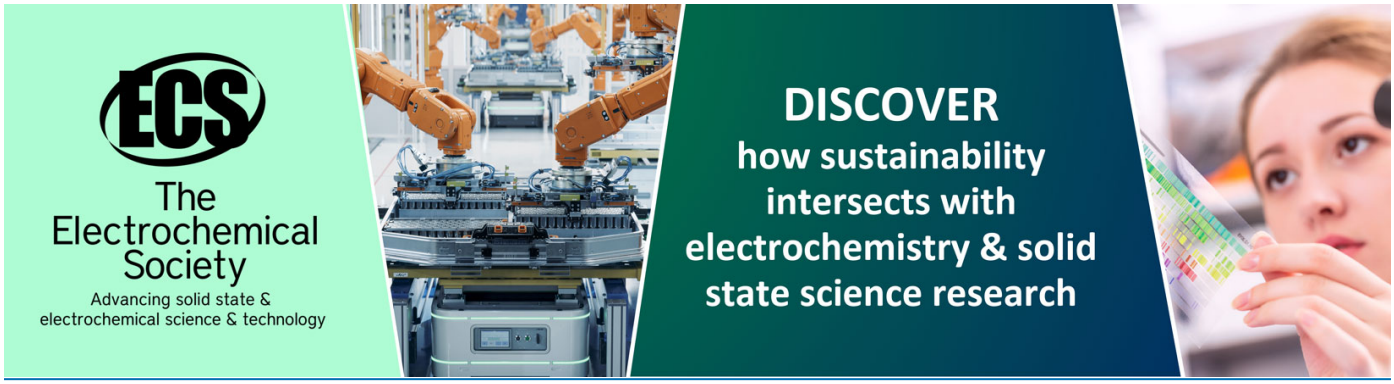
The Diversity of *Shorea* spp. (Meranti) at Some Habitats in Indonesia



The Diversity of *Shorea* spp. (Meranti) at Some Habitats in Indonesia

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Abstract. *Shorea* is one of the largest genus in Dipterocarpaceae with 194 species in the world, ±160 originated from Malesia region and consisted of ±125 species in Indonesia. *Shorea* population which grown in Indonesia have high economic value of wood. Distribution of *Shorea* would be affected by some factors especially edaphic, climate, and altitude. Based on the observation of speciment collection in Herbarium Bogoriense,*Shorea*werehighest distributed in 0-500 m and 500-1000 m of the altitude in Dipterocarps forest type. Borneo (102 species) and Sumatera (52 species)islands were highest distributed habitat of *Shorea*species and population. *Shorea* distributon pattern in Indonesia have high endemicity, especially it grow in Borneo. *Shorea* trees start to flower at 8-10 years and usually it mast flowers every 4-5 years. *Shorea* grow in some habitats such as lowland dipterocarp forest (98 species), hill forest (57 species), coastal forest (12 species), peat swamp forest (11 species), heath forest (11 species), swamp forest (6), riparian forest (6 species) and limestone forest (2 species).
Keywords: *Shorea*, dipterocarpaceae, habitats, peat swamp forests, heath forest

1. Introduction

Dipterocarpaceae generally grows in tropical forests as an emergent trees with stem height can reach 70-80 meters, consisting of 14 genus and about > 500 species [1-3].There are 8 genus and about 238 species of Dipterocarpaceae in Indonesia, it means that 62% of the total species of Malesia region (386 species). *Shorea* (Meranti) is the largest genus of the Dipterocarpaceae and contains the highest number of species in Indonesia [3,4]. Generally, Dipterocarpaceae grows in the red and yellow podzolic soil type with altitude below 1300 m asl, and rainfall > 1000 mm per year [5].

Shorea has a buttresed, a 5 winged fruit (2 rudimentary wings and 3 large wings) and dome-shaped canopy. It's grows in a variety habitats such as lowland dipterocarp forest, peat swamp forests, hill forest, heath forests, swamp forest, riparian forests, coastal forests and limestone forests with the different characteristic of each species. Generally, it is not always fruiting in every year, but in a few years it has dense fruits, commonly known as a great season. When the long dry season, *Shorea* blooms from August to October and ripe fruit from January to March. In this season, the trees in many regions has flowers and bear fruits in the same time, and in abundance. Although some species of *Shorea* have been planted by many people, but most of the seeds are taken from the forest and generally the seeds can not be stored for long time (recalcitrant). In the fruit season if it has not immediately taken, the seed is difficult to germinate. Beside recalcitrant, the seeds are also contain of

the vegetable fat so that seeds are favored by wild boars. Therefore, although *Shorea* trees has abundance fruit, but only a little can germinate.

Meranti trees has slow growth and the wood are widely used as building materials and furniture. If these species are continuously exploited over time, they will be very drastic reduction in population numbers while for recovery it takes a very long time. *Shorea* and other Dipterocarpaceae wood generally have high economic value, so it have been dominating in international timber trade, especially in Southeast Asia [6,7]. Many species of *Shorea* are included in the IUCN list (Red Data Book) to categorize their level of existence. There are a critical category (CR), endanger (EN), vulnerable (VU) and even possibly for long time there are several species of *Shorea* in extinct category (EX) [8]. Beside the timber, there are also some non-timber minor products from Dipterocarp such as oil, resin, and camphor so as to have an economic impact on the local community [9].

2. Materials and methods

Research on the diversity of *Shorea* has done by a literature study. Data collection was obtained from several literatures as reference materials. It also take note of all existing *Shorea* collections in Herbarium Bogoriense and sorted according to their distribution on the major islands of Borneo, Sumatra, Java, Sulawesi, Moluccas, Nusa Tenggara and Papua. The data are also grouped into some habitats such as lowland dipterocarp forest, hill forest, coastal forest, peat swamp forest, heath forest, swamp forest, riparian forest and limestone forest. It also sorted for Shorea species that are endemic based on the island.

3. Results

Shorea was recorded ± 160 speciesin Malesia region and reported reaching ±125 species (78,1 % of Malesia region) in Indonesia, with uneven distribution in each island (figure 1). According to [3] the distribution of *Shorea* covering to the east of Indonesia is getting smaller. The distribution in Borneo reachs 102 species (81,6%), Sumatera 52 species (41,6%) whereas in some other islands, *Shorea* has insignificant existence even in Nusa Tenggara and Papua has not been found (figure 2). Taking considerations from the results of the data, collecting of specimens from the Hebarium Bogoriense which is that many species of *Shorea* still have not been identified yet, so it is a better way to complete the identified species. However, in the Java island is only found one species of *Shorea* namely *Shorea javanica*, and this species also found in Sumatra with a small population.

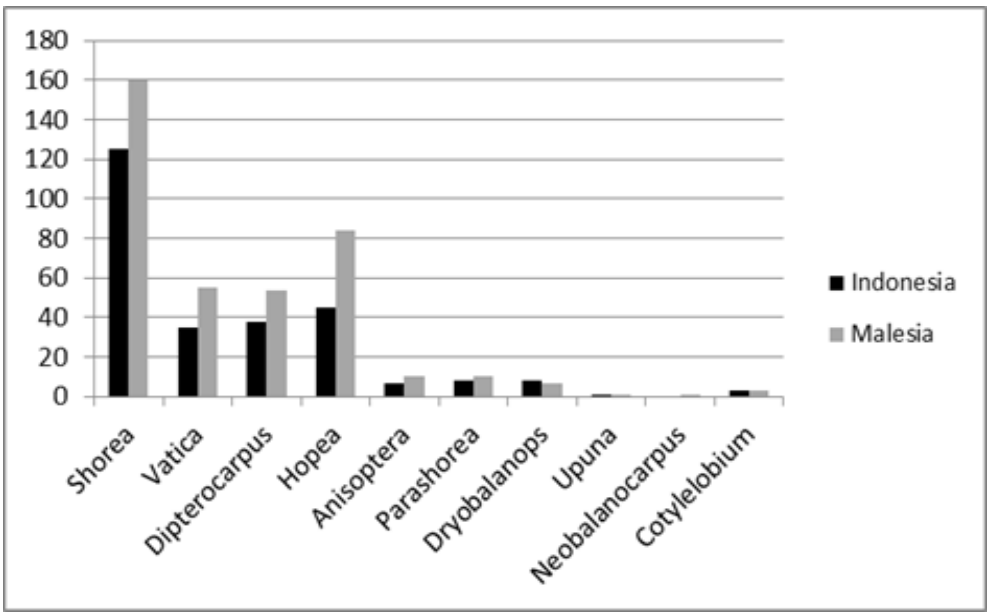

Figure 1. Distribution genera of Dipterocarpaceae in Indonesia

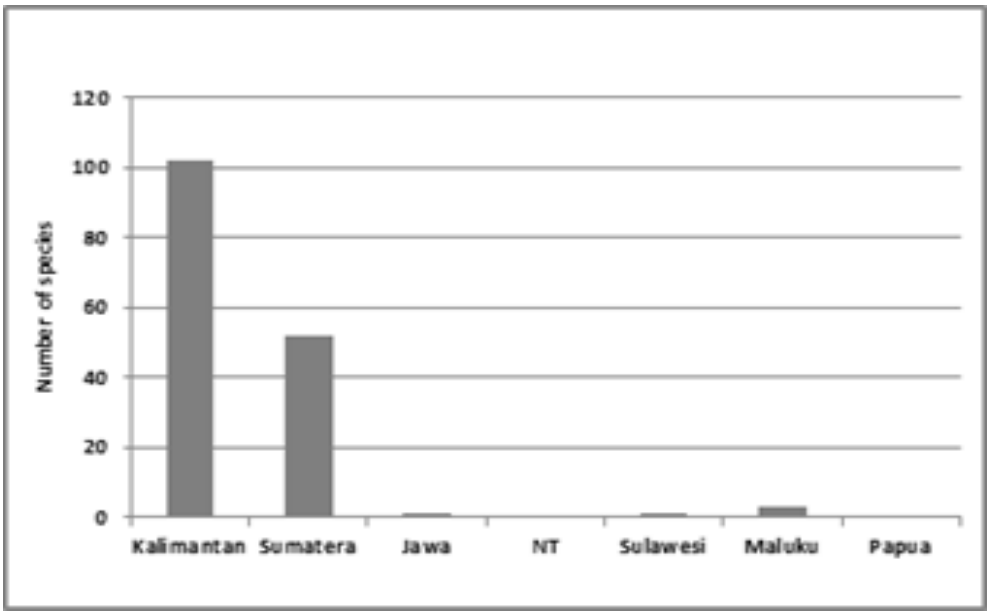

Figure 2. Distribution species of Shorea in Indonesia islands

Shorea population have been declined rapidly, especially in Java, Borneo and Sumatera islands. It was impacted by illegal logging and diversion of land. Currently, the existence of lowland forest in Java is hard to found. The remain forest only foundin the mountains with altitude above 1500 m above sea level(asl) and itis not viable habitat of *Shorea*. According to [10], Sulawesi has a composition of *Shorea assamica* Dyer ssp. Koordersii (Brandis) Sym and *Shorea montigena* Sloot. However, *S.montigena* was distributed in Sulawesi and Moluccas (table 2).

Shorea in Indonesia are found on several habitats such as lowland dipterocarp forests, hill forests, coastal forests, peat swamp forests, heath forests, swamp forests, riparian forests and limestone forests. However, the population of *Shorea* are dominant in lowland mixed dipterocarp forest (98 species) and hill forest (57 species) at an altitude of 500-800 m asl.It's not suitable to grow at the altitude of more than 1500 m asl. However, it grows in some extreme forests types such as peat swamp forests (11 species), heath forest (11 species), swamp forest (6), riparian forest (6 species) and limestone only 2 species which are adaptive of their extreme habitats (figure 3 and figure 4). Based on the distribution of species in the habitat on each island, it showed that in the lowland mixed dipterocarps forest is the most suitable habitat for *Shorea*. There are able to grow in the limestone and heath forests containing by quartz sandy soil type because the species having better adaptation in those habitats such as *S. scabrida, S. richetia, S. albida* (in health forests) and *S. guiso*, while *S. glauca* are able to grow in the limestone forest. In addition, only a few species of *Shorea* which are growing in peat swamp forest, including *S. balangeran, S. albida, S. teysmanniana and S. uliginosa.*

Based on the IUCN list, there are ± 54 species (global) of *Shorea* included as the critical criteria, endangered and vulnerable species. The list has determined much species of *Shorea* with the critical criteria (CR) 40 species, endanger (EN) 12 species and vulnerable (VU) 2 species. That included into these three categories are listed in the table 2 and table 3. The number of *Shorea* catagorised as the critical criteria by the time will certainly change and possibly increase to the higher level of extinct (EX). In addition, to categorise a level of scarcity for it determined by the limited distribution of the species and isolated in one location (endemic). *Shorea* are the highest number of endemic species compared to other Dipterocarpaceae genus such as *Dipterocarpus, Vatica, Hopea* and *Dryobalanops*.

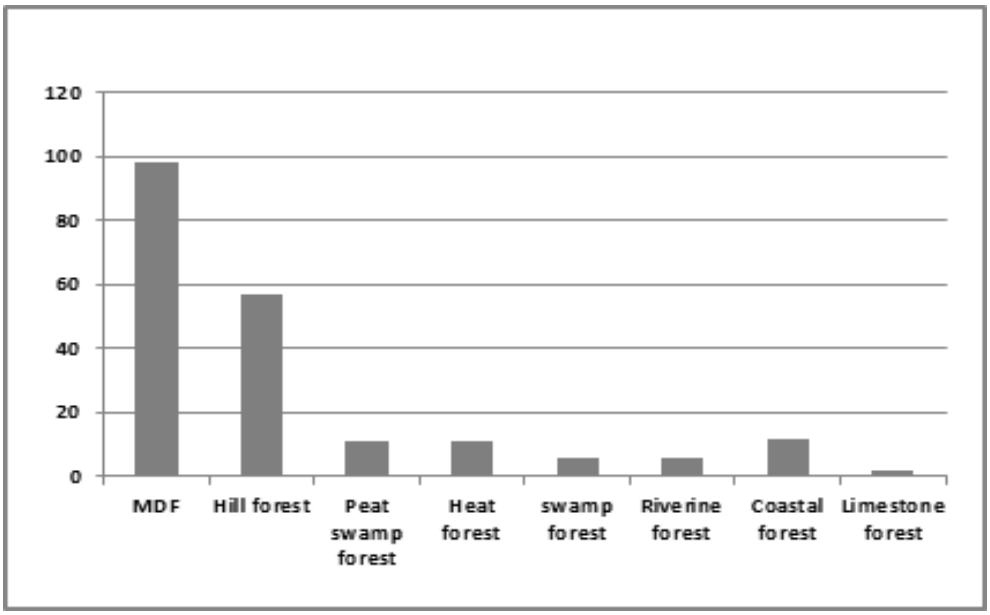

Figure 3. Distribution *Shorea* in some forest type

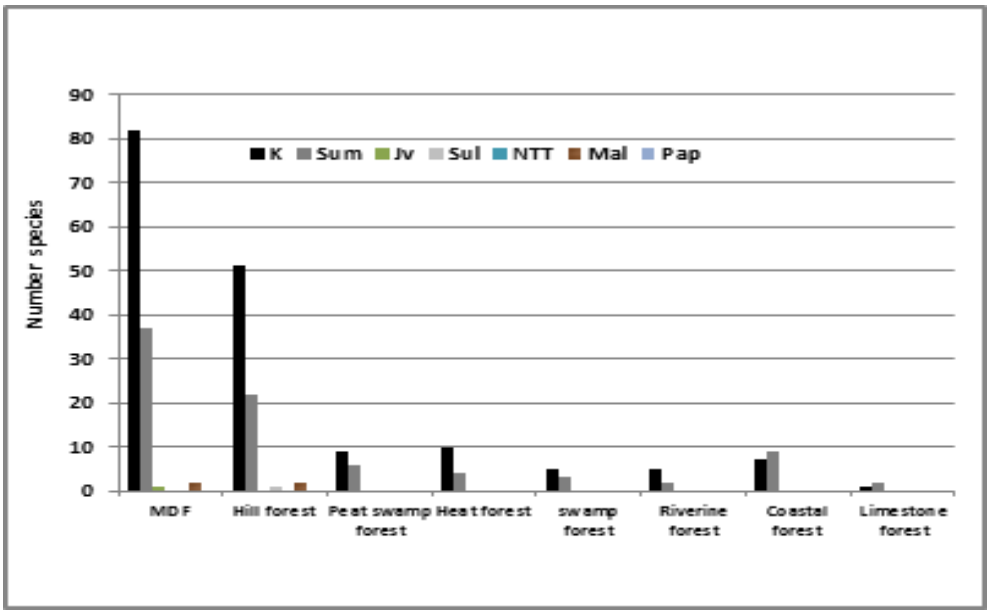

Figure 4. Number of *Shorea* species at some forest types in Indonesia islands

Table 1. Number of endemic *Shorea* spp. in the Indonesia islands.

Island	Number of endemic *Shorea*
Borneo	69
Sumatera	19
Java	0
Nusa Tenggara	0
Sulawesi	0
Moluccas	2
Papua	0

Table 2. List species of *Shorea* spp. in Borneo with the status of scarcity

	Borneo	SK[1]	Habitat
*	*Shorea acuminatissima* Sym.	CR[2]	MDF[6]
*	*Shorea agamii* Ashton ssp.*diminuta* Ashton	-	MDF,BKT[7]
*	*Shorea albida* Sym. (*ex* Thomas)	EN[3]	G[8],K[9]
*	*Shorea almon* Foxw.	CR	MDF
*	*Shorea amplexicaulis* Ashton	-	MDF, BKT
*	*Shorea andulensis* Ashton	EN	BKT
*	*Shorea angustifolia* Ashton	-	MDF
*	*Shorea argentifolia* Sym.	EN	MDF
*	*Shorea asahi* Ashton	-	MDF
	Shorea assamica Dyer *ssp.globifera* (*Ridl.*) Sym.	-	MDF
	Shorea atrinervosa Sym.	-	BKT
	Shorea balangeran (Korth.)Burck	CR	G
	Shorea balanocarpoides Sym.	EN	MDF
*	*Shorea beccariana* Burck	-	MDF, BKT
	Shorea bracteolata Dyer	EN	MDF, BKT, PT[10]
*	*Shorea brunnescens* Ashton	EN	MDF
*	*Shorea carapae* Ashton	CR	BKT
*	*Shorea collaris* Sloot.	-	MDF, DAS[11]
*	*Shorea confusa* Ashton	-	MDF
*	*Shorea cordata* Ashton	CR	MDF
*	*Shorea coriacea* Burck	-	K
*	*Shorea curtisii* Dyer *ex* King ssp.*grandis* Ashton		BKT
	Shorea dasyphylla Foxw.	EN	MDF
	Shorea dealbata Foxw.	CR	MDF, BKT, PT,RW
*	*Shorea domatiosa* Ashton	EN	MDF
*	*Shorea elliptica* Burck	CR	MDF
*	*Shorea exelliptica* Meijer	-	MDF
*	*Shorea faguetiana* Heim	EN	MDF
*	*Shorea faguetioides* Ashton	-	MDF
*	*Shorea falciferoides* Foxw.ssp.*glaucescens* (Meijer) Ashton	CR	MDF
*	*Shorea fallax* Meijer	-	MDF
*	*Shorea ferruginea* Dyer *ex* Brandis	-	MDF, PT
*	*Shorea foraminifera* Ashton	CR	G
	Shorea foxworthyi Sym.	CR	BKT
	Shorea gibbosa Brandis	CR	MDF
	Shorea gratissima (Wall *ex* Kurz) Dyer	EN	MDF
	Shorea guiso (Blco) Bl.	CR	MDF, L[12]
*	*Shorea havilandii* Brandis	-	G,K,RW[13]
*	*Shorea hemsleyana* (King) King *ex* Foxw.ssp.*grandiflora* (Brandis) Ashton	-	MDF
	Shorea hopeifolia (Heim) Sym.	CR	MDF
*	*Shorea hypoleuca* Meijer	CR	MDF
	Shorea inappendiculata Burck	CR	BKT, PT
*	*Shorea induplicata* Sloot.	CR	BKT,K
*	*Shorea isoptera* Ashton	CR	MDF
	Shorea johorensis Foxw.	CR	MDF, BKT

	Borneo	SK[1]	Habitat
	Shorea kunstleri King	CR	MDF, BKT
	Shorea laevis Ridl.		MDF, BKT
	Shorea leprosula Miq.	EN	MDF
*	*Shorea leptoderma* Meijer	CR	MDF
*	*Shorea longiflora* (Brandis)Sym.	CR	BKT,G
	Shorea longisperma Roxb.	CR	MDF
*	*Shorea macrobalanos* Ashton	CR	MDF, DAS
*	*Shorea macrophylla* (De Vriese)Ashton	VU[4]	DAS
*	*Shorea macroptera* Dyer ssp.*bailonii* (Heim) Ashton	-	MDF, BKT
*	*Shorea macroptera* Dyer ssp.*sandakanensis* (Sym.) Ashton	-	MDF, BKT
	Shorea maxwelliana King	EN	MDF, BKT
*	*Shorea mecistopteryx* Ridl.	-	MDF
*	*Shorea micans* Ashton	CR	MDF
*	*Shorea monticola* Ashton	-	BKT
	Shorea multiflora (Burck)Sym.		MDF,K
*	*Shorea myrionerva* Sym.e*x* Ashton	CR	DAS
*	*Shorea obovoidea* Sloot.	CR	MDF
*	*Shorea obscura* Meijer	EN	MDF, BKT
*	*Shorea ochracea* Sym.	-	MDF, BKT
	Shorea ovalis (Korth.) Bl.ssp.*ovalis*	-	MDF
	Shorea ovata Dyer *ex* Brandis	EN	MDF, BKT, PT
*	*Shorea pachyphylla* Ridl.	CR	G
	Shorea palembanica Miq.	CR	DAS, RW
	Shorea parvifolia Dyer ssp.*parvifolia*	-	MDF, BKT
*	*Shorea parvistipulata* Heim ssp.*albifolia* Ashton	-	PT
*	*Shorea parvistipulata* Heim ssp.*parvistipulata*	-	BKT, PT
*	*Shorea patoiensis* Ashton	-	MDF, BKT
	Shorea pauciflora King	EN	MDF, BKT
	Shorea peltata Sym.	CR	MDF
*	*Shorea pilosa* Ashton	-	MDF, BKT
*	*Shorea pinanga* Scheff.	-	MDF, BKT
	Shorea platycarpa Heim	CR	G
	Shorea platyclados Sloot. *Ex* (Endert) Foxw.	EN	BKT
*	*Shorea polyandra* Ashton	CR	MDF
*	*Shorea quadrinervis* Sloot.	EN	MDF, BKT
	Shorea resinosa Foxw.	CR	MDF
*	*Shorea retusa* Meijer	-	K
*	*Shorea revoluta* Ashton	CR	K
*	*Shorea richetia* Sym.	CR	MDF, K
*	*Shorea rubella* Ashton	CR	MDF,PT
*	*Shorea rubra* Ashton	-	MDF, BKT
*	*Shorea rugosa* Heim	CR	MDF
*	*Shorea sagittata* Ashton	CR	MDF, BKT
*	*Shorea scaberrima* Burck	-	MDF, BKT
	Shorea scabrida Sym.	-	K, RW
*	*Shorea scrobiculata* Burck	-	MDF, BKT
*	*Shorea seminis* (De Vriese) Sloot.	CR	DAS
*	*Shorea slootenii* Wood *ex* Ashton	CR	MDF, PT
*	*Shorea smithiana* Sym.	CR	MDF, BKT

	Borneo	SK[1]	Habitat
*	*Shorea splendida* (De Vriese)Ashton	EN	PT
*	*Shorea stenoptera* Burck	EN	MDF
*	*Shorea superba* Sym.	CR	MDF
*	*Shorea symingtonii* Wood	CR	MDF
	Shorea singkawang (Miq.) Miq.ssp.*singkawang*	CR	BKT
	Shorea teysmanniana Dyer *ex* Brandis	EN	G
	Shorea uliginosa Foxw.	VU	MDF, G
	Shorea virescens Parijs	-	MDF
*	*Shorea xanthophylla* Sym.	CR	MDF

Table 3. List species of *Shorea* spp. in Sumatra, Java, Sulawesi and Mollucas with the status of scarcity

	Sumatra	SK	Habitat
*	*Shorea acuminata* Dyer	CR	MDF,BKT
	Shorea agamii Ashton ssp.*diminuta* Ashton	-	MDF, BKT
	Shorea assamica Dyer ssp.*globifera* (Ridl.) Sym.	-	MDF
	Shorea atrinervosa Sym.	-	BKT
	Shorea balangeran (Korth.)Burck	CR	G
	Shorea balanocarpoides Sym.	EN	MDF, BKT
*	*Shorea blumutensis* Foxw.	CR	MDF
	Shorea bracteolata Dyer	EN	MDF, BKT,PT
*	*Shorea conica* Sloot.	CR	MDF,PT
*	*Shorea crassa* Ashton	-	BKT
*	*Shorea curtisii* Dyer *ex* King ssp.*curtisii*		BKT
	Shorea dasyphylla Foxw.	EN	MDF
*	*Shorea dealbata* Foxw.	CR	MDF,PT,RW
*	*Shorea falcifera* Dyer *ex* Brandis	EN	BKT,PT
	Shorea foxworthyi Sym.	CR	BKT
*	*Shorea furfuracea* Miq.	-	MDF
	Shorea gibbosa Brandis	CR	MDF
*	*Shorea glauca* King	EN	BKT,L
	Shorea gratissima (Wall *ex* Kurz) Dyer	EN	MDF,PT
	Shorea guiso (Blco) Bl.	CR	MDF,L
*	*Shorea hemsleyana* (King) King *ex* Foxw.ssp.hemsleyana	-	G
	Shorea hopeifolia (Heim) Sym.	CR	MDF, BKT
*	*Shorea hypochra* Hance	CR	MDF
	Shorea inappendiculata Burck	CR	BKT,PT
	Shorea javanica K & V.	-	MDF, BKT
	Shorea johorensis Foxw.	CR	MDF, BKT
	Shorea kunstleri King	CR	MDF, BKT
	Shorea laevis Ridl.		MDF, BKT
*	*Shorea lepidota* (Korth.) Bl.	CR	MDF
	Shorea leprosula Miq.	EN	MDF
	Shorea longisperma Roxb.	CR	MDF, BKT
*	*Shorea macrantha* Brandis	CR	G
*	*Shorea macroptera* Dyer ssp.*macroptera*	-	MDF
*	*Shorea materialis* Ridl.	CR	PT,K,DAS
	Shorea maxwelliana King	EN	MDF, BKT

	Sumatra	SK	Habitat
	Shorea multiflora (Burck)Sym.		MDF,K
*	*Shorea ochrophloia* (Sym.*apud* Desh) Strugnell	CR	MDF
	Shorea ovalis (Korth.) Bl.ssp.*ovalis*	-	MDF
	Shorea ovata Dyer *ex* Brandis	EN	MDF, BKT,PT
	Shorea palembanica Miq.	CR	DAS,RW
	Shorea parvifolia Dyer ssp.*parvifolia*	-	MDF
	Shorea pauciflora King	EN	MDF, BKT
	Shorea peltata Sym.	CR	MDF
	Shorea platycarpa Heim	CR	G
	Shorea platyclados Sloot. *ex* (Endert) Foxw.	EN	BKT
	Shorea resinosa Foxw.	CR	MDF
*	*Shorea retinodes* Sloot.	-	BKT,PT
	Shorea scabrida Sym.	-	K, RW
*	*Shorea singkawang* (Miq.) Miq.ssp.*singkawang*	CR	BKT
*	*Shorea sumatrana* (Sloot.*ex* Thorenaar)Sym.	CR	DAS
	Shorea teysmanniana Dyer *ex* Brandis	EN	G
	Shorea uliginosa Foxw.	VU	MDF,G
	Java	**SK**	**Habitat**
	Shorea javanica K & V.	-	BKT
	Sulawesi	**SK**	**Habitat**
	Shorea montigena Sloot.	CR	BKT
	Shorea assamica Dyer ssp. Koordersii (Brandis) Sym	-	MDF
	Moluccas	**SK**	**Habitat**
*	*Shorea assamica* Dyer ssp.*koordersii* (Ridl.) Sym.	-	BKT
*	*Shorea selanica* Bl.	CR	MDF
	Shorea montigena Sloot.	CR	BKT

[1]SK= Status of scarcity
[2]CR= Critical
[3]EN= Endanger
[4]VU= Vulnerable
[5]EX= Extinct
[6] MDF= Lowland Mix Dipterocarp Forest
[7] BKT= Hill Forest
[8] G= Peat Swamp Forest
[9] K= Heath Forest
[10] PT= Coastal Forest
[11] DAS= Riparian Forest
[12] L= Limestone Forest
[13] RW= Swamp Forest
*endemic species

Source:[3,11]

4. Discussion

Distribution of *Shorea* is triggered on natural factors that affects on its growth. There are several limiting factors identified such as habitat, climate and altitude. In general, *Shorea* grow in the areas of rainfall> 1000 mm / year, dry season less than 6 months and altitude <1500 m asl [12]. Climatic factors were illustrated by [13]. It comparing rainy and dry seasons. If Q values werelow, it mean that low rainfall <1000 mm as seen in East Nusa Tenggara. *Shorea*could not grow in this area, because the common soil type was red yellow podzolic.*Shorea* is not suitable to grow at the altitude more than 1500 m asl. In the higher altitude, it is just a small species of *Shorea* found. But, in the other country

for instance Brunei, *Shorea ovata, S. longisperma*, are able togrow at an altitude of 1750 m asl. Most of Dipterocarp species grow in the slopes and ridges, growing as emergent trees with a height of 50 m (strata A). The largest distribution of *Shorea* are in Borneo and Sumatera, because these islands are the two major islands as the distribution centers of the *Shorea* species, and both are the center of its population and number of species [1,2]. The wood of these species usually have a high commercial value [3].

Based on speciment collection of Herbarium Bogoriense, most of *Shorea* lives in the altitude of 0-500 m asl and 500-1000 m asl from Borneo and Sumatera. The herbarium data were grouped by habitat. It showed that most of *Shorea* are taken from lowland forests, hill forests, riparian forests, and coastal forests. On the other hand, only a few species of *Shorea* were recorded in heath forest, peat swamp forest and limestone forest. *Shorea* in those forest where the soil is less nutrient and bad drainage so less diverse. It is probably also because of a poor seed dispersal, the seeds are easily damaged and easily isolated naturally as in small rivers in the valleys and the rapid changes in soil factors [14].

The endemicity of *Shorea* are high, reaching 90 species (37.8% of 238) Dipterocarp species in Indonesia. Borneo has a high endemic species (69 species) [15]. It can indicated that seed dispersal correlated with the recalcitrant seed.Seed dispersion is conjunctioned with the flowering pattern and It is possible that desiccation rate may influence viability; for example, seeds dried quickly might give lower germination than seeds dried more slowly and gently to the same moisture content [16]. *Shorea*, the flowering pattern in the forest does not occur every year, but has irregular intervals of time with varying intensities, sometimes flowering is abundant [17,18]. According to [3], flowering on several species of *Shorea* is present every 2 or 5 years. Flowering of *Shorea* requires sufficient sunlight, it seen in the emergent trees, need much sunlight, so that the flowering season almost all the canopy has flowers. Whereas, the *Shorea* trees under the canopy, the flowering will occur sporadically, only on the branches that are directly sun exposed. Trees age to be able to flowering also varies, in the emergent trees can be many years to reach the age of flowering, depending on the environmental conditions of the forest. According to [19], the planted *Shorea* tree has a flowering age after 15-30 years.*Shorea* has various speed of growth, seedling is intolerant to light intensity and usually it grows under the shade for a little time untilsunlight make the growth faster. Adult age is reached after the age of about 60 years, and the life is expected to reach ± 250 years. While other species are tolerant to shade will have a slow growth rate, but the age can reach 1000 years [3]. The presence of forest disturbances such as large scale of illegal logging, forest fires, diversion of land can causes declining population of *Shorea* species in their habitats sharply, so it will increase the status of scarcity.

5. Conclusion

Borneo and Sumatera islands were highest distributed habitat of *Shorea* species and population. *Shorea* grows in some habitats such as lowland dipterocarp forest (98 species), hill forest (57 species), coastal forest (12 species), peat swamp forest (11 species), heath forest (11 species), swamp forest (6), riparian forest (6 species) and limestone forest (2 species). *Shorea* populations aredeclined sharplyin their habitats cause of forest disturbance.

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