DISTRIBUTION AND ECOLOGY OF ANURANS AT SG. MOYOG WATER CATCHMENT AREA, CROCKER RANGE, SABAH

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DECLARATION

I hereby declare that all the information of material in this thesis is my own expect research result followed from quotations, equations, summaries, and reference, which have been duly acknowledged.

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ABSTRACT

Water catchment areas are an important resource for providing a major ecosystem service to diversity and human living. However, it is also reported as a resident settlement center. Therefore, in order to understand the impact of population placement on these resources, studies on the ecological function of the irrigation in Sungai(=Sg) Moyog catchment have been conducted. Studies have focused on four different landscapes; forests, plantation, grasslands and dams. Visual sampling has been implemented and a total of 26 species including 9 additional new species have been recorded. Most irradiation shows the high dependence and richness of species in the forest. Additionally, the community has been confirmed differently in forest, plantation, grassland and dams (p = 0.03). This shows that land-use conversion has a negative impact on the community of anuran (r = 0.47, p < 0.001). Changes in the barometric aspect also showed a strong impact on the diversity of the irrigation compared to the conversion of soil (r = 0.35, p < 0.001). Land conversion observations using satellite images of WorldView2 showed an increase in land placement and development due to urbanization and plantation activities in the study area. Population placement is observed mostly in the downstream and upstream Moyog River. The species distribution model (SDM) has been created on the settlement of the population around the downstream river and finds the subdivision and composition of the community anakan is low. On the other hand, upstream is also a part of the community and the composition of the community is high. It is therefore unreasonable to suggest that the interests of ecosystem services are not understood, and human activities create a negative impact on the ecosystem. Generally speaking, although plantation is regarded as an appropriate landscape, it can maintain the community of anatomy, but, changes in the barometric aspect can have an impact on the variety of irrigation. Furthermore, the species distribution model also shows the biological marker dependent on water vapor pressure. Therefore, it can be concluded that the environment with good canopy coverage, high humidity and water vapor pressure is important to ensure community conservation and the subdivision of ecosystems.

ABSTRAK

DISTRIBUSI DAN ECOLOGI ANURANS DI SUNGAI MOYOG KAWASAN TADAHAN AIR, CROCKER RANGE, SABAH

Kawasan tadahan air merupakan satu sumber penting dan menyediakan perkhidmatan ekosistem yang utama. Bagaimanapun, ia juga merupakan pusat penempatan penduduk. Maka, untuk memahami kesan penempatan penduduk terhadap sumber ini, kajian tentang fungsi ekologi anuran di kawasan tadahan Sungai Moyog telah dilakukan. Kajian telah bertumpu di empat landskap berbeza; hutan, perladangan, ladang rumput dan empangan. Persampelan visual telah dilaksanakan dan sejumlah 26 spesies termasuk 9 spesies tambahan baru telah direkodkan. Kebanyakan anuran menunjukkan pergantungan yang tinggi dan kekayaan spesies di hutan. Tambahan pula, komuniti anuran telah disahkan berbeza di kawasan hutan, perladangan, ladang rumput dan empangan ($p < 0.03$). Ini menunjukkan bahawa penukaran guna-tanah mempunyai kesan negatif terhadap komuniti anuran ($r = 0.47$, $p < 0.001$). Perubahan pada aspek barometrik juga menunjukkan kesan yang kuat terhadap diversiti anuran jika dibandingkan dengan penukaran tanah ($r = 0.35$, $p < 0.001$). Pemerhatian penukaran tanah menggunakan imej satelit WorldView2 menunjukkan peningkatan dalam penempatan dan pembangunan tanah disebabkan oleh aktiviti pembandaran dan perladangan di kawasan kajian. Penempatan penduduk diperhatikan kebanyakan di kawasan hilir dan hulu Sungai Moyog. Model taburan spesies (SDM) telah dibuat keatas penempatan penduduk disekitar hilir sungai dan mendapati kepelbagian dan komposisi komuniti anuran adalah rendah. Manakala, di hulu sungai pula kepelbagian dan komposisi komuniti anuran adalah tinggi. Maka, adalah tidak keterlaluan untuk dicadangkan bahawa kepentingan perkhidmatan ekosistem tidak difahami dan aktiviti manusia mewujudkan kesan negatif terhadap ekosistem. Secara umumnya, walaupun perladangan dianggap sebagai landskap yang sesuai dapat mengekalkan komuniti anuran, tetapi, perubahan pada aspek barometrik dapat memberikan impak terhadap kepelbagaian anuran. Tambahan pula, model taburan spesies juga menunjukkan anuran sebagai penanda biologi yang bergantung pada tekanan wap air. Oleh itu, boleh disimpulkan bahawa persekitaran dengan liputan kanopi yang baik, kelembapan yang tinggi dan tekanan wap air adalah penting untuk memastikan pemuliharaan komuniti dan kepelbagian anuran dalam ekosistem ini.

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LIST OF SYMBOLS

%	Per cent
°C	Degree
m	meter
mm	millimeter
Rad	Radian
$m^{2/}m$	square meter to meter
$kJm^{-2}day^{-1}$	kilojoules of energy per square metre per day
kPa	kilopascal
km	kilometer
mmhg	millimeter of mercury
mS/cm	millisiemens per centimeter
mg/L	milligram per liter
ppt	prts per thousand
kg/L	kilogram per lite

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
AU	Approximately Unbaised
AUC	Area Under the Receiving Operator Curve
BC	Bray-Curtis
BBEC	Bornean Biodiversity and Ecosystem Conservation
BOD	Biochemical Oxygen Demand
BP	Booststrap Probability
CCA	Canonical Corresponding Analysis
CE	Critically Endangered
COD	Chemical Oxygen Demand
CRNP	Crocker Range National Park
CUZ	Community Zone
db-RDA	Distance based Redundancy Analysis
DEM	Digital Elevation Model
DM	Dam
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
EN	Endanger
ESRI	Environmental Systems Research Institute
FR	Forest
GIS	Geographic Information System
GPS	Global Positioning System

GR	Grassland
HCl	Hydrochloric acid
HDPE	High-Density Polyethylene
Hum	Humidity
HoB	Heart of Borneo
IUCN	International Union for Conservation Nature
iNEXT	iNterpolation and EXTrapolation
IndVal	Indicator Value
LC	Land Cover
LC	Least Concern
MAXENT	Maximum Entropy
MEA	Millennium Ecosystem Assessment
NASA	National Aeronautics and Space Administration
NGA	National Geospatial-Intelligence Agency
NE	Not Evaluated
NH^3	Ammonia
NRE	Ministry of Natural Resources and Environment
NT	Near Threatened
NumSpec	Number of Species
NMDS	Non-metric Multi-Dimensional Scaling
OSM	Open Street Map
PCA	Principle Component Analysis
PERMANOVA	Permutational multivariate analysis of variance
PL	Plantation

RDA	Redundancy Analysis
ROC	Receiver Operating characteristic Curve
SAL	Salinity
SDM	Species Distribution Modeling
SG	Sungai
SRTM	Shuttle Radar Topography Mission
SS	Suspended Solids
TauDEM	Terrain Analysis Using Digital Elevation Model
TEEB	The Economics of Ecosystems and Biodiversity
TDS	Total Dissolved Solid
TN	Total Nitrogen
TOC	Total Organic Carbon
TOD	Total Oxygen Demand
TSS	Total Suspended Solid
TUKEY HSD	Tukey's Honestly Significant Difference
UMS	University Malaysia Sabah
UNDP	United Nations Development Programme
UPGMA	Unweighted Pair Group Method with Arithmetic Mean
VU	Vulnerable
WQI	Water Quality Index
WTem	Water temperature
WV2	WorldView2

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CHAPTER 1

INTRODUCTION

Although Malaysia has only 0.2% of the global land mass, but the richness of its ecosystem is the second highest after Indonesia in Southeast Asia. Flora and fauna diversity are perhaps the highest in its aquatic and terrestrial ecosystems in the vicinity of water catchment, and Malaysia is blessed with 157 riverine systems (Sabah, 16 rivers). These riverine systems with its extensive catchment area provide an environmental condition benefiting the human living and ecosystem service (Hardter, 1997). As in other ecosystems, most of the species are distributed and dependent on the "river corridor" that acts as an important habitat in feeding and breeding (Viessman and Hammer, 1993). In this regard, amphibians are an important group (NRE, 2009) and are often regarded as vital bio-indicators during the assessment of these ecosystems. However, drastic economic progress coupled with infrastructure development has shown an obvious impact on the land-cover and drop in total ecosystem services provided by water catchment area ecosystems since 1980 (Jamaluddin, 2000). Observation during the mid-1980 and 1990 had indicated clearly an increasing level of pollution inside the catchment area especially around the lowland area (Department of Environment, 2014). Therefore, general perception that habitat and biodiversity in the water catchment areas will continuously be placed under

pressure is not far-fetching. Thus, in an effort to maintain the integrity of this ecosystem, water pollution and sedimentation management efforts are being pursued rigorously in the identified localities (Laurance, 1999; United Nation, 2001; Rasul and Thapa, 2003; Bruijnzeel, 2004; UNDP,2014).

1.1 Background

Global distribution of amphibians has shown a strong decreasing tendency of their population structure, to the extent that it is being reported to be facing the 6th highest risk of extinction warranting immediate effort to conserve them (Blaustein and Wake, 1995; Houlahan *et al*., 2000; Pimm and Raven, 2000; Stuart *et al*., 2004; Beebee and Griffiths, 2005; Mendelson *et al*., 2006; Wake and Verdenbarg, 2008; IUCN, 2010; Hocking and Babbitt, 2014). Recent reports have indicated a 200 times higher average extinction rate of amphibian in the past 3.5 million years, highest rates than any other extinction records and it is still increasing (Beebee and Griffths, 2005; Roelants *et al*., 2007; Alroy, 2013). Generally, amphibian species inhabitant in small scale habitats or micro-niches that are well connected to the watershed and rainforest areas, but amphibians in tropical region are recorded to have the highest number of endangers species facing extinction (Figure 1.1; Holt *et al*., 2012). Ironically, amphibians are still the least understood in terms of their biology, species richness and their conservation status (Wanger, 2009).