

Habitat preference and spatial distribution model of threatened species *Saurauia microphylla* in Mt. Slamet, Central Java, Indonesia

HENDRA HELMANTO^{1,2}, NISYAWATI^{1,*}, IYAN ROBIANSYAH², RIZMOON NURUL ZULKARNAEN²,
NABELA FIKRIYYA¹

¹Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia. Jl. Lingkar UI, Depok 16424, West Java, Indonesia

²Research Center for Plant Conservation and Botanic Gardens (Bogor Botanic Gardens), Indonesian Institute of Sciences. Jl. Ir. H. Juanda No. 13, Bogor 16122, West Java, Indonesia. Tel./fax.: +62-251-8322-187, *email: nsywt@yahoo.com

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Abstract. Helmanto H, Nisyawati, Robiansyah I, Zulkarnaen RN, Fikriyya N. 2020. Habitat preference and spatial distribution model of threatened species *Saurauia microphylla* in Mt. Slamet, Central Java, Indonesia. *Biodiversitas* 21: 2946-2954. *Saurauia microphylla* de Vriese has the potentials for medicinal uses, yet it is listed in the IUCN Red List under Vulnerable status. The natural population of this species is only found in highlands one of which is in Mount Slamet, Central Java, Indonesia. This study aims to determine the population structure, habitat preference and predicted spatial distribution of *S. microphylla* in the Mount Slamet area. The method used was purposive sampling by establishing 103 observation plots with size of 20x20 m² for each plot. The research parameters recorded were abiotic variables and biotic associations. Data were analyzed using Principal Component Analysis (PCA) to determine the most influencing environmental factors on the presence of *S. microphylla*. Species association of *S. microphylla* was analyzed using the Jaccard index equation. Spatial distribution model was analyzed using Maxent (Maximum Entropy) software. The results showed that *S. microphylla* populations were found in highland forest areas with elevations of 1689-2265 m above sea level, slope of 3-40°, temperature of 16°-26°C, air humidity of 49.3-90%, soil pH 5.8-7, soil moisture 5-70% and canopy cover of 0-92%. Our analyses revealed that elevation is the most influential factor in the presence of *S. microphylla*. There are 20 tree species which found around *S. microphylla* habitat with 4 species have significant association with the species. The spatial distribution model showed that *S. microphylla* spread across all the slopes of Mount Slamet with the southwestern slope was predicted had the most extensive habitat suitability for the species and become smaller to the north, east, and south slopes.

Keywords: Habitat preference, Mount Slamet, *Saurauia microphylla*, spatial distribution

INTRODUCTION

Saurauia is a member of the family Actinidiaceae. *Saurauia* has the origin distribution in subtropical and tropical areas (Briggs 2011), including Indonesia (Walter and Gillett 1998). Several new *Saurauia* species have been discovered (Takeuchi 2008; Conn and Damas 2013) with some of them have compounds potential for uses (Rafidah 2013; Briggs 2015). The leaf extraction of several *Saurauia* species is known to contain phenolic compounds, alkaloids, flavonoids, glycosides, O-glycosides, terpenoids, carbohydrates, steroids, reducing sugar, tannins, phlorotannins and saponin (Ahmed et al. 2013). *Saurauia* has anticancer properties (Muaja et al. 2013), anti-oxidants (Kadji et al. 2013), anti-diabetes drugs, and cholesterol (Sitorus 2015; Hutapea 2018), and been used for traditional medicine to treat several diseases (Ahmed et al. 2016).

Saurauia microphylla is one of several *Saurauia* species that is included in the IUCN Red List and is under the category of vulnerable IUCN (2020). Besides *S. microphylla*, there are several *Saurauia* species in Indonesia listed in the IUCN Red List in endangered species, including *S. bracteosa* (vulnerable), *S. cauliflora* (vulnerable), *S. lanceolata* (vulnerable) and *S. bogoriensis* (critically endangered).

Saurauia microphylla has a shrub-tree shaped habitus. The species has lanceolate leaves with a leaf length of 10-20 cm. *S. microphylla* has serrated leaf edge with a pointed tip. The young leaves are green-reddish and hairy. *S. microphylla* has much fruit on tree branches and leaf axillar with short fruit stem. As *Saurauia* in general, *S. microphylla* has are hermaphroditic and unisexual flowers. White stamens with yellow anthers. Berries-capsule fruit flowers shaped, slimy, seedy, wingless, dashed endosperm, embryo straight, or slightly curved (Dressler and Bayer 2004).

Mount Slamet in Central Java Province, Indonesia is one of the *S. microphylla* natural distribution area. Based on previous study, *S. microphylla* was discovered in the eastern slope of the Mount Slamet area (Soemarno and Girmansyah 2012). Purnomo et al. (2015) reported the existence of several types of *Saurauia* in several regions of Mount Slamet at an altitude of 700-1100 m above sea level (m asl). The forest in Mount Slamet has a high diversity of plants across several vegetation zones (Soemarno and Girmansyah 2012), which likely provides a good habitat for *S. microphylla*. However, there are several factors that can disturb the habitat for *S. microphylla* in this area. For example, Mount Slamet is one of the active volcanoes in Indonesia (Vukadinovic and Sutawidjaja 1995). Soemarno

and Girmansyah (2012) reported land conversion in Mount Slamet from forest into agriculture and mixed garden.

The main causes of plant extinction throughout the world are habitat fragmentation and disturbances (Sala et al. 2010). Conservation of *S. microphylla* in Mount Slamet area requires some information related to population, habitat preferences, and location of species distribution. Research on population, habitat preferences, and prediction of *S. microphylla* distribution in Mount Slamet area has never been done before. Intense pressures on land use and management require up-to-date information on the status of native species (Keith 2000). Therefore, this research becomes important to be done as an effort to support the *S. microphylla* conservation.

This study aims to determine the population, habitat preferences, and predicted spatial distribution of *S. microphylla* in Mount Slamet region, Central Java, Indonesia. The results of the study can be used as baseline information for the conservation of *S. microphylla* and to prevent local extinction of the species in Mount Slamet region.

MATERIALS AND METHODS

Study area and period

This study was carried out in the Mount Slamet forest area, Central Java, Indonesia, more specifically around the hiking trails on the four slopes (northern, eastern, southern and western). Data collection began from the starting point of the hiking trail and ended at the altitude at which there

was no longer *S. microphylla* founded. The southern slope was started from Baturraden area at the point S 7°18'14.43" and E 109°13'48.99" at ± 916 m asl, the eastern slope was started from the Bambang village at S 7°13'33.72" and E 109°15'51.45" at ± 1485 m asl, the western slope was started from the Kalikidang village S 7°16'04.72" and E 109°08'34.91" at ± 1850 m asl, the northern slope was started from the Guci area at S 7°11'50.14" and E 109°09'59.02" at ± 1176 m asl. Map of research locations can be seen in Figure 1. Data collection in the field and identification of species were carried out in 2019.

Sampling methods

The data of population and habitat preferences were collected using purposive sampling method (Mueller-Dombois and Ellenberg 1974) with total 103 plots on different four slopes. Parameters recorded for the population data were number of individuals, stem diameter (dbh), and height of *S. microphylla* plant. Habitat preferences data were taken based on the presence (42 plots) and absence (61 plots) of *S. microphylla* in the observation plot. The environmental parameters included elevation recorded by GARMIN GPSMAP 78S, slope and aspect taken using Suunto® Tandem Global Compass/Clinometer, canopy cover recorded using *Habitapp* (Zulkarnaen et al. 2019), soil pH and soil moisture taken by Takemura DM 5 Soil tester. Trees that grew around the habitat of *S. microphylla* were inventoried and identified to determine the association of tree species with a plot size of 20x20 m².

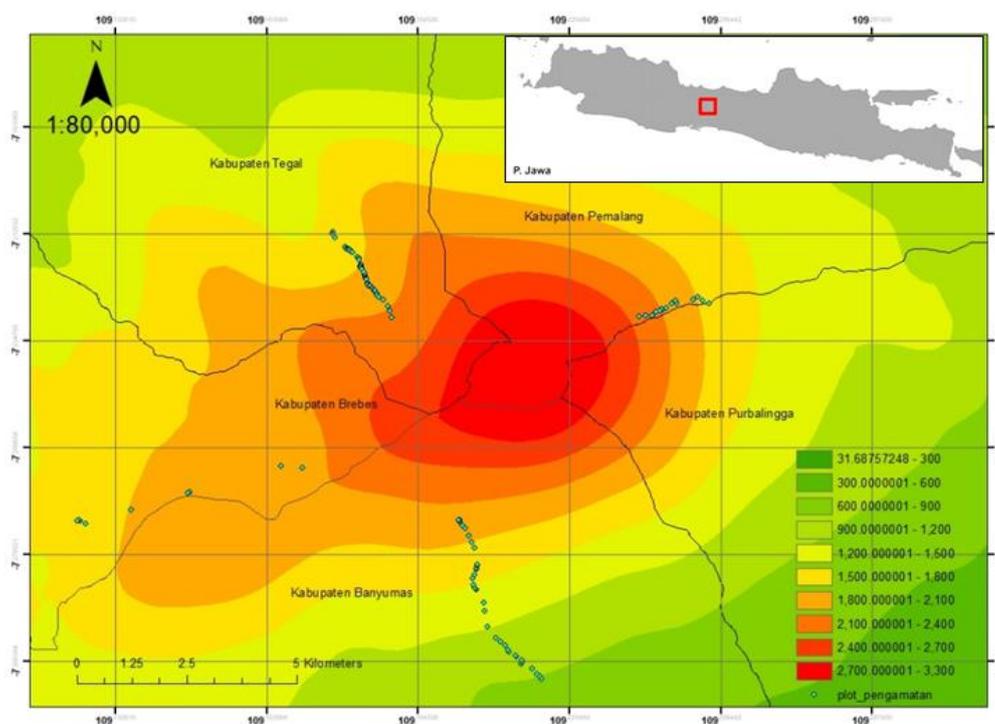


Figure 1. Research locations (green dots) of *S. microphylla* habitats along the four slopes in the Mount Slamet area, Central Java, Indonesia

Data analysis

Saurauia microphylla population data were analyzed based on number, dbh, and height of individuals. Each individual was classified into 4 growth phases (i.e. seedlings, sapling, poles, trees) based on plant height and diameter. Mueller-Dombois and Ellenberg (1974) classified seedling= height < 1,5 m; sapling= height ≥1,5 m and dbh <10 cm; poles= height ≥1,5 m and dbh 10-20 cm; trees= height ≥1,5 m and dbh ≥20 cm. The analysis of habitat preference was performed using the Principle Component Analysis (PCA) method using *IMB SPSS Statistics 26 for Windows*. PCA analysis was performed to determine the effect of environmental parameters on the presence of *S. microphylla* and it is one of the most commonly used tools in the analysis of ecological data (Franklin 1995; Peres-Neto 2003). SPSS software is one software that can be used for data analysis related to the habitat preferences of a species (Robiansyah and Davy 2015).

The association between *S. microphylla* and other tree species was analyzed with a 2x2 contingency table for each species pair. Furthermore, it was tested using the Chi-Square test (Ludwig and Reynolds 1988). The association value between *Saurauia* and other plant species was calculated using the Jaccard Index. The direction of the association was determined by comparing the observed value for x (F (x)) with the expected value (E (x)). If F (x) > E (x), then the association is positive, while if F (x) < E (x), then the association is negative (Ludwig and Reynolds 1988).

Spatial distribution model analysis was performed using *Maxent Software v3.3*, *ArcMap 10.3 (ArcGIS)*, and *QGIS 3 software*. Leathwick et al. (2006) reported that MaxEnt is one of the modeling tools in spatial distribution that has good performance in prediction accuracy. Modeling was done by combining several maps/spatial datasets of various

parameters. The parameters of elevation, aspect, and slope were obtained from a contour map obtained from the Rupa Bumi Indonesian (RBI) map and National Digital Elevation Model from Geospatial Information Agency (Badan Informasi Geospasial). Climate parameters in the form of maximum temperature, minimum temperature, maximum rainfall, minimum rainfall, and average rainfall were taken from the Worldclim database (Worldclim 2020). The results of the analysis were used to predict the presence of *S. microphylla* in the Mount Slamet area.

RESULTS AND DISCUSSION

Population structure and habitat preference

The results showed that *S. microphylla* was found on the four slopes of Mount. A total of 145 individuals of *S. microphylla* was recorded at 42 observation plots. Sapling phase dominated the population of *S. microphylla* with 89 individuals, followed by pole phase with 39 and tree phase with 14 (Figure 2). The seedling phase was the lowest with 3 individuals.

The analysis of habitat preference was generated from 103 observation plots in which 42 plots had the presence of *S. microphylla* while the other 61 plots had the absence of the species. Environmental data on the 42 presence observation plots showed the tendency of habitat *S. microphylla*. In general, the population of this species was found at altitude of 1689-2265 m asl, slopes of approximately 3-40°, temperature during the day of 16-27.2°C, humidity of 49.3-90%, canopy cover of 0-92%, soil pH between 5.8-7 and soil moisture between 15-70% (Table 1).

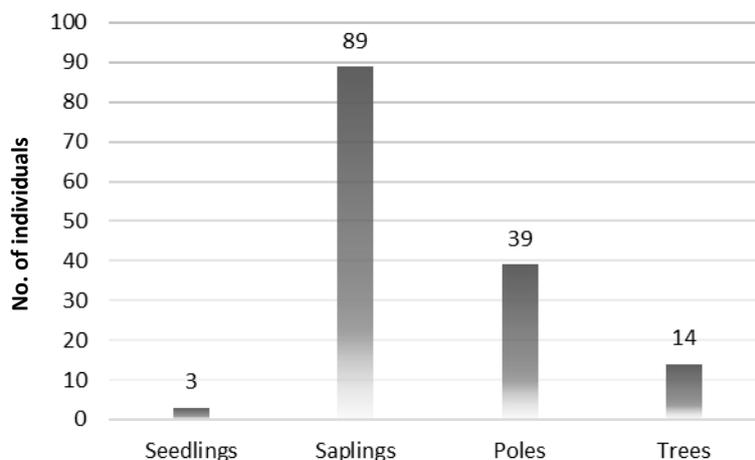


Figure 2. The population structure of *S. microphylla* in Mount Slamet, Central Java, Indonesia area based on the growth phase (seedling = height <1.5 m; sapling = height ≥1.5 m and dbh <10 cm; pole = height ≥1.5 m and dbh 10-20 cm; tree = height ≥1.5 m and dbh ≥20 cm.)

Table 1. The results of measurement data of environmental factors in *S. microphylla* habitats in Mount Slamet area, Central Java, Indonesia

Environmental parameters	Min	Max	Mean	Standard deviation
Elevation (m asl)	1687	2265	1942.64	± 127.83
Slope (°)	3	40	24.45	± 9.13
Temperature (°C)	16	27.6	20.50	± 3.51
Soil pH	5.8	7	6.59	± 0.35
Soil Humidity (%)	15	70	39.98	± 15.37
Humidity (%)	49.3	90	67.59	± 11.42
Canopy cover (%)	0	92	55.05	± 22.43

The result of Principal Component Analysis (PCA) across all observation plots (i.e. 103) showed that the presence and absence of *S. microphylla* were influenced by two-factor interactions. The first interaction was influenced by elevation (0.844), soil pH (0.842), and humidity (-0.732). While the second-factor interaction was influenced by slope (-0.805) and canopy cover (0.727). The Kaiser-Meyer-Olkin sampling size adequacy value is 0.60 and the significance of Bartlett's Test of Sphericity <0.001. These values indicate that the results of the PCA analysis can be received statistically with the condition that the Kaiser-Meyer-Olkin value > 0.5 and significance <0.01 (Franklin 1995). The Eigen variant value from the analysis was 67.303%. This shown that the environmental factors analyzed have an important role approximately 67.303% while 32.697% are influenced by other factors. Eigenvalues > 50% also indicate the distribution of *S. microphylla* spread evenly. Species distribution is be spread evenly if the Eigenvalue is more than 50% (Jongman et al. 1987; Kent and Coker 1992; Franklin 1995; Peres-Neto 2003).

The results of PCA on the 42 presence plots showed two-factor interactions that affect the distribution of the species. The first environmental factors interaction was humidity (0.798), slope (-0.730), and canopy cover (0.618). The second-factor interaction was elevation (0.829) and soil pH (0.824). The Kaiser-Meyer-Olkin sampling adequacy value was 0.514 and Bartlett's Test of Sphericity significance is 0.008. The Eigenvalue of the analysis results was 61.255%. Each environmental parameter has a value

range of -1 to 1. The maximum value of each component is 1 which means that the factor is very influential. While the 0 value has the meaning that the factor has no effect. Positive values indicate the existence of a direct relationship with a parameter to the presence of factor interactions and the presence of species. Meanwhile, negative values indicate an inverse relationship to factor interactions and species presence (Franklin 1995; Peres-Neto 2003).

Figure 3 shows the distribution of all 103 plots with the presence or absence of *S. microphylla* in relation to environmental factors interact. The figure indicates that the larger circle (i.e. plot with the presence of *S. microphylla*) is more distributed above the regression line 1 and on the right side of the regression line 2. These results suggest that *S. microphylla* has a tendency to grow in environment with higher elevation, higher soil pH, lower humidity, lower slope, and denser canopy cover.

Figure 4 shows the distribution of plots with the presence of *S. microphylla* in relation to environmental factors interact. From the 42 presence plots, it can be seen that the distribution of the larger circles is more distributed above the regression line 1 and on the left of the regression line 2. These results suggest that a larger population of *S. microphylla* tends to be found at locations with higher humidity and canopy cover density. *S. microphylla* also more presence in lower slopes, elevations, and soil pH conditions.

Association of *S. microphylla* with other tree species

The analysis of association revealed that *S. microphylla* has association with 18 tree species belong to 13 families (Table 3). Chi-square test showed that there were three species that were significantly associated with 95% confidence level, i.e. *Bellucia axinanthera* (Melastomataceae), *Lepisanthes rubiginosa* (Sapindaceae) and *Saurauia pendula* (Actinidiaceae). *B. axinanthera* has Jaccard index value by 0.3333, *L. rubiginosa* 0.1628, and *S. pendula* 0.1219. Kurniawan and Parikesit (2008) classifies the strength of the association based Jaccard index values into four levels association, which are very high (0.75-1.00), high (0.49-0.74), low (0.48-0.23) and very low (<0.22).

Table 2. Results of principal component analysis (PCA) on environmental factors of the habitat of *S. microphylla* in Mount Slamet area, Central Java, Indonesia

Factor	All plots (presence and absence)		Presence plots only	
	1	2	1	2
Elevation	0.844	0.240	0.070	0.829
Slope	0.035	-0.805	-0.730	-0.112
Soil pH	0.842	-0.095	-0.111	0.824
Humidity	-0.732	0.404	0.798	-0.338
Canopy cover	-0.030	0.727	0.618	0.018

Note: Analysis of the Varimax rotation method by Kaiser normalization: (1) For all plots, the Eigenvalue was 67.303%, the adequacy value of Kaiser-Meyer-Olkin sampling was 0.60 and the significance of Bartlett's Test of Sphericity was <0.001. The presence plots only had an Eigenvalue value of 61.255%, the adequacy value of Kaiser-Meyer-Olkin sampling of 0.514 and the significance of Bartlett's Test of Sphericity of 0.008.

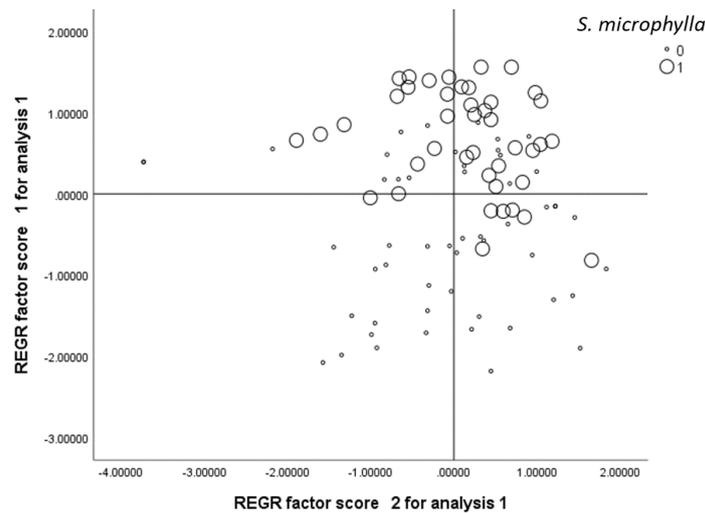


Figure 3. The distribution of plots with the presence (big circle=1) and absence (small circle=0) of *S. microphylla* related to environmental factors interact. The plot with *S. microphylla* presence is indicated by circle with larger size

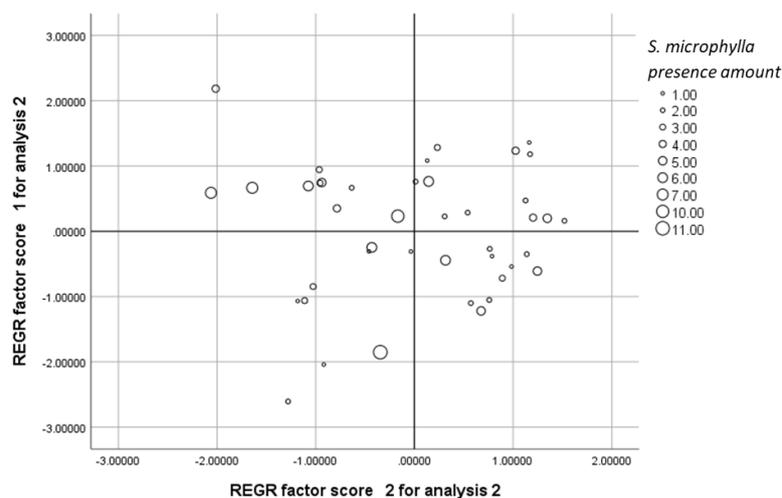


Figure 4. The distribution of *S. microphylla* on presence plots related to environmental factors interact. Circle with larger size indicate more *S. microphylla* in that environment condition

Saurauia microphylla has positive association with *B. axinantha* and *L. rubiginosa*. But, this species has negative association with *S. pendula* 0.1219. Barbour et al. (1980) states positively association (significant) indicated both species produce a positive spatial relationship. Negative associations are interpreted to have a tendency to exclude one another or can mean different effects in the same environment (Whittaker and Likens (1975).

Spatial distribution model of *S. microphylla*

The results of the spatial distribution model analysis of *S. microphylla* are shown in Figure 5. The modeling results show that *S. microphylla* has a distribution on all slopes of Mount Slamet, but with a higher possibility on the southwestern slope.

The results of spatial distribution analysis of the model show training AUC of 0.988 can be seen in Figure 6. These

values suggest that the results of the *S. microphylla* modeling can be categorized as accurate because it is almost close to the maximum value of 1. The AUC value can be used to indicate the spatial distribution model accuracy (Lobo et al. 2008; Yudaputra 2020) and model performance level (Krzanowski and Hand 2009). The AUC value divided into several categories, i.e. 0.9-1 (excellent), 0.8-0.9 (good), 0.7-0.8 (fair), 0.6-0.7 (poor) and 0.5-0.6 (fail) (Krzanowski and Hand 2009). The number of Maxent simulations in this analysis was as many as 500 runnings to find one best model. The results of the analysis showed that from the 8 total parameters used in the Maxent modeling, there were 3 parameters that had the most influence on habitat suitability of *S. microphylla*, i.e. elevation with contribution value of 61.2%, minimum temperature with 20.5% and aspect with 9.4%.

Table 3. Association of *Saurauia microphylla* with other species of trees

Species	Family	Jaccard index	Association α 0.05	Association type
<i>Bellucia axinanthera</i> Triana.	Melastomataceae	0.3333	Significant	Positive
<i>Lepisanthes rubiginosa</i> (Roxb.) Leenh.	Sapindaceae	0.1628	Significant	Positive
<i>Saurauia pendula</i> Blume	Actinidiaceae	0.1219	Significant	Negatif
<i>Lithocarpus sundaicus</i> (Blume) Rehder	Fagaceae	0.3443	Not significant	-
<i>Macropanax dispermus</i> (Blume) Kuntze	Araliaceae	0.2143	Not significant	-
<i>Elaeocarpus stipularis</i> Blume	Elaeocarpaceae	0.1818	Not significant	-
<i>Castanopsis argentea</i> (Blume) A.DC.	Fagaceae	0.0889	Not significant	-
<i>Neolitsea cassiifolia</i> Merr.	Lauraceae	0.0698	Not significant	-
<i>Pinus oocarpa</i> Schiede	Pinaceae	0.0476	Not significant	-
<i>Myrsine avenis</i> (Blume) A. DC.	Primulaceae	0.0454	Not significant	-
<i>Cyathea latebrosa</i> (Wall. ex Hook.) Copel.	Cyatheaceae	0.0425	Not significant	-
<i>Pinus merkusii</i> Jungh. et de Vriese	Pinaceae	0.0377	Not significant	-
<i>Lepisanthes amoena</i> (Hassk.) Leenh.	Sapindaceae	0.0238	Not significant	-
<i>Litsea elliptica</i> Blume	Lauraceae	0.0238	Not significant	-
<i>Magnolia candollei</i> (Blume) H.Keng	Magnoliaceae	0.0238	Not significant	-
<i>Toona sureni</i> (Blume) Merr.	Meliaceae	0.0238	Not significant	-
<i>Litsea firma</i> (Blume) Hook.f.	Lauraceae	0.0238	Not significant	-
<i>Bischofia javanica</i> Blume	Phyllanthaceae	0.0227	Not significant	-

Note: There are three significant association of tree species with α 0.05; $df = 1$; Jaccard index showed the level of association 0-1 (the maximum association level)

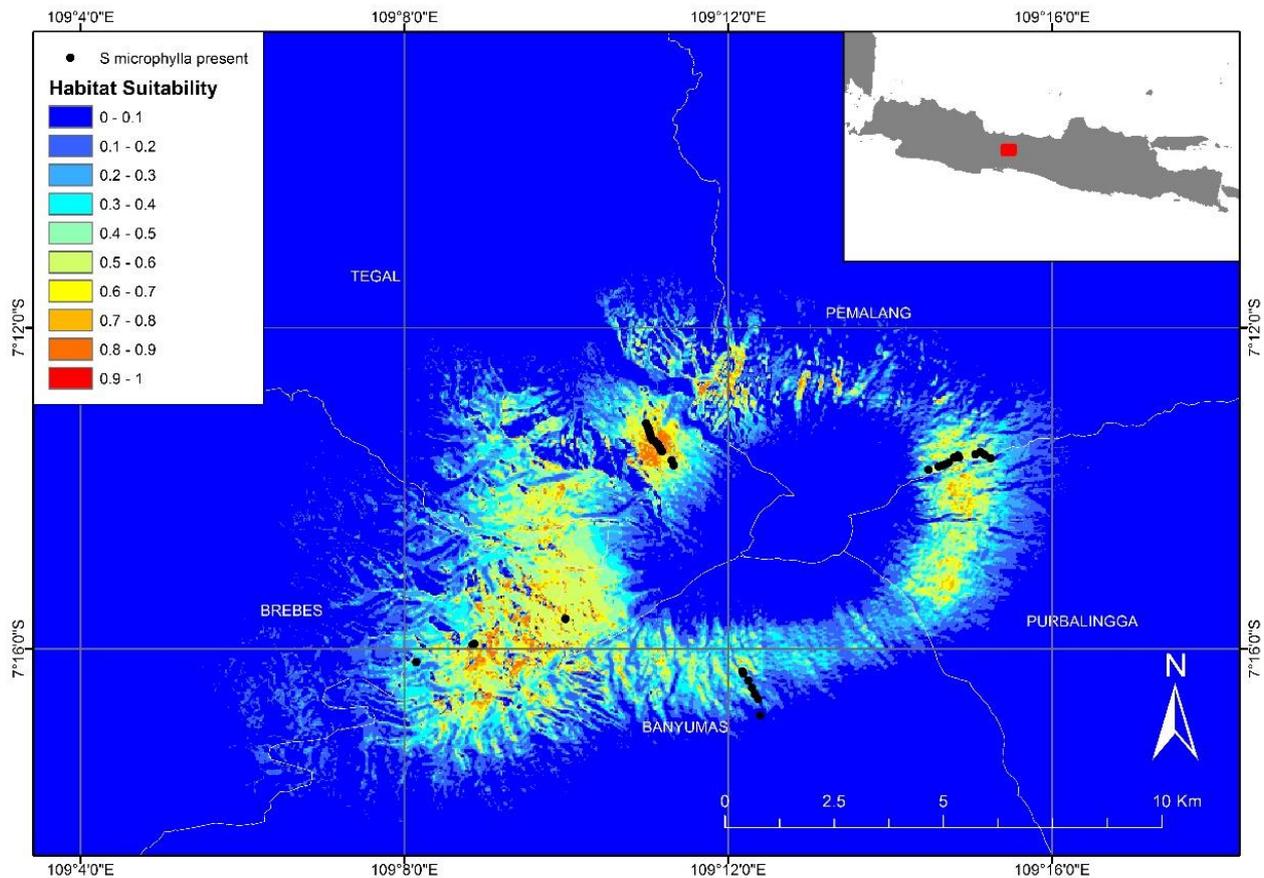


Figure 5. Spatial distribution model (or habitat suitability maps) of *S. microphylla* in Mount Slamet area, Central Java, Indonesia

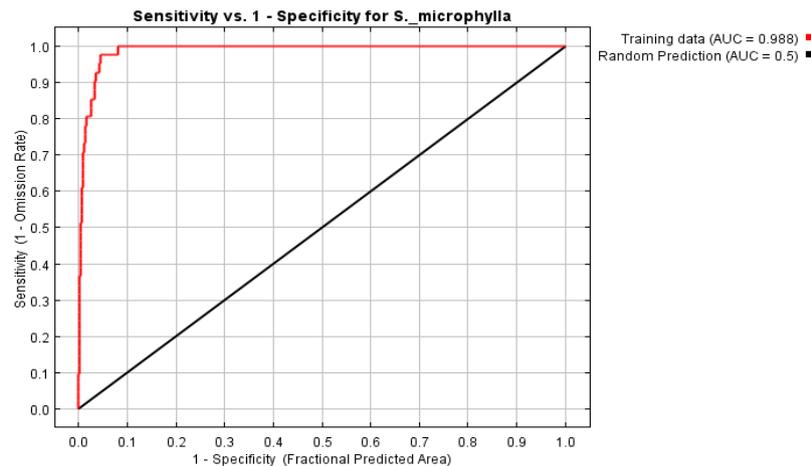


Figure 6. The Area Under the Curve (AUC) training score of *S. microphylla*

Discussion

This research strengthened the existing information that Mount Slamet is one of the natural distribution areas of *S. microphylla* in Indonesia. We revealed that the species were found in almost all directions on the slopes of the Mount Slamet region. In this study, a total of 145 individuals of *S. microphylla* was recorded in which the population was dominated by sapling phase. However, the population at trees and seedlings phases were rarely found, implying a deficiency in regeneration.

Local people around Mount Slamet recognized *S. microphylla* as *umbel-umbelan* in local names. Other communities in West Java, called *S. microphylla* and plants from the genus *Saurauia* as *ki leho* (Wihermanto 2004), those in Central Java and East Java called *lotrok* (Van Steenis 1972), *pidot* in North Sumatra (Sitorus 2015), *lempede* in Borneo and *soyogik* in North Sulawesi (Kadji et al. 2013).

Environmental data from the 42 plots where *S. microphylla* recorded provided information about on habitat preference of the species. The population of *S. microphylla* was found in the forest at high altitude, ranged between 1689-2265 m asl. This is in accordance with the finding by Soemarno and Girmansyah (2012) which found *S. microphylla* in forest area of the Slamet Mountain at 1000-2500 m asl elevation. This result is also in line with Van Steenis (1972) which stated that in general the genus *Saurauia* live in upland forests with altitude of about 600-2100 m asl. Our study found that *S. microphylla* grew in a relatively sloping to steep terrain with slopes approximately 3-40°. Based on field observations, this species tended to grow on hillsides or valley floor. This result consistent to Van Steenis (1972) which stated *Saurauia* generally lives along a small river and the valley floor. *S. microphylla* was also found in locations with temperatures of 16-27.2 °C during the day and air humidity of 49.3-90%. The soil habitat of *S. microphylla* has pH of 5.8-7 with soil moisture of 15-70%. This species can live in habitats with canopy cover between 0-92%, suggesting that *S. microphylla* has high adaptability to light intensity.

The result of PCA on all observation plots (both presence and absence plots) showed two-factor interactions that influenced the presence of *S. microphylla* (Table 2). Altitude, soil pH, and humidity were the first interaction factor, while slope and canopy cover was the second interaction factor. Further, the PCA results on the presence-only plots showed the trend of *S. microphylla* distribution in which there was two interaction of factors that affect the distribution of species, i.e. humidity, slope and canopy as the first factor. The second factor is elevation and soil pH.

The two PCA results suggest that the most influential factor in the presence and distribution of *S. microphylla* is elevation with a factor value of 0.844 and 0.829, respectively. Our finding is in line with Robiansyah and Davy (2015) that reported elevation had an influence on the presence of *Dipterocarpus littoralis* along with litter thickness, litter cover, and slope factors. Elevation is one of the important factors in the distribution of several plant species (Kurniawan and Parikesit 2008), making it as the discriminant factor in classifying vegetation zones in the tropics (Dolezal and Srutek 2002). Elevation has a strong influence on the microclimate of habitat including light intensity, temperature, and air humidity (Kaufman 1989). Further analysis revealed that the presence and absence of *S. microphylla* from all 103 observation plots showed that this species had a tendency to live in an environment with high elevation approximately 1942.64 ± 127.83 m asl and can survive in a higher soil pH (Table 1, Figure 3). These species were also found more in locations with lower air humidity had a tendency to appear at locations with slope approximately $24.45^\circ \pm 9.13^\circ$ and able to grow in denser canopy cover. When focusing on the presence-only plots (Figure 4), we found that larger population of *S. microphylla* grew on habitat with higher humidity and denser canopy cover. In addition, *S. microphylla* preferred habitats with more gentle slopes at lower elevations and lower pH. Field observations indicate some *S. microphylla* individuals are able to live in the shade, under the other tree stands.

The analysis of association shown that there were 18 tree species live around *S. microphylla*. The Chi-square test result showed that there were only 3 species had significant association at 95% confidence level, i.e. *Bellucia axinanthera*, *Lepisanthes rubiginosa*, and *Saurauia pendula*. The Jaccard index value indicates that the association of *S. microphylla* with *Bellucia axinanthera* can be classified as low with Jaccard index value of 0.333, while the two other can be categorized as very low. In terms of the direction of association, *S. microphylla* had 2 positive associations and 1 negative association. Positive value association indicates that the species are dependent on each other (Whittaker and Likens 1975). In contrast, negative association is interpreted that the species have a tendency to exclude one another, or they respond differently in the same environment (Whittaker and Likens (1975). Morin (2011) mentioned that negative interactions between two or three species which live in the same niche or tropic level will tend to create interspecific competition, resulting in reduced abundance, decreased phenotype or some phenotypic components such as body size, growth rate, fertility or survival ability.

The result of the spatial distribution model of *S. microphylla* suggests that this species has predicted distribution on all slopes of Mount Slamet. Nonetheless, the distribution of *S. microphylla* is more dominated on the southwestern slope. It is because the southwestern slope has the most extensive area with altitudinal ranges most suited with *S. microphylla* habitat preference. It can be seen in Figure 1 that the western slopes towards the southwest have the most extensive areas with elevation of 1500-1800 m asl, while habitat suitability on the north is decreasing and becoming lower to the east and south slopes. The habitat suitability map of *S. microphylla* predicted using spatial modelling has a shape like a ring with a hole in the middle. The low suitability index around the middle hole, which is the area around the Mount Slamet pass, implies that *S. microphylla* has maximum elevation threshold to grow.

The results of spatial distribution analysis have AUC training value of 0.988 (Figure 6), suggesting the high accuracy in predicting the distribution area of *S. microphylla*. Elevation is the environmental factor with the highest contribution in prediction model with a contribution value of 61.2%. This is consistent with the results of the PCA analysis which found that elevation is one of the factors that greatly influences to the distribution and presence of *S. microphylla*.

Based on the results above, the best conservation strategy to preserve *S. microphylla* is by creating zone-based conservation delimited according to the elevation. It means that areas with altitude of more than 1600 m asl need to be protected by stakeholders to prevent disturbances on *S. microphylla* habitat. Activities that are not in accordance with conservation principles and have the potential to cause habitat damage need to be suppressed, especially in the natural distribution area of *S. microphylla* with altitude of 1687-2265 m asl.

In conclusion, this research concludes that the total number of *Saurauia microphylla* found in the observation

plots was 145 individuals consisting of 89 saplings, 39 poles, 14 trees, and 3 seedlings. The population of *S. microphylla* was found in forests with altitudinal ranges of 1689-2265 m asl and slopes of 3-40°. The species grows in a relatively cold climate with air humidity of 49.3-90%. Soil in *S. microphylla* habitat has pH of approximately 5.8-7 with soil moisture between 15-70%. It can grow on a wide range of light intensity indicated by canopy cover of 0-92% and. There were 18 tree species that grew around *S. microphylla* with three species have significant association with the species. Analysis of spatial distribution model shown that *S. microphylla* predicted to spread across all slopes of Mount Slamet with the southwestern slopes predicted has the most extensive habitat suitability areas.

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