Integrated GIS and GPS for mapping of land suitability for Multy Purpose Tree Species (*Persea americana*) at community agroforestry land in Peria-ria Village

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**Abstract.** *Persea americana* is known as the Multy Purpose Tree Species (MPTS), which comes from the Lauraceae family. In community agroforestry land in Deli Serdang Regency. The objective of this study was to map the suitability of land for *Persea americana* in Peria-ria Village. This research was conducted using survey methods. Soil samples are collected from survey results in the field based on land units, then the coordinates were marked using the Global Positioning System (GPS). To create a map of land suitability class distribution, Geographic Information System (GIS) technology was used. In land suitability study, were adopted from the Soil and Agro-climate Research Centre, Bogor, West Java, Indonesia, namely: references and land suitability criteria for Agricultural Plants. The actual land suitability for *Persea americana* is not suitable (N) (98.55%) and marginally suitable (S3) (1.45%) and potential land suitability for *Persea americana* is marginally suitable (S3) (1.45%) and moderately suitable (S2) (98.55%) in Peria-ria Village, Biru-Biru Sub district. Water availability (wa), erosion hazard (er) and root zone media (rc), were limiting factors. The most difficult constrain to overcome were the root zone medium and water availability.

1. Introduction
Evaluation of land is a process of estimating potential land resources for various uses. The basic framework for evaluating land suitability is to compare the requirements required for a particular land use, with the nature or quality of land in question. One type of land characteristic can affect more than one type of land quality, for example soil texture can affect water availability, whether or not land is easily cultivated, erosion sensitivity, other factors [1]. The purpose of land evaluation is to choose the optimal land use for each particular unit of land by considering social, economic and physical factors as well as conservation of environmental resources for sustainable use [2]. Land suitability is used as basis for land use planning and for consideration in making land use decisions. Several studies on land suitability have been carried out in several locations based on GIS [3-10]. The Geographic Information System (GIS) technology has been used to analyse land suitability and land capability. The GIS technology application such as for mapping land evaluation in map form as well as show the phenomenon of geographical spatial distribution [3,5]. The GIS technology was used for collection of data, storage of data, analysis of data and manipulation of data [11-17]. It has been applied in various fields, such as land evaluation [3-10].
One of the places that has potential to be planted by *Persea Americana*, namely Deli Serdang Regency, North Sumatra, Indonesia. *Persea americana* is known by the local name "alpukat". These plants can be found in several locations, such as on community land (in agroforestry patterns). Many studies have also been carried out related to *Persea americana* in various places [18-20]. Furthermore, studied about *Persea americana* such as: evaluation of in vitro antioxidant activities of methanol extracts of *Persea americana* [21], research about effects of anti-inflammatory and aqueous extract analgesic of the of *Persea americana* Mill. Leaves [22], and preliminary study regarding the hypotensive activity of *Persea americana* leaf extracts [23]. Nevertheless, research about mapping of land suitability for *Persea Americana* has never been conducted, especially in this location. Due to less data and information about the suitability land of *Persea americana* in Deli Serdang Regency, hence, the objective of this study was to map the the suitability of land both actual and potential land suitability for *Persea americana* in Peria-ria Village, Biru-biru Sub district.

2. Material and methods

2.1. Study area
This study was conducted in Peria-ria Village, Biru-Biru Sub district. This village was located in Deli Serdang Regency, Province of North Sumatra, Indonesia. Biru-Biru Sub district is an area that has fertile soil so that most of the land is cultivated for agriculture. Most of the people of Peria-ria Village are farmers. In general, the community implements a monoculture planting system and implements an agroforestry planting system. In addition, many people use land to be used as rice fields. The survey of land, laboratory analysis and data analysis were conducted from March to July 2019.

2.2. Data collection
The soil samples were collected in the field by survey method on land unit as well as mark it using GPS. There are two land units in this area that have their own characteristics. Growing requirements for *Persea americana* namely: optimal temperature ranges from 12.8-28.3 °C, optimum rainfall is 750-2700 mm / year, soil types for growth are sandy loam, loamy clay and silt clay soils. Soil acidity for a *Persea americana* ranges from 5.5 to 6.5. In general, *Persea americana* can grow in the lowlands to the highlands, which is 100-3,000 meters above sea level [24-25].

2.3. Data analysis
To evaluate the actual land suitability class for *Persea americana* plants were used a matching method [24,25], which is matching data that has been obtained both from the field and from the laboratory (results from sample analysis). In this study, the criteria for determining land suitability classes were based on criteria determined by the FAO, namely: S1, S2, S3, and N. [26,27,28]. For highly suitable called as S1, S2 for moderately suitable, S3 for marginally suitable, and N for not suitable. Soil sample points were recorded using GPS [17], then integrated with GIS technology to map the land suitability class distribution. Potential land suitability assessment is carried out by making possible improvements to the quality of land which is a limiting factor, so that land suitability is expected to increase.

3. Result and discussion
The actual land suitability for *Persea americana* in Peria-ria Village based on land unit, is presented in Table 1 as well as potential land suitability is presented in Table 2.

The actual land suitability map for *Persea americana* in Biru-biru Sub District is presented in Figure 1 and Figure 2 and the condition of land in Peria-ria Village, Biru-biru Sub District is presented in Figure 3. Based on Table 2 and Figure 2, Development of *Persea americana* in Biru-biru Village still potential based on the area of land suitability that dominated by moderately suitable (S2) that is 98.55%.
Table 1. The actual land suitability classes for *Persea americana* in Peria-ria Village based on land unit

| Land unit | Actual land suitability | Area (Ha) | (%) |
|-----------|-------------------------|-----------|-----|
| 1         | S3 rc                   | 10.39     | 1.45|
| 2         | N eh                    | 708.33    | 98.55|
| Total     |                         | 718.72    | 100.00|

Note: S3 = Marginally suitable, N = Not suitable, rc = root zone medium, eh = erosion hazard

Table 2. The potential land suitability for *Persea americana* in Peria-ria Village based on land unit

| Land unit | Potential land suitability | Area (Ha) | (%) |
|-----------|---------------------------|-----------|-----|
| 1         | S3 rc                     | 10.39     | 1.45|
| 2         | S2 wa,rc,eh               | 708.33    | 98.55|
| Total     |                           | 718.72    | 100.00|

Note: S3 = Marginally suitable, S2 = Moderately suitable, rc = root zone medium, eh = erosion hazard, wa = water availability

Figure 1. Map of actual land suitability distribution for *Persea americana* in Peria-ria Village
Figure 2. Map of potential land suitability distribution for *Persea americana* in Peria-ria Village

Figure 3. The condition of agroforestry land in Peria-ria Village

Actual land suitability for *Persea americana* were not suitable (N) (98.55%) and marginally suitable (S3) (1.45%) and potential land suitability for *Persea americana* were marginally suitable (S3) (1.45%) and moderately suitable (S2) (98.55%) from the total area of Peria-ria Village (Figure 1 and Figure 2) in Peria-ria Village, Biru-biru Sub District. Nothing highly suitable (S1) was found in this area. The moderately suitable class or S2 means that land has limiting factor that will affect its productivity and require additional input. The marginally suitable or S3 means that land has sever limiting factor for the sustainable land use application [26,27,28]. According to FAO, land suitability class N (not suitable) is divided into two, namely: N1 and N2. N1 means currently is not suitable, but by the treatment can become suitable. Whereas N2 means it is permanently not suitable, even though it is given treatment it cannot become suitable. There are some limiting factors in evaluating land suitability in Peria-ria...
Village, such as: water availability (wa), root zone medium/texture (rc) and erosion hazard (eh). Limiting factors in the most difficult constraints to overcome in this area, were root zone medium and water availability. Water availability (wa), eh and rc cannot be increased. The erosion hazard (slope) can be increased by terracing in steep areas.

4. Conclusion
The actual land suitability for *Persea americana* were not suitable (N) (98.55%) and marginally suitable (S3) (1.45%), nevertheless, potential land suitability for *Persea americana* were marginally suitable (S3) (1.45%) and moderately suitable (S2) (98.55%) in Peria-ria Village, Biru-biru Sub District. Water availability, erosion hazard as well as root zone medium, were the limiting factor in this area. The difficult constrain to counter, namely: root zone medium and water availability.

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