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Conservation Gap Analysis of Endemic Dipterocarp in Sarawak Using GIS and Remote Sensing Techniques

Stephen Teo, Satoshi Tsuyuki and Mui-How Phua[1]
[1]Corresponding author
Universiti Malaysia Sabah, Malaysia
Email: pmh@ums.edu.my

ABSTRACT: Dipterocarps or Dipterocarpaceae are a commercially important timber-producing and dominant keystone tree family in the rain forests of Borneo. Borneo's landscape has been changing at an unprecedented rate in recent years, which affects this important biodiversity. The present paper applies Inverse Distance Weighting (IDW) method for modelling the occurrence of the endemic dipterocarp species in Sarawak, which is important for forest biodiversity conservation and management. The results indicate that only 3% and 4% of endemic dipterocarp of Borneo and Sarawak, respectively, are protected in existing totally protected areas (TPAs). The present study also shows that the central part of Sarawak is a hotspot area for both these endemic endemic species (i.e. Borneo and Sarawak). These hotspot areas should be prioritized.

KEYWORDS: *Dipterocarp, conservation gap, GIS, remote sensing, Sarawak*

Introduction

Borneo is a global mega-diverse hotspot where biodiversity and endemism is high (Ashton, 1995). However, deforestation is an inevitable part of development in the tropics, including Borneo. The tropical forests of Sarawak are converted to other land uses as well as logged to provide capital for development. Average annual deforestation rate calculated from land cover classification maps of 1990 and 2009 was 0.64% (Tsuyuki et al., 2011), which is lower than that of Borneo. Bearing in mind that the deforestation rate for Sarawak was averaged over a long period of time and large-scale oil palm plantation development was very recent, this rate is a conservative estimate. Given current trends in deforestation and the lack of proactive intervention measures, it is estimated that forest cover in Sarawak will decline further, thereby affecting biodiversity.

The quality of protected areas, such as biodiversity, is as important as the size conserved. Dipterocarp is the dominant tree family of the tropical rain forests of Southeast Asia and a commercially important timber as well. It has its centre of diversity in Borneo where at least 267 species are found. The northern part of Borneo harbours a higher wealth of biodiversity than the rest of Borneo. For example, about 92% of dipterocarp species

in Borneo are found in Sarawak (Ashton, 2004). Such a keystone and dominant tree family ought to be conserved, and there is an urgent need to know where in the landscape they are located.

Species distribution modelling is significantly important for biodiversity conservation because it can determine areas that have high potential of occupancy by certain species. By conserving these areas that could be part of an endangered species habitat, conservation strategies would be more effective. The use of GIS with inventory data has been instrumental in plant species distribution modelling (e.g. Rael et al., 2009; Jantakat et al., 2010). Rael et al. (2009) combined abundant data of angiosperm families (including dipterocarp) in species distribution modelling using multiple linear regression. In a compilation of Peninsular Malaysian dipterocarp for plant red lists, distribution map of dipterocarp for Sabah and Sarawak species that occur in Peninsular Malaysia were also included (Chua et al., 2010). The distribution map shows species occurrence polygons that are created by following herbarium points, similar to the minimum convex polygon method. GIS-based modeling of dipterocarps distribution has been limited to only the dry dipterocarp forests of Thailand (Jantakat et al., 2010). The distribution of ten tree species including five dipterocarp species was predicted using environmental variables in the dry dipterocarp forest in northern Thailand. The lack of such modelling studies on dipterocarp could be due to the unavailability of field data, which is very costly to collect. Teo and Phua (2012) compared global and local modelling methods based on herbarium database coupling with GIS data for modelling species of selected genera of dipterocarp in Sarawak. Using the best modelling method, we discuss the conservation gaps of endemic dipterocarp in Sarawak.

Methods

In Teo and Phua (2012), local modelling method of Inverse Distance Weighting (IDW) was compared with the commonly-used global method (Binary Logistic Regression) to build the best natural distribution models for three genera (*Anisoptera*, *Dipterocarpus* and *Upuna*) of dipterocarp. The three genera were selected as members found in different habitats and included both endemic and non-endemic species. *Upuna* is a monotypic genus endemic to Borneo. The results show that IDW produced the best and consistent prediction with an average accuracy of about 85%.

Species Occurrence Models (SOMs) were generated for all endemic dipterocarp in Sarawak using IDW in ArcGIS 9.0 software. Species occurrence density maps for endemic Borneo and Sarawak dipterocarp were generated by overlaying SOMs of the species. The resulting species density maps for all of Sarawak were then re-classified into 4 groups: 0–25%, 26–50%, 51–75% and

HIGHLIGHTS

- Herbarium and GIS data provide a species occurrence model of dipterocarp, the most important commercial timber species in Sarawak.
- Hotspot areas of endemic Borneo and Sarawak dipterocarp were found in central Sarawak.
- Boreno and Sarawak dipterocarp inside existing totally protected areas are only 3% and 4%, respectively, of the entire Sarawak area.

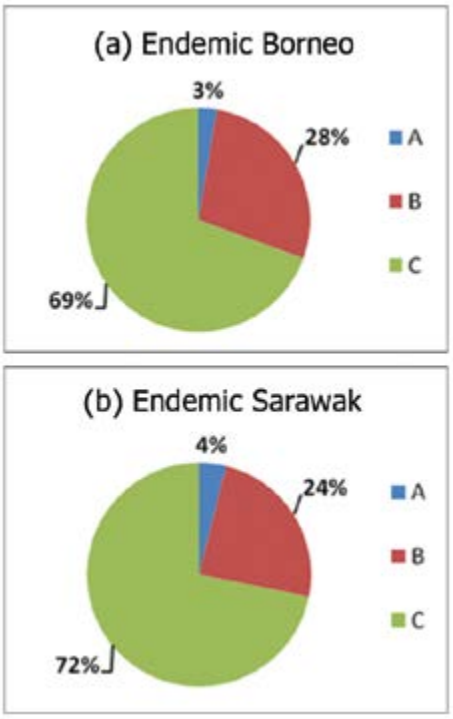


Figure 1. Hotspot areas (>75% species density) of Sarawak's total area for (a) Endemic Borneo and (b) Endemic Sarawak

Note:
(A) Inside protected areas;
(B) outside protected areas with intact forest cover;
(C) outside protected areas without intact forest cover.

76–100%, expressed in percentage of total species in that category. For example, if the species occurrence density of a particular genus is 5 and the total number of species in that genus is 28, the percentage will be 5/28 x 100% = 17.8% and fall under the 0–25% classification. Hotspot areas were represented by the 76–100% class in the re-classified density map. The total area of hotspots that are covered by intact forest and situated inside or outside TPAs were determined by overlaying TPA and land cover maps that were generated from supervised classification of Landsat TM or ETM+ images (Kamlun et al., 2012).

Results

For Borneo's endemic dipterocarp species, hotspot areas (with species density >75% of the total endemic species) inside protected areas were only about 3% of the total area of Sarawak. The hotspot areas for Sarawak's endemic dipterocarp species were slightly higher at 4%. For areas outside the protected areas, about 69% and 72% were still covered with intact forest for high species density areas (>75%) for endemic Borneo and Sarawak, respectively. This indicates that dipterocarp species, irrespective of Borneo or Sarawak endemism, are inadequately conserved in existing protected areas.

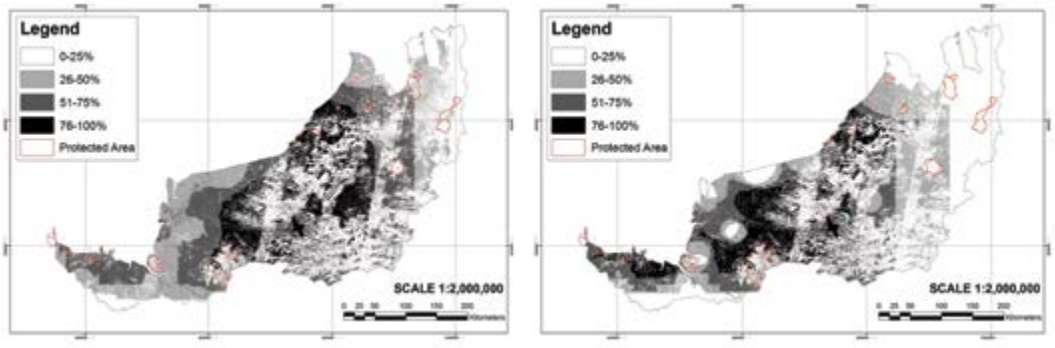
In terms of distribution, the major hotspot of dipterocarp endemism was located in central Sarawak, which is least protected. Overlaying between the species density and protected area maps revealed that most protected areas are in southwestern Sarawak (for example, Bako, Kubah and Gunung Gading National Parks) and in northern Sarawak (for example, Niah and Lambir National Parks).

Discussion

Current conservation policy is inadequate for biodiversity conservation and specifically for dipterocarp conservation because forest policy does not specifically address dipterocarp conservation despite the fact that this timber contributes enormously to revenue in Sarawak. Also, forest policy lacks spatial information for prioritizing conservation.

Conservation hotspots have been identified globally but not locally, especially for dipterocarp in Sarawak. Most hotspots for endemic species at the local scale have been identified along the Atlantic coast of Brazil (Zaforlin et al., 2007). The study showed for the first time that the central region of Sarawak appears to be a hotspot for endemism of dipterocarp in Sarawak. Currently, almost all totally protected areas (TPAs) are concentrated in northern and southern parts of Sarawak. A systematic approach as demonstrated in this study can be used to identify TPAs to ensure conservation of endemic species.

There is a priority now for Sarawak to set aside 10% (about 1.2 million ha) of its land as TPAs. Currently, over 500,000 ha have already been gazetted as TPAs. Remaining TPAs to be gazetted ought to take into account the geographical distribution of the TPAs, especially by considering central



(a) Endemic Dipterocarp (Borneo) (b) Endemic Dipterocarp (Sarawak)

Figure 2. Hotspot Areas of (a) Endemic Dipterocarp (Borneo) and (b) Endemic Dipterocarp (Sarawak) in the Intact Forest of Sarawak

Sarawak as an important hotspot area for endemic dipterocarp.

This study provide strong and scientific justifications for gazetting the proposed TPAs in central Sarawak such as the Proposed Hose Mountains-Batu Laga National Park, the Proposed Bukit Sarang National Park, the Proposed Bukit Mersing National Park as well as the Proposed Bukit Kana National Park as well as other forested areas in the central region. These hotspot areas must therefore be considered as priority areas for conservation.

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Dr. Mui-How PHUA

School of International Tropical Forestry, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, Malaysia

Tel: +60 88 320 000

Email: pmh@ums.edu.my

Website: www.ums.edu.my/v5