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Article

Factors Behind Cessation of Illegal Logging by Local Communities for Valuable Timber-producing Endemic Species, *Hopea celebica*

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Abstract. *Hopea celebica* is a species of Dipterocarpaceae that produces strong and durable wood. This species is endemic to Sulawesi Island, where its spread is restricted to specific habitat types in the southern part of the island. The high quality of the wood has exposed this species to high levels of illegal logging and is endangered. However, in the last two decades, the threat of logging to this tree species has ceased to occur. Through field surveys and interviewing of respondents in 6 small FGDs, this study aims to determine the factors behind the cessation of illegal logging activities. We found that this species has good regeneration ability and identified 3 leading causes of stopping illegal logging of *H. celebica*: restricting its habitat to the Bantimurung Bulusaraung National Park, the change in cultural interest from building houses on stilts to concrete houses, and the shift in the lifestyle of young generation who are no longer interested in working as woodcutters. Thus, the cessation of illegal logging of *H. celebica* is not due to the correct public perception of the importance of conserving *H. celebica* to increase its population so that it can be used sustainably in the future. The Bantimurung Bulusaraung National Park still needs to make people aware of the importance of *H. celebica* conservation.

Keywords: karst ecosystem, regeneration, conservation, sustainable

INTRODUCTION

The extinction of a species is an ecological issue (Noss & Kranz, 2001), but preserving a species from extinction cannot be done only through an ecological approach. This occurs because the factors driving the extinction of a species are not primarily due to ecological agents (Mankga & Yessoufou, 2017). Through their activities in exploiting natural resources, humans are the agents most responsible for causing species extinction, either directly or indirectly (Western, 2001; Vold & Buffett, 2008). There is a dilemma, on the one hand, humans need various species as natural resources, but on the other hand, their actions in utilizing natural resources have often caused a number of species to become endangered or even extinct, which can threaten the survival of humanity itself. Therefore, every conservation approach that is taken to save species from extinction inevitably must involve humans with their various cultures.

Hopea celebica is a species of Dipterocarpaceae endemic to Sulawesi Island, Indonesia and is threatened with extinction (Ashton, 1998; Purwaningsih, 2004). This species is the only dipterocarp species found in the southern part of the South Sulawesi Peninsula, which is specifically distributed in the karst ecosystem in the Maros and Pangkep Regencies. It grows well on the steep cliffs of karst towers and has never been found growing on soil substrates even though it is still under the karst habitat environment. However, there is a publication reporting that *H. celebica* was also found to grow in ultrabasic soil habitats in the Luwu

Timur Regency, which is located in the central part of Sulawesi Island (Sirimorok & Rusdianto, 2020; Sudarmonowati et al., 2020). Given the very different preferences for habitat characteristics between populations found in the Maros and Pangkep regencies compared to those found in Luwu Timur, it is necessary to phylogenetically examine whether the two populations are truly the same species. Some reports also state that this species was found in Java (Heyne, 1950; Backer & Van den Brink, 1963; Ashton, 1982), but there is no further explanation regarding the habitat where this species is found, as well as an explanation of whether the tree grows naturally or was introduced from Sulawesi Island.

Unlike common species of Dipterocarpaceae, which grow rapidly (Chia, 2013, Widiyatno et al., 2020), *H. celebica* is a very slow-growing species and therefore produces very hard and durable wood. Local people describe the strength of *H. celebica* wood as being more durable than iron, especially if used in places that come in direct contact with wet ground, such as when used as poles of Buginese traditional houses on stilts or as garden fences (Pers. com. Pado', staff of Bantimurung Bulusaraung National Park, November 2018). Due to its very strong and durable nature, *H. celebica* wood was in great demand by the local community to be used as poles for houses on stilts. Most of the old traditional houses in the Maros and Pangkep Regencies used *H. celebica* wood - which the local community calls "Keri" wood – as house poles (author's observation).

The great demand for *H. celebica* wood in the past has put this species under tremendous logging pressure. Trees that had just reached the diameter required for a house on stilt poles (approximately 15-20 cm in diameter) were usually cut down, while *H. celebica* trees of that size were just beginning to bear fruits. The mother trees, which were supposed to produce seeds for reproduction, had mostly been cut down, leaving saplings ready to be cut down before they were able to produce seeds. The considerable logging pressure had made the population of *H. celebica* decline to the level where it is feared that it could threaten its sustainability; thus, *H. celebica* has been categorized as an endangered species in the IUCN Red List of Threatened Species since 1998 (see also Sudarmonowati et al., 2020).

In the last few decades, especially after most of the karst ecosystems in the Maros and Pangkep Regencies were designated as the Bantimurung Bulusaraung National Park (Babul National Park), *H. celebica* wood is no longer circulating in the local timber market. This study aimed to uncover a number of reasons behind the reduced pressure for illegal logging on *H. celebica*, such as its population in the wild, the role of Babul National Park, cultural change, and the modernization of the younger generation's lifestyle in the surrounding area. The research results are expected to be a reference in the management of endangered species elsewhere.

MATERIAL AND METHODS

Study Period, Site, and Species

This study focused on the population of *H. celebica* spread in the karst ecosystem in the Maros and Pangkep Regencies from October 2018 to March 2019. Overall, the Maros-Pangkep karst area, which is a potential habitat for *H. celebica*, is approximately 40,000 ha, and approximately half of it (19,488 ha) is part of the Babul National Park area that was designated in 2004. Field observations of *H. celebica* populations were performed in the karst ecosystem both inside and outside the Babul National Park. As previously mentioned, this species only grows on steep cliffs and soil-less limestone hills. During the field survey, 6 seedlings were found growing in clumps on the soil substrate at the base of the cliff, but mature *H. celebica* trees were never found growing in the soil substrate.

Field Survey of the *H. celebica* Population

It was impossible to make horizontal sample plots on steep cliffs and sharp limestone hills. Instead, data collection was performed by assigning one karst hill or a cluster of hills as the observation unit to substitute the plots. The determination of limestone hills for sample plots was performed purposively by considering the existence of a climbable cliff. When we find a hill where the cliff face can be climbed, we set the starting point of the climb as the zero point and measured its geographic coordinates using three GPS units (GPSmap 62S). The tracking mode of the GPS was activated, and then we started climbing while collecting data by going around the hills (cliffs and peaks) until we finally returned to the zero point. If the karst hills were a cluster with cliffs that were very dangerous to cross back to the zero point, then we did not return to the

zero point but continued our observations to the adjacent hills. In addition to activating the GPS tracking mode, we regularly recorded the geographic position of the outer cliff boundary of the hill group.

Using the data from GPS, the area of each cluster of limestone hills used as a substitute for observation plots was mapped from satellite imagery, and its area was calculated. Therefore, the size of one observation unit with other observation units is not the same. Overall, there were 20 sample plots with a total area of 36.46 ha that were purposively distributed to represent all karst ecosystems in the Maros and Pangkep Regencies. However, there were some parts of the site that could not be reached due to difficult accessibility.

Because cliffs were often very steep and dangerous to traverse, not all trees could be approached to measure their diameter. Therefore, we classified individual trees of *H. celebica* into seven height-diameter classes: (1) height >150 cm but diameter <5 cm; (2) diameter 5–10 cm; (3) diameter 10–20 cm; (4) diameter 20–30 cm; (5) diameter 30–40 cm; (6) diameter 40–50 cm; (7) diameter >50 cm. For the seedling population (individuals <150 cm tall), small horizontal plots of 2 m × 2 m were systematically made every two hours during the observation period, and the number of *H. celebica* seedlings present in the small plots was counted.

Table 1. Number, distribution, and area of observation units

Plot Num.	Location	Area specifications	Plot Area (ha)
01	Leang-Leang 1	Hill next to rice field	1.63
02	Leang-Leang 2	A small hill under a steep high hill	1.85
03	Gua Pattunuang 1	High and steep hills	0.80
04	Gua Pattunuang 2	A small hill, the cliff of which is a river	0.33
05	Karaenta 1	bank	0.82
06	Karaenta 2	Small hill near the main road	0.90
07	Karaenta 3	Small hill near the main road	3.12
08	Balocci 1	Isolated clusters of hills	8.35
09	Balocci 2	The hills around the marble mine	6.81
10	Ujung Batu	Hills near settlements	0.98
11	Leang Lonrong 1	Hills next to rice fields	0.27
12	Leang Lonrong 2	The hill near the rock quarry	0.59
13	Batu Napara	The hill is slightly far from the settlement	1.80
14	Bantimurung	Hills near rice fields	1.05
15	Kalabirang	Hill near tourist area	2.53
16	Matampa	High hill with steep cliffs	0.43
17	Minasabaji’	Small hills in the fault passage	0.75
18	Takamasea	Steep cliffs of the fault alley	1.38
19	Simbang	A small hill between steep high hills	0.75
20	Sambueja	A hill with high steep cliffs	1.33
		Cliffs around the fault passage	
Total plot area			36.46

Focus Group Discussion and Interview with Local Community

We held six short, limited, and informal focus group discussions (FGDs) when we met with 4 to 8 people (over 50 years old) who gathered in certain places such as on the roadside, at the cemetery, in the field, and in front of their houses in the village. The questions we asked were mainly: (1) do they know the *H. celebica* tree and its wood; (2) utilization of *H. celebica* wood; (3) do they have house stilts made of *H. celebica* wood; (4) past and present logging activities of *H. celebica*; (5) *H. celebica*'s status as a protected tree species; (6) their opinions on the future use of *H. celebica* wood; (7) the reason people stop cutting down *H. celebica* trees; and (8) their perceptions of the *H. celebica* tree. In addition, we also conducted a short interview when

we met elderly residents in front of their stilt houses on our way to the field to survey the *H. celebica* population, and we asked some questions to obtain additional information.

To evaluate *H. celebica*'s timber circulation in the timber market, we interviewed five wood shop owners, two of whom operate small sawmills to saw wood into beams or planks. The questions we asked of the timber shop owners were as follows: (1) how long have they been operating a timber shop; (2) do they know *H. celebica* wood; (3) are they selling *H. celebica* timber; (4) if they are not selling, whether they ever sold *H. celebica* timber; and (5) are there any consumers who want to buy *H. celebica* timber.

Data Analyses

We used the data from the measurement of the tracking mode and geographic points in the field to map the limestone hills that we explored in the field on satellite imagery. Using this method, we can calculate the area of the hills that we were exploring in the field as a plot area. Thus, from the 20 sample plots that we explored, the plot size was not uniform but varied between 0.27 and 8.23 ha (Table 1). Using this approach, we calculated the density per hectare of the tree, pole, and sapling of *H. celebica*, while the seedling population was calculated from the data obtained from the 2 m × 2 m plots.

RESULTS

Brief Description and Habitat of *H. celebica*

Hopea celebica is a tree species of Dipterocarpaceae. It can grow up to 80 cm in diameter and 25 m in height. Unlike the Dipterocarpaceae species in general, whose boles are upright, tall, and free of branches, *H. celebica*'s boles are not very tall, branches are close to the rootstock and can easily produce sprouts if the main stem is broken. Leaves vary in shape, mainly oblong to oval, sometimes lanceolate, ovate, or rarely elliptic. Leaf size largely varies, with length between 14.5 and 29.5 cm and width between 5.5 and 11 cm, apex acute to acuminate, base mostly truncate and rarely rounded, with entire margin (Fig. 1 left). The secondary vein varies between 9 and 11 pairs and often has domatia on the axillar between the midrib and secondary vein. Large leaves are generally not whole because they are eaten by insects. Flower: bisexual, panicle, axillary or terminally, actinomorphic, much smaller than common Dipterocarpaceae species; perianth consists of calyx and corolla, distinct; calyx actinomorphic, persistent, accrescent, imbricate; corolla consists of 5 lobes, in one whorled, imbricate, approximately 6 mm in diameter when bloom, yellowish white with almost pink around the edges; stamen 5-15; pistil 1, style 1, ovary superior. Fruits: nut with 2 wings approximately 2 cm in length.

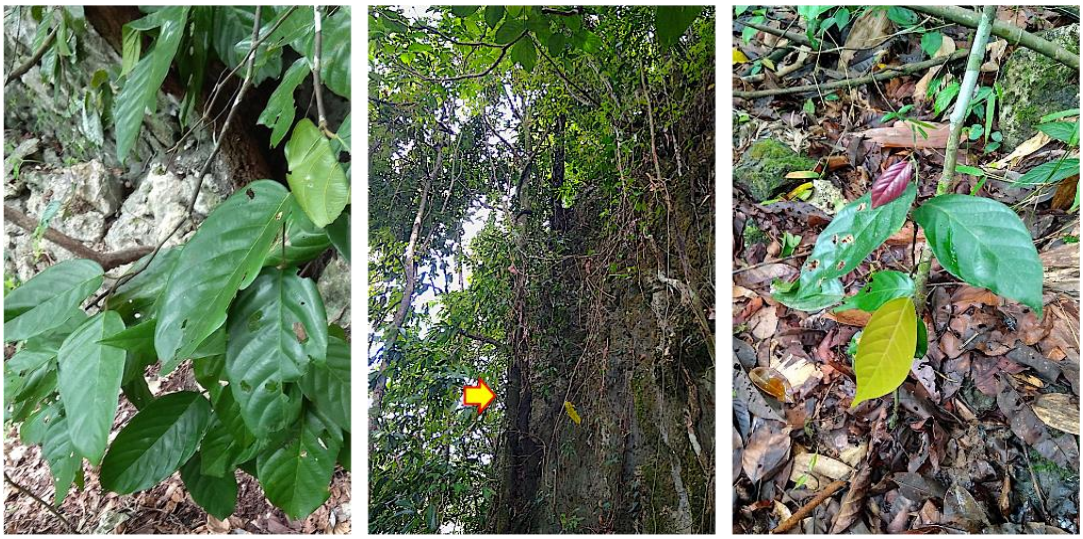

Figure 1. Leaves of *H. celebica* (left), a tree of *H. celebica* grows well on an upright cliff (center), and seedlings of *H. celebica* grow on shallow soil substrate below a cliff (right).

Spatial Distribution of *H. celebica* on Karst

In the southern part of South Sulawesi Province, *H. celebica* was found only growing in karst ecosystems, especially on soil-less limestone cliffs. The steeper were the cliffs, the more *H. celebica* trees were found (Fig. 1 center). However, this species was not evenly distributed in the karst hills of the Maros and Pangkep Regencies (Fig. 2). It generally avoided high hills with rocks that look very massive, arid, and barren. Such limestone hills were mainly located around the Balocci, Batu Napara and Kalabirang areas in Pangkep Regency, while in Maros Regency, such limestone hills were located starting from the Leang-Leang to Ramang-Ramang areas.

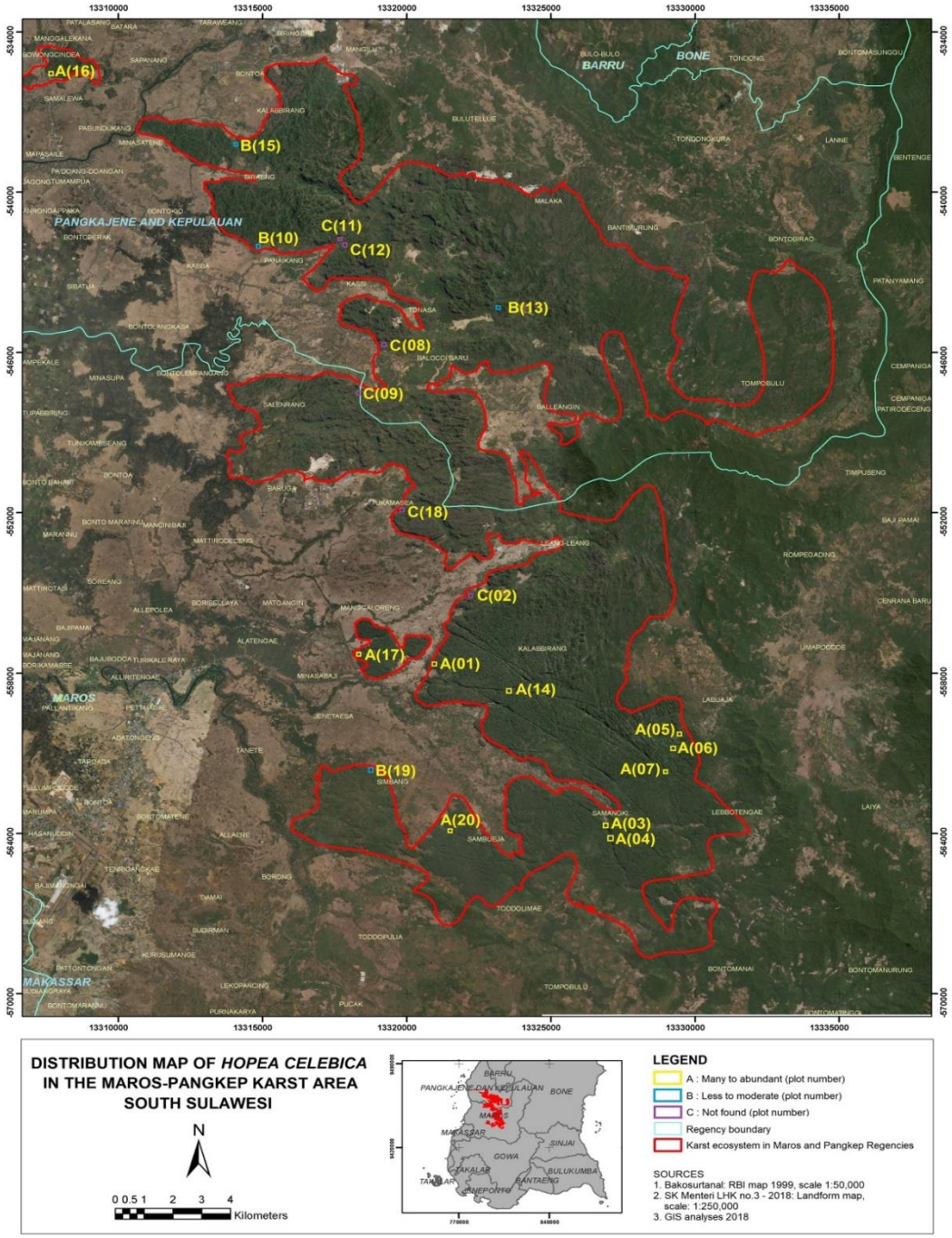

Figure 2. Map of the spatial distribution of *H. celebica* trees in karst ecosystems in the Maros and Pangkep Regencies: capital letters indicate the abundance of *H. celebica* (A: many to abundant, R: rare to moderate, N: not found); the numbers in brackets following each letter indicate the plot number.

Trees of *H. celebica* are mostly found in hills with porous karst rocks whose surfaces are usually sharp and can injure the hands if held without gloves. The karst hills with such rocks are distributed in many areas of Maros Regency, starting from the Pattunuang and Karaenta to Kapang areas, as well as in the Simbang and Sambueja areas and around Bantimurung to the Leang-Leang area. In Pangkep Regency, karst hills with rock structures such as this were found in Matampa and surrounding areas, Ujung Batu, Batu Napara, and Kalabirang. While mature *H. celebica* trees were found only on soil-less limestone hills, seedlings of this species were once found in shallow soil substrates at the bottom of cliffs (Fig. 1 right).

Regeneration Potential

Of the 20 plots with a total area of 36.46 ha, there were plots where *H. celebica* was abundantly found, but there were also plots where no individual of the species was found. The population structure in Fig. 3 was constructed by averaging the population data over 20 plots. By taking the 5 cm diameter range for individuals with a diameter of less than 10 cm and the 10 cm diameter range for individuals with a diameter of more than 10 cm, Fig. 3 shows the population structure of *H. celebica*, which is inverted J-shaped. In other words, the number of individuals is greater at a lower growth stage.

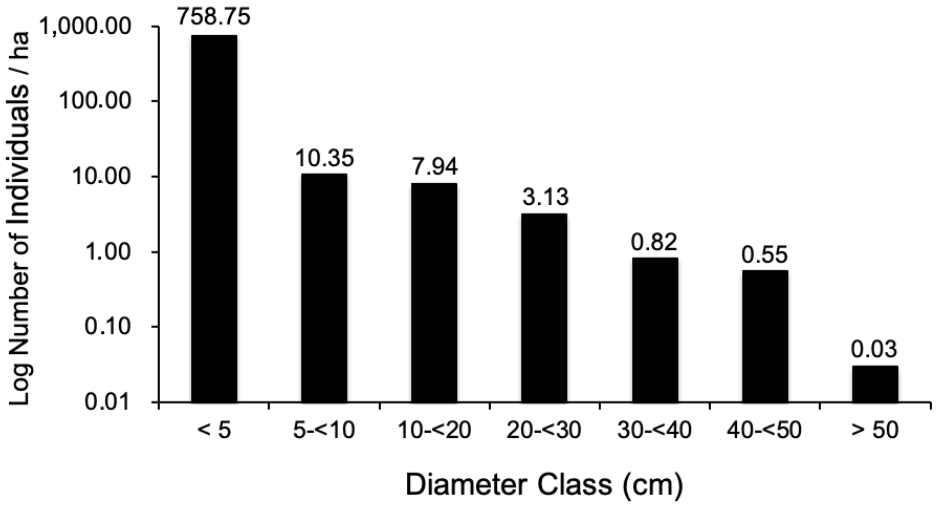

Figure 3. The population structure of *H. celebica* shows a slightly sloping inverted J-shape

The mean number of individuals with a diameter of less than 5 cm was 758.75 individuals/ha. Field surveys showed that the distribution of seedlings was not evenly distributed across the area but instead concentrated under the mother tree. Of the twenty plots observed, no seedlings were found without a mother tree. On the other hand, there are always seedlings or saplings around a mother tree. Fig. 3 shows that the population density of mature trees >20 cm in diameter is 4.83 individuals per ha.

Community Perception, Culture Shift and Utilization of *H. celebica* Wood

Due to its high durability and strength, *H. celebica* wood was generally processed into wooden beams to be used as poles of houses on stilts (Table 2). All respondents who attended the six FGDs agreed that this wood is timeless even though it has been buried in the ground for tens or even hundreds of years. When used as poles for houses on stilts, it is generally installed directly in the ground without needing to be supported using footing, which is usually made of stone or concrete (Fig. 4).

Most of the poles of old traditional houses on stilts in Maros and Pangkep Regencies were made of *H. celebica* wood. Apart from being used for house poles, respondents in Bantimurung also stated that *H. celebica*'s wood in the past was also used to make truck bodies. When the FGD was held in Leang-Leang Village, the participants stated that *H. celebica* wood was also used as a material for making plows for use in rice fields. An FGD participant who works as a machete craftsman (blacksmith) stated that charcoal from *H. celebica* wood waste is ideal to heat iron that will be formed into machetes or other household tools. Respondents in Labuaja Village stated that in the past, *H. celebica* wood was also used as power poles.

Table 2. Answers agreed upon by all participants in the 6 FGDs about their perceptions of *H. celebica* wood

Topics Covered	Approved Answer		Total FGD
	Yes	No	
1. Know about *H. celebica* wood	6	0	6
2. Strong and durable	6	0	6
3. Good for the poles of houses on stilts	6	0	6
4. Was used as power pole*	1	5 (ND)	6
5. Good for charcoal to forge iron*	1	5 (ND)	6
6. It was intensively logged in the past	6	0	6
7. No more logging activity at present	6	0	6
8. Know *H. celebica* as endangered species	0	6	6

* = Not specifically discussed; NA = Not discussed

Figure 4. Wood of *H. celebica* installed directly into the ground without needing to be supported using footing

Most of the poles of old traditional houses on stilts in Maros and Pangkep Regencies were made of *H. celebica* wood. Apart from being used for house poles, respondents in Bantimurung also stated that *H. celebica*'s wood in the past was also used to make truck bodies. When the FGD was held in Leang-Leang Village, the participants stated that *H. celebica* wood was also used as a material for making plows for use in rice fields. An FGD participant who works as a machete craftsman (blacksmith) stated that charcoal from *H. celebica* wood waste is ideal to heat iron that will be formed into machetes or other household tools. Respondents in Labuaja Village stated that in the past, *H. celebica* wood was also used as power poles.

When we met elderly people on our way to the forest and asked if he knew the *H. celebica* tree, they were usually nervous and quick to answer that they did not know. However, after we introduced ourselves that we were researchers from a university studying *H. celebica*, they opened up and even showed us which hills we should head to find *H. celebica* easily. An old man even showed us that initially, the poles of his house on stilts were made of *H. celebica* wood, but later, he replaced it with another wood. Several other people did not want to admit that they knew the *H. celebica* tree, even though we saw that the poles of their houses were made of *H. celebica* wood. In the FGD, it was revealed that the community was reluctant to honestly admit that they knew *H. celebica* wood because after most parts of the karst area in the Maros and Pangkep

regencies were designated as Babul National Park, many people were arrested for cutting *H. celebica* wood. Since the designation of the Maros-Pangkep karst ecosystem as Babul National Park, no one has dared to illegally cut *H. celebica* wood anymore.

Among the 5 wood shop owners we interviewed (Table 3), three owners stated that they had been operating a wood shop for more than 10 years and the other two for less than 10 years. All wood shop owners stated that they were not selling *H. celebica* wood at the time, but two of them (running shop for more than 10 years) stated that they sold it in the past. A wood shop owner, who has been operating for less than 10 years (the owner was less than 40 years old), admitted that he was not familiar with *H. celebica* wood, commonly known as "keeri" wood. All wood shop owners stated that recently they have never received orders for *H. celebica* wood.

Table 3. Results of interviews with 5 wood shop owners in the Maros and Pangkep Regencies

Interview topic	Woodshop Answer		Total Woodshops
	Yes	No	
1. Know about *H. celebica* wood	4	1	5
2. Selling *H. celebica* wood	0	5	5
3. Ever sold *H. celebica* wood	2	3	5
4. Received an order for *H. celebica* wood recently	0	5	5

Culturally, traditional Bugis houses in the Maros and Pangkep regencies are stilt houses. However, houses on stilts are increasingly rare, especially in urban areas, and are being replaced by modern minimalist houses made of concrete. In the countryside, the existence of houses on stilts is still ubiquitous. Several new stilt houses built mainly in rural areas look more presentable, larger, and seem more luxurious. Respondents in all FGDs agreed that concrete houses are cheaper, tidier, easier to maintain, and provide more opportunities to design models and room layouts. However, having a large stilt house made of good-quality wood is still a good indicator of high social status in rural communities.

Respondents in the villages of Batu Napara, Bulu Tellue, and Liang Lonrong, who have large houses on stilts, stated that they replaced the poles and stairs of their houses from *H. celebica* wood to *Eusideroxylon zwagerii* wood (iron wood) because *E. zwagerii* wood is a wood with a smoother surface texture, straighter, with better colors, and looks more luxurious. Eusideroxylon zwagerii wood is also known as a strong and durable wood. The price of E. zwagerii wood is also more expensive (IDR 1,400,000) than that of *H. celebica* wood (IDR 900,000) for one beam the size of a house pole (15 cm × 15 cm × 400 cm). This shows that currently, people in the Maros and Pangkep regencies prioritize aesthetics over durability.

Table 4. Answers provided by the FGD participants to the questions they were given regarding the use of *H. celebica* wood

Interview topic	Respondent Answer		Total FGD
	Yes	No	
1. Your house made of *H. celebica* wood	2	4	6
2. Prefer concrete house to house on stilts	4	2	6
3. No more logging activities after the area is designated as a National Park	6	0	6
4. Young people are not interested in working as *H. celebica* loggers	5	1	6

Young Job Seekers and Woodcutters of *H. celebica*

The work of obtaining wood from the *H. celebica* tree that grows on a very steep karst hillside is not easy. The hard work involves not only climbing steep karst hillsides while cutting down *H. celebica* trees but also carrying logs from the forest to the village because large *H. celebica* trees still remain deep in the forest. This work is not only exhausting but also dirty and less intellectual. In addition, given that *H. celebica* is a tree

species that is protected by law and grows in conservation areas, cutting down *H. celebica* trees is an illegal act that carries the risk of being arrested by law enforcement.

In the past, when there were fewer jobs, being a woodcutter of *H. celebica* was the best job option, especially for people with low educational backgrounds. In addition, the demand for *H. celebica* wood at that time was high, and the price was also good. A job as a woodcutter of *H. celebica* could provide enough income to support a family. A former illegal logger from the village of Labuaja stated that his work as a woodcutter of *H. celebica* could provide him with sufficient income to support his family of 4 children.

In the FGD, it was revealed that in an era where job opportunities are plentiful, varied, and not tiring, young job seekers with good educational backgrounds are no longer interested in working as woodcutters of *H. celebica* (Table 4). They are more interested in working in air-conditioned rooms as company employees, sales promotion girls/boys in malls or supermarkets, cleaning staff in office buildings, or other indoor jobs.

DISCUSSION

Community-based conservation is not a new issue in the movement to save biodiversity from extinction (Berkes, 2007; Ruiz-Mallén & Corbera, 2013; Campos-Silva et al., 2021). This is relevant because the main agents of species extinction are humans through their need for natural resources to live (Forester & Machlist, 1996; Yule et al., 2013; Sodhi et al., 2014; Ceballos et al., 2015). However, involving the community to be consciously engaged in the conservation movement is not an easy matter (Lammers et al., 2017; Aldashev & Vallino, 2019), especially in developing countries where the human resource capacity of the majority of the population is still low, and natural resources are their only source of livelihood (Noss, 1997; Ozuruoke et al., 2021). Local people, who were previously reported to rely on local wisdom (Acciaioli, 2008), are becoming exploitative along with the increasing needs of life and the increasingly limited availability of natural resources (Ngakan et al., 2006; Ikpa et al., 2009).

The population structure diagram for *H. celebica* shows that this species naturally has a good ability to regenerate (see Maua et al., 2020); thus, its population in nature should be high. Thus, the low population of *H. celebica* in its habitat is an indication that this species is experiencing very high exploitation pressure. As revealed by the FGD, this species had been under exploitation pressure for various reasons without people realizing that its population was threatened. When large trees were no longer found, small trees that had not yet begun to bear fruit for regeneration were cut down. Such use of biodiversity is a major cause of the extinction of many species (Ngakan, 2006).

The designation of karst areas in the Maros and Pangkep Regencies as Babul National Park is a strategic decision in an effort to save endangered species in the area, one of which is *H. celebica*. With the designation of its habitat as a national park, Babul National Park is now the institution responsible for the conservation of *H. celebica* by arresting people who cut it down. This may sound like an unpopular policy in an era where conservation organizations are increasingly seeking to integrate components of economic development with conservation issues (Noss, 1997). However, this is an emergency and urgent policy that the management of Babul National Park must take to save *H. celebica* from extinction. As a representative of the government, Babul National Park has the mandate to preserve natural resources and ensure their availability in a sustainable manner to meet the needs of the community. Conservation is not intended to block people's access to natural resources but to regulate their use so that they remain available to meet community needs in a sustainable manner, something the local people generally do not think of. If by conserving it, the population of *H. celebica* can later recover, of course, at that time, the wood can be harvested again.

The community's greater interest in building minimalist concrete houses than stilt houses is another reason why people no longer depend on *H. celebica* wood. Likewise, the younger generation is no longer interested in hard work of cutting down *H. celebica* trees on the cliffs of the limestone hills and bringing them to the village, which is another factor that has helped save the *H. celebica* population. However, people stopping logging *H. celebica* because they were afraid of being arrested and imprisoned or because they were no longer interested in building houses on stilts, and the younger generation no longer being interested in working as *H. celebica* loggers do not reflect the success of the conservation program. Conservation is not about fear, it is about awareness.

Perhaps because of insufficient education or increasing living needs, local communities often do not exhibit a 'conservation ethic' in exploiting natural resources (Noss, 1997). Although there have been many publications on the wisdom of the interior tribes in Indonesia in utilizing natural resources (Syarif et al., 2016; Christiawan, 2017), Ngakan (2006) reveals that many researchers have misperceptions in understanding wise people and fearful people (see also Pesurnai, 2018). In some cases, people who do not cut down trees in sacred forests may not be truly wise, rather they are people who, according to their beliefs, fear bad luck by cutting down trees there. Conservation requires logical intelligence to consciously understand that to maintain human existence on earth, we need as many natural resources as possible not only for now but also for the future and generations to come. A community can be judged to be wise based on the integrity of the natural resources in the area, and their income from these natural resources should be sustainable and not excessive.

Through various approaches, Babul National Park still needs to educate local communities about the importance of conserving *H. celebica*. For now, we need to stop logging *H. celebica* and develop its population so that when its population has increased, the next generation can use it again.

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CONFLICTS OF INTEREST

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REFERENCES

Acciaioli, G. (2008). Environmentality reconsidered: indigenous To Lindu conservation strategies and the reclaiming of the commons in Central Sulawesi, Indonesia. In: People, Protected Areas and Global Change: Participatory Conservation in Latin America, Africa, Asia and Europe (M. Galvin and T.Haller Eds.). NCCR North-South. Pp. 401-430. Available at https://research-repository.uwa.edu.au/en/publications/environmentality-reconsidered-indigenous-to-lindu-conservation-st. Accessed on July 20, 2021.

Aldashev, G., & Vallino, E. (2019). The dilemma of NGOs and participatory conservation. *World Development*, 123, 104615. https://doi.org/10.1016/j.worlddev.2019.104615.

Ashton, P.S. (1982). Dipterocarpaceae. Flora Malesiana - Series I Spermatophyta, Flowering Plants. 9(2), 237-552.

Ashton, P. (1998). *Hopea celebica*. The IUCN red list of threatened species 1998: e.T33093A9750682. http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T33093A9750682.en. Accessed on March 12, 2019.

Backer C.A., & Van den Brink, R.C.B. (1963). Dipterocarpaceae in Flora of Java I. NVP Noordhoff, Groningen, The Netherlands.

Berkes, F. (2007). Community-based conservation in a globalized world. *PNAS*, 104(39), 15188-15193. https://doi.org/10.1073/pnas.0702098104.

Campos-Silva, J.V., Peres, C.A., Hawes, J.E., Abrahams, M.I., Andrade, P.C.M., & Davenport, L. (2021). Community-based conservation with formal protection provides large collateral benefits to Amazonian migratory waterbirds. *PLoS One*, 16(4), e0250022. https://doi.org/10. 10.1371/journal.pone.0250022.

Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M., & Palmer, T.M. (2015). Accelerated modern human–induced species losses: entering the sixth mass extinction. *Science Advances*, 1(5), e1400253. https://doi.org/10.1126/sciadv.1400253.

Chia, F.R. (2013). Growth performance of dipterocarp species planted under Poring bamboo (*Gigantochloa levis*). *Sepilok Bulletin*, 17 & 18, 47-55. https://forest.sabah.gov.my/images/pdf/publication/sepilok-bulletin/SepilokBulletin.17.18.pdf. Accessed on July 18, 2021.

Christiawan, P.I. (2017). The role of local wisdom in controlling deforestation. *International Journal of Development and Sustainability*, 6(8), 876-888. Available at https://isdsnet.com/ijds-v6n8-25.pdf. Accessed on 22 November 2022.

Syarif, E., Fatchan, A., Sumarmi, & Astina, I.K. (2016). Tradition of "Pasang Ri-Kajang" in the forests managing in system mores of "Ammatoa" at District Bulukumba South Sulawesi, Indonesia. *Mediterranean Journal of Social Sciences*, 7(6), 325-332. Available at https://www.richtmann.org/journal/index.php/mjss/article/view/9604. Accessed on 22 November 2022.

Forester, D.J., & Machlist, G.E. (1996). Modeling human factors that affect the loss of biodiversity. *Conservation Biology*, 10(4), 1253-1263. https://doi.org/10.1046/j.1523-1739.1996.10041253.x.

Heyne, K. (1950). De nuttige planten van Indonesie. Deel I. 3e Druk. NV Uitgeverij W Van Hoeve 's-Gravenhage/Bandung.

Ikpa, T.F., Dera, B.A., & Jande, J.A. (2009). Biodiversity conservation: why local inhabitants destroy habitat in protected areas. *Science World Journal*, 4(4), 22-27. https://doi.org/ 10.4314/swj.v4i4.53584.

Lammers, P.L., Richter, T., Lux, M., Ratsimbazafy, J., & Mantilla-Contreras, J. (2017). The challenges of community-based conservation in developing countries—A case study from Lake Alaotra, *Madagascar. Journal for Nature Conservation*, 40, 100-112. https://doi.org/10.1016/j.jnc.2017.08.003.

Mankga, L.T., & Yessoufou, K. (2017). Factors driving the global decline of cycad diversity. *AoB Plants*, 9(4), plx022. https://doi.org/10.1093/aobpla/plx022.

Maua, J.O., MugatsiaTsingalia, H., Cheboiwo, J., & Odee, D. (2020). Population structure and regeneration status of woody species in a remnant tropical forest: a case study of South Nandi forest, Kenya. *Global Ecology and Conservation*, 21, e00820. https://doi.org/10.1016/j.gecco.2019.e00820.

Sirimorok, N. & Rusdianto, E. (2020). The importance of being political: emergence of a multi-stakeholder forum at the Lake Malili Complex, South Sulawesi. *Forest and Society*, 4(1), 98-114. https://doi.org/10.24259/fs.v4i1.7442.

Ngakan, P.O., Komarudin, H., Achmad, A., Wahyudi, & Tako, A. (2006). Community dependence, perception and participation on forest resources: a case study in Pampli Hamlet, North Luwu Regency, South Sulawesi Province, Indonesia. Center for Forestry Research: Forests and Governance Programme No 8/2006. Intiprima Karya, Jakarta. Available at https://www.cifor.org/publications/pdf_files/Books/BNgakan0601.pdf. Accessed July, 04 2019.

Noss, A.J. (1997). Challenges to nature conservation with community development in Central African forests. *Oryx*, 31(3), 180-188. https://doi.org/10.1046/j.1365-3008.1997.d01-10.x.

Noss, R.F. & Kranz, R. (2001). Ecological issues in conservation. *Ecological Applications*, 11, 945–946. https://doi.org/10.1890/1051-0761(2001)011[0945:EIIC]2.0.CO;2.

Ozuruoke, P.N., Wokekoro, E., & Ihuah, P.W. (2021). Challenges facing community participation in managing natural resources in Omoku, Nigeria. *MOJ Ecology & Environmental Sciences*, 6(3), 70–73. https://doi.org/ 10.15406/MOJES.2021.06.00217.

Pesurnai, A.J. (2018). Local wisdom in a new paradigm: applying system theory to the study of local culture in Indonesia. *IOP Conf. Series: Earth and Environmental Science*, 175, 012037. https://doi.org/10.1088/1755-1315/175/1/012037.

Purwaningsih, P. (2004). Ecological distribution of Dipterocarpaceae species in Indonesia. *Biodiversitas*, 5(2), 89-95. https://doi.org/10.13057/biodiv/d050210.

Ruiz-Mallén, I., and Corbera, E. (2013). Community-based conservation and traditional ecological knowledge: implications for social-ecological resilience. *Ecology and Society*, 18(4), 12. http://dx.doi.org/10.5751/ES-05867-180412.

Sodhi, N.S., Brook, B.W., & Bradshaw, C.J.A. (2014). Causes and consequences of species extinctions. In: The Princeton Guide to Ecology (S. A. Levin, S. R. Carpenter, H.C.J. Godfray, A.P. Kinzing, Michel Loreau, J.B. Losos, B. Walker, and David S. Wilcove Eds.). Princeton University Press. Pp: 514-520. https://doi.org/10.1515/9781400833023.514.

Sudarmonowati, E., Yulita, K.S., Partomihardjo, T., & Wardani, W. (2020). Indonesia plant red list 1: 50 species of commercial timber trees. LIPI Press Bogor Indonesia. In Indonesian. Available at https://e-service.lipipress.lipi.go.id/press/catalog/download/310/270/1106-1?inline=1. Accessed on 24 July 2021.

Vold, T., & Buffett, D.A. (2008). Ecological concepts, principles and applications to conservation, BBC. 36 pp. Available at: http://www.biodiversitybc.org/assets/pressReleases/BBCPrinciplesWEB.pdf. Accessed on 24 July 2021.

Western, D. (2001). Human-modified ecosystems and future evolution. *Proceeding of the National Academy of Science of the United State of America*, 98: 5458-5465. https://doi.org/10.1073/pnas.101093598.

Widiyatno, Hidayati, F., Hardiwinoto, S., Indrioko, S., Purnomo, S., Jatmoko, Tani, N., & Naiem, M. (2020). Selection of dipterocarp species for enrichment planting in a secondary tropical rainforest. *Forest Science and Technology*, 16(4), 206-215, https://doi.org/10.1080/21580103.2020.1831620.

Yule, J.V., Fournier, R.J., & Hindmarsh, P.L. (2013). Biodiversity, extinction, and humanity's future: the ecological and evolutionary consequences of human population and resource use. *Humanities*, 2(2), 147–159. https://doi.org/10.3390/h2020147.