Research background  
1.2 Statement of the problem  
1.3 Research objectives

### LITERATURE REVIEW

2.1 History of study area  
2.2 Natural environment at Kenyana River  
   2.2.1 Hydrological feature  
   2.2.2 Peat swamp forest  
   2.2.3 Soil classification  
   2.2.4 Blackwater fish fauna  
2.3 Land development status at Kenyana and nearby area  
   2.3.1 Settlement Area (Kampung Sitieng)  
   2.3.2 Infrastructures  
   2.3.2.1 School (SK Kuala Kenyana)  
   2.3.2.2 Balai Raya Kg. Sitieng  
   2.3.2.3 Kenyana Lake Information Centre  
2.4 Agricultural land use  
2.5 Fishing methods  
   2.5.1 Active gears  
   2.5.2 Passive gears
2.6 Biodiversity Indices
2.7 Water condition and quality

METHODOLOGY

3.1 Research sampling stations
3.2 Fish assessment
   3.2.1 Blackwater fish sampling
   3.2.2 Fish identification
3.3 Data analysis

RESULTS AND DISCUSSION

4.1 Fish fauna at Kenyana River and its tributaries
4.2 Species diversity
4.3 Physico-chemical water parameters
4.4 Limitation of the study

CONCLUSION AND RECOMMENDATION

5.1 Conclusion
5.2 Recommendation
   5.2.1 Government assistance in inland fisheries sector
   5.2.2 Government assistance in to gazette the area as sensitive area
   5.2.3 Government and corporate agencies develop eco-tourism services
5.3 Future study

REFERENCES

APPENDICES
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Habitat descriptions and coordinate of sampling stations.</td>
</tr>
<tr>
<td>4.1</td>
<td>The composition of fish fauna collected from Kenyana River and its tributaries, Mukah.</td>
</tr>
<tr>
<td>4.2</td>
<td>The mean values for the total length, standard length, fork length and body weight of each fish species collected at Kenyana River and its tributaries.</td>
</tr>
<tr>
<td>4.3</td>
<td>Biodiversity Indices for all stations.</td>
</tr>
<tr>
<td>4.4</td>
<td>Water Quality Index for Station 1, Station 2, Station 3 and Station 4 (Dayang Farhana, 2013).</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.1</td>
<td>This picture shows the cutoff channel (highlight) from the upper stream of</td>
</tr>
<tr>
<td></td>
<td>Batang Mukah.</td>
</tr>
<tr>
<td>3.1</td>
<td>Map of study area at Kenyana Lake Information Centre, Kenyana River and</td>
</tr>
<tr>
<td></td>
<td>Liwak River and the sketch map.</td>
</tr>
<tr>
<td>3.2</td>
<td>Example of external characteristics for fish identification.</td>
</tr>
<tr>
<td>4.1</td>
<td>The overall percentage of fish family collected from the Kenyana River and</td>
</tr>
<tr>
<td></td>
<td>its tributaries.</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

cm  centimetre
m   meter
ha  hectare
kg  kilogram
sp  species
mg/L milligram/litre
NTU Nephelometric Turbidity Units
mS/cm milliSiemens/centimetre
ppt  Part per thousand
GPS  Global Positioning System
LANDAS Land and Survey Department
MDDM Mukah Dalat Municipal Council
JKR Jabatan Kerja Raya Bahagian Mukah
NREB Natural Resource and Environment Board Mukah Division
DOE Department of Environment
SFC Sarawak Forestry Corporation
SFD Sarawak Forest Department
SCORE Sarawak Corridor of Renewal Energy
SIMU State Implementation Monitoring Unit
WQI Water Quality Index
H' Shannon-Wiener Index
J  Pielou Index
D  Margelaf Index
Kg. Kampung
SK Sekolah Kebangsaan
DO Dissolved Oxygen
BOD Biological Oxygen Demand
COD Chemical Oxygen Demand
TSS Total Suspended Solid
TCC Total Coliform Count
FCC Feacal Coliform Count
<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Research permit</td>
<td>42</td>
</tr>
<tr>
<td>B</td>
<td>Research study stations</td>
<td>45</td>
</tr>
<tr>
<td>C</td>
<td>Blackwater fish species caught</td>
<td>52</td>
</tr>
</tbody>
</table>

LIST OF APPENDICES

P Phosphate
NH$_3$-N Ammonia-Nitrogen
NO$_3$ Nitrate
Preliminary Study on Impact of Land Use on Fish Fauna at Kenyana River and its tributaries, Mukah, Sarawak

Hasanaliza Binti Bujang Abdillah

Master of Environmental Science
Faculty of Resource Science and Technology
Universiti Malaysia Sarawak

ABSTRACT

The assessment of blackwater fish fauna available at Kenyana River and its tributaries was conducted from 19th March until 21st March 2013. The study area is a natural habitat for variety types of blackwater fish including the Asian Arowana. In order to protect this valuable fish and its habitat, the area has been focus to be protected by local authority and it has been marked as sensitive area. Besides that, the area will become one of the eco-tourism destinations in Mukah area. The fish sampling were conducted in three days and four sampling stations were chosen which located at Kenyana Lake Information Centre, Kenyana River mouth, Kenyana River and Liwak River. Monofilament gill nets were used (mesh size 5.1 cm, 7.6 cm and 10.1 cm) for fish sampling. Each individual of fish caught were measured for total length, standard length, fork length and body weight. A total of 41 individual of fish were caught with overall 7 blackwater fish species identified which dominated by Pangasiidae (Pangasius macronemus) followed by Cyprinidae (Anemichthys apogon), Notopteridae (Notopterus chitala), Bagridae (Hemibagrus baramensis), Helostomatidae (Helostoma temminckii), Osteoglossidae (Scleropages formosus) and Siluridae (Wallago leerii). Station I (Liwak River) shows the most individual fish caught and the highest species diversity compared to other stations. However, the Shannon-Wiener diversity index H’ in Liwak River was low with H’ value 0.65 and this illustrate that the fish in Kenyana River and its tributaries were in agitated which might cause by the habitat disturbance in that area. As for species richness ‘D’ in Station I was greater with value 1.41 as compared to the other station. Though the diversity index in Station 1 was high but the opposite result was shown for river water quality. Based on Water Quality Index (WQI), Station 1 was categorized as Class IV (polluted) and followed by Station 2 (Class III - polluted) and Station 3 (Class III - slightly polluted). The high value of nutrient input at Station 1 and 2 might be due to surface run-off that contained excessive fertilizer drained into the river during raining. Though the fish population was high in Station 1 with low water quality, this condition might due to the biasness in sampling time frame and method used. Nevertheless, the growing agricultural land use area especially oil palm plantation which located at the middle and upper part of the Kenyana River and its tributaries might influenced the river condition lead to habitat disturbance.

Key Word: Fish fauna, water quality index, blackwater, biodiversity index, land use
ABSTRAK

Penilaian fauna ikan air hitam di Sungai Kenyana dan anak-anak sungainya telah disyorkan bermula dari 19 Mac hingga 21 Mac 2013. Kawasan kajian merupakan habitat semulajadi pelbagai jenis ikan air hitam termasuk Arowana Asian. Untuk melindungi habitat dan ikan bernilai ini, kawasan tersebut telah mendapat fokus daripada pihak berkuasa tempatan dan telah di tanda sebagai kawasan sensitif. Selain itu, kawasan tersebut juga akan menjadi salah satu destinasi eko-perlancongan di Mukah. Kajian ini dijalankan selama tiga hari dan empat stesen persampelan telah dipilih dilokasi Pusat Informasi Tasik Kenyana, Kuala Sungai Kenyana, Sungai Kenyana dan Sungai Liwak. Kaedah menangkap ikan yang digunakan adalah jaring monofilamen (mata pukat 5.1 cm, 7.6 cm and 10.1 cm). Setiap individu ikan yang telah ditangkap disukat untuk panjang total, panjang standard, panjang 'fork' dan berat. Sejumlah 41 ekor ikan telah ditangkap dengan jumlah keseluruhan 7 spesis ikan telah dikenalpasti yang di dominasi oleh famili Pangasiidae (Pangasius macronemus), diikuti dengan Cyprinidae (Anematichthys apogon), Notopteridae (Notopterus chitala), Bagridae (Hemibagrus baramensis), Helostomatidae (Helostoma temminckii), Osseoglossidae (Scleropages formosus) dan Siluridae (Wallago leerii). Stesen 1 (Sungai Liwak) menunjukkan jumlah ikan yang paling banyak dan mempunyai kepelbagaian spesis yang tinggi jika dibandingkan dengan dengan stesen-stesen yang lain. Walaubagaimanapun, mengikut nilai indeks kepelbagaian Shannon-Wiener H' di Sungai Liwak adalah rendah dengan nilai H' 0.65 dan keadaan ini menunjukkan kepelbagaian ikan di Sungai Kenyana dan anak-anak sungainya telah terancam dengan serius yang mungkin berpunca dari gangguan habitat. Stesen 1 dan Sungai Kenyana sebagai kawasan ladang yang berhampiran. Begitu juga dengan pengkayaan spesis 'D' di Stesen 1 adalah tinggi berbanding dengan stesen-stesen yang lain. Walaupun indeks kepelbagaian adalah tinggi di Stesen 1 tetapi keputusan yang diperolehi untuk kualiti air di stesen tersebut adalah terbalik. Merujuk kepada Indek Kualiti Air (WQI), Stesen 1 dikategorikan sebagai Kelas IV (tercemar) dan diikuti dengan Stesen 2 (Kelas III – tercemar) dan Stesen 3 (Kelas II – tercemar sedikit). Nilai nutrien yang tinggi di Stesen 1 dan 2 mungkin disebabkan oleh larion tanah yang mengandungi lebihan bahan yang mengalir ke sungai ketika hujan. Walaupun populasi ikan di Stesen 1 adalah tinggi dan kualiti air yang rendah, keadaan ini mungkin disebabkan oleh kepincangan dalam pemilihan kaedah dan rangka masa persampelan. Namun, perkembangan kawasan penggunaan tanah untuk pertanian terutamanya untuk ladang sawit yang terletak dibahagian tengah dan hulu Sungai Kenyana dan anak-anak sungai tersebut mungkin mempengaruhi keadaan sungai tersebut yang menjurus kepada gangguan habitat.

Kata Kunci: Fauna ikan, indeks kualiti air, air hitam, indeks kepelbagaian, guna tanah
INTRODUCTION

1.1 Research background

In this new world revolution, we can see that human population rate increase rapidly and this pattern will continue its trend in the next few decades. A sufficient amount of water, food and energy are found to be the main factors which accommodate almost double the number of people living today. Oceans hold over 97% of the planet water and freshwater hold 3% in the form of ice sheets and glaciers, ground water, lakes, soil moisture and rivers (Matt, 2013). However, these small amounts of freshwater sources contribute to major uses for human activities and also are exposed to pollution at the same time. Extensive and modern plantation, high tech industries and mining are characterised by the main source of pollutant which contaminate the soil and water. The pollutants release into the environment without treatment will leaching into groundwater and flow into streams and the ocean which can harm the aquatic organisms and later affecting human through the food web.

Peat swamp forest is one of the most remarkable and harshest environment in tropical rain forest. It rich with not only habitat for variety of plants but also as nesting area to wildlife which includes birds, small mammals, amphibians and fishes. The peat swamp forest has a substrate of peat that gives its tea-coloured or an opaque tint, this comprising of plant detritus which gradually release tannins and organic acids into the water (Peter et al., 1992). The aquatic fauna such as fish, insect and plant can act as indicator to water condition as a result of its sensitivity towards the changes in their environment. In addition, the quality of the water would also reflect the condition and health of the peat swamp all together.
A huge portion of peat and freshwater swamps and the habitat is generally considered to be wastelands with not much economic value (Zakaria et al., 1999). Due to this, most of these swamp area have been converted to industrial areas and for other uses (Kamaruddin and Mustafa, 2009). According to Parish (as cited in Peter et al., 1992) reported that it is already 50% of the peat swamp areas in Peninsular Malaysia have been destroyed by logging, agriculture, housing and industrial development. Deforestation of natural habitat especially at or in close proximity to the rivers and stream has significant impact on fish diversity, population and fisheries activities (Wright and Flecker, 2004). Processes involved land clearance will certainly destruct the natural environment and also the organism which sharing the same resources.

Particular habitat such as blackwater in Peninsular Malaysia and Borneo has been outlined in several publications on the importance of fish fauna (Khairul Adha et al., 2009). There is relatively few information of blackwater fish species in Mukah area. Therefore, a preliminary study on fish fauna at Kenyana River is a good focus area whereby the area are selected to be one of the eco-tourism destination in Mukah and at the same time it can provide information on the status of fish fauna composition in the area. Due to the adjacent area were once part of the swamp forest but are now occupied by big scale oil palm plantation, it leads to critical condition whereby the changing environment will affect the composition and fish fauna diversity in that area. With the recommendation from the local authority, this area is in needs for conservation and management in order to save the natural habitat and at the same time to develop an area for eco-tourism. The findings of the study try to analyse the impact of land use in the surrounding area on fish fauna at Kenyana River and its tributaries. The baseline data acquired from the study can be used to make proper recommendations for conservation and management in future.
1.2 Statement of the Problem

Kenyana River and its tributaries are located in peat swamp area whereby it plays an important role as the natural habitat for blackwater fish including the Asian Arowana. In order to protect this valuable fish and its habitat from the land development, the area had been proposed to be nature reserved. Besides that, the area will become one of the eco-tourism attractions in Mukah area. However, there is no baseline study and information with regard to the fish fauna in that area.

Besides that, most area in Mukah Division especially peat swamp which includes Kenyana area already converted into plantation area either for oil palm or sago plantation. The growing plantation surrounding the area has became one of main contribution to river disturbance other than land clearing activities that takes over first before the plantation operation.

Therefore, this study is essential to identify the condition of Kenyana River as the blackwater fish natural habitat. Few questions are formulated in order to indicate empirical explanation to the research problem as stated below:

I. How many blackwater fish species are there in Kenyana River and its tributaries?

II. Based on diversity indices, what is the status of the fish diversity in Kenyana River and its tributaries?

III. Does land development influences the water quality and affect the population of blackwater fish at Kenyana River and its tributaries?
1.3 Research Objectives

This study aimed to collect some baseline information on blackwater fish at Kenyana River and its tributaries. The specific objectives of this study were:

1. Assess and record the blackwater fish population at Kenyana River and its tributaries.

2. Evaluate the diversity of fish using diversity indices.

3. Relate the blackwater fish population with water quality parameters and land use (plantation).
LITERATURE REVIEW

2.1 History of study area

In this decade, the rapid growing of population in Mukah area especially when the Chief Minister of Sarawak announced the Sarawak Corridor of Renewal Energy (SCORE) project in 2009 had brought positive development to that area. Mukah which is also known as the ‘Sago Town’ is rich with natural resources and biodiversity.

In addition to economic perspective, the local authorities are also active in developing the tourism aspect whereby Mukah will be one of the main targets for tourism industry in Sarawak by 2015 (State Implementation Monitoring Unit, 2004). In tourism management plan for Mukah, the Sibu Tourism Board has suggested conserving and protecting several areas which contain the valuable element not only for culture purposes but includes the natural biodiversity. This is where Kenyana has been chosen and becoming one of the attractions for eco-tourism because of its unique potential as natural habitat for breeding and nesting of the river’s flagship and keystone species Asian Arowana (green variety). Furthermore, this fish is and it also listed as protected species in Sarawak.

The phase 1 of eco-tourism project includes building facilities comprising of the Belian plank walk and gazebo (600 m overall length) with costing of RM 1,000,000 undertaken by Mukah Resident Office. The effort is to establish the upgrade tourism of Kenyana River project and sectors of Mukah River by local authority. Though the phase 1 project completed, the area is still not functioning as it had been planned which might due to several external factors that undermine the efforts. In addition to the dilemma, the
widening and clearing the upper sector of Kenyana River using heavy machinery by the plantation workers leads to severe impact on the river quality and also natural habitat to aquatic organism.

2.2 Natural environment at Kenyana River

2.2.1 Hydrological feature

The origin of the ‘Kenyana Lake’ is from the old mainstream of Batang Mukah Lama river basin which has been realigned as a result of the hydrological force and erosion in that area. The cut-off channel from the original alignment of main river Batang Mukah Lama that have been divert into Batang Mukah Baru which act as a new waterway downstream. The remaining river of Batang Mukah Lama became almost stagnant and will become an oxbow lake in future. Batang Mukah Lama which is also known as Kenyana Lake by local people and it has one tributary that is Kenyana River, and Liwak River as its sub-tributary. Kenyana Lake is also known as ‘Takau’ by the local Melanau which means an old river (Figure 2.1).
2.2.2 Peat swamp forest

There are two type of forest that can be found in the area nearby Kenyana; (1) mixed dipterocarp forest which covers approximately 64,167.6 ha of total forest in Mukah Division and it only covers the middle part which hill site area towards Selangau area and (2) peat swamp forest approximately 25,277.4 ha which is also included area in Kenyana (Sarawak Forest Department Mukah Division, 2013).

The peat swamp forest in the study area is mostly remnants of the past logging activities (Natural Resource and Environment Board, 2009) and most of the area was already converted into plantation area especially in the upstream area of Kenyana River. There are several important peat swamp species, namely non-dipterocarp or fruit trees such as ‘Entupong’, ‘Gurah’, ‘Kertam’ and some valuable logs [ ‘Ramin Batu’ (Gonystylus sp.), ‘Kumpang’ (Myristica sp.) and ‘Keruntum’ (Tristania sp.)]. Besides that, shrub
covers most of the area such as *Costus specious* (wild ginger), 'Bemban' (*Donax* sp.), rattan (*Korthalsia* sp.), and 'simpoh paya' (*Dellinia suffruticosa*) (Rosli Usop, Pengawas Hutan, SFD, personal communication, March 7, 2013). Along the river we can see 'Pandan' (*Pandanus* sp.) trees dominated along the riverbank and wild sago trees (*Metroxylon* sp.) also can be found in abundance. There were also epiphyte plants found such as 'Paku Sarang Burung' (*Asplenium* sp.) and 'Tanduk Rusa' (*Platycerium* sp).

### 2.2.3 Soil Classification

In accordance to Soil Maps source from Agriculture Department (2000), the major soil type cover in Kenyana area belongs to Anderson Series. Other than Anderson, there are Grey-White Podzolic Soils (mainly in between Kenyana Lake Information Centre and Kenyana River) and Gley Soils along the main river of Batang Mukah. The upstream of Kenyana River is dominated by Red-Yellow Podzolic Soils.

### 2.2.4 Blackwater Fish fauna

The river at Kenyana and its tributaries are categorised as blackwater because of the opaque black or tea-coloured water. The information of blackwater fish composition in Mukah area is scarce except for report produced by Inland Fisheries Section, Agriculture Department Mukah Division (2007) on local ornamental fish survey which only records the common or local name of blackwater fish found in Kenyana River and its tributaries. The report stated that a total of 14 species of blackwater fish were recorded in Kenyana River which are also commonly be found in other rivers in Mukah such as Feather Back (Belida), Snake head (Toman), Giant Gourami (Kaloi), Giant Catfish (Tapah) and River
Catfish (Baung). There were other fish records with local name which are ‘Adong’, ‘Biawan’, ‘Ipun’, ‘Boieng’, ‘Engkarik’ (one type of Barb), ‘Seluang’, ‘Sejolong’ and ‘Lajong’. Dragon fish or Asian Arowana is also in the list whereby it is the unique findings which it was found in natural habitat. It was believed that the area was a breeding area of the keystone species especially at Liwak River. Due to the findings, the area has been selected as a sensitive area.

According to Mr. Tai Kim Ann (Headman of Kg. Sitieng, personal communication, March 7, 2013) the freshwater fish namely ‘Tapah’ (Wallago sp.), ‘Belida’ (Notopterus sp.), ‘Baung’ (Hemibagrus sp.) and ‘Lajong’ (Pangasius sp.) have economic importance to inland fishery due to their high market value and is partly contribute to the livelihood of the local people. Other than for own consumption, local people sell sale the fishes to the middle men for local market in Mukah or nearby location (Selangau or Bintulu). However, the number of the fishes is currently declining and this trend might affect the inland fisheries activities.

2.3 Land development status at Kenyana District and nearby area

2.3.1 Settlement Area (Kampung Sitieng)

Kampung Sitieng is the only settlement area nearby Kenyana River. It is located at the river mouth in between Batang Mukah Baru and Kenyana River. There is only one old wooden shop to serve the whole area. The village is isolated from other place and can be reached only by boat.
Kampung Sitieng is the last Melanau’s settlement along Batang Mukah towards upstream and the area further upstream is dominated with Iban’s settlement (Rumah Panjang). Most of Melanau’s settlement area are located downstream of Batang Mukah. Kampung Sitieng comprises of overall 12 houses which are built isolated from each other, 3 houses belong to Iban families, 1 Chinese family and the rest belong to Melanau families.

Kenyana River serves the main as economic resource and water transportation for the villagers because there is still no road that can reach the area. Inland fishery is one of economic activities for the local communities to maintain their livelihood other than involved in harvesting sago trees and work as general workers at nearby plantations.

Besides that, according to Mr. Tai Kim Ann (Headman of Kg. Sitieng, personal communication, March 7, 2013), the villagers also sometimes depend on the river for daily consumption (drinking and cooking) during dry season whereby rain water is not enough to support their needs, though they knew that it is not safe to use the water from the river directly because they claimed that the river has been polluted by the plantation area near to Kenyana River. Nevertheless, it is the last result after no other options.

### 2.3.2 Infrastructures

There are no basic infrastructures such as road, clean water and electricity supply and communication line in that area. The communities who live nearby the area depending on generators to supply electricity and rain water for consumption. The only developments in that area are SK Kuala Kenyana, Balai Raya Kg. Sitieng and Kenyana Lake Information Centre.
2.3.2.1 School (SK Kuala Kenyana)

Sekolah Kebangsaan Kuala Kenyana is the main government building structure in that area. It consists of four small wooden building and a jetty. It is a primary boarding school to the nearby village children from Rumah Mawar, Rumah Butang and Kampung Sitieng. This school has 11 teachers and 36 students.

2.3.2.2 Balai Raya Kg. Sitieng

Balai Raya Kampung Sitieng is located next to SK Kuala Kenyana and is being used by the local people as the meeting place to gather all the villagers. Besides that, it also acts as multifunction building whereby the outsiders can use the building as rest house for any event within the area. It also functions as the flood victim temporary settlement and as food storage for the local people during flooding season.

2.3.2.3 Kenyana Lake Information Centre

This Eco-tourism project in Kenyana area has been suggested by Tourism Board (Sibu) in 2008 and has been approved by State Planning Unit. The project was carried out by Mukah Residence Office and Jabatan Kerja Raya Bahagian (JKR) is the operational agencies. The Kenyana Lake Information Centre was completed in 2009 and handed over to Mukah Dalat Municipal Council in 2010 for maintaining the area. The purposed of building the Kenyana Lake Information Centre is to attract tourists to Mukah by promoting Asian Arowana (green variety) and its natural habitat available at Kenyana. However, the current status of the area as eco-tourism project is still pending due to lack of promotions
and no transportation service to transport tourist to the area. The area has been proposed to be gazetted as Nature Reserved and will be one of the eco-tourism destinations in Mukah.

2.4 Agricultural Land Use

Peat swamp forest coverage only left approximately 20% of the original peat land as reported by Sarawak Forest Department (cited in NREB(c), 2009). The majority of peat lands in Mukah Division have been converted to variety of uses including oil palm plantation, sago plantation and planted forest (NREB(c), 2009). Peat land palm oil cultivation is one of the peak issues whereby about 55% of total peat land has already converted. This followed by sago plantation 16% and planted forest 9% (NREB(c), 2009). The State Government ensures that a series of sustainable project management schemes are implemented and not merely done through random salvage logging. These project components include an integrated water management system which is a combination of drainage, sub-irrigation and water conservation to enhance sustainable agricultural land use.

By the end of 2007, Mukah Division had an area of 295,614 ha planted with oil palm, accounting for more than 40% of the total planted areas in Sarawak (NREB(b), 2009). It covers an area of 15,121 ha of oil palm plantation under Rinwood Pelita (Mukah) Plantation which included half of Kenyana River (NREB(b), 2009). There was also several other big scales oil palm plantation nearby Kenyana River. Besides oil palm plantations, sago plantations also have their importance role in economic enlargement in Mukah Division. The location of sago plantation was also nearby the Kenyana River.
However from the field observation, the area that already being planted with sago tree is far from the study area which is also separated by Batang Mukah.

2.5 Fishing methods

Inland fishery involves in Kenyana District both active and passive gears in order to get optimum catch. Therefore, choosing the right fishing method is important to make sure the quality of fish captured (alive) with high catch. Active gears are the fishing gears which involved human energy in order to capture fish, while passive gears left over for a period of time to trap the fish.

2.5.1 Active gears

There are several fishing methods that were used at Kenyana River as mentions by the Ketua Kampung Sitieng namely ‘Pancing’ (hook and line) and ‘Jala’ (cast net). ‘Pancing’ (hook and line) seems to be a popular method among the locals people consist is very selective and usually the main purposed is to catch ‘Tapah’ (Wallago sp.). The bait used is usually small catfish or other type of small fishes.

2.5.2 Passive gears

Gill nets with various mesh sizes are one of the common passive gears used by the locals and the commonly mesh sizes used are 5.1 cm, 7.6 cm, 8.9 cm and 10.1 cm. Usually they left the nets for about 3 to 4 hours before collecting the fishes to ensure the caught fish were still alive. Another passive fishing gear that was used is ‘Berong’ (fish trap) or
common name is ‘Bubu’. However this method is seldom be used because lots of other fishing methods are more effective.

Besides that, ‘Selambau’ also is commonly used during high tide and nets that were used also various (mesh size 5.1 cm, 7.6 cm, 8.9 cm and 10.1 cm). Usually the fish that were captured using this method is still alive. Types of fish that are captured using this method were ‘Belida’, Arowana, ‘Toman’, ‘Kaloi’, ‘Tapah’, ‘Puyu’ and ‘Mantak’.

2.6 Biodiversity Indices

A diversity index is a mathematical measure of species diversity in a community. Diversity indices provide more information about community composition than simply species richness (i.e., the number of species present). They also take the relative abundances of different species into account (Beals et al., 2000). Diversity indices also provide important information about rarity and commonness of species in a community. The ability to quantify diversity using the indexes is an important tool for biologists trying to understand community structure which is also used to detect the health of the population (Beals et al., 2000). There are lots of diversity indices that can be used, and each of the diversity indexes has its own calculation strength and weaknesses.
2.7 Water condition and quality

Water of peat swamp forest appears to be tea coloured or opaque black. The water is acidic condition due to high humic acid which pH ranges 3.69 to 5.37 (NREB(d), 2010). Water of peat swamp contains low dissolved oxygen (DO) because of transformation of inorganic ions into larger molecules by humic acid. A low biochemical oxygen demand (BOD₅) indicates the oxygen consume by the bacteria during decomposing organic matter under anaerobic condition. Chemical oxygen demand (COD) indicates the level of pollution by organic and inorganic chemical in the water. The value of the turbidity and total suspended solid (TSS) is high due to the forest clearance nearby the river which lead to erosion and water runoff direct into the river. High value of faecal coliform count (FCC) and total coliform counts (TCC) indicates the high bacteria loading especially involve settlement area (NREB(d), 2010).