Mapping *Shorea* natural distribution in the last remaining forests in Riau as a baseline information for conservation strategy

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Abstract. *Shorea* divided into four groups: *Shorea Red Meranti*, *White Meranti*, *Yellow Meranti* and *Balau*. In the past, conservation was not an important issue as this groups were common and abundant. However, Sumatran rain forest were cleared and converted at annual rate of 500,000 Ha with the most extensive in the Province of Riau where had lost 63% between 1985 and 2009. This study conducted to determine the potency and availability of most valuable tropical *Shorea* dipterocarps in Riau Province. Lines transect and point count methods used to determine the presence any of the *Shorea* species in the designated remnants area. Leaves samples for morphological identification collected for further taxonomic identification. Data analysis for mapping conducted by overlaying the secondary and primary data source. The result showed that the patchy remnants forests in Riau still conserve at least of around 22 *Shorea* species, included 14 species those of *Shorea Red Meranti*, 1 species *Shorea White Meranti*, 4 species *Shorea Yellow Meranti*, and 3 species of *Shorea Balau*. However, in average the numbers of individual found for each of the species was low with uncomplete occurrence of the life stage in several spots, showing the fragility of local species loss and extinction.

1. Introduction

Dipterocarpaceae is the dominant timber trees family of tropical rain forest in Malesia region, including Indonesia, Malaysia, Brunei, the Philippines and eastward to New Guinea. Dipterocarps is economically important where its timber (round wood logs) counted for 25% of total global consumption of tropical hardwood [1]. Ecologically, dipterocarps is significantly important in tropical primary forest where its wood volume was estimated 211.75 m$^3$ ha$^{-1}$ which means it counts for 86.9% of total volume [2].

*Shorea* is the biggest genus emergent dipterocarps which comprise of more than 190 species. They naturally grow from sea level up to 1750 m altitude [3]. The majority of *Shorea* species are listed as being critically endangered due to a population reduction over 80% in the past three generations, caused by a decline in its natural range and exploitation. In global market, the four group of *Shorea* are well known for their common identification, those represented by *Shorea Red Meranti*, *Shorea White Meranti*, *Shorea Yellow Meranti*, and *Shorea Balau*. The grouping of *Shorea* is mainly based on their wood colour appearance and grain. Based on their timber characteristic on water, the three group of
Shorea Red, White and Yellow Meranti are categorized as light hardwood while Shorea Balau is categorized as medium to heavy hardwood.

In the past, conservation of the dipterocarp family was not that important as the family was still very common and abundant. However, forest conversion and fragmentation together with habitat deterioration are happening progressively. In the case of Sumatran rain forest, the loss of forest area mainly because of the combination from followed factors: 1) industrial plantations; 2) small-scale forest clearing; 3) roads development; 4) and semi-wildfires [4]. Only in less than two decades, Sumatra has lost its 12.5 million ha of natural forest and this amount is nearly half of its natural cover forest covers in 1985 [5]. The annual conversion rate of Sumatran tropical forest itself is said to be at 500,000 hectares, or 2.56 % yr\(^{-1}\). Even though there are significant numbers of protected areas available in Sumatera, however it is well understood that these protected areas have generally been established in remote highland and other agriculturally unsuitable areas where its biological diversity is the lowest [4]. Contrast to that situation, more than 80 percent of forest loss occurred in the most accessible lowland areas, where the most biodiversity and carbon-dense ecosystems are found. We can see clearly that fact from the largest Sumatran national park of Kerinci Seblat and Gunung Leuser that covers large pieces of inaccessible forests in the mountains [4,6] while all oil palm and timber concessions are granted in lowland forests.

Among all provinces in Sumatra, the most extensive of forest loss was happened in Riau Province. Riau Province lost 63% or 4.4 million hectares of its 6.9 million hectares of forest cover between 1985 and 2009 and this was accounted for nearly half of Sumatra's total forest loss between 2000 and 2009 [5]. The remnants forest in Riau now is very fragmented and scattered into pieces surrounded either by oil palm plantation and or exotic timber plantation, e.g Acacia and Eucalyptus. This study was carried out to determine the potency and availability of dipterocarps *Shorea* species in the remnant forests of Riau Province. The result will be very important to describe current condition of the species and can be put as baseline information to propose appropriate conservation strategy.

2. Methods

2.1 Primary Data
The presence of any *Shorea* species were obtained by conducting several field surveys using methods including; purposive sampling by line transect and point count. The surveys were conducted in several remnant forested areas in Riau Province, covered Tesso Nilo National Park (3 spots), Bukit Tiga Puluh National Park (4 spots), Bukit Rimbang Bukit Baling (4 spots), Ampang Delapan, Rumbio Indigenous Forest (2 spots), Hapansas Pasir Pangaraian (2 spots), Sutan Syarif Qasim Minas, Riparian RAPP Kuansing, and Siak river watershed. In most of the case, it took around 3-4 days to conduct survey at each of the sites. The length of survey mainly depends on the difficulties or accessibility of the area. Interviews were also conducted with local people as well as forest practitioners, (e.g. forest ranger, staff and or head of governmental conservation body, non-governmental conservationist, environment division of forest plantation companies) to get information on the presence of *Shorea* species in non-direct surveyed areas of study interest. This non-direct survey was essential to do a complete *Shorea* distribution checklist in Riau considering the constraint of our limitation in budget and time. Primary data were collected in form of GPS positioning for each tree individuals during field exploration trips using Garmin Dakota 20.

2.2 Secondary data, analysis and mapping
Data used in this study were mainly secondary data such as model position, digital elevation model, administrative map, and land typology. In this system, we turned these maps into each thematic map. Then, the species distribution data were overlaid with these thematic maps. We did not execute spatial data because we only showed the position of the object (trees) into the background data. The species distribution map was modify based on the latest information.
3. Results and Discussion
The four groups of Shorea are well known in global timber market based on their timber color appearance. Classification using vernacular names is divided Shorea into four groups, namely Balau (Selangan Batu), White Meranti (Meranti Pa’ang), Yellow Meranti (Meranti Damar Hitam) and Red Meranti [7]. All four group of Shorea were found during our field surveys. Among 22 species, Shorea Red Meranti are most dominant and consist of 14 species, followed by 4 species of Shorea Yellow Meranti, 3 species of Shorea Balau and only 1 species of Shorea White Meranti.

3.1 Shorea Red Meranti
Shorea Red Meranti is usually large tree with cylindrical bole. The timber is generally used for sliding, interior joinery, flooring, furniture and weatherboarding. In particular market such as in Europe, it is preferred for making window frames and sills. Morphologically, this Meranti group is easily recognized by their drooping twigs and branchlet.

Among 23 species of Shorea Red Meranti reported to grow in Sumatera [3], there were 14 species within the group that still can be found in remnants forest. This numbers is the most abundant among the four groups to be discovered in Riau. As seen in distribution map of Shorea Red Meranti showed in Figure 1, it is known that this group naturally grows both at peat swamp and also mineral soil type, from lowland to the lower montane zone. Figure 1 is also helping us to recognize that the species diversity in one particular place located at mineral soils is richer than those at peat swamp area. Tesso Nilo National Park, Bukit Tigapuluh National Park, Rumbio, Bukit Rimbang Bukit Baling (BRBB), Hapansan, and Bukit Bungkuk are among the sites that preserved 8 or more Shorea Red Meranti species inside their areas. Figure 1 is also helping us to determine that S. leprosula and S. acuminata have a wide distribution in Riau Province that could occupy both mineral and rather swampy area.

The high diversity at both national parks is mainly due to the forest status where all extraction activities are prohibited and counted as illegal and against the law. Meanwhile, the high of species richness of Bukit Rimbang Bukit Baling was attributed to the site condition where BRBB is well known for its extreme contour that is hilly with frequent extreme slope. It is actually one of Bukit Barisan mountain ranges located in Riau Province. This naturally gifted condition makes the area less attractive to be converted to agricultural areas.

At peat swamp areas, Sinepis forest holds the richest biodiversity compare to others. This mostly because this area has not been logged so much. The high biodiversity in this swampy area is in accordance with mammals condition where often reported this site as one of the limited valuable pocket of the natural habitat for Sumatran tiger.

3.2 Shorea Yellow Meranti
Shorea Yellow Meranti is also known as Meranti Damar Hitam because the exudation of black or brown damar on bark. The timber colour is yellow to yellow-brown and will get darken along the age. The timber is generally less preferred compare to those of Shorea Red Meranti. The timber is also reported as non-durable to rot attacks. In workability, this group of Meranti is typically rather easy to work with. However, some species may have a slight blunting effect on tools due to small levels of silica present in the wood.

Among 8 species of Shorea Yellow Meranti reported to grow in Sumatera [3], there were found 4 species within the group that still can be found in remnants forest in Riau. Figure 2 showed us that the species within the groups, including Shorea balanocarpoides, S. conica, S. multiflora, and S. peltata always grows naturally at mineral soils type habitat. None of the Shorea Yellow Meranti species found to grow at peat swamp area in our field surveys. Figure 2 is also helping us to recognize that Bukit Tigapuluh National Park own all 4 Shorea Yellow Meranti inside its area. It also determined that S. balanocarpoides and S. conica are spread widely while S. peltata showed high level of habitat specificity that it confined to only one area of Bukit Tigapuluh National Park.

3.3 Shorea Balau
Shorea Balau is known for its heavy timber. The heartwood is very hard and logs are drowning into the water. Species within this group are usually have straight cylindrical bole with concave buttresses.
The timber colour can be highly variable depending on the species: ranging from a pale straw colour to a darker reddish brown. Even though the timber is hard, but in most of the case they are considered as non-durable in regard to decay resistance, and are also susceptible to insect attack. As the timber is hard, it is also typically hard to work on, due to its high density. The practical use of the wood is usually for plywood, veneer, general construction, flooring, as well as a number of other general utility purposes.

Among 11 species of *Shorea Balau* reported to grow in Sumatera [3], there were only 4 species found in remnants forest in Riau during our field surveys, those including *S. atrinervosa*, *S. falcatana* and *S. sumatrana*. Figure 3 showed us that the species within the groups are mainly grow in mineral soil type. Through Figure 3 it is also known that *S. sumatrana* found not only can grow in dry mineral soil but also can grow crossing into wetter area along Siak River. This distribution map also showed that Tesso Nilo National Park own more species than that of Bukit Tigapuluh National Park. In general all three species seems to be distributed more evenly where one species can appear in 4-5 areas in Riau. None showed the very high distribution ability or habitat specificity.

### 3.4 Shorea White Meranti

*Shorea White Meranti* is less popular for sawmilling and joinery because of the abundant silica present in ray cells that dulls saw and tools. The colour of its heartwood is a pale yellowish-orange when freshly cut, aging to a golden yellow-brown. Because of that, species within this group is preferred to be peeled for plywood and has bright white colour that make the species attractive for face veneer.

Among 9 species of *Shorea White Meranti* reported to grow in Sumatera [3], only 1 species was found during our field survey, namely *S. bracteolata*. Figure 4 showed the distribution of *S. bracteolata* in Riau Province. From this figure it was clearly recognizable that *S. bracteolata* is mineral soil type Meranti, that means its natural distribution is only confined to mineral soil habitat and never be found in peat swamp areas. It is also found from lowland forest until lower montane. Based on our direct field survey and non-direct survey, it is determined that the species distributed at least in 13 areas of remaining forested land in Riau.

### 3.5 Why mapping natural distribution of Shorea is necessary for conservation strategy

Manifesting direct data survey into distribution map of the species is necessary to do. It is beneficial to describe the distribution pattern of the species along with their brief description of the habitat. Rather than reading detailed information in form of descriptive paragraph, showing the result in form of distribution map will deliver the message easier and faster. However, detailed information in form of text is still crucial to those who want to know more detailed information. Overlying the primary data of species position into the background data (e.g elevation, habitat type, administrative area, etc) will give clearer description on how and where certain species located in one compact landscapes. In case of *Shorea*, the distribution map of each figure (Figure 1 – Figure 4) clearly described on how one species distribute in Riau Province, where it is distributed (mineral soil vs peat swamp), how many species own by each certain area (species abundance), and how the sites can be accessed (far vs near the road, etc). The benefit of displaying species distribution into a map is its congeniality of the exact position. Certain species both flora and fauna has a very high economic or ecological value. Publishing their position clearly into exact coordinate for public consumption can be harmful for their conservation status because it can trigger massive exploitation or hunting. Presenting their distribution and existence into distribution map only give rough location without discarding important information of its location in whole.

### 4. Conclusion

Mapping species distribution in forestry is important. It can show clearly how the species distribute together with their habitat condition. Natural distribution of *Shorea* (*Dipterocarpaceae*) in Riau showed that the species within the Genus is currently still available in small pockets of the remnants forest. Both mineral soil and peat swamp area still preserved several common and or endangered ones. Remnants forest is characterized by its mineral soil and tend to have higher diversity than those of peat swamp, while forest status with high and intense prevention for extraction (e.g National Park) together
with difficulties in accessibility were known to be effective in maintaining high diversity of the *Shorea* species. Based on distribution map resulted in this study, concern on conservation strategy of the species can be designed both by species based and or area based.

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