Land suitability for *Persea americana* as one of multi-purpose tree species at community agroforestry land in Langkat District North Sumatra Indonesia

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Abstract. *Persea americana* or commonly call as *alpukat* in Indonesia is one of Multy Purpose Tree Species (MPTS), found in agroforestry land in Langkat District, North Sumatra. This study aimed to map the distribution of land suitability for *P. americana* in Langkat District, North Sumatra, Indonesia. This research was conducted by survey method to collect soil samples based on land unit in the field. Land unit was obtained from overlay some maps (land use map, soil map and slope map) using Geographic Information System (GIS) in the research location. There were ten land units in the study area. Land suitability was evaluated based on the matching method. The GIS also was used to map the distribution of land suitability. The results showed that the actual land suitability classes for *P. americana* were moderately suitable (S2) and marginal suitable (S3). Moderately suitable with area 11.20 ha (0.1%) in Land Unit 8. This area has limiting factor in water avaiability (wa), root zone medium (rc), and erosion hazard (eh). Marginal suitable is located in several places, i.e. Land Unit 1, 4, 5, 6, 7, and 9 with wa was limiting factor (10,022.88 ha; 88.96%); Land Unit 2 and 10 with wa and rc were limiting factor (926.48 ha; 8.22%); and Land Unit 3 with wa, rc and eh were limiting factor (308.19 ha; 2.73%).

1. Introduction

The community of Sei Bingai sub-district, Langkat District, North Sumatra Province, Indonesia commonly use their land by planting various kinds of fruit trees combined with forest trees and plantation crops, such as mahogany, rubber and palm oil. One of tree species found on the community land is avocado (*Persea americana*) or *alpukat* in Indonesian. This species is in great demand, because of its delicious fruit taste and has many health benefits. Apart from fruit, other parts of this tree are also widely used, so it is also called as MPTS. Some research about the benefit of avocado have been done, such as: In-vitro antioxidant activities evaluation of methanol extracts of *P. americana* [1], anti-inflammatory effects and analgesic of the aqueous extract of leaves of *P. americana* Mill. [2], the hypotensive activity of *P. americana* leaf
extracts [3], modulation by avocado unsaponifiables [4], Hypoglycemic activity of aqueous leaf extract of *P. americana* Mill. [5], and effects of methanolic extract of *P. americana* seeds [6]. In order to increase the productivity of avocado plants, especially in Sei Bingai Sub-district, research on land suitability is required. The research has a view to find suitable or unsuitable locations for establishing avocado plants both in the community and in other lands in Sei Bingai sub-district. In addition, evaluation process will find out what are the limiting factors in land management for avocado plants. This study is aimed to evaluate the class of avocado plant land suitability in the Sei Bingai sub-district and determine the limiting factors for land management of avocado plants.

2. Materials and Methods

a. Study area

This study was conducted in Sei Bingai Sub-district, Langkat District, North Sumatra Province, Indonesia, on February to May 2019. Sei Bingai district is about 62 km from Medan City, within about 2 hours. Based on data from Sei Bingai District Statistics Center 2018 [7], Sei Bingai District has a total area of 333.17 km². Sei Bingai is located in Langkat District, North Sumatra Province, Indonesia. Sei Bingai District is a buffer zone of Gunung Leuser National Park. Geographically, Sei Bingai is located at 03°19’10’’-03°34’30’’ north latitude and 98°21’14’’-98°31’30’’ east latitude, located 106 meters above sea level.

b. Data collection

Soil samples were taken representatively in the field [8] based on land unit. There were 10 units of land that distributes in four villages in Sei Bingai Sub-district, namely: Telagah Village, Gunung Ambat Village, Rumah Galuh Village and Simpang Kuta Buluh Village. Soil samples were needed to analyze the physical and chemical properties of the soil [9]. There are two kinds of soil samples were taken in the field, namely: disturbed soil samples and undisturbed soil samples. Undisturbed soil samples are soils located below the surface of the soil that has not been disturbed by external factors. Disturbed soil samples are soils that have the same particle size distribution as in their original place, but the structure is sufficiently damaged or completely destroyed.

c. Data analysis

Analysis of land suitability classification was done by matching methods [8-13] or matching data that has been obtained from primary data, secondary data, and laboratory results data with land use requirements. To find out the distribution of avocado land suitability classes, the GIS technology was used [14-29].

3. Result and Discussion

The data and distribution of actual land suitability map of *P. americana* in Sei Bingai Sub-district is presented in Table 1 and Figure 1 respectively.
Table 1. Actual land suitability class for *P. americana* in Sei Bingai Sub-district, Langkat District, North Sumatra Province, Indonesia

| Land suitability class for *Persea americana* | Limiting factor | Area (ha) | % |
|----------------------------------------------|-----------------|----------|---|
| S3                                           | wa              | 10,022.88| 88.96 |
| S3                                           | wa,rc           | 926.48   | 8.22  |
| S3                                           | wa,rc,eh        | 308.19   | 2.73  |
| S2                                           | wa,rc,eh        | 11.20    | 0.10  |
| Total                                        |                 | 11,268.75| 100.00|

Note: water availability (wa), root zone medium (rc), and erosion hazard (eh)

Figure 1. Map of actual land suitability distribution for *P. americana* in Langkat District, North Sumatra Province, Indonesia

Table 1 and Figure 1 shows that the actual land suitability classes for *P. americana* were moderately suitable (S2) and marginal suitable (S3). Moderately suitable (S2) with area 11.20 ha (0.1%) in Land Unit 8 water availability (wa), root zone medium (rc), and erosion hazard (eh) were limiting factor in this area. Marginal suitable (S3) with area 10,022.88 ha (88.96%) in Land Unit 1, 4, 5, 6, 7, and 9 (wa was limiting factor). Marginal suitable (S3) with area 926.48 ha (8.22%) in Land Unit 2 and 10 (wa and rc were limiting factor). Marginal suitable (S3) with area 308.19 ha (2.73%) in Land Unit 3 (wa, rc and eh were limiting factor).

The area of potential land suitability map for *P. americana* in Sei Bingai Sub-district is presented in Table 2. The distribution of actual land suitability map for *P. americana* in Sei Bingai Sub-district, Langkat District, North Sumatra Province, Indonesia, is presented in Figure 2.
Table 2. Potential Land suitability class for *P. americana* in Sei Bingai Sub-district, Langkat District, North Sumatra Province, Indonesia

| Potential Land suitability class for *Persea americana* | limiting factor | Area   | %    |
|-------------------------------------------------------|-----------------|--------|------|
| S3                                                    | wa              | 10,860.03 | 96.39 |
| S3                                                    | wa, rc          | 397.52     | 3.52  |
| S2                                                    | wa, rc          | 11.2       | 0.10  |
| **Total**                                             |                 | **11,268.73** | **100.00** |

*Note: water availability (wa), root zone medium (rc)*

Figure 2. Map of potential land suitability distribution for *P. americana* in Sei Bingai Sub-district, Langkat District, North Sumatra Province, Indonesia.

Table 2 and Figure 2 showed that the potential land suitability classes for *P. americana* were also moderately suitable (S2) and marginal suitable (S3). The moderately suitable (S2) area is the same with the actual land suitability (0.1%) in Land Unit 8 (wa and rc were limiting factor in this area). The marginal suitable (S3) with area 99.91% in Land Unit 1-7, 9 and 10 (wa was limiting factor). Marginal suitable (S3) with area 926.48 ha (8.22%) in Land Unit 2 and 10 (wa and rc were limiting factor in this area).

Requirements growth of *P. americana* were at optimal temperatures (tc) ranging from 12.8-28.3 °C. At the research location, temperature was not a limiting factor, because tc in the study area ranged from 22.0-22.5 °C. The optimum rainfall for *P. americana* growth requirements was 750-2700 mm/year. At the research location was 2010 mm/year. The slope conditions in the study area were 15% to 30% except for land units VIII (30-45%), so that the avocado were still suitable to be planted at this location with the level of land suitability classes were S2 and S3. The eh limiting factor can be improved by soil and water conservation techniques in the form of making terraces and planting parallel contours [10]. The limiting
factor of rc (soil texture) cannot be improved because it is a heavy limiting factor and the texture of the soil cannot change in a short time so the limiting factor of rc (soil texture) cannot be improved [8,9,10,29].

4. Conclusion
Actual land suitability classes for *P. americana* in Sei Bingai Sub-district, Langkat District, North Sumatra Province, Indonesia, were moderately suitable (S2) and marginal suitable (S3), with the limiting factors of land were erosion hazard, water availability and root zone medium. Potential land suitability classes for *P. americana* were moderately suitable (S2) and marginal suitable (S3), with the limiting factors of land were water availability and root zone medium.

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