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Comparison of Stumpage Value in Old and Young Recovered Primary Forest at FRIM Selangor Forest Park

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ABSTRACT

Forest Research Institute (FRI) was a former name of Forest Research Institute Malaysia (FRIM). It had begun restoration activities back in 1920s. Nowadays, it is a paid off with a FRIM being known as a nearly 100 years old artificial forest located in the heart of the city. To date, 92% of total forested area in FRIM consisted of 85% of planted forest and 7.4% of natural forest. In order to sustain the conservation effort, the institute was declared as National Heritage in 2012 and currently in the process of pursuing the title of UNESCO World Heritage Sites. For this conservation to be translated into monetary value that reflects the richness of its natural treasure, the estimation of the stumpage value of these old and young recovered was made to highlight the importance of reforestation in degraded areas. The economic valuation of timber resources was estimated with residual value technique for four Fields that represent both types of forest. An old recovered primary forest; which located in Field 11 and 20 and a young recovered primary forest; Field 52 and 53. The results showed significant difference of stumpage value in old and young recovered forest. While the estimated stumpage value of young recovered forest is much lower, the estimated stumpage value of old recovered primary forest that aged between 72 (Field 20) to 93 years old (Field 11) is higher than the value of other Malaysia forest reserves. The findings indicated the importance of forest reforestation and proved that FRIM has a universal value as a man-made forest.

Keywords: Man-made forest, old forest, young forest, stumpage valuation, ecosystem services

INTRODUCTION

Malaysian forest is classified as tropical rainforest, which are believed to be among the oldest and most complex ecosystems in the world. It can be specified into four categories; old primary forest, young primary forest, old recovered primary forest and young recovered primary forest (Esa P. & Markku S., 2002). Primary forest can be defined as forest with no or inconsequential human disturbance, while recovery forest defined as forest that have regained natural-like status after human disturbance.

Forest Research Institute Malaysia (FRIM) is one of the leading institutions in tropical forestry research in the world. The Institute sits on a 545-ha site adjacent to the Bukit Lagong Forest Reserve in the Kepong municipality, 16 km northwest of Kuala Lumpur (FRIM official website, 2020). FRIM is known to experienced deforestation and being turned into vegetable farming and mining Field in 1920s. The restoration efforts were initiated to restore this degraded landscape. Forest restoration is defined as efforts to assist recovery of damaged forest ecosystems to their initial conditions (Fawzi et. al, 2020) while reforestation means the artificial establishment of forest on lands which carried forest before (Jim & Peter, 2003).

FRIM's restoration and reforestation efforts made it renowned as a man-made forest that is previously vegetable farming and mining activities. Thus, from a condition with only pockets of remnant forests, FRIM has now turned into a lush forest that serves as the green lung of the Klang Valley where the capital of Malaysia, Kuala Lumpur, is located. In order to sustain the conservation effort, the institute was gazetted as a Natural Heritage Site on 10 February 2009 under the National Heritage Act 2005, and officially declared as a National Heritage in 2012. Through the 11th Malaysia Plan, FRIM seeks to gain the World Heritage Site's top recognition to ensure the conservation of FRIM as the world's first and oldest man-made tropical forest (Azreena et. al, 2018) and then FRIM was nominated and accepted under the name of FRIM Selangor Forest Park (FRIM SFP) to be included in the Tentative List of the UNESCO World Heritage Sites (UNESCO Website, 2020).

FRIM SFP is now becoming one of old forest plantations in Malaysia which considered as one of outstanding universal values in UNESCO ratings. The richness of this natural treasure in FRIM SFP is to be translated into the form of value to show the significance of it to be conserved. FRIM areas consist of 502.01 ha forested areas including natural forest; 40.13 ha and planted forest; 461.88 ha, whereas there are 42.76 ha of non forested area. All these areas were developed and been identified as Field area. Out of 55 identified Field area, 53 Fields are plantation area with the initial year tree planting was started as early as in the year 1927 (FRIM official website, 2020). The reforestation process continued to other Fields in FRIM and created old and young recovered primary forest.

Estimation of stumpage value is one of the methods to acknowledge the ecosystem services value of timber as one of the forest goods and services. This paper will highlight the composition of trees according to family, species, diameter and tree volume in both recovered primary forest. FRIM SFP has 55 identified Field area which 53 Fields are plantation area with the initial year tree planting was started as early as in the year 1927 (Forest Research Institute Malaysia, 2018). The economic valuation of timber resources will be estimated for four Fields that represent both old; Field 11 and 20 and young recovered primary forest; Field 52 and 53. This comparison study is made to justify the importance of reforestation of a degraded area.

Malaysia has one of the most complex tropical rainforest ecosystems in the world. The country as a whole has a tropical maritime climate. It is also a relatively small country, and with a land area of only about 33 million ha, is about the size of the British Isles. However, the combination of its warm equatorial climate and the variation of its geographical, edaphic and climatic features has endowed Malaysia with extremely rich plant and animal life forms. The country is still predominantly forested with about 59% of its land area under forest cover. This is in spite of the fact that, in recent years Malaysia has lost some of its forest to agricultural development and in unmanaged exploitation for timber.

The restoration efforts were initiated back in the 1920s to restore this degraded landscape in Kepong. The park occupies 544.3 hectares and 87% of this area is covered with planted forest heritage. A study on economic valuation of landscape trees in FRIM, found that there are a total of 126 trees had heights more than 25 m and 64 of trees had diameter breast height (DBH) more than 80 cm which are having average ages of 61–89 years old (Siti Aishah, 2018). This is proof to show that the trees are healthy to embellishing the area and increasing urban biodiversity, besides play a huge role in improving the air quality at FRIM SFP. Previous research stated a large trees are excellent filters for pollutants and also important in climate change mitigation. A mature tree is able to absorb up to 150 kg of carbon dioxide per year. These two classes had the highest tree value, RM31,691,213.65 and RM19,585,539.28 respectively.

Reforestation is approved by literatures to have a big impact on improving biodiversity and on carbon sequestration (Fawzi et al., 2019; Helms et al., 2018 and Locatelli et al., 2015). According to Helms et al. 2018, biomonitoring efforts in oldest reforestation site, documented the return of 70 native bird species, an approximately eightfold increase from a low of eight species when planting started while, the stumpage value appraisal is to estimate the value of the standing timber available for cutting at a particular time and on a particular area (Awang Noor et.al, 2007; Leushner, 1984; Davis and Johnson, 2000). Shifley et al., 1995 reported that a comparison between old and young forest were done to develop a better understanding of the measured characteristics and their value for the two types of forests. This work provides information about similarities between old and young forests and also identifies some characteristics that differ sufficiently from those two types of forests. The Young recovered forest in this study are aged between 11 to 23 years old. For this young recovered forest to be as rich as Field 11 and 20, the area have to be open for more plantation and increase the number of trees planted.

MATERIALS AND METHODS

Location of the study area

The study area consists of Field 11, 20, 52 and 53 in FRIM with the total area of 47.12 ha; 6.53 ha, 12.74 ha, 14.35ha and 13.5 ha respectively that located in FRIM, Kepong. Field 11 located in conservation zone, Field 20 located in the recreational and educational zone while Field 52 and 53 are located in the plantation zone in FRIM SFP (Fig. 1).

PETA FUNCTIONAL ZONES
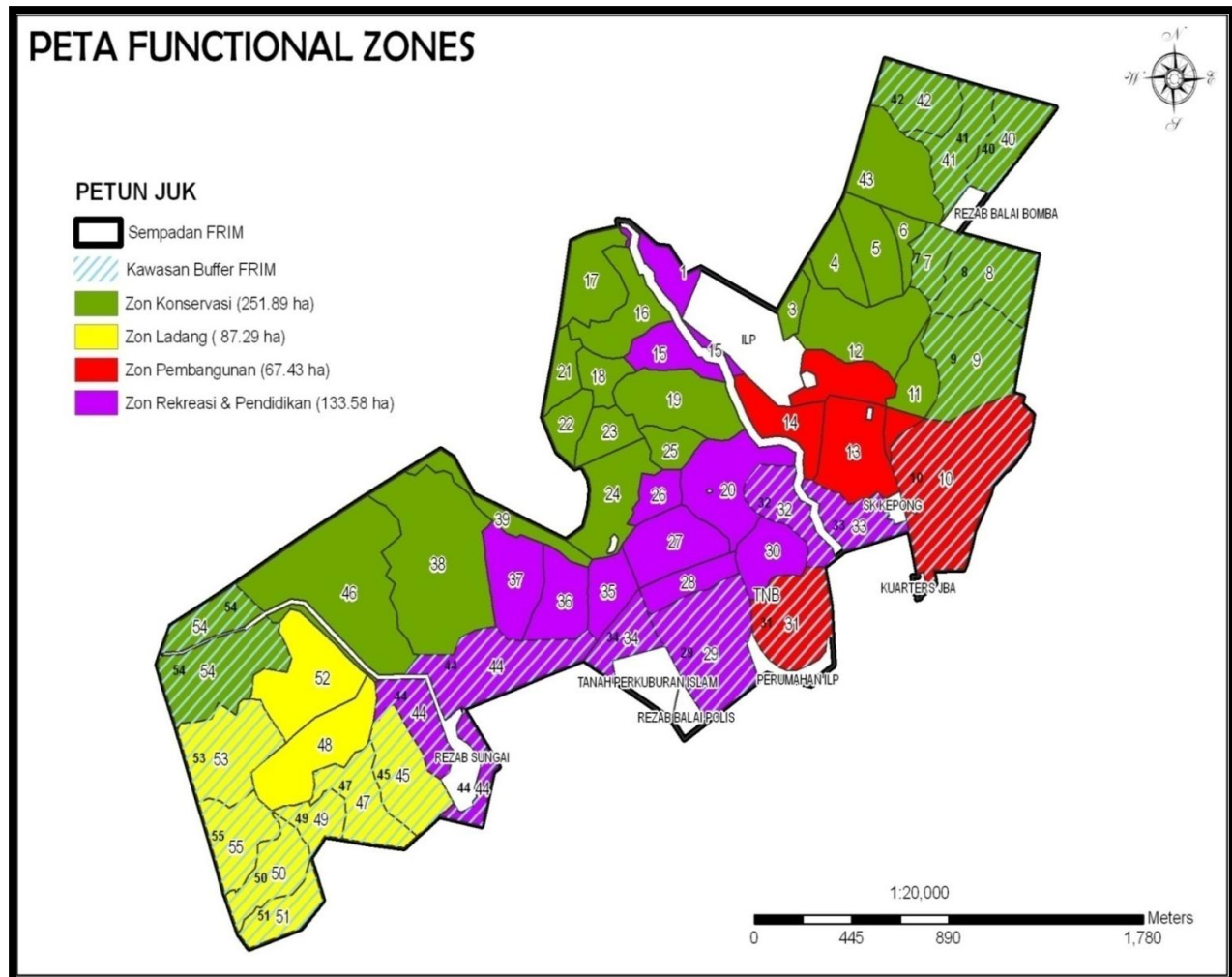
Adapted from Empowering research conservation of FRIM campus as a country and world heritage site study

Fig. 1. Functional zones in FRIM SFP

Data collection

Four Fields in FRIM are selected to be compared. Two Fields; Field 11 and Field 20 represent old growth forest while young growth forest represents by Field 52 and 53. The data collection for old forest (Field 11 and 20) were conducted in 2018 while the young forest (Field 52 and 53) were conducted in 2019. The collected data were number of standing trees, family name, species, DBH and tree volume. These data was taken from the Forestry and Environment Division and Forest Biotechnology Division, FRIM. Price of the logs were collected from MASKAYU, and logging cost is determined at RM 200/ m3 by Hafidz Abdullah et al., 2016 and Awang Noor et al., 2007 while profit ratio (PR): 30% or 0.3, is based at Awang Noor et al., 2007.

As for the species that have no market price in MASKAYU statistics, they are classified under the timber classes; heavy, medium and light base on bulletin of MASKAYU (Malaysian Timber Industry Board, n.d) and T. M. Wong (2002).

Data analysis

The compositional characteristics measurement of the four Fields including two old recovered primary forest; Field 11 and 20 and two young recovered primary forest; Field 52 and 53 are analyzed. The tree distribution

were classified according to family, genera, species, year of planting, DBH and tree volume and will be descriptively analyzed.

As for the stumpage valuation, the value will only be estimated for the timber with DBH of 15 cm and above.

The stumpage value will be estimated using residual value technique;

$$SV_{i,j} = (P_{i,j} - C - PM_{i,j}) * V_{i,j} \qquad \textbf{Eqn. 1}$$

SV   : Stumpage value (RM)
P   : Log price (RM/m³)
C   : Logging cost (RM/m³)
PM   : Profit margin (RM/m³)
V   : Volume (m³)
PR   : Profit ratio (%).

Profit margin (PM) was derived from the formula as below;

$$PM_{i,j} = \frac{(P_{i,j} * PR)}{(1 + PR)} \qquad \textbf{Eqn. 2}$$

PM   : Profit margin (RM/m³)
PR   : Profit ratio (%).

The estimated stumpage value will be compared in old and young recovered forest to assess the difference between both type of forest.

Statistical analysis

One-way ANOVA was conducted to study the significant difference of stumpage value between these two type of forest.

RESULTS AND DISCUSSION

Field establishment and tree composition according to family and species

A total of 6194 individual trees and the composition of trees have been identified according to its family, genera, species, diameter and tree volume. Table 1 shows that the total area of these four Fields is 47.12 ha with Field 52 as the largest Field (14.35 ha), followed by Field 53 (13.5 ha), Field 20 (12.74 ha) and the smallest is Field 11 (6.53 ha). Field 11 is the earliest planting Field with the duration of plantation ranged between 1927 to 1958. Plantation in Field 20 took place in 1948 to 1953 while Field 52 and 53 began reforestation activity at 1997 to 2008 and 2009 respectively (Forest Research Institute Malaysia, 2018).

All of four Fields were majority planted with non-dipterocarp family except for Field 52 which is planted with 498 (51%) trees from dipterocarp family. Field 11 has 1428 (87%) trees from non-dipterocarp family, Field 20, 1659 (63%) trees and Field 53, 308 (75%) trees. Total species planted in four Field are 372 species with more species are planted in Field 11 and 20 compared to Field 52 and Field 53. Total volume for all four species apparently different with Field 20 has the most tree volume (1792 m3), followed by Field 11 (1280 m3), Field 52 (48 m3) and Field 53 (14 m3). The summary of trees inventory in both Fields are as in Table 1.

Table 1. Summary of trees inventory in Field 11, 20, 52 and 53

| Item	Field 11	Field 20	Field 52	Field 53	Total
Area	6.53	12.74	14.35	13.5	47.12
Year planting started[1]	1927 -1958	1948 – 1953	1997 -2008	1997 – 2009	
Total standing trees	2,167	2,650	969	408	6,194
Trees with DBH > 15cm	1,601	1,745	335	87	3,768
Trees with DBH < 15cm	560	905	634	321	2,420
NA	6	-	-	-	6
Total family	49	51	4	5	109
Dipterocarp	739	650	498	100	1,987
Non-dipterocarp	1,428	1,659	471	308	3,866
NA	-	341	-	-	341
Total genera	110	123	6	5	244
Total species	127	233	7	5	372
Total volume (m³)	1,280	1,792	48	14	3,134

1 Forest Research Institute Malaysia (2018).

The different pattern in number of trees with DBH above 15 cm can be obviously seen in these both type of forest. Trees with DBH at 15cm and above represents the most standing trees in both Fields in old recovered forest at 74% (1601) for Field 11 and 66% (1745) for Field 20 while in young recovered forest, trees with DBH less than 15cm represents the majority of the Field; 65% (634) of Field 52 and 79% (321) of Field 53. (Fig. 2).
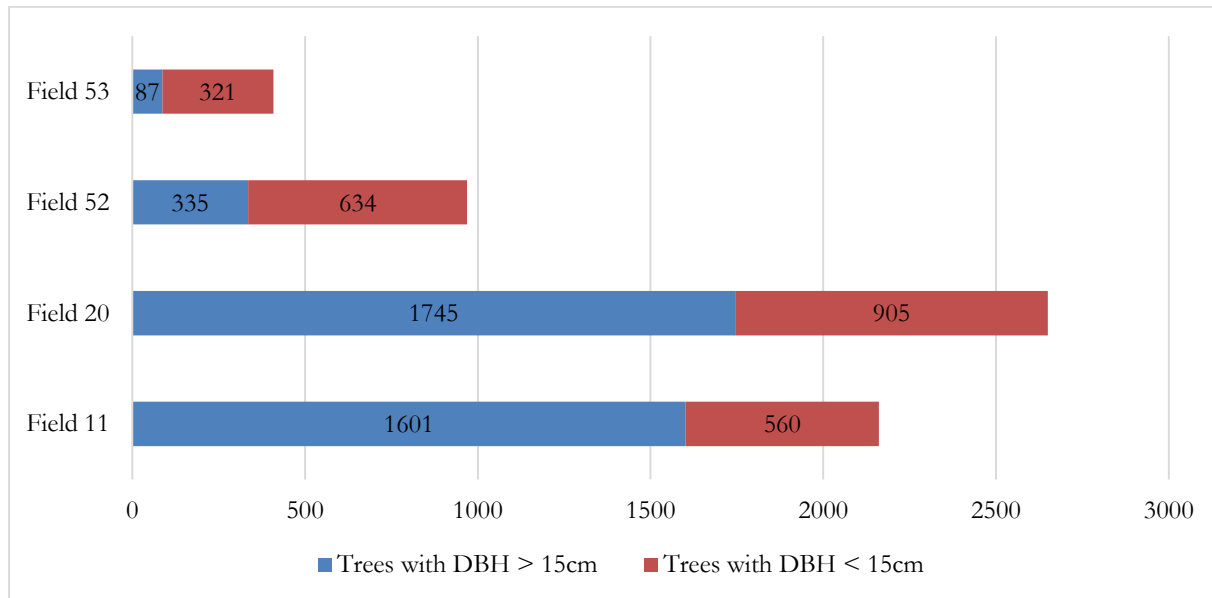
Fig. 2. Tree distribution by DBH

Height and DBH distribution

The graph showed tree distribution in all Fields show a positive association between DBH and height. The different pattern of trees distribution in old recovered forest and young recovered forest clearly portrayed the range of standing trees. The highest tree in old recovered forest is 57.9 meter in Field 11 with DBH at 44 cm while the biggest DBH in old recovered forest is 164.2 cm in Field 20 with height at 26.3 m. On the other hand, the highest and the biggest tree in young recovered forest is located at Field 52 with 22.9 meter of height and DBH at 29.8 cm (Fig. 3).
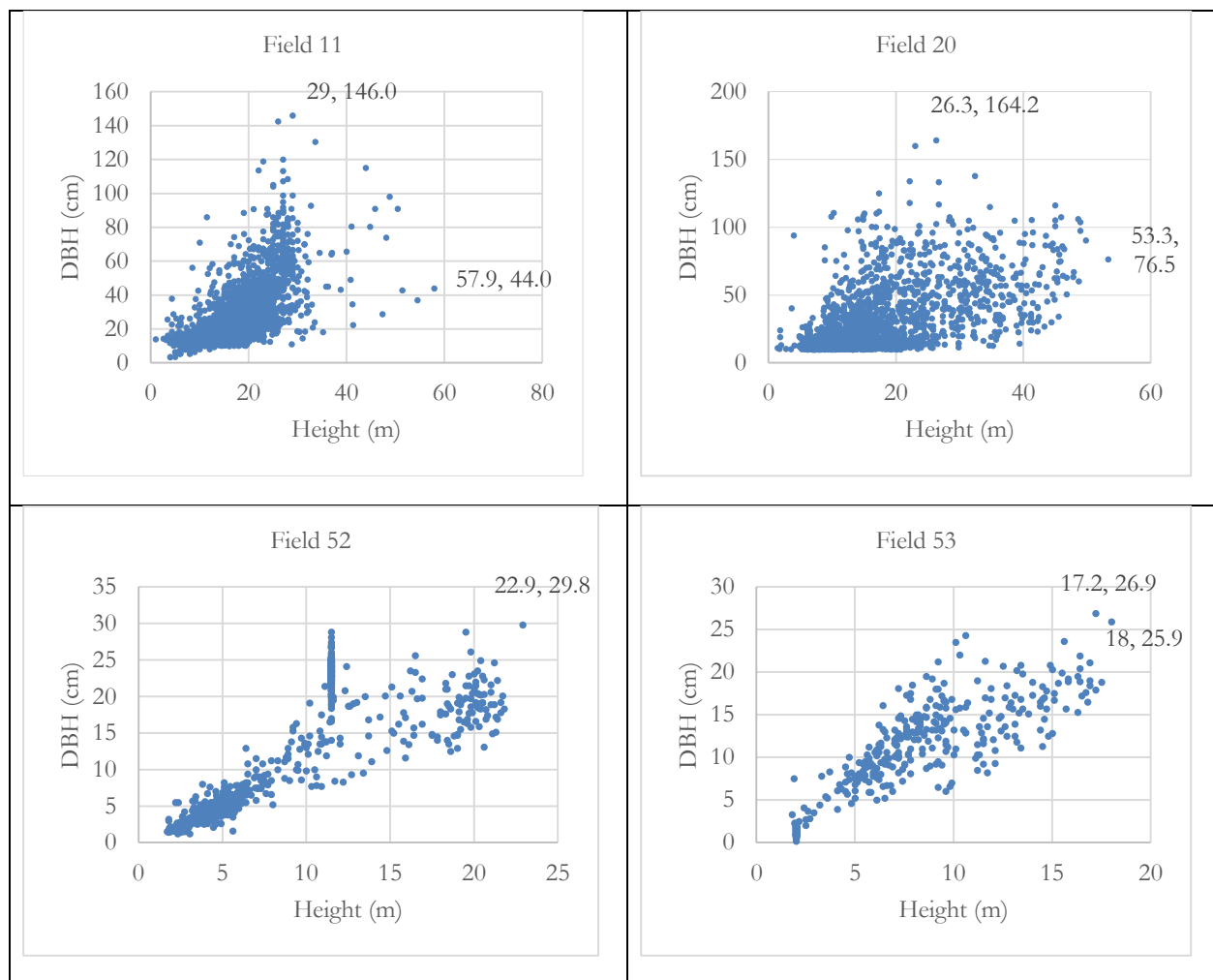
Fig. 3. scatter plot of tree height against DBH

The largest family planted in four Fields are Dipterocarpaceae (1985) followed by family Olacaceae (726), Euphorbiaceae (581) and Thymelaeaceae with 269 trees. Other trees planted are from Family Sapotaceae (182), Leguminosae (169), Moraceae (160), Myrtaceae (158), Meliaceae (106) and Araliaceae (102) (Table 2).

Table 2. Ten largest family planted in old and young recovered forest

No.	Family	Field 11	Field 20	Field 52	Field 53	Total
1	Dipterocarpaceae	737	650	498	100	1,985
2	Olacaceae	508	218	-	-	726
3	Euphorbiaceae	104	156	221	100	581
4	Thymelaeaceae	17	2	150	100	269
5	Sapotaceae	148	34	-	-	182
6	Leguminosae	70	99	-	-	169
7	Moraceae	56	104	-	-	160
8	Myrtaceae	59	99	-	-	158
9	Meliaceae	14	92	-	-	106
10	Araliaceae	25	77	-	-	102

Stumpage estimation value

The stumpage value are estimated for all four Fields included the trees with DBH at 15cm and above. Total old and young recovered forest show substantial different estimated stumpage value due to different forest aged-classes. For Field 11, the total estimated stumpage value is RM 682,130 and the value per hectarage (ha) is RM 107,857. Field 20 stumpage value was estimated at RM 825,279 with value of RM 88, 184 per ha. Field 52 stumpage value was RM 4,073 with the estimated value of RM 2,602 per ha. Field 53 shows the smallest estimated stumpage value at RM 351 with the value of RM 239 per ha (Table 3).

Table 3. Estimated stumpage value of old and young recovered forest

Item	Field 11	Field 20	Total old recovered forest	Field 52	Field 53	Total young recovered forest
Total estimated stumpage value (RM)	682,130	825,279	1,507,409	4,073	351	4,424
Total area (ha)	6.52	12.82	19.34	14.23	13.38	27.61
Total planted area (ha)	6.32	9.36	15.68	1.57	1.47	3.04
Average estimated stumpage value per ha (RM)	107,857	88,184	96,117	2,602	239	1,457

The estimated stumpage value of old recovered forest; Field 11 and Field 20 equal to RM 107,857 per ha and RM 88,184 per ha are higher than other forest reserves; Pasir Tengkorak Forest Reserve, Langkawi, Kedah that valued at RM51,423 (Hafidz Abdullah, et. al., 2016) and Pasoh Forest Reserve, Negeri Sembilan which valued at RM 4,200 per ha (Malaysia Report on Data and Information of the Value of Coastal Habitats, 2006). The results indicated that the value of FRIM SFP old recovered forest that aged between 72 (Field 20) to 93 years old (Field 11) is equivalent to the value of other Malaysia forest reserves even though they are recovered forest (Noor Hazmira et. al, 2018).

Comparison of stumpage value in old and young recovered forest

The ANOVA analysis results show that forest ($F_{(3,3455)}$) = 25.244, p-value<0.05) which means stumpage value in all four Fields differ significantly. Duncan pairwise comparison supported that stumpage value differ significantly between old and young recovered forest which the mean stumpage value for both type of forest fall in two different columns (Table 4). Field 53 and 54 represents young recovered forest while Field 11 & 20 represents old recovered forest.

Table 4. Duncan pairwise comparison results

Fields	Subset for alpha = 0.05	
	1	2
Field 53	4.0398	
Field 52	12.1578	
Field 11		426.0650
Field 20		574.7071

CONCLUSION

The estimation of stumpage value in old and young recovered primary forest in this study are predicted to be different with a big gap due to aged-classes. Young recovered forest have a low volume of trees and smaller diameter at breast height (DBH) compared to old forest. On top of that, there is huge difference in the numbers of planted trees and type of species planted in both area. Age class, volume and numbers of planted trees and type of trees planted were the identified factors in the calculation of stumpage value. The results show significant difference of stumpage value in old and young recovered forest. The value obtained from the old recovered forest in FRIM is comparable and even exceeds the value of other forest reserves like Pasir Tengkorak Forest Reserve, Langkawi, Kedah and Pasoh Forest Reserve, Negeri Sembilan. This indicates that reforestation is important and even a degraded forest area is able to be restored. This study proves that although FRIM is a man-made forest, it has a universal values and has to be acknowledged. This study is hoped to reinforce the selection of FRIM as one of the UNESCO world heritage site as it had justify itself as a rich tropical man-made forest through the reforestation.

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