ASSESSING THE SEVERITY OF PATCH SIZE AND PERIMETER OF FRAGMENTED FOREST BY USING WEB BASED SPATIAL ANALYSIS

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By

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DEDICATION

A special feeling of gratitude to my loving beloved family especially my parents Mr. Mohd Noh Bin Bahar and Mrs. Rozdzila Bt Shamsudin who give me a tons of love as well as financial supports.

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Thank You for Everything

And

May God Bless All of Us

ABSTRACT

Although forest edges have been studied extensively as an important consequence of fragmentation, a unifying theory of edge influence has yet to be developed. This study intended to take steps toward the implementation of optimal shape of habitat fragments which is circular shape that will be benchmarked against the readily available forest fragments. With online Web-based virtual globes such as Google Earth Pro (GEP), satellite images can be zoomed in the matter of seconds. This study compiled 90 randomly chosen forest fragments around three different regions including Africa, South America and Southeast Asia. Data retrieved from Google Earth Pro will undergo visual interpretation before the digitizing and circular shape were introduced. Landscape parameter including Original Area and Theoretical Area, Original Perimeter, Theoretical Circumference, Latitude and Longitude were taken into consideration to calculate the Fragmentation Effect Value based on the Area [FEVba] and the Fragmentation Effect Value based on Perimeter [FEVbp]. This study answered the question on how Google Earth Pro can be used as a tools at landscape level to measure the severity of forest fragmentation based on the criterion of patch size and perimeter. A statistical analysis using ANOVA was used to assess the [FEVba] and [FEVbp] in the three tropical regions. The results showed that the South America (0.6252 $^{a)}$ have the highest mean for [FEVba] followed by Africa (0.6112 $^{a)}$ and Southeast Asia (0.6026 ^{a}). However, mean for [FEVbp] resembled Southeast Asia (0.2202$^{a)}$ as the highest, followed by South America (0.1778^{a}) and Africa (0.1468^{a}). Both Fragmentation Effect Value metrics did not feature significant differences at 5% significant level. This shows that the higher the [FEVba], the bigger the area need to be reserved as more core area can be protected. Despite, the higher the [FEVbp], the more the perimeter that need to be mitigate in order to reduce the edge effects. Fragmentation Effect Value allowed us to gain a better understanding of the current severity of forest fragmentation. In short, this study represents an example of using Fragmentation Effect Value for land cover pattern quantification in three large continents. The severity of forest fragmentation based on the area and perimeter warrants the assumption that the approach developed here is sufficiently generic to be applicable to any forest fragments elsewhere.

ABSTRAK

Walaupun persisiran hutan telah dikaji secara meluas sebagai akibat penting pemecahan, teori penyatuan pengaruh masih belum dikembangkan. Kajian ini bertujuan untuk mengambil langkah ke arah memperkenalkan bentuk serpihan habitat yang optimum bentuknya iaitu bentuk bulat yang akan menjadi penanda aras terhadap serpihan hutan yang sedia ada. Dengan penggunaan glob maya berasaskan Web seperti Google Earth Pro (GEP), imej satelit boleh dizoomkan dalam masa beberapa saat.Kajian ini menghimpunkan 90 serpihan hutan yang dipilih secara rawak di sekitar tiga rantau yang berbeza termasuk Afrika, Amerika Selatan dan Asia Tenggara. Data yang diambil dari GEP akan menjalani tafsiran visual sebelum bentuk digitasi dan bulat diperkenalkan. Parameter lanskap termasuk Saiz Asal dan Saiz Teoritis, Perimeter Asal, Lingkaran Teoritis, Latitud dan Longitud telah diambil kira untuk mengira Nilai Kesan Fragmentasi berdasarkan Saiz [FEVba] dan Nilai Kesan Fragmentasi berdasarkan Perimeter [FEVbp]. Kajian ini akan menjawab soalan tentang bagaimana Google Earth Pro akan digunakan sebagai alat di peringkat landskap untuk mengukur keparahan pemecahan hutan berdasarkan kriteria saiz serpihan dan perimeter. Analisis statistik menggunakan ANOVA digunakan untuk menilai [FEVba] dan [FEVbp] di tiga rantau tropika yang berbeza. Hasil menunjukkan bahawa Amerika Selatan (0.6252^{a}) mempunyai purata tertinggi untuk [FEVba] diikuti oleh Afrika (0.6112^{a}) dan Asia Tenggara (0.6026^{a}). Walau bagaimanapun, berbeza untuk [FEVbp] dimana Asia Tenggara (0.2202^{a}) sebagai yang tertinggi, diikuti Amerika Selatan (0.1778^{a}) dan Afrika (0.1468^{a}). Untuk makluman, kedua metrik Nilai Kesan Fragmentasi tidak menunjukkan perbezaan yang signifikan pada tahap 5% signifikan. Ini menunjukkan bahawa [FEVba] yang lebih tinggi, semakin besar kawasan perlu dirizabkan supaya lebih banyak kawasan inti dapat dilindungi. Berbeza dengan [FEVbp], semakin tinggi [FEVbp], lebih banyak perimeter perlu dikurangkan untuk mengurangkan kesan persisiran hutan. Nilai Kesan Fragmentasi boleh memberi kita pemahaman yang lebih baik tentang keparahan semasa pemecahan hutan. Pendek kata, kajian ini merupakan contoh menggunakan Nilai Kesan Fragmentasi untuk menganalisa corak kuantiti tanah di tiga rantau besar. Keparahan pemecahan hutan berdasarkan kawasan dan perimeter memberi andaian bahawa pendekatan yang dibangunkan di sini cukup generik untuk digunakan pada mana-mana serpihan hutan.

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APPROVAL SHEET

I certify that this research project report titled "Assessing the Severity of Patch Size and Perimeter of Fragmented Forest by using Web Based Spatial Analysis" by Nurfarah Aqilah Bt Mohd Noh has been examined and approved as a partial fulfillment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia.

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LIST OF ABBREAVIATIONS

[FEVba]	Fragmentation Effect Value Based on Area
[FEVbp]	Fragmentation Effect Value Based on Perimeter
ANOVA	Analysis of Variance
FAO	Forest and Agricultural Organization
GE	Google Earth
GEP	Google Earth Pro
GIS	Geographical Information System
IUCN	International Union for Conservation of Nature
MCT	Ministry of Science and Technology
PA	Protected Area
PRF	Protected Reserved Forest
UN	United Nation
WWF	World Wildlife Fund

CHAPTER 1

INTRODUCTION

1.1 Background

1.1.1 Forest Fragmentation

Forest loss and forest fragmentation to meet the human needs of firewood, logging activities, crop areas as well as urbanization results in habitat loss and habitat fragmentation simultaneously (Didham, Kapos & Ewers, 2012). This in turns affect biodiversity and ecological processes (Fahrig, 1997, 2003; Wilson *et al*., 2016). Habitat area was represented as the percentage of non-built-up area in the landscape, while habitat fragmentation was measured using several landscape metrics (Liu, He & Wu, 2016). According to MacArthur and and Wilson (1967), when human start converting the natural landscape and reduce the natural habitat into smaller fraction of its former area, the term 'habitat fragmentation, is most commonly employed. From 2010 to 2050, the proportion of urban population is estimated to increase from 51.6% to 67.2% around the world (UN, 2012), meanwhile the built-up area will increase by 3 times (Angel *et al.*, 2011). The relationship between habitat loss and habitat fragmentation during urbanization is commonly parallel, indicating that the degree of habitat fragmentation per se increases with habitat loss in general (Liu, He & Wu, 2016).

Urbanization has been accelerating around the world during the past several decades, becoming an increasingly important cause of habitat loss and fragmentation (Seto, Guneralp & Hutyra, 2012; Güneralp & Seto, 2013). During urbanization, large areas of natural habitat have been converted into impervious surfaces, causing habitat loss (Güneralp & Seto, 2013). Habitat loss are considered severe threats to global biodiversity (Foley *et al*., 2005), and are believed to negatively effects virtually taxanomic groups including birds and mammals (Andren, 1994), reptiles (Gibbons *et al*., 2000), amphibians (Stuart *et al.*, 2004), invertebrae (Didham *et al*., 1996) and plants (Hobbs & Yates, 2003).

To assess the impacts of urbanization on habitat, and further on biodiversity and ecosystems, understanding the correlation between habitat loss and habitat fragmentation during urbanization is an important and essential (Fahrig, 2003).

1.1.2 Remote Sensing and Geographic Information System (GIS) in Landscape Ecology

Sensing the Earth has proven to be tremendously valuable tool for understanding the world around us. Data from satellites have exposed great potential in environmental monitoring and resource management capabilities thus increasing the curiosity of the biologist as well conservationist on the need to answers distribution of forest fragments and how it affects biodiversity loss (Mansor, 2008). The use of remotely sensed data can improve decision making by the physical and environmental parameters and information derived from them. (Mansor, 2008).

Current techniques for measuring forest fragmentation by which to observe, describe, and quantify landscape pattern and process in term of biology is exclusively limited to experts of GIS and remote sensing technology. Furthermore, the possession of satellite images as well as commercial GIS and remote sensing software is extremely expensive to natural resource managers and scientists from emergent countries. Many tools available (e.g. Fragstats 2.0, V-LATE, Landscape Analyst (Lang *et al.,* 2004) but to make them fully available and operable for designers and planners is still a challenge. (Botequilha leitao & Ahern, 2002).

Here comes the Google Earth Pro. The GEP plays an important role in generating land use/cover information from regional to global scales, not only due to its spatially-explicit representation of the earth surface, but also due to its frequent temporal coverage and relatively low observation costs (Wu *et al*., 2008; Bargiel & Herrmann, 2011). The improved data availability from new sensors and improved computing resources and data analysis tools have resulted in a number of studies conducted (Wang *et al*., 2009; Jiang, Zhao, Cai & An, 2012). With online Web-based virtual globes latest version GEP, satellite images can be zoomed in on from the full earth disk to detailed views of any places on the earth in the matter of seconds (Daqamseh *et al*., 2009). The program is almost completely automated and thus requires little technical training (Ploton *et al.* 2012).

1.2 Problem Statement

Fragmented forest may be suitable for some floras and faunas to adapt with. In order to obtain such information (the adaption factors), examination on the properties of fragmented forest is needed. Fragmented forest usually varies in size and shape, thus edge effect may become problem to the suitability of fragmented forest to floras and faunas. Area far from forest edge (core area) has been identified as protected area and ideal to hinder the effect from the edge. Examining the characteristics of fragmented forest with i.e., no route access, difficult surveying work due to multi story/age vegetation make it impossible to be conducted manually.

However, with the advances of technology in surveying such as satellite remote sensing, and easy and/or free access to source of satellite image such as online Web-based virtual globes; GEP coupling with additional tools for analysis, surveying work can be done in a couple of hours or days and details can be surveyed.

Thus, this study is intended to use GEP application to measure the severity of forest fragmentation.

1.3 Justification

A unifying theory of best shape for forest fragmentation influence has not yet been implemented. The objectives was to take steps towards the implementation of such theory. Efforts to link landscape pattern and biotic response have most commonly used metrics such as: patch area, edge density and nearest neighborhood distance. I extend existing metrics by incorporating a more functional component by approaching using optimal circular shape of reserve design as the benchmarks. Focus primarily with patch area, patch perimeter and patch shape because: 1) The linkages between such measures and ecological process are often perceived to be relatively clear and 2) Most commonly used to quantify the structural changes associated with forest loss and fragmentation (Kupfer *et al*., 2012).

The method relies on the area and perimeter of a readily available patch that are benchmarked against those measured for an optimal (i.e. circular) shaped patch (Diamond, 1975). The methodology applied to assess forest fragmentation in this study can also be used to assess the severity of forest fragmentation and improve forest policies, planning, and the management of forest fragmentation. The study's findings support the theory on the best reserved design shape for the forest fragmentation and contribute to a new vision of forest fragmentation as a valuable ecological resource by demonstrating how shape can be used to enhance ecosystem health and promote a better quality of life for the biodiversity.

1.4 Objective

This study was intended to measure the severity of forest fragmentation by using GEP application. To be specific, the objective of this study were:

1) To access the forest fragmentation in tropical regions by using GEP
2) To measure the severity of forest fragmentation based on the criterion of patch size and perimeter in different tropical region

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