Mapping Distribution Approach in Various Types of Use Sub-Optimal Dry Land in Aceh Besar District

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Abstract. Sub-optimal land can be defined as land that naturally has low productivity due to internal (intrinsic) factors such as parent material, physical, chemical, and biological properties of soil, and external factors such as rainfall and extreme temperatures. For that reason, it is necessary to map foreknow the various types of sub-optimal dry land uses and their size in the district Aceh Besar. Administration maps, land use maps, slope maps, and soil type maps would later be overlaid and digitized on the screen to obtain the map and the area of research to be carried out. The slope gradient was limited to only 25% due to looking conditions that allow it to be used in the management business agriculture. The forest area was 19,136.65 ha, the dry land agricultural area was 89,472.15 ha, area open land of 1,070.75 ha, and scrub area of 58,840.87 ha. It can be observed that land use in the Aceh Besar district is dominated by Dryland farming.

1. Introduction

Soil is an important natural resource and is a repository of information about various things about the natural ecological environment. Different soil attributes greatly affect the vegetation that grows on it [1], in particular for plants, which makes soil attributes important for food security, human health, and the development of an ecologically sustainable environment [2]. The importance of different soil attributes can be summarized as soil quality, but there is still no universally accepted definition of soil quality [3]. Most experts emphasize that soil productivity is a large component of soil quality; Therefore, most soil quality assessments are based on soil nutrient indicators [4].

The land use and land change (LULC) is a challenge for an area of land management unit ecologically and under sustainable development [5] and has been informed by several studies [6, 7, 8, 9, 10, 11, 12], this shows significant differences in surface objects or phenomena over time. The process detects changes in the characteristics of objects that can provide insight into the form and types of systematic interactions between anthropogenic problems and common ones [13, 5, 14].

The main causes of land change (LC) have been linked to anthropogenic factors such as fires, territorial fragmentation, intensification of agriculture, livestock, housing, infrastructure development, deforestation, urbanization [12], the mining industry [6], and natural phenomena (flooding and erosion) [15].

Knowledge of LULC over some time can be very important in the context of preparing for key local, regional and national land management measures and can be used to address problems of land use,
illegal work, habitat destruction, ecological and natural resource damage, loss of biodiversity [16], biodiversity conservation planning [17] and modeling the world's climate and biogeochemistry [18].

The application of remote sensing techniques using satellite imagery has become an important tool in the management and monitoring of areas and spaces over time [12]. This technique provides economically viable multispectral and multitemporal data, and this information is combined into a dataset that is essential for the assessment and analysis of the state, health, and ecosystem resources [19], mapping, and monitoring of coastal resources [20]. It also provides useful and important information for analyzing the processes and patterns of ecosystem change at different scales [7, 20, 21].

At temporal and spatial scales, ecosystem use can change and there is vulnerability especially associated with land use/land cover change (LUCC) [22, 23, 24, 25]. Land-use change has led to rapid changes in ecosystem composition and structure, as well as biophysical and biochemical processes [26], which can increase or decrease the quantity and quality of services required. For example, simulations show that the transformation from forest to cultivated soil can increase temperature and decrease rainfall (climate regulatory services) by increasing albedo and reducing roughness [27]. The importance of the linkage between the two LUCC and ecosystem services has been recognized in studies involving biodiversity [28, 29], global carbon cycles [30, 31], water regulation [32], and pollination [33, 34]. The relationship between the two has been carried out in many studies [35, 36, 37, 38], however, some are based on the district level and analyze spatial heterogeneity.

The latest technological advances in Geographical Information Systems, Remote Sensing, Decision Support Systems, and web-based applications allow more robust, precise, and sustainable interventions in agriculture in terms of where to farm and what crops are most suitable for cultivation. DSS in agriculture is driven by computer-based data systems that aim to solve unstructured problems and improve the performance of decision-makers [39, 40, 41, 42]. GIS serves as a tool for input, storage and retrieval, manipulation, and analysis and output of spatial data while RS provides information on various spatial criteria/factors being considered [43]. Every method of Agricultural land suitability analysis (ALSA) provides uncertainty due to the uncertainty that multiplies in the data source. A variety of methods have been developed including, but not limited to weighted averages [44], hierarchical analytical processes (AHP) [45 46, 47], ordered weighted averaging (OWA) [48, 49, 50], and rule-based classification of methods. [51, 52].

Sub-optimal land can be defined as land that naturally has low productivity due to internal (intrinsic) factors such as parent material, physical, chemical, and biological properties of soil, and external factors such as rainfall and extreme temperatures [53]. Based on data on Indonesia's land resources (soil, climate, parent material, physiography, landform), sub-optimal land can be grouped into four land typologies, namely acid dry land, dry climate dry land, tidal swampland, lowland swamp, and peatland. Acid dry land is classified as suboptimal dry land with the main limiting soil acidity, while the main limitation of dry climate dry land is water availability [54].

Aceh Besar District, with the capital city of Jantho, consists of 23 Districts geographically located at positions 5.2 ° - 5.8 ° N and 95.0 ° - 95.8 ° East Longitude, at altitudes ranging from 12 to 400 meters above sea level. According to the Center for Agricultural Information Data (2013), of 1,140,548.54 ha, the total area of agricultural land in Aceh Province is around 89,227.34 ha, consisting of dry land consisting of; non-irrigated land, tegal land/gardens, fields, and idle or abandoned land [55]. Therefore, mapping is necessary to determine the various types of suboptimal dry land use and their area in Aceh Besar district.

2. Methodology
To analyze the spatial distribution of various types of land use, it can be obtained from Bappeda Aceh sources, namely administrative maps, land use maps, slope maps, and land type maps which will later be overlaid and digitized on a screen so that a map and area of the research will be obtained. The slope is limited to 25% due to the conditions that allow it to be used in agricultural management [56, 57].
3. Result and Discussion

Aceh Besar District with the capital city of Jantho consists of 23 Districts geographically located at a position of 5.2 ° - 5.8 ° North Latitude and 95.0 ° - 95.8 ° East Longitude, at an altitude ranging from 12 to 400 meters above sea level. According to the Center for Agricultural Information Data (2013), of 1,140,548.54 ha, the total area of agricultural land in Aceh Province is around 89,227.34 ha, consisting of dry land consisting of; non-irrigated land, tegal / garden land, fields, and idle or abandoned land (Table 1). From the results of the overlay and digitization on the screen, the distribution of spatial data is obtained as follows [55].

Figures 1, 2, and 3 are administrative, slope, and soil-type maps in Aceh Besar district. Then, they were overlaid into Figure 4.

**Figure 1.** Administrative Map in Aceh Besar District
**Figure 2.** Slope Map in Aceh Besar District

**Figure 3.** Map of soil types in Aceh Besar District
Figure 4. Spatial Distribution of Various Types of Suboptimal Dry Land Use in Aceh Besar District

Table 1. Table of Suboptimal Land Use Types, Types of Land, Slopes, and Area of Areas in Aceh Besar district

| SPL | Information       | Type of soil | Slope | Area (ha) |
|-----|------------------|--------------|-------|-----------|
| 1   | Dryland farming | Entisol      | 0 - 8%| 114.2     |
| 2   | Forest           | Ultisol      | 8 - 15%| 36,192.5  |
| 3   | Forest           | Andisol      | 15 - 25%| 3,408.9   |
| 4   | Forest           | Entisol      | 15 - 25%| 39,445.27 |
| 5   | Forest           | Ultisol      | 15 - 25%| 17,089.98 |
| 6   | Open field       | Inceptisol   | 8 - 15%| 304.28    |
| 7   | Open field       | Ultisol      | 8 - 15%| 213.77    |
| 8   | Open field       | Andisol      | 0 - 8% | 157.89    |
| 9   | Open field       | Entisol      | 0 - 8% | 394.81    |
| 10  | Dryland farming | Entisol      | 8 - 15%| 9,192.55  |
| 11  | Dryland farming | Inceptisol   | 0 - 8% | 37,573.07 |
| 12  | Dryland farming | Andisol      | 0 - 8% | 17,434.94 |
| 13  | Dryland farming | Ultisol      | 0 - 8% | 25,175.39 |
| 14  | Shrubs           | Andisol      | 0 - 8% | 10,683.24 |
| 15  | Shrubs           | Entisol      | 0 - 8% | 31,295.31 |
| 16  | Shrubs           | Ultisol      | 0 - 8% | 16,862.32 |
|     | Total            |              |       | 245,538.78 |
Based on the results of digitizing on-screen and overlay in Figure 4, four sub-optimal dry land use classifications in Aceh Besar district are obtained, namely:

a. Forest area is land that develops naturally / semi-naturally, in the form of dense trees and other plants such as bamboo forests.

b. Open land is land without natural, semi-natural, or artificial land cover, like a field.

c. Dryland farming is an agricultural activity (cultivation plants) by exploiting land that is not inundated by water, as well as in the process of growing plants that are generated using rainfed water sources.

d. Shrubs are dryland overgrown with a variety of heterogeneous plants or homogeneous [59].

4. Conclusion

The forest area was 19,136.65 ha, the dry agricultural area was 89,490.15 ha, the open land area was 1,070.75 ha and the scrub area was 58,840.87 ha. It can be seen that land use in the Aceh Besar district is dominated by dryland agriculture. The classification of dryland agricultural uses in Aceh Besar district includes rainfed land, moor, mixed garden, plantation, and pasture.

Acknowledgments

The researcher would like to thank all those who supported in conducting this research and to the committee who accepted this research into the ICARD journal, Faculty of Agriculture, Sultan Ageng Tirtayasa University.

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