Cannarium (Jurnal Ilmu-Ilmu Pertanian)
P-ISSN: 1693–1491 . E-ISSN:2774-5201

Volume 19 Number 1
Juni 2021

Distribution and Number of Capilong (*Calophyllum inophyllum*) in Ternate Island of Indonesia

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Abstract

Indonesia has a diverse of new and renewable energy sources including biofuels. Biofuels are promising eco-friendly energy sources generated from biological raw materials. Biofuels can also be derived from the seeds of Capilong trees. However, the occurrence of Capilong trees in North Maluku has not been tapped to support a local economic income due to the lack of knowledge of the local community. The present study was undertaken with the aim at investigating the distribution and number of Capilong trees across Ternate Island. A field investigation using a census method was held to collect data on the number and distribution of Capilong trees while observing the following parameters: stage of growth, topography, rock materials and landforms. The findings revealed that Capilong trees are mostly occurred in a tree group, while the seedling population number was low. Interestingly, Capilong trees have demonstrated a natural characteristic that are tolerance to various topography, rock materials and landforms condition. It is therefore recommended to cultivate the plant through a community development program and classify the plant as a potential species that can be used for land rehabilitation programs.

Keywords: Landforms, natural characteristics of Capilong, rock materials, stage of growth, topography.

Abstrak

Indonesia memiliki beragam sumber energy baru dan terbarukan termasuk biofuel. Biofuel merupakan sumber energy yang menjanjikan, ramah lingkungan, yang berasal dari bahan-bahan biologis seperti tumbuhan. Salah satu jenis tumbuhan yang dapat menghasilkan biofuel adalah Capilong yang juga tumbuh liar di Maluku Utara. Namun, keberadaan Capilong di wilayah ini belum mendapat perhatian untuk dikelola untuk mendukung pendapatan ekonomi lokal karena rendahnya pengetahuan masyarakat lokal. Penelitian ini bertujuan untuk mengukur sebaran dan jumlah tanaman Capilong di wilayah Pulau Ternate. Investigasi lapangan dilakukan menggunakan metode sensus untuk mengumpulkan data mengenai jumlah dan sebaran tanaman dengan mengukur beberapa parameter yaitu tingkat pertumbuhan tanaman Capilong, topografi, bahan batuan, dan bentuk lahan. Hasil penelitian menunjukkan bahwa tegakan Capilong paling banyak ditemukan dalam kelompok pohon, sedangkan kelompok semai memiliki jumlah paling sedikit. Menariknya, tanaman Capilong memperlihatkan suatu karakteristik alamiah, dimana mereka toleran terhadap berbagai kondisi topografi, bahan batuan dan bentuk lahan. Oleh karen itu, perlu direkomendasikan untuk membudidayakan tanaman ini melalui sebuah program pengembangan masyarakat dan mengelompokkan tanaman tersebut sebagai spesies yang potensial digunakan dalam berbagai program rehabilitasi lahan.

Keywords: Bahan batuan, bentuk lahan, karakteristik alami Capilong, tingkat pertumbuhan, topografi.

INTRODUCTION

Indonesia has a diverse of new and renewable energy resources including biofuels or known as liquid bio-origin fuels that can be produced to meet energy demand across the country (Erdiwansyah *et al*., 2021). In the context of current energy scenarios, biofuels are promising eco-friendly energy sources generated from biological raw materials. Previous findings have revealed that biofuels are the potential alternative fuels for kerosene stove, petrol and diesel engine, and biodiesel in particular has been proven to be proper substitutes for oil in transportation and agricultural sector (Jahirul *et al.*, 2012; Wise *et al*., 2014; Bhuiya *et al*., 2015; Bhuiya *et al*., 2016). In order to promote the development of biofuels, Indonesian government has issued a national energy policy in form of the Government regulation No 5/2006, to set a target of producing biofuels up to 5% of the total need of national energy in 2025 (Leksono *et al*., 2014).

Despite being good substitutes for oil, Indonesian energy source supplied from biofuels is currently still very low. By 2016, for instance, the Ministry of Energy & Mineral Resources of RI (2017) reported that biofuels supply just accounted for 0.04% from the total supplied energy (1,248,942,000 BOE). It is also noted that the major energy consumption in Indonesia still relies heavily on fossil fuels (coal, oil, natural gas) that contribute about 76% of the total supplied energy in 2016. However, those conventional energy sources tend to deplete due to their finite reserve (Bentley, 2002). Meanwhilst, energy demand is increasing over time due to the rapid growth of population (Erdiwansyah *et al*., 2021). Also, environmental degradation and global warming resulted from the use of fossil fuels has raised a major concern on human and environmental health. Thus, a search for alternative energy sources like biofuels is currently required. Liquid bio-origin fuels can be extracted from parts of plant materials. The seeds of *Calophyllum inophyllum* or Beaty Leaf (English name) or Capilong (common name in Ternate) is one of the potential part of the plant that contain a liquid bio-origin fuel. Capilong seeds are non-edible that have higher biokerosene and biodiesel potential and economic viability than palm and jatropha oil (Ashwath 2010).

Oil contained in Capilong kernels can be converted into biofuel (biokerosene and biodiesel). Further, Dweck & Meadows (2002) reported that Capilong oil can also be used for pharmacy (medicine for burns, wounds, itchy, skin irritation, skin and breast cancer) and as a raw material for cosmetics (facial mask, soap, shampoo, and other hair care products). Unfortunately, the occurrence of Capilong trees particularly along the coast of North Maluku region has not been tapped to support economic households due to the lack of knowledge of the local community. To get better understanding on the occurrence of Capilong trees to support its economic potential use, and to find strategies of cultivating this plant particularly on sub-optimal or degraded lands in North Maluku, the present study was undertaken with the aim at investigating the distribution and number of Capilong trees across Ternate Island.

MATERIALS AND METHODS

Field Investigation and Method of Data Analysis

A field investigation using a census method was held in 2019 to collect data on the number of Capilong trees across Ternate Island. The distribution of the trees was observed based on the growth stages of the plant and the environmental physical conditions of study sites. The envrionmental physical conditions included two topography components (elevation and slope); geology and landform. Using topography and geology maps of Ternate Island, the distribution of Capilong trees was analysed using a Digital Elevation Model with a 10 x 10 m resolution.

RESULTS AND DISCUSSION

The distribution and number of Capilong trees in different stages of growth

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In North Maluku, the tree has widely distributed along the coast of Ternate Island, Tidore Island, Hiri Island, Halmahera Island, Bacan Island, Obi Island and Sula Island. Our field investigation showed that Capilong trees distributing in Kastela have been planted since the year 1870s by the Dutch Colonial and are predicted to age ± 150 years old. Trunk of the tree have about 159 cm in diameter and 38 m in height. The oldest trees are found on the coast of Kastela and of Afetaduma in Ternate Island. It is assumed that other trees found in other study sites had grown wildly.

The finding revealed that many Capilong trees are mostly found in the ten locations: Kastela (01), Rua (02), Afetaduma (03), Togafo (04), Takome (05), Sulamadaha (06), Tobololo (07), Bula (08), Kulaba (09), and Tafure (10) village (**Fig. 1**). As shown on the map, the order number of the locations stretches from the southern part towards the western and northen part of Ternate Island. Meanwhile, only few trees are found along the coastal area at the eastern part the island. Less stands of Capilong trees along this site is because many Capilong trees have been removed, and the area has been replaced with buildings. Our current survey showed that there are about 1,346 stands left in different growth stages spreading out across the island. As shown in **Table 1,** most Capilong population is centralised in some recreational areas (Kastela, Rua, Afetaduma, Takome, and Bula), whilst the least population is found in Kulaba, Tobololo, Tafure, Togafo, and Sulamadaha.

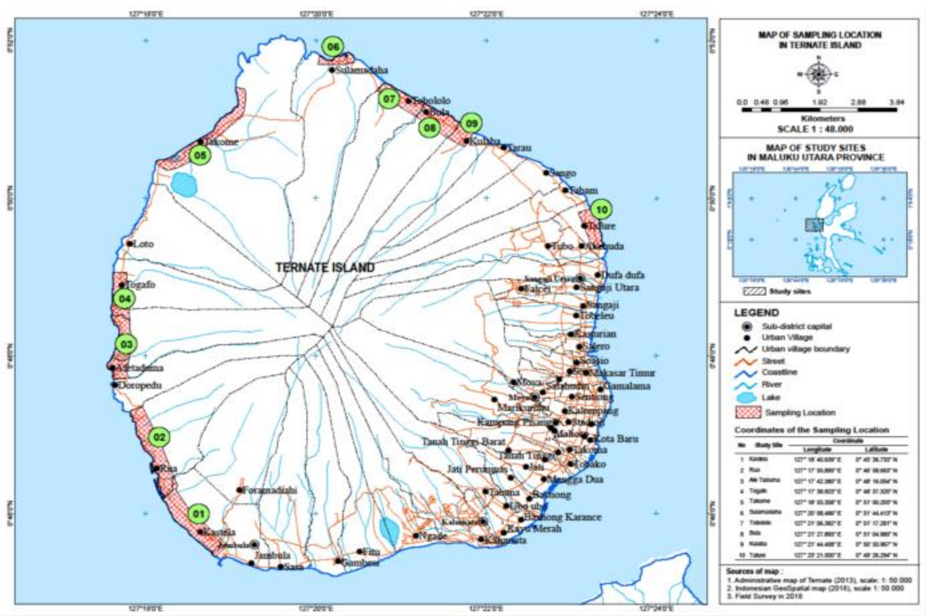

Fig 1. Map of distribution of Capilong stands in Ternate Island

From different stages of growth found in the field, nearly 47% of the total stands is dominated by the tree group. It is then followed by the stake group about 35%. Additionally, about 12% of the total is covered by the pole group and the least 6% covered by seedling group. The low number of seedling group found in the field is closely associated with the increase in the intensity of human intervention in converting the land to tourism and recreational purposes. Various practices that significantly caused the decline of seedling and stake population number include the removal of Capilong's seedling and stake population that were growing naturally; the lost of habitat for Capilong's seeds to germinate due to the establishment of concrete on the cleared soil surface; and burnt activity of the seeds fallen down from the trees. There is no cultivation activity performed as to compensate the lost of natural vegetation from the areas.

Table 1. The distribution and number of Capilong stands in different stage of growth in Ternate Island

No	Location	Stage of growth				Number of stands
		Seedling	Stake	Pole	Tree	
1	Kastela	29	229	60	143	461
2	Rua	6	15	10	144	175
3	Afetaduma	23	40	8	99	170
4	Togafo	-	-	-	8	8
5	Takome	6	109	49	62	226
6	Sulamadaha	-	-	-	5	5
7	Tobololo	5	9	3	6	23
8	Bula	9	52	23	141	225
9	Kulaba	6	20	3	9	38
10	Tafure	-	1	4	10	15
Number of stands		84	475	160	627	1,346
%		6.24	35.29	11.89	46.58	100

The distribution and number of Capilong stands at various topography

The finding showed that the highest population (71%) of Capilong trees distribute on the land ranging from 0 to

3 m above see level, whilst the lowest (nearly 2%) grows at elevation of up to 100 m (Table 2). As reported by Syakir & Karmawaty (2009), Capilong trees are adaptable to various elevation ranging from 100 to 350 m. In addition, in the equator the tree can survive at the elevation of up to 800 m (Friday & Okano, 2006).

Table 2. The distribution and number of Capilong stands in different elevation in Ternate Island

No	Location	No of stands in different elevation (m above see level)					Number of stands
		0-3	3-5	5-10	10-25	25-100	
1	Kastela	416	45	-	-	-	461
2	Rua	167	7	1	-	1	176
3	Afe Taduma	131	17	9	3	10	170
4	Togafo	1	2	-	1	4	8
5	Takome	136	42	34	11	3	226
6	Sulamadaha	5	-	-	-	-	5
7	Tobololo	17	6	-	-	-	23
8	Bula	29	53	69	67	7	225
9	Kulaba	36	2	-	-	-	38
10	Tafure	15	-	-	-	-	15
Number of stands		953	174	113	82	25	1,347
%		70.7	12.9	8.4	6.1	1.9	100.0

Referring to the landscape of Ternate, the study found that nearly 80% of Capilong stands growing well on the flat area with the slope of 0-3% based on USDA classification (Edmonds *et al*., 1998). Yet, some (12.9%) grow on moderately steep (15-30%) and few are found on a very steep land (45-65%) (Table 3). Leksono *et al*., (2021) had also found that Capilong trees tolerate to various land slope.

Table 3. The distribution and number of Capilong stands in different class of slope in Ternate Island

No	Location	Flat (0-3%)	Gently sloping (3-8%)	Sloping (8-15%)	Moderately steep (15-30%)	Steep (30-45%)	Very steep (45-65%)	Number of stands
1	Kastela	460	1	-	-	-	-	461
2	Rua	162	1	-	1	10	1	175
3	Afe Taduma	136	9	2	4	2	17	170
4	Togafo	1	-	2	-	-	5	8
5	Takome	124	22	5	61	14	-	226
6	Sulamadaha	5	-	-	-	-	-	5
7	Tobololo	20	-	-	3	-	-	23
8	Bula	113	-	10	102	-	-	225
9	Kulaba	36	-	-	2	-	-	38
10	Tafure	15	-	-	-	-	-	15

Number of stands	1,072	33	19	173	26	23	1.346
%	79.6	2.5	1.4	12.9	1.9	1.7	100.0

The distribution and number of Capilong stands on land with various rock materials

The Capilong trees have demonstrated their high tolerance to grow on soils generated from different rock materials. Referring to the Geology map of Ternate Island, soils in the island were originated from materials of volcanic eruption including lava and pyroclastic, which further formed as alluvium deposit, sand sediment on the beach, volcanic tuff, and basalt andesite.

The result of our investigation showed that nearly 65% of total stands grows well on the soils dominated by sand sediment along the coast. We also found the population of Capilong (18.9% of total stands) grows on soils derived from basalt andesite and 13.6% of total stands grows on alluvium deposit soils. Only about 1.8% of total stands grows on volcanic tuff soils and very few (1.2% of total stands) can survive on landfill (Table 4).

Table 4. The distribution and number of Capilong stands on land with different rock materials in Ternate Island

No	Location	Beach sand sediment	Alluvium deposit	Volcanic tuff	Basalt andesite	Landfill material	Number of stands
1	Kastela	422	38	-	1	-	461
2	Rua	148	13	-	13	1	175
3	Afe Taduma	136	-	-	34	-	170
4	Togafo	1	-	2	5	-	8
5	Takome	124	-	22	80	-	226
6	Sulamadaha	5	-	-	-	-	5
7	Tobololo	20	-	-	3	-	23
8	Bula	13	100	-	112	-	225
9	Kulaba	-	36	-	2	-	38
10	Tafure	-	-	-	-	15	15
Number of stands		869	187	24	250	16	1,346
%		64.6	13.9	1.8	18.6	1.2	100

The distribution and number of Capilong stands on land with various landform

Ternate Island is formed through volcanism processes from the volcanic mountain called Gamalama Mount, and is categorized as a young volcanic island. The morphology of landform in the island varies from lower, middle and upper volcanic slopes. Other landforms occurred as a result of erosion and sedimentation on rivers and beaches found on the foot of the volcanic mountain include alluvial plain, flood plain, sandy shore, tidal swamp, sloping land. In addition, another landform that occurred due to an anthropogenic activity called reclaimed land, is also included in our investigation.

Our result showed that Capilong stands are widely distributed in a high number of population (65% of total stands) on the sandy sea shore, followed by 20% on the sloping land, and 12% on the alluvial plain. About 2% of the population is found growing on the tidal swamp. Dweck & Meadows (2002) noted that Capilong trees prefer to grow on the coral sand and on sandy sea shore saline soils. Their ability to survive on wetland indicating that the plants not only grow on dry lands but also have shown a high tolerance to occasional waterlogging on the sea shore (Friday & Okano, 2006).

Table 5. The distribution and number of Capilong stands on different landform in Ternate Island

No	Location	Sandy sea shore	Flood plain	Alluvial plain	Tidal swamp	Sloping land	Reclamation area	Number of stands
1	Kastela	422	-	11	27	1	-	461
2	Rua	146	-	13	2	13	1	175
3	Afe Taduma	136	-	-	-	34	-	170
4	Togafo	1	-	-	-	7	-	8
5	Takome	124	-	-	-	102	-	226
6	Sulamadaha	5	-	-	-	-	-	5
7	Tobololo	20	-	-	-	3	-	23
8	Bula	13	4	96	-	112	-	225
9	Kulaba	-	-	36	-	2	-	38
10	Tafure	-	-	-	-	-	15	15
Number of stands		867	4	156	29	274	16	1.346
%		64,6	0,3	11,6	2,0	20,4	1,2	100

CONCLUSIONS

In conclusion, the Ternate Capilong trees have demonstrated a natural characteristic that are able to distribute widely on various topography, landforms, and rock materials. They also uniquely show a high tolerance to a brief period of waterlogging indicating that the plant is a tolerant species to the harsh environmental conditions. Given the number of population of Capilong is low due to some destructive anthropogenic activities, it is recommended to develop a community development program to cultivate the plant. In addition, it is significantly important for the local government to classify Capilong trees as the potential species to be used for land rehabilitation programs particularly in improving sub-optimal or degraded lands due to mining activities.

ACKNOWLEDGEMENTS

The authors would like to extend their sincere gratitude to Australian Government for a supporting fund provided through an Alumni Grant Scheme (AGS) project administered by Australia Awards Indonesia in 2018-2019 to do this study. Also, a special thank goes to Yamin for his assistance in field investigation.

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