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Tree standing dynamics after 30 years in a secondary forest of Bali, Indonesia

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Abstract. *Siregar M, Undaharta NKE. 2018. Tree standing dynamics after 30 years in a secondary forest of Bali, Indonesia. Biodiversitas 19: 22-30.* Tree standing dynamics in 0.5 ha plot after 30 years in Bukit Tapak secondary forests, Batukahu Nature Reserve, Province 0f Bali was studied by using plot method. The results showed that the tree species richness is same, 33 species, but there are six species disappear and be replaced by another species as a newcomer. Eight species persist as major species based on the importance value, namely: *Homalanthus giganteus, Vernonia arborea, Dendrocnide stimulans, Meliosma angustifolia, Saurauia reinwardtiana, Trema orientalis, Macaranga triloba* and *Polyosma integrifolia*. Tree density decreased 19.7%, but the total basal area increased 12.2% with an average basal area per tree were also increased by 39.7%. Shannon diversity index (H`) and Equitability index (E) was increased in 2016. Forests in the plot categorized as old secondary forest are still in the process of maturation toward the primary forest. Species predicted would disappear with a succession of increasingly advanced process is *Trema orientalis*, while the predicted to survive for much longer are *Homalanthus giganteus, Acronichia trifoliolata, Meliosma angustifolia, Polyosma integrifolia, Saurauia reinwardtiana* and *Dendrocnide stimulans*.

Keywords: Bali, Batukahu Nature Reserve, Bukit Tapak, forest dynamic, tree

INTRODUCTION

Bukit Tapak mountain forest has an area of 810.40 ha with a peak height of 1,807 m asl. is part of Batukahu Nature Reserve in Tabanan District, Bali Province, Indonesia (BKSDA Bali 2017). People often enter this forest area from the eastern side to pick up firewood from dried branches and herbs for livestock feed (Nugroho et al. 2008) or pass to sacred places at the top of Bukit Tapak. However, the condition of the forest is relatively protected from damage. The stump of logged-over trees is rarely found except due to weather or age. Local wisdom of Balinese people as reflected in the ceremony Tumpek Pengatag or Tumpek Wariga participate in preserving the forest, especially the plants. In addition, this forest in the east is bordered by *Altingia excelsa* plantation forest, *Manglietia glauca* and Bali Botanical Garden which serves as a buffer zone of encroachment.

In 1986, a permanent plot of 0.5 ha was created at the lower part of Mount Tapak to the east at an altitude of 1250 m above sea level. This forest is dominated by secondary species such as *Trema orientalis* (L.) Blume, *Vernonia arborea* Buc-Ham and *Homalanthus giganteus* Zoll. & Moritzi (Siregar 1990). Judging from the dominance of the types of stands shows that the vegetation is still classified as secondary forest that is still in the process of succession to the climax.

In another study in the southeastern part of Bukit Tapak mentioned forest vegetation at an altitude of 1200-1400 m asl. also dominated by secondary species especially *T. orientalis* (LIPI 1992). Unlike forests at altitudes above 1400 m asl. dominated by primary species such as *Dacrycarpus imbricatus*, *Astronia spectabilis*, *Acronychia trifolioata* and *Casuarina junghuhniana*. Even at an altitude of 1500-1600 m asl. found dominance of *D. imbricatus* which almost form a pure stand (LIPI 1992). Secondary species are rarely found indicating forest above altitude of 1400 m asl. has reached maturity in the process of success.

After 30 years, the secondary forest plot at the 1250 m asl. was made Siregar (1990) re-examined to see the dynamics of tree stands. During this time period, forest condition is relatively safe from disturbance, so it becomes interesting to know the change of species composition, standing structure and regeneration of main species in condition without severe disturbance.

MATERIALS AND METHODS

Study site

The study was conducted in the Bukit Tapak forest of Batukahu Nature Reserve (8^0 16` 43.22`` S and $115^0$ 08` 57.78`` E) at an altitude of 1250-1275 m asl. within the Baturiti sub-district, Tabanan District, Province of Bali, Indonesia (Figure 1). Located about ± 55 km north of Denpasar, the capital city of Bali Province. The altitude difference between the lowest and highest point in the plot is + 25m and steeper towards the top of the hill.

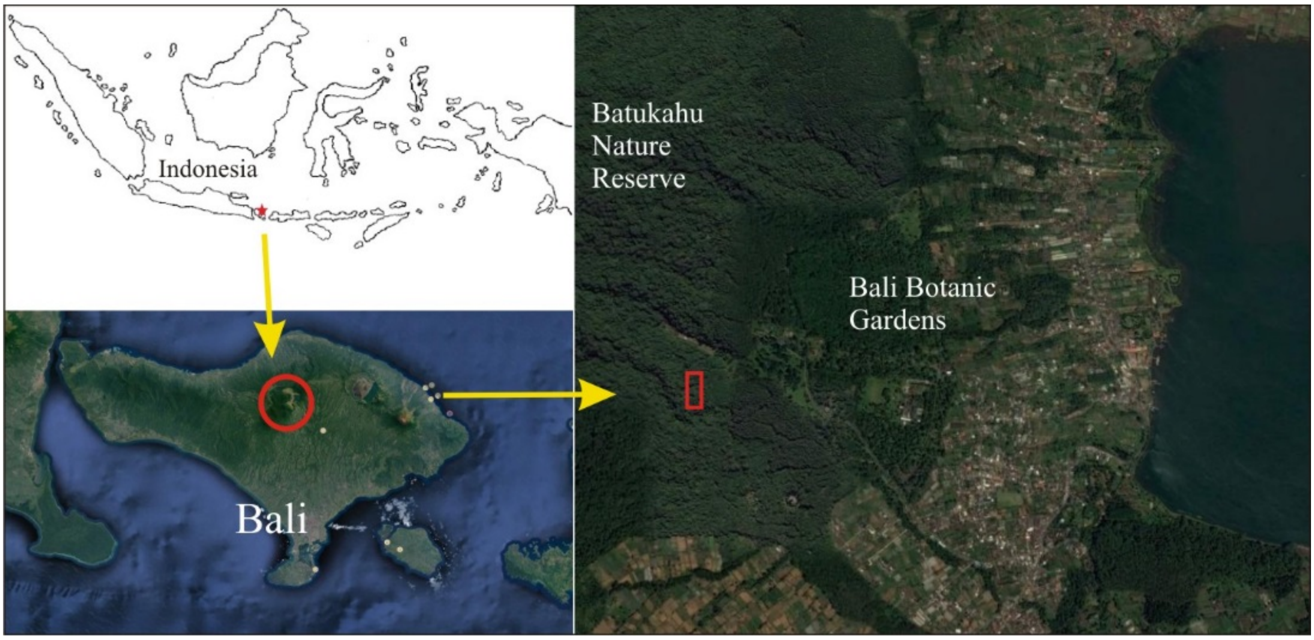

Figure 1. Plot site in the Bukit Tapak forest of Batukahu Nature Reserve, Province of Bali, Indonesia

Average annual rainfall of 236.7 mm with wet months occurs in January, February, April, and December, while dry months are in August and September. The air temperature ranges from 11.5-20.0 ^{0}C, the lowest in July-September and the highest in May, November, and December. Air humidity ranges from 81.6 to 97.6%, the lowest in October and the highest in February (BKSDA Bali 2017).

Methods

The data sampling used a plot method of 0.5 ha in the same location as Siregar (1990) in 1986. The plot position may not be exactly the same as 1986 considering the 30-year period. The boundaries of the plots and tree numbers could no longer be traced given the absence of coordinate points in the 1986 research. The 1986 tree position map did not help much as the size and population of trees (dead/new individuals) changed, so placement of plots could only be done by guessing.

The 0.5 ha main plot is divided into 50 of 10m x 10m (0.01 ha) plots for individual tree sampling with stem diameter at breast height-dbh (± 130 cm from ground level) > 10 cm. Subsequently, a subplot of 5 m x 5 m plot was made in each 0.01 ha plot for the saplings (height > 1.5 m; dbh <10 cm). The data collected includes the species, dbh and total height. Especially for saplings, the diameter of the stem is measured at a height of 50 cm from the ground level. Voucher specimens (if any flowers and fruits) are taken for identification purposes.

Data analysis

The result data is tabulated into an excel spreadsheet format. The ecological status of each tree species is calculated based on relative Importance Value (RIV) obtained from the sum of the relative percentage values of frequency, density and dominance (Mueller-Dombois and Ellenberg 1974; Oyun et al. 2009; Oladoye et al. 2014). To know the level of species diversity is calculated based on the Shannon diversity index (H'), as follows (Ludwig and Reynold 1988; Magurran 1988):

$$H` = -\sum \rho_i \ln \rho_i$$

ρ_i = the proportion of abundance of a species i to the abundance of all species (n_i/N). Further calculated the level of *Equitability index-E*) use the following formula (Magurran 1988):

$$E = H`/\ln S$$

S=the total number of species found.

The Important Value of the Family (IVF) was calculated by the sum of the relative number of species in a family (RS), the relative basal area of a family (RD) and the relative number of individuals of a family (RA).

Species similarity of the two plot is calculated using two different formulas, using the index of Jaccard similarity based on the presence of the species, and the Sorensen similarity index based on the species abundance data. Index of Jaccard Similarity (IS_J) is:

$$IS_j = [c/(a+b+c)] \times 100$$

a = number of species that exist only in plot A, b = number of species that exist only in plot B and c = the number of species that are equally contained in plots A and B.

Index of Sorensen similarity (IS_{so}) is:

$IS_{so} = [2\sum Mw/(MA + MB)] \times 100$

MA = the number of individuals of all species in the plot A, *MB* = the number of individuals of all species in the plot B and *Mw* = the lowest abundance value of the same species found in plots A and B.

The tree stand structure was study based on the distribution of stem diameter (dbh) and tree height (Mueller-Dombois and Ellenberg 1974; Ige et al. 2013). The regeneration of the main tree species was study based on the distribution of diameter (dbh> 10 cm) and the population of saplings (height> 1.5m; dbh <10cm).

RESULTS AND DISCUSSION

Species composition

Number of tree species (dbh > 10 cm) recorded as 33 species, the same as recorded in 1986. Species-area curve shows a gradually increasing graph in the addition of quadratic plot (0.1 ha) after 45 units, which indicates the addition quadratic plots have little effect on the cumulative addition of species (Mueller-Dombois and Ellenberg, 1974). In contrast to some research results in lowland tropical forests that even one-hectare plot is not adequately representative of the minimum area of the forest (Kartawinata et al. 1981, 2004). In this study, at the altitude of 1250-1275 m above sea level, a sample plot of 0.5 ha may be considered adequate (Figure 2). Referring to research results, elsewhere, it is possible that the cumulative number of species will increase sharply when the range altitude is widened (Aiba and Kitayama 1999; Grell et al. 2005; Devlal and Sharma 2008; Baniya et al. 2012; Saha et al. 2016).

Based on the Shannon diversity index (H`), species diversity increased by 3.8 % (H` = 2.8648 in 1986 and H` = 2,9742 in 2016). Equitability index (E) increased by 3.8 % (E = 0.8193 in 1986 and E = 0.8506 in 2016). Comparison of frequency (Fr), basal area (BA), tree density (D) and species importance value (SIV) of each species in 1986 and 2016 are presented in Table 1.

Cyathea contaminans (Hook.) Copel. and *Acronychia trifoliolata* Zoll. & Moritzi is a new list of 10 main species based on the SIV in 2016. Both species were previously also found in 1986 but not including 10 main species. The population of *C. contaminans* increased 12-fold from 4 trees/ha in 1986 to 48 trees/ha in 2016, followed by an increase in total LBD from 0.16 m^2/ha in 1986 to 1.43 m^2/ha in 2016. The population of *A. trifoliolata* increased from 14 trees/ha in 1986 to 22 trees/ha in 2016, as well as its frequency (Fr) increased from 12.0% in 1986 to 20% in 2016. But the total BA decreased from 0.90 m^2/ha in 1986 to 0.81 m^2/ha in 2016. *Syzygium acuminatissimum* (Blume) DC. and *Ficus septica* Burm.f., which entered 10 main species in the 1986 plot, is no longer listed as the 10 main species in 2016 but is still found respectively occupying positions 12 and 19 based on the SIV in 2016.

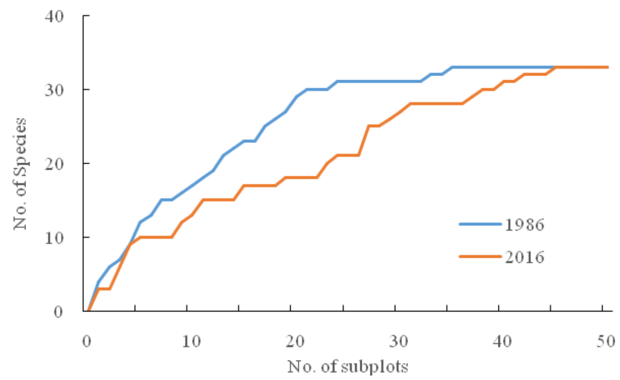

Figure 2. Species-area curve in the plots of 1986 and 2016. Each plot has an area of 0,01 ha

The species that still occupy the position of 10 main species based on the SIV are *Homalanthus giganteus* Zoll. & Moritzi, *Vernonia arborea* Buc-Ham, *Dendrocnide stimulans* (L.f.) Chew, *Meliosma angustifolia* Merr,. *Saurauia reinwardtiana* Blume, *Trema orientalis* (L.) Blume, *Macaranga triloba* (Reinw.ex Bl.) M.A. and *Polyosma integrifolia* Blume.

There are 6 species found in 1986 but disappeared in 2016, namely: *Acalypha caturus* Bl., *Dysoxylum excelsum* Bl., *Engelhardtia spicata* Lech.ex Bl., *Guazuma ulmifolia* var. *tomentosa* K. Schum, *Litsea velutina* (Bl.) Boerl., and *Melastoma affine* D. Don. In contrast, there are 6 new species in 2016 that were not previously found in 1986: *Elaeocarpus* sp., *Euodia* sp., *Ilex odorata* Buch D Ham, *Lophopetalum javanum* Turcz., *Mauotia* sp., and *Phyllanthus* sp.

Based on Sorensen similarity index in 1986 and 2016 is 65%, while based on the Jaccard similarity Index of 53.5%. Mueller-Dombois and Ellenberg (1974) stated that the Jaccard similarity Index above 50% indicates a similarity of species is very large.

The eight family of the 10 main families in 1986 still appear as the main family in 2016, namely: Euphorbiaceae, Urticaceae, Cannabaceae, Asteraceae, Myrtaceae, Primulaceae, Actinidiaceae and Escalloniaceae (Table 2). Moraceae and Lauraceae who were previously in 1986 recorded as the top 10 main families, in 2016 were frozen although still encountered. In contrast, Cyatheaceae and Rutaceae which in 1986 were not the main family, in 2016 emerged as the top 10 main families. Undiscovered tree family is Juglandaceae, Malvaceae, and Meliaceae, where there is three new families, i.e., Celastraceae, Elaeocarpaceae, and Aquifoliaceae.

Forest structure

Density of trees decreased by 19.7% (640 trees per ha in 1986 and 514 trees per ha in 2016). In contrast, the total basal area (BA) increased by 12.2% (34.16 m^2/ha in 1986 and 38.33 m^2/ha in 2016). Based on the average BA per tree then the increase reached 39.7% (0.053 m^2/ha in 1986 and 0.075 m^2/ha in 2016).

Table 1. Frequency (Fr), Basal area (BA), Density (D) and Species importance value (SIV) of each tree species (dbh > 10 cm) in 1986 and 2016 plots. The sort order is based on the SIV in the 2016 plot

Species	FR (%)		BA (M^2/HA)		D (Trees/ha)		SIV	
	1986	2016	1986	2016	1986	2016	1986	2016
Homalanthus giganteus Zoll. & Moritzi	40	56	4.22	3.13	78	82	33.8	39.7
Vernonia arborea Buc-Ham	28	26	4.26	6.08	34	36	24.3	30.1
Cyathea contaminans (Hook.) Copel.	4	34	0.16	1.43	4	48	2.0	22.5
Dendrocnide stimulans (L.f.) Chew	50	32	6.12	1.43	116	46	47.6	21.6
Meliosma angustifolia Merr.	40	24	1.74	2.34	62	28	24.0	18.2
Saurauia reinwardtiana Blume	26	14	1.28	2.49	58	38	18.8	17.8
Trema orientalis (L.) Blume	20	6	6.10	5.36	28	6	26.9	16.8
Macaranga triloba (Reinw.ex Bl.) M.A.	18	22	0.86	1.54	20	28	9.8	15.6
Polyosma integrifolia Blume	28	16	2.08	1.25	34	28	17.9	13.2
Acronychia trifoliolata Zoll. & Moritzi	12	20	0.90	0.81	14	22	7.6	12.0
Erythrina subumbrans (Hassk.) Merr.	2	10	0.02	1.38	2	24	0.8	11.0
Syzygium acuminatissimum (Blume) DC.	28	16	1.60	0.40	40	18	17.4	9.0
Lindera polyantha (Bl.) Boerl.	10	2	0.42	2.73	8	2	4.8	8.1
Lophopetalum javanum Turcz.	-	10	-	0.74	-	16	-	7.8
Gordonia amboinensis Miq.	6	6	0.22	1.04	6	6	3.0	5.5
Claoxylon indicum (Reinw. ex Blume) Hassk.	8	6	0.26	0.20	8	14	3.9	4.9
Elaeocarpus sp.	-	4	-	1.09	-	4	-	4.7
Astronia ferruginea Elmer	2	6	0.02	0.51	2	6	0.8	4.2
Ficus septica Burm.f.	16	6	0.76	0.40	24	6	9.7	3.9
Celtis tetranda Roxb.	4	2	0.08	1.08	4	2	1.8	3.8
Ehretia javanica Blume	4	2	0.04	0.97	4	2	1.7	3.5
Ficus fistulosa Reinw. ex Bl.	2	2	0.04	0.53	2	6	0.9	3.1
Syzygium zollingerianum (Miq.) Amshoff	4	6	0.08	0.09	4	6	1.8	3.1
Platea latifolia Blume	2	4	0.34	0.44	2	4	1.8	3.0
Cryptomeria japonica (Thunb.ex L.f.) D. Don	8	4	0.24	0.14	8	6	3.8	2.7
Mouretia sp.	-	4	-	0.05	-	6	-	2.4
Euodia sp.	-	4	-	0.14	-	4	-	2.2
Hypobathrum frutescens Blume	20	4	0.30	0.13	20	4	8.6	2.2
Phyllanthus sp.	-	4	-	0.02	-	4	-	1.9
Palaquium sp.	8	2	0.50	0.20	6	4	4.3	1.8
Glochidion rubrum Blume	10	2	0.18	0.06	10	4	4.4	1.5
Ilex odorata Buch.-Ham. ex D.Don	-	2	-	0.09	-	2	-	1.2
Ardisia javanica A.DC.	6	2	0.10	0.06	14	2	3.9	1.1
Acalypha caturus Blume	6	-	0.42	-	6	-	3.6	-
Dysoxylum excelsum Blume	2	-	0.02	-	2	-	0.8	-
Engelhardtia spicata Lech.ex Bl.	8	-	0.30	-	8	-	4.0	-
Guazuma ulmifolia Lam.	2	-	0.18	-	2	-	1.3	-
Litsea velutina (Bl. Boerl.	4	-	0.26	-	4	-	2.3	-
Melastoma malabathricum L.	4	-	0.06	-	6	-	2.0	-

Table 2. Number of species, basal area (BA), density (D) and family importance value (FIV) 10 main family in1986 and2016 plots. The sort order is based on the FIV in the 2016 plot

Family	Number of species		BA (m^2/ha)		D (trees/ha)		FIV		Ranking	
	1986	2016	1986	2016	1986	2016	1986	2016	1986	2016
Euphorbiaceae	4	3	5.76	4.86	112	124	46.48	45.91	1	1
Asteraceae	1	1	4.26	6.08	34	36	20.81	25.91	4	2
Cannabaceae	2	2	6.18	6.43	32	8	29.15	24.40	3	3
Urticaceae	1	2	6.12	1.48	116	52	39.07	20.03	2	4
Actinidiaceae	1	1	1.28	2.49	58	38	15.84	16.92	7	5
Cyatheaceae	1	1	0.16	1.43	4	48	4.12	16.09	21	6
Primulaceae	1	1	1.74	2.34	62	28	17.81	14.58	6	7
Rutaceae	1	2	0.90	0.95	14	26	7.85	13.59	11	8
Myrtaceae	2	2	1.68	0.49	44	24	17.85	12.01	5	9
Escalloniaceae	1	1	2.08	1.25	34	28	14.43	11.74	8	10

The distribution of trees based on the stem diameter at breast height (dbh) in 1986 and 2016 both showed the form of a negative exponential curve or an inverted 'J' curve (Figure 3). A curve showing that tree populations in 1986 and 2016 were both abundant in small diameter classes and decreased with the rise of dbh classes. The population of trees with dbh <30 cm in 2016 recorded 412 trees/ha (80.16% of the total population), decreased compared to 1986 which reached 492 trees/ha (76.88% of the total population), but the percentage of total population increases. In the dbh > 70 cm class there was a population increase of 4 trees/ha (0.63%) in 1986 and 20 trees/ha (3.89%) in 2016. Fifty percent of trees with dbh> 70 cm in 2016 is owned by *Vernonia arborea* (6 trees/ha) and *Trema orientalis* (4 trees/ha), the rest is owned by *S. reinwardtiana*, *Lyndera polyantha*, *Erythrina subumbrans*, *Ehretia javanica* and *Celtis* sp. every 2 trees/ha.

The main species that have increased population and BA in 2016 are *V. arborea, M. triloba*, and *C. contaminans*. In contrast, the main species that have decreases population and BA are *T. orientalis, D. stimulans, P. integrifolia, S. acuminatissimum* and *F. septica*. There are two main species that have increased population, but BA decreases, i.e. *H. giganteus* and *A. trifoliata*. In contrast, there are 2 main species of decrease in population, but BA increases, i.e. *M. angustifolia* and *S. reinwardtiana* (Table 1).

T. orientalis recorded a population decline of 78.6 % and leaving only individuals with dbh> 40 cm without regeneration in small dbh classes. This species is also noted as the largest dbh owner in 2016 that is equal to 143.2 cm, increased sharply compared to the largest dbh of 1986 of 71.5 cm which is also owned *T. orientalis*. *M. angustifolia* and *S. reinwardtiana* also increase in the maximum dbh. *V. arborea* is relatively well regenerated and also able to grow up to dbh> 100 cm. A similar pattern is also shown by *C. contaminans* and *M. triloba* which have increased population and maximum dbh. *H. giganteus*, *A. trifoliolata*, *D. stimulans*, *P. integrifolia* and *S. acuminatissimum*, had a smaller maximum dbh than in 1986 (Figure 4).

The vertical spread of the tree is presented through a tree distribution based on tree height class (Figure 5). In 1986 showed a linearly approximated form of curves with abundant trees in low tree grades and decreased as the tall class of trees grew. In the year 2016 formed a normal curve or polynomial with abundant trees in high-grade trees 10.1-20.0 m. The population of trees on the lower layers that have a height of <10 m decreased drastically (-75.1%) in 2016 compared to 1986, but increased in tree height> 10 m.

The trees on the top layer of crown (tree height> 25 m) are generally occupied by *H. giganteus* and *V. arborea*. Emergent trees with height > 35 m filled by *T. orientalis*. In the middle layer of the canopy ranging from 15.0- 25.0 m is characterized by the presence of *P. integrifolia*, *A. trifoliolata*, and *M. angustifolia*. In the middle layer is also inhabited by *H. giganteus* as the most abundant tree population in the forest of Bukit Tapak. In the lower layers of the canopy (tree height <15 m) is characterized by the presence of *C. contaminans*, *D. stimulants, Erythrina subumbrans* and *S. reinwardtiana*. The crown stratification between 2016 is relatively the same as 1986. The striking change is found only in the lower filler species with the presence of *C. contaminans* as an abundant species previously dominated only by *D. stimulants, S. reinwardtiana* and *Hypobathrum frutescens* (Siregar 1990).

Regeneration

A total of 37 species of saplings (tree height > 1.5 m; dbh <10cm) were encountered in the study plot (Table 3). From 33 tree species in 2016 (Table 1), twenty-three species were encountered at saplings. The species of trees that have abundant regeneration (density > 50 individuals/ha) at the saplings are *D. stimulans, Ardisia javanica, A. trifoliolata, Platea latifolia, Claoxylon indicum, S. reinwardtiana, Dysoxylum excelsum* and *Glochidion rubrum*. From the 10 main species of tree level, only three species remain abundant at saplings, namely: *D. stimulans, A. trifoliolata* and *S. reinwardtiana*, four species can still be found ie.*H. giganteus, P. integrifolia, M. angustifolia* and *M. triloba*, while 3 species are not found at saplings level, namely: *V. arborea, C. contaminans* and *T. orientalis*.

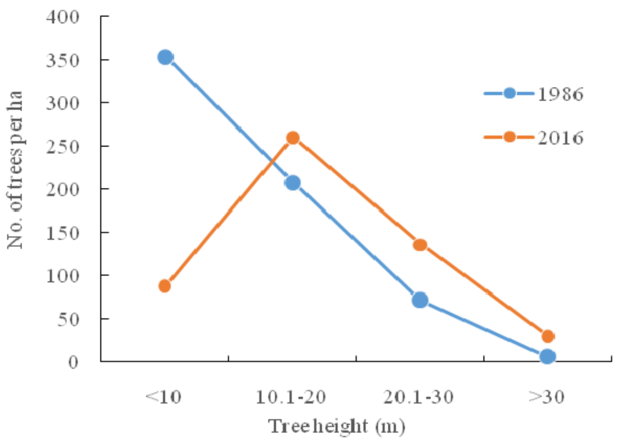

Figure 5. Distribution of trees based on height class in plots 1986 and 2016

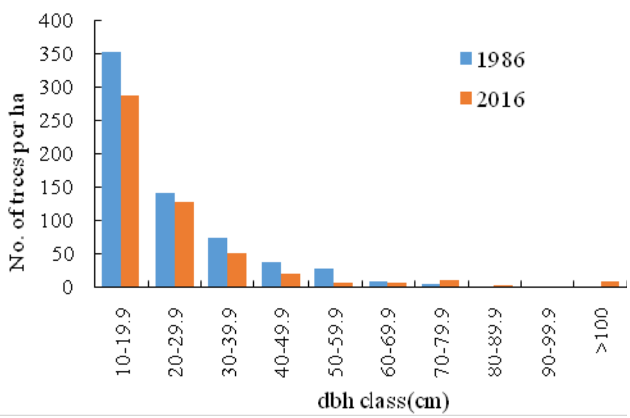

Figure 3. Distribution of trees based on dbh class in plots 1986 and 2016

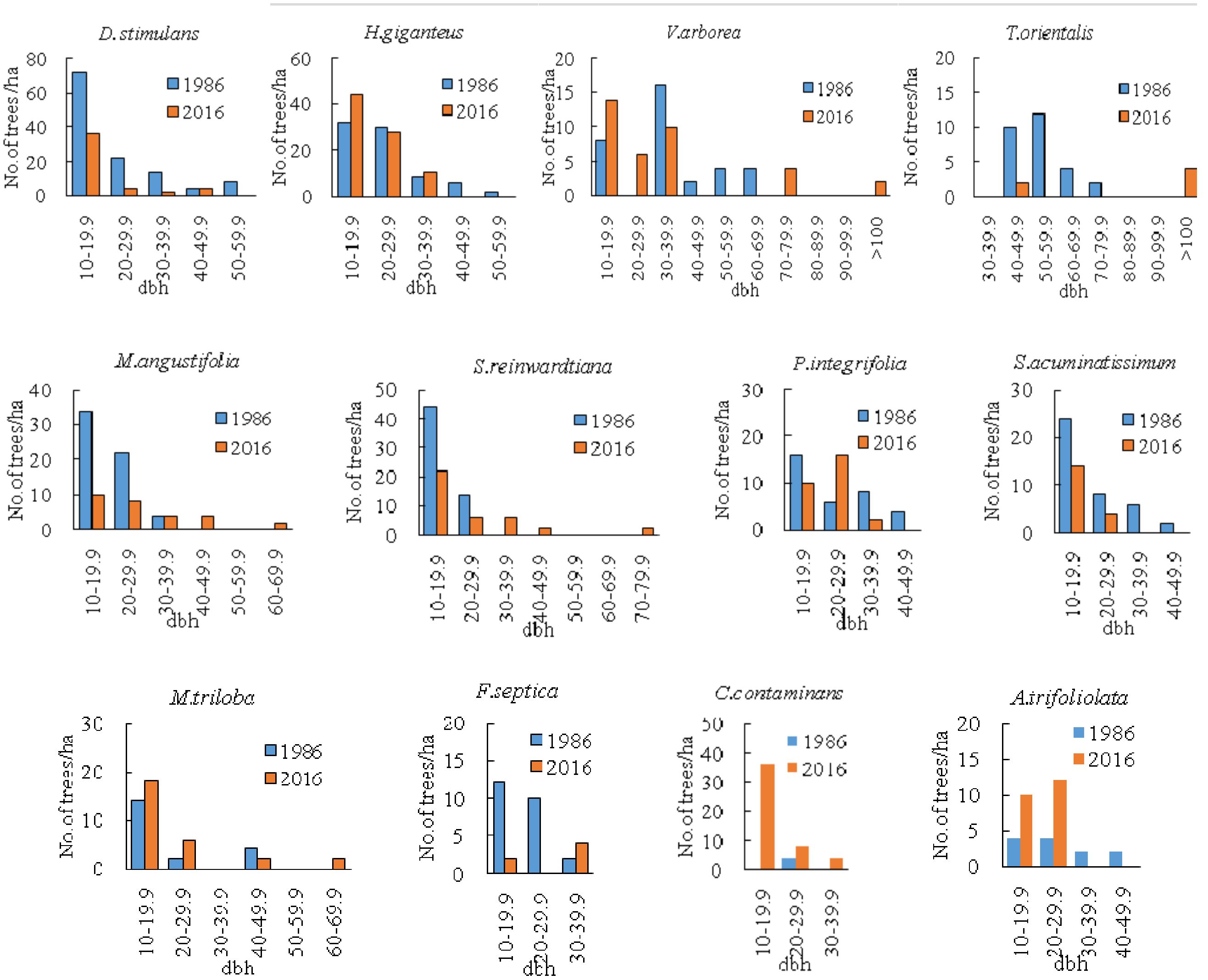

Figure 4. Distribution of main species based on dbh class in plots 1986 and 2016

Discussion

The richness of tree species in the study plots is relatively low compared to the Central Sulawesi mountain forest of 150 species in 1 ha plot (Kessler et al. 2005), Mt. Halimun in West Java with 69 species in 1 ha plot (Yusuf 2004) and mountain forest on the island of Negros, Philippines which recorded 92 species in 1 ha plot (Hamann et al. 1999). The area of plot in this study is smaller, so the wealth of the species is also smaller. However, based on species-area curves from various research results in tropical areas compiled by Kartawinata (2010) indicate species richness in the research plot is still lower than that of the Mt. Gede and Mt. Halimun forest. The species richness in the research plots will appear lower in comparison with lowland forest plots which are generally richer in species (Kartawinata et al. 2004; Sambas and Siregar 2004; Simbolon 2005; Simbolon et al. 2005; Rahmah et al. 2016). Species richness generally decreases with increasing altitude (Pysek et al. 2002; Hadi et al. 2009; McCain and Grytnes 2010). However, when compared with mountain forests on the Bali island, species richness in the study plot is still higher. Research on Mt. Pohen which is still included in the area of Batukahu Nature Reserve in Bali recorded only 24 species in 1 ha plot (Sutomo et al. 2012). In Mt. Batur-Kintamani, Province of Bali even only 11 species in 6 separate plots each measuring 400 m^2 (Sujarwo and Darma 2011).

Forest stand and regeneration conditions in the study plot after 30 years are relatively good. Some of the facts that support the argument are as follows: first, the shape of the relationship curve between the number of trees and the dbh class that forms an inverted 'J' curve in both years of research (Fig. 3). A condition common to tropical rainforests (Meyer 1952; Lorimer 1980; Mori et al. 1989; Leak 1996; Kartawinata et al. 2004; Simbolon 2005; Aigbe and Omokhua 2014), and indicates that the forests in the study sites consistently maintained their specificity distribution of dbh size classes from natural rainforests (Richards 1996; Fashing et al. 2004; Ige et al. 2013). Second, of the 10 main species based on the magnitude of the important value of the species, eight of which are the same. Only two species are changing positions in the top 10, but still encountered in the two different years. Similarly, species riches in 1986 and 2016 were the same (33 species) and only 6 species were missing or emerging as newcomers with low populations (<10 trees/ha). Based on the value of the species diversity index (H`) and the equitability index (E) there was an increase in the 30 year period of forest age. This is consistent with the notion that species diversity increases with age (Odum 1971; Barbour et al. 1987; Saldarriaga et al. 1988).

The condition of forests over a period of 30 years indicates the mature age of the forest. Some evidence shows, such as total BA increased (12.2 %), but density decreased (19.7 %). The average BA per tree increased by 39.7 %. The abundance of trees in the small dbh class decreases, but in the large dbh class increases (Figure 3). Total abundance of trees in high-grade trees <10 m decreased drastically (-75.1%), but increased in tree height > 10 m (Figure 5). This result is not much different from research elsewhere (Saldarriaga et al. 1988; Mani and Parthasarathy 2009).

Forests in the study sites appear to be still in the process of maturation into primary forests or can be categorized as old secondary forest. This can be seen from the dominance of *H. giganteus, V. arborea* and *T. orientalis* known as the inhabitants of secondary forests, open areas or disturbed forests and included as fast-growing tree species (Orwa et al. 2009). In comparison, Abdulhadi (1992) reports that in Australian sub-tropical forest after 60 years of damage still dominated by secondary species. In this study, the primary species found in both years studied were still the same.

Table 3. Frequency, basal area (BA), density (D) and species importance value (SIV) of saplings (tree height≥ 1.5 m; dbh < 10cm) in plot of 2016

Species	Frequency %	BA m^2/ha	D (ind./ha)	SIV
Dendrocnide stimulans (L.f.) Chew	72.0	0.5371	1,176.0	97.87
Cyrtandra aclada Merr.	20.0	0.1493	416.0	29.96
Pinanga coronata (Blume ex Mart.) Blume	34.0	0.0947	240.0	24.39
Ardisia javanica A.DC.	30.0	0.0846	232.0	22.23
Acronychia trifoliolata Zoll. & Moritzi	20.0	0.0462	120.0	12.97
Platea latifolia Blume	18.0	0.0432	104.0	11.67
Gynura sp.	14.0	0.0327	96.0	9.48
Claoxylon indicum (Reinw. ex Blume) Hassk.	14.0	0.0299	72.0	8.52
Saurauia reinwardtiana Blume	6.0	0.0298	72.0	6.22
Dysoxylum excelsum Blume	8.0	0.0282	56.0	6.17
Glochidion rubrum Blume	8.0	0.0174	56.0	5.35
Elaeocarpus sp.	8.0	0.0188	48.0	5.21
Hypobathrum frutescens Blume	6.0	0.0236	40.0	4.75
Magnolia sp.	8.0	0.0096	40.0	4.27
Syzygium sp.	6.0	0.0088	40.0	3.63
Erythrina subumbrans (Hassk.) Merr.	4.0	0.0139	40.0	3.45
Syzygium polyanthum (Wight) Walp.	6.0	0.0115	24.0	3.34
Freycinetia sp.	6.0	0.0088	24.0	3.13
Mouretia sp.	6.0	0.0087	24.0	3.12
Polyosma integrifolia Blume	4.0	0.0155	24.0	3.07
Ficus elastica Roxb. ex Hornem.	6.0	0.0077	24.0	3.05
Homalanthus giganteus Zoll. & Moritzi	2.0	0.0150	40.0	2.95
Syzygium zollingerianum (Miq.) Amshoff	4.0	0.0124	24.0	2.83
Sanchezia sp.	4.0	0.0122	24.0	2.82
Lophopetalum javanum Turcz.	4.0	0.0086	32.0	2.79
Lindera polyantha (Bl.) Boerl.	4.0	0.0088	24.0	2.56
Blumea sp.	4.0	0.0073	24.0	2.44
Passiflora quadrangularis L.	4.0	0.0057	16.0	2.08
Litsea sp.	2.0	0.0052	8.0	1.21
Macaranga triloba (Reinw. ex Bl.) M.A.	2.0	0.0052	8.0	1.21
Ficus septica Burm.f.	2.0	0.0041	8.0	1.13
Ficus thonningii Blume	2.0	0.0031	8.0	1.06
Meliosma angustifolia Merr.	2.0	0.0031	8.0	1.06
Psychotria sp.	2.0	0.0031	8.0	1.06
Astronia ferruginea Elmer	2.0	0.0023	8.0	1.00
Cryptomeria japonica (Thunb. ex L.f.) D. Don	2.0	0.0023	8.0	1.00
Antidesma sp.	2.0	0.0016	8.0	0.94

If the condition of the forest is not disturbed, *T. orientalis* is predicted to disappear as the process of succession continues. This can be seen from the absence of this species in the small dbh class (<40 cm) or at the saplings level. *V. arborea, M. triloba* and *C. contaminans* have recorded an increasing population and their total BA in the last 30 years, but regeneration is not found at saplings level (Table 3). In the long run they may disappear. Saplings or tillers are the next generations of trees in the upper layer (Hartshon 1980). The length of time each secondary species can survive in one succession ecosystem depends on the life spans of the species (Abdulhadi 1992). In the absence of severe disturbance, the species predicted to persist for longer periods in the upper layer of the canopy are *H. giganteus, A. trifoliolata, M. angustifolia* and *P. integrifolia*, while in the lower layers are *S. reinwardtiana* and *D. stimulants* still have regeneration at saplings level.

In conclusion, from the results of this study can be concluded, as follows: (i) Number of tree species in 1986 and 2016 are the same ie. 33 species, but the species diversity index (H`) and the equitability index (E) increase in the year 2016. (ii) Eight species survive as the main species based on the magnitude of the important values of the species, namely: *Homalanthus giganteus*, *Vernonia arborea*, *Dendrocnide stimulans*, *Meliosma angustifolia*, *Saurauia reinwardtiana*, *Trema orientalis, Macaranga triloba* and *Polyosma integrifolia*. (iii) Density of trees decreased by 19.7 %, but total basal area increased 12.2% with average per tree which also increased by 39.7 %. (iv) Orientalist tricks are predicted to disappear as the process of succession continues, while the predicted species still survive for longer periods are *Homalanthus giganteus, Acronichia trifoliolata, Meliosma angustifolia, Saurauia reinwardtiana, Polyosma integrifolia* and *Dendrocnide stimulants*. (v) Forests in study plots can be categorized as old secondary forests that are still in the process of maturation into the primary forest.

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