Conservation and sustainable utilization of tropical trees from North Sumatra, Indonesia

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Abstract. Tree species have received more attention recently due to its contribution and prospective utilization. Although provided many function for human and ecosystem, the existence of trees also threatened due to illegal harvesting and forest conversion. Sustainable utilization approaches were needed for increasing the value and willingness of the community to engage in conservation activities. Although many tropical tree species, especially in North Sumatra, have been exploited, there are still few reports of sustainable approaches to those species. In this study, the assessment of several local tree species in North Sumatra was approached with five conditions adopted from previous research, those were :1) sustainable harvesting, (2) no threat interaction, (3) effective commercialization, (4) economic benefits to farmers, and 5) utilization of financial proceeds to promote conservation initiatives. The results of the study illustrate that although these four criteria are fulfilled, the forest product trade often does not provide sufficient financial benefits to protect forests from other threats. Therefore, it is necessary to understand the interaction between threats for sustainable use and conservation, by using a precise conceptual model. The financial benefits of sustainable use must be adequate to support conservation efforts that can overcome various threats to tree species conservation.

1. Introduction
For a long time, the role of harvesting activities in species conservation has been a source of debate. [1]. The exploitation of flora and fauna from nature has been reported throughout human history and this has led to the extinction of various species. This exploitation activity is the most serious threat in species conservation activities [2]. Scientific principles of sustainable resource management, especially for resources of economic value, have been tried to be adopted but have often failed when applied to populations of species that exist in nature [3]. As a conservation strategy, active promotion of sustainable use is encouraged, especially for tree species, is very important considering that most research focuses on management, especially mammals and fish due to they high value in global market. The conservation approach through sustainable use for tropical forest conservation is quite
interesting to study. This approach is based on the idea that forests can be sustainable if the communities around them profit directly from the harvesting of forest products [4].

Many conservation organizations have proved that the development of tropical forest resources is commercially viable for conservation purposes based on the conceptual, but it still requires proper attention and regulation. As known the existence of forest have many impact for people due to ecologically, economically and socio-culturally services. Therefore, integration and utilization is not only choice but a must. The concept of utilization itself can be described in various ways, depending on the point of view to be taken: wild species populations, structure or function of ecosystems, or human livelihoods [5]. The "sustainable use" term refers to the population preservation of a species that can be harvested by humans. Because trees are stationary, the exploitation may be relatively obvious. Many tree species are hermaphrodites, with high reproductive yields, able to reproduce vegetatively. Many trees also have a variety of products (such as fruit, nuts, latex, resin, and leaves) that can be harvested without cutting the trees [6]. These properties, when combined with individual longevity, provide a reasonably high potential for continuing use.

As happen in fauna species, overexploitation is a major threat to tree species. In the global threat assessment at least 4,585 tree taxa are in critical condition, 25% of threatened tree species are generally timber-producing species [7]. The high threat is illegal logging following by forest conversion to land, urban expansion, agricultural fragmentation, conversion by livestock, the use of fire and invasive species [2]. Therefore, it is necessary to have a collective strategy to deal with these threats so that conservation activities can be carried out effectively. Several studies looked at issues such the importance of specific management goals, financial incentives, political will and governance, and the impact of market forces on species [8-10]. Furthermore, [11] considers the following factors: (1) forest product harvesting must be sustainable in terms of maintaining populations of suitable species to be harvested; (2) forest product harvesting must not interact positively with other threats; (3) forest product commercialization must be economically feasible.; (4) harvest natural resources must receive the economic rewards of commercialization; (5) commercialization income should be driven by the type of tree harvested. Based on those consideration and sustainable utilization, this approach was adopted for the assessment of native tree species in North Sumatra from. The results of are expected to be one of the considerations in the aspect of tree species conservation in North Sumatra with the concept of sustainable use.

2. Results and Discussion

2.1. Sustainable harvesting

The concept “sustainable management” is often used to describe the process of determining the environmental and socioeconomic consequences of harvesting. Sustainable forest management is the broader concept and become to focus of worldwide forest policy activities. We show 10 tree species in this study that are highly promising, yet their existence is quite concerning.

*Scaphium macropodum*, commonly known as merpayang or kembang semangkok, is a multipurpose tree native to Sumatera and Borneo. The seeds of this plant are commonly used as a fever, pain, and inflammation therapy. Several research have also discovered therapeutic potential of this species. The community's harvesting activities involve cutting down trees and harvesting the seeds directly. The kembang semangkok wood is also used as a raw construction material in the local community. The excessive logging and seed harvesting activities have hindered the species' reproduction. Moreover, the Semangkok flower has a flowering and fruiting period every 3-4 years. As a result, its population in nature is also decreasing, and International Union for Conservation Nature (IUCN) has listed this species into least concern status [12].

*Vatica pauciflora*, is known as raru by the local people of North Sumatra. This species is recognized as a bark producer and also is utilized as a palm wine mixer by the Bataknese people. The community gathers raru bark in the same way it harvests other raru species like *C. melanoxylon*: by cutting down the tree and peeling it from the base to the tip. The community not only gets the
bark, but also uses the wood from the debarking for construction and ships raw materials. The harvest sustainability of this species is particularly restricted by the uncertain flowering and fruiting time in natural forest, which occurs once every 3-4 years and has specific growing requirements. The lack of evidence about planting effort for this species has resulted in a dramatic decline in its natural population. Based on IUCN this species listed into vulnerable [13]

What happened to the incense tree (*Styrax sumatrana*), a resin-producing tree in North Sumatra, was a little different. While many individuals accept kemenyan is only resin produced tree, several research have demonstrated that it has antioxidant, anti-free radical, and anti-inflammatory properties [28]. Unlike the kembang semangkok and raru, the community has been cultivating this species for decades and has even planted it in their gardens. The unproductive trees, conversion of existing forest and garden into oil palm plantation and other physical structures, threatened the sustainable harvest of kemenyan. This also found in other species, which are shown in Table 1. Each species has its own set of limits that must be addressed in order to achieve long-term harvests.

2.2. Interaction between threat

Effective conservation is determined by the process of detecting and reducing threats that increase the probability of extinction. As a result, the conservation with sustainable use approach could be considered as a trade-off between two threats: raising one (i.e., utilization) while lowering the risk of the other (i.e., conversion of forest to other land uses). In fact, tree species are frequently confronted with multiple threats simultaneously (Table 1). The the dynamics interactions of these threats have an impact on species survive. Furthermore, [30] also offers a conceptual model that illustrates the dynamics of forest product economic outcomes.

![Figure 1. Conceptual model describing the economic dynamics of forest products](image)

Producers lack sufficient market information regarding commodities, prices, and consumer preferences [30]. This indicates the possibility of an increasing risk of extinction during the exploitation process if exploitation and other threats interact positively. Harvesting and forest conversion to agriculture are the most likely interactions. Timber harvesting can improve access to forest areas while also allowing for the exploitation and expansion of agricultural lands [31]. Harvesting and conversion of forest to agricultural land may increase the chance of extinction during the process, compared to harvesting alone. There must be no such positive interaction for the conservation-through-sustainable-use method to be successful. By improving forest resources, increased productivity should reduce conversion to agricultural land.
Table 1. Native species from North Sumatera, status, utilization and threat.

| No | Species                      | Local name         | IUCN status | Utilization       | sustainability of current use                                                                 | principal threat                                           | References |
|----|------------------------------|--------------------|--------------|-------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------|------------|
| 1  | Aquilaria malaccensis        | kayu alim, gaharu  | VU           | resin from infected wood, leaf                     | Traditional harvesting apparently sustainable; currently unsustainable exploitation is widespread. | forest conversion to agriculture.                        | [14]       |
| 2  | Scaphium macropodium         | kembang semangkok, mepayang | LC   | timber, nuts     | Traditional harvesting apparently sustainable; exploitation is widespread.                       | forest conversion to agriculture; ilegall logging; lower regeneration. | [15-16]   |
| 3  | Taxus sumatrana              | taksis             | EN           | bark              | No sustain, exploitation.                                                                       | Lower regeneration, specific habitat.                     | [17]       |
| 4  | Dryobalanops sumatensis      | kapur, kamper      | VU           | resin, wood       | Traditional harvesting currently unsustainable exploitation is widespread.                      | forest conversion to agriculture; lower regeneration. ilegall logging | [18]       |
| 5  | Dipterocarpus cinereus       | lagan beras        | CR           | timber            | Traditional harvesting apparently sustainable; exploitation is widespread.                      | forest conversion to agriculture; lower regeneration.    | [19-20]   |
| 6  | Pinus merkusii               | tusam              | VU           | timber            | No sustain, exploitation.                                                                       | forest conversion to agriculture; habitat fragmentation   | [21]       |
| 7  | Cotylelobium melanoxylon     | raru               | LC           | bark, timber      | Traditional harvesting currently unsustainable exploitation is widespread.                      | forest conversion to agriculture; lower regeneration.    | [22-23]   |
| 8  | Vatica pauciflora            | raru               | VU           | bark, timber      | Traditional harvesting apparently sustainable; currently unsustainable exploitation is widespread. | forest conversion to agriculture; lower regeneration.    | [24]       |
| 9  | Shorea leprosula             | meranti bunga      | NT           | timber            | No sustain, exploitation.                                                                       | forest conversion to agriculture; lower regeneration.    | [25-26]   |
| 10 | Eurycoma longifolia          | pasak buni         | not listed   | root, leaves, seed | Traditional harvesting currently unsustainable exploitation is widespread.                      | forest conversion to agriculture; ilegall harvesting      | [27]       |
| 11 | Syzygium sumatrana           | kemeryan           | not listed   | resin, wood       | Traditional harvesting currently unsustainable exploitation is widespread.                      | forest conversion to agriculture; lower regeneration, unproductive trees | [28-29]   |
2.3. Success of commercialization

The sale of products with a cash imbalance is referred to as commercial use [4]. Despite the widespread commercialization of NTFPs for the development of forest resources, this strategy has frequently failed [1]. This failure might happen in a variety of ways. Demand and efforts to build new enterprises based on existing supply have made it difficult to succeed for the majority of the NTFP value chain, among other reasons. Many forest commodities have a lower value and might be easily substitutes by other items. Several studies have identified potential species measures for domestication. Domestication can perform to produce forest products live longer, but many tree species possess biological or technological limits that are difficult to domesticate [32]. The relationship between successful domestication of a tree species and its conservation potential has earned little investigation. Domestication of trees is considered to reduce pressure on natural resources. The successful domestication of trees is considered to decrease dependence on natural resources; however, empirical data to support this assumption is still lacking.

In comparison to horticulture crops, forest tree domestication is still quite limited [33]. The availability of specialized ecosystem needs for various species, diversified species features and long rotation are all factors that contribute to this situation [34]. This domestication activity, however, is not a genuine possibility, given the success stories for *Acacia senegal*, *Tectona grandis*, *Acacia mangium*, *Dipterocarpus aluatus* and *Eucalyptus dumii* [33]. Domestication has also been shown to increase people's income in several studies [32] This indirectly promotes public awareness about the importance of preserving certain tree species so that production can continue to be sustainable.

2.4. Economic benefits to producers

Harvesters often receive only marginal economic benefits from commercial forest product trade [9]. This assumption is based on the structure and function of the market network, as well as the relationships between the many parties involved. This could give an access to exploitation, collaboration, conspiracies, and even resistance [10]. Collectors in the Aquilaria trade, for example, frequently borrow money from intermediaries to fund their acquisitions. The amount can be substantial (USD 1,000-2,000), and many collectors (73 %) struggle to return their loan [14]. The solution to this issue is better organizational governance, which can reduce economic risks, help share expenditures, and increase community opportunities to attract merchants. Producer organizations can strengthen their negotiating position with dealers, lowering the potential of exploitation [1].

2.5. Income from trade as an incentive for conservation

It's difficult to predict whether the financial value of forest products serve as an incentive for tree conservation, as the conservation through sustainable use approach implies. This necessitates an understanding of rural populations' decision-making processes surrounding their livelihood choices, which is still required for observation. However, because the financial returns from selling products are frequently low, it is likely that peoples might contribute to conservation. Agricultural products have a far higher economic value than forest products. Forests have a difficulty competing economically with agricultural land use. The assumption that forest products have such a lower economic value than land conversion has been proven to be misleading [9].

Certification is one strategy that is particularly created to offer financial incentives for forest conservation. Certification intends to enhance sustainable forest management practices by evaluating activities using a set of criteria [4]. The preference of consumers for certified products is likely to rise, leading to higher producer yields. Tree conservation through sustainable use is a challenging task to accomplish. Financial resources might be spent better to support alternative approaches such protected areas, according to [4]. However, because the amount of forest that can be conserved is limited, the conservation strategy focused on forest areas for use. Furthermore, [2] recommends protecting the forest that has been harvested; important timber species have been taken, lowering the value of the land and thus lowering the cost of protection [3]. While this approach can result in forest conservation,
it has no impact on tree species that have been logged [35]. Various factors played a role to adequately conserve harvested species [1]. Various factors make it difficult to adequately conserve harvested species [1]. Due to forest conversion to agriculture and illegal harvesting, all of the trees shown are threatened (Table 1). These examples show that, although sustainable harvesting and commercialization benefit communities economically, the profits are not used to support conservation efforts to prevent extinction.

The long-term viability of a tree species is not guaranteed by sustainable forest management. On the other hand, management for the sustainable harvesting of certain trees does not ensure sustainable forest management. These need to be recognized in applications where threats affect one type of threat versus those that affect the entire forest. The mahogany case at Quintana Roo illustrates the importance of their relationship. This example has benefited the forest from four points but failed for the harvested main trees [36]. The threat of widespread liar exposure is harming species conservation efforts. One of the main issues that must be resolved is a lack of financial resources to counter this threat with legal control [37].

3. Conclusion
The threat of widespread illegal logging is threatening conservation efforts for several species. The issue is that there are insufficient financial resources to counter the threat by enforcing existing legal controls. Some provisional approaches are still needed to address community will in species conservation. For this condition, financial and legal support must also be improved.

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