Land cover changes monitoring over ten years in upstream watershed of Deli Serdang Regency North Sumatra Province

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Abstract. Deli Serdang is one of the regencies in North Sumatra Province, experiencing relatively rapid development and population. Increasing in demand for the availability of land as living space. Two sub-districts of upstream watershed experienced changes in land cover, namely; Sinembah Tanjung Muda (STM) Hilir and STM Hulu. Monitoring changes in land cover in both sub-districts is essential, given that they are located in the upstream area of the watershed and will impact other areas in the lower watershed. This study aims to analyse land cover changes in both sub-districts over ten years (2009 - 2019). The method used in calculating land changes that occur is change detection. Field surveys were carried out to ensure that the land cover conditions on the land cover maps followed the field's actual conditions. The research shows the period of 2009 – 2019, land cover that has increased in the area are mining, industry, open land, settlements, livestock and shrubs. The decrease in the area occurred in land cover, including dryland forest, mixed gardens and cultivated land.

1. Introduction
Deli Serdang is one of the districts in North Sumatra that is experiencing very fast development. This is because Deli Serdang is close to the city of Medan. Deli Serdang is also a satellite area that supports all activities in the city of Medan. In its development, the land cover of Deli Serdang is always changing according to the needs of the people who live in it [1]. The increase in population is often a triggering factor for the increasing need for land availability. The sub-districts that have experienced changes in land cover within ten years namely; Sinembah Tanjung Muda (STM) Hilir District and Sinembah Tanjung Muda (STM) Hulu District. Monitoring changes in land cover is important because both are located in the upstream area of the watershed. Land cover changes that occur in both sub-districts will have an impact on other areas below them.

Increasing population in an area, economic growth, industrial development and infrastructure development, and developments in various sectors often trigger changes in land use [2]. The interaction that occurs between the community and the land causes land changes that can threaten the sustainability of natural resources. Therefore, it is important to monitor and assess land changes,
considering that land changes always impact environmental sustainability [3,4]. Thus, humans as natural resource managers will be able to plan optimal land use in the future while taking into account the principles of environmental sustainability.

Various researchers in various places have carried out research on land cover change. Up-to-date data and information on land cover changes that have occurred in both sub-districts are needed. This is because the latest data and information on land cover changes can describe community interactions with land to meet their daily needs. The research results are expected to be input to the Deli Serdang Regency government and various stakeholders in planning the area and managing land as a natural resource.

2. Materials and Methods
This research was conducted from January 2020 to August 2020. The research locations are in two sub-districts of Deli Serdang Regency (Figure 1), namely STM Hulu District and STM Hilir District. The materials used in this study include; Deli Serdang Regency administration map, 2009 land cover map, 2014 land cover map and 2019 land cover map. The tools used in this research are; digital camera, Global Positioning System (GPS) and computer equipped with GIS (Geographic Information System) software.

![Figure 1. Research Location](image)

The study begins by collecting primary and secondary data. Land cover analysis in the three sub-districts was carried out using Geographic Information System software. The process of land cover change during the observation period was analyzed using a change detection tool [5]. Ground check activities are carried out to ensure the type of land cover on the map is following the conditions on the ground. The activity uses GPS and digital camera.

3. Result and Discussion
Deli Serdang Regency is divided into 22 sub-districts consisting of 394 sub-districts/villages. The STM Hulu and STM Hilir sub-districts are located in the upstream of the watershed that crosses this district. Therefore, land changes that occur in these both sub-districts will influence other sub-districts
below them. Based on the results of land use analysis, it is known that there are 13 types of land cover found in research location. The land cover that dominates these both sub-districts from 2009 to 2019 includes; cultivated land, mixed gardens and dryland forest (Table 1). Cultivation is a form of exploitation of certain seasonal plants by humans in a certain landscape or media for commercial purposes. Cultivation is carried out massively through the use of science and technology, capital and business management. Generally, the cultivated plants cultivated in these three sub-districts are monoculture plantations, namely rubber and oil palm [6]. Cultivation activities are one of the driving forces of the economy in this area. Therefore, the use of land in cultivation activities cannot be avoided because it is related to meeting the needs of people's lives.

| Number | Land cover  | Year 2009 | Year 2014 | Year 2019 |
|--------|-------------|-----------|-----------|-----------|
|        | Area (ha)   | Proportion (%) | Area (ha)   | Proportion (%) | Area (ha)   | Proportion (%) |
| 1      | Lake        | 0,99      | 0,00      | 0,99      | 0,00      | 0,99      | 0,00      |
| 2      | Mining      | 14,94     | 0,04      | 32,18     | 0,08      | 96,08     | 0,23      |
| 3      | Dryland forest | 7,365,94 | 17,94     | 7,365,94 | 17,94     | 7,325,18 | 17,84     |
| 4      | Industry    | 4,10      | 0,01      | 8,13      | 0,02      | 8,13      | 0,02      |
| 5      | Mix garden  | 8,991,29  | 21,90     | 8,842,87  | 21,54     | 8,837,83 | 21,53     |
| 6      | Open land   | 1,90      | 0,00      | 34,69     | 0,08      | 63,87     | 0,16      |
| 7      | Plantation  | 1,655,16  | 4,03      | 1,655,16  | 4,03      | 1,655,16 | 4,03      |
| 8      | Cultivation | 21,032,46 | 51,23     | 21,013,59 | 51,18     | 20,942,67 | 51,01     |
| 9      | Settlement  | 415,61    | 1,01      | 425,08    | 1,04      | 425,08    | 1,04      |
| 10     | Livestock   | 10,43     | 0,03      | 114,18    | 0,28      | 125,67    | 0,31      |
| 11     | Paddy field | 1,143,64  | 2,79      | 1,143,64  | 2,79      | 1,143,64  | 2,79      |
| 12     | Shrub       | 368,39    | 0,90      | 368,39    | 0,90      | 380,56    | 0,93      |
| 13     | River       | 49,43     | 0,12      | 49,43     | 0,12      | 49,43     | 0,12      |
| **Total** | **41,054,29** | **100,00** | **41,054,29** | **100,00** | **41,054,29** | **100,00** |

In 2009 cultivated land cover dominated in research location with a proportion of 51.23%, followed by mixed gardens 21.90% and dryland forest 17.94%. In 2014 the cultivated land and mixed gardens area decreased by 0.05% and 0.36% respectively, while dryland forest did not change. However, in 2019, dryland forest area decreased by 0.10% to 7,325.18 ha. The same thing happened to the cover of cultivated land and mixed gardens. Both have decreased in area. This indicates that there are other forms of land use that have occurred in the past 10 years.

Land cover that experienced an increase in area during the observation period included; mining, industry, open land, settlements, livestock and shrubs. Settlement in 2009 reached an area of 415.61 ha, in 2014 it increased to 425.08 ha (1.04%) and it did not change in 2019. The increase in settlements in these both sub-districts is in line with the trend of the population tends to increase (Figure 2). The increase in population is one of the triggering factors for increasing demand for land availability and the emergence of pressure on land.
The increasing of population (person) in research location

The increase in population triggers the increase in residential areas as a basic need of the community. Table 1 also shows an increase in settlements followed by an increase in the area of important life support sectors such as industry, livestock, mining and open land.

It is quite interesting that the paddy field cover did not change during the observation period. The paddy fields at research location reached 1,143.64 ha in 2009. It has the same area after ten years (Figure 3).

These data indicate that paddy fields are still become one of important land use in these both sub-district. Paddy fields can provide basic needs of population [7]. Map of land cover change over a 10 year period can be seen in Figure 4.
Changes in land cover from one form of land use to another is a consequence of population growth and changes in the socio-economic conditions of the community. Changes that occur are often triggered by a desire to meet the needs of life, living space and quality of life that are considered better. From a development point of view, land use change is difficult to avoid. Changes that occur in a landscape will positively impact some parties but will also harm other parties [8]. Therefore, well-documented data and information on land cover changes are needed to support the decision-making process. Thus the decisions taken will minimize the negative impact while maximizing the positive impact of a development.

4. Conclusion
There are 13 types of land cover found in the STM Hulu and STM Hilir, namely lake, mining, dryland forest, industry, mixed gardens, open land, plantation, cultivation, settlements, livestock, paddy fields, shrubs and rivers. In the observation period of 2009 – 2019 there has been a change in land cover in these two sub-districts. Land cover that has increased in area are mining, industry, open land, settlements, livestock and shrubs. The decrease in area occurred in land cover, including dry land forest, mixed gardens and cultivated land.

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