Land use changes monitoring over a period of ten years in Panjang Island, Pangkalan Susu, Langkat, North Sumatra

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Abstract. Panjang Island is one of the islands in Pangkalan Susu Sub-district, Langkat Regency, North Sumatra Province. This study aimed to analyze Land use changes during ten years period in Panjang Island. Land use changes was analyzed spatially using Geographical Information System (GIS). The results showed that within an interval of ten years (2009-2019), there were changes in the area of Land use in Panjang Island. In 2009, the land cover on Panjang Island only consisted of mangroves and settlements. There are five types of landcover in 2009 on Panjang Island, namely: open land, mangrove, settlement, pond and shrub. Over a period of ten years, the mangrove area was reduced by 6.29 ha in Panjang Island, Pangkalan Susu Sub-district. Changes of mangrove into open land was 0.44 ha, changes of mangrove into shrub was 3.51 ha and changes of mangrove into pond was 2.34 ha. During a period of ten years, the settlement in Panjang Island did not change.

1. Introduction
Humans as environmental managers on this earth will determine the pattern and use of Land use in an area. Population growth is synonymous with increasing demand. It will result in increased pressure on land resources and Land use changes. Land use is one of the main determining factors in environmental management. It is an effort to plan land utilization in an area including the division of areas for the specificity of certain functions. For instance: settlement, mining, industry and plantation as well as agriculture. Several studies on the factors that cause changes in land cover conditions have been conducted [1-6]. For example: study about transition matrix analysis of land-cover change in the accretion area in Argentina [1] and study about the influence of land-use changes in Mexico. Based on previous research, it is known that the factors that encourage land conversion to land cover changes, such as: population (land requirements for non-agricultural activities, economic (heat from lease land obtained by non-agricultural sector activities compared to the agricultural sector), socio-cultural, regional autonomy, weak legislation and law enforcement of existing regulations [7].

The latest information on land conditions in Langkat Regency is one of the important information needed to support the efforts of the local government in carrying out spatial planning in the context of development sustainability. The trend of occurred Land use shows that the development of Langkat Regency will continue to increase due to population growth, including in Panjang Island, Pangkalan Susu Sub-district. The increasing population will have implications in needs of land. As a consequence,
land conversion into various uses, such as: settlement, plantation, industry and agriculture land will occur.

Langkat Regency is one of the regions in North Sumatra Province which in the last five years has always experienced an increase in population [8,9]. The increasing population has an effect on the increase in space requirements. It is included the need for housing, workplaces and other basic infrastructure. It is one of the factors that influence Used land change. Increased population growth and increased material requirements are likely to lead competition in Used land. Changes in Used land in development implementation can not be avoided. These changes occur for two reasons, firstly there is need to match for needness in increasing population and secondly, it is related to the increasing demands for more good life quality in society.

Physical factors that affect Used land and cover are factors related to land suitability, including environmental factors that affected plant growth and cultivation, ease of cultivation techniques or land management and environmental sustainability. These physical factors include climatic conditions, water and aquatic resources, land forms and topography, as well as soil characteristics that together limit what can and cannot be done on a plot of land [1-3].

The latest information regarding land cover changes that occurred in Langkat Regency, especially in Panjang Island, are needed, but the newest information is not yet available. Given the importance of data and information regarding changes in Used land for ten years in Used land, this research is necessary. This study aimed to determine the various types of Used land in Panjang Island and monitor changes in Used land from 2009 to 2019. The results of this study are expected to provide actual information in regional development planning in Langkat Regency, North Sumatra Province.

2. Methods

2.1. Research location and materials

This research was conducted from January 2020 to June 2020. The research location was conducted on Panjang Island, Pangkalan Susu, Langkat Regency (Figure 1). Data analysis was conducted in Forest Inventory Laboratory, Forestry Study Program, Faculty of Forestry, Universitas Sumatera Utara. The materials used in this research such as: digital maps of Panjang Island administrative, administrative maps of Langkat Regency, land cover maps of Panjang Island 2009 and 2019. The tools were used such as: computers and their equipments, ArcGIS software, Global Positioning System (GIS) and digital camera.

Figure 1. Study site in Panjang Island, Pangkalan Susu Sub-District, Langkat Regency
2.2. Data collection and data analysis

The implementation of this research includes collecting the required data and information as well as analyzing the data as needed. There were two kinds of data collected in this research, namely: primary data and secondary data. Primary data is defined as data that is collected by checking directly at the research location. It was obtained by taking the coordinates of the point using GPS. Secondary data is defined as data that has existed before. Both data issued by related agencies, previous research, and other supporting literature.

Geographical Information System (GIS) was used to map the land cover change that occurred in Panjang Island. This system records, checks, integrates, manipulates, analyzes, and displays data that spatially references earth conditions. Various studies using GIS have been carried out by various researchers and various regions and countries [10-18].

3. Results and discussion

Each Used land/cover has a unique elemental characteristic of interpretation. Used land and land cover have different meanings [19]. Used land relates to human activities on a plot of land, while land cover is more of a physical manifestation of objects covering land without questioning human activities toward these objects. In this study, the types of land cover identified were open land, mangrove, settlement, pond and shrub. In 2019, land cover on Panjang Island only consisted of mangrove and settlement. In 2019, Used land in Panjang Island increased to five land cover classes. The land cover changes in Panjang Island are presented in Table 1.

| Used land | 2009 | 2019 | Changes |
|-----------|------|------|---------|
|           | Area (Ha) | Area (%) | Area (Ha) | Area (%) | (Ha) |
| Open land | - | - | 0.44 | 0.10 | +0.44 |
| Mangrove  | 435.72 | 99.46 | 429.43 | 98.02 | -6.29 |
| Settlement | 2.37 | 0.54 | 2.37 | 0.54 | - |
| Shrub     | - | - | 3.51 | 0.80 | +3.51 |
| Pond      | - | - | 2.34 | 0.53 | +2.34 |
| Total     | 438.09 | 100.00 | 438.09 | 100.00 | |

Note: (+) = increase, (-) = decrease

Based on Table 1, it can be seen that Panjang Island is dominated by mangrove (99.46% in 2009 and 98.02% in 2019). The types of land cover in Panjang Island in 2019 were: open land, mangrove, settlement, shrub and pond. In 2019, there was new land cover on Panjang Island, namely 0.44 ha of open land. Open land is land that is not covered by vegetation or buildings and there is little vegetation. In 2019, it appears that the area of settlement on Panjang Island did not change in area (2.37 ha). This indicates that during ten years period, no building, housing, roads, public facilities, schools construction was conducted in this island. Settlement is defined as a Used land which is covered with buildings, either in the form of permanent or semi-permanent buildings so that rainwater does not fall directly onto the ground. This utilization group include residential houses, offices, schools, public facilities, roads and industry. In Table 1, it can also be seen that there was no shrub in 2009, while in 2019 there were shrubs with an area of about 3.51 ha over ten-year period. Shrub is defined as land overgrown with grass, small plants less than two meters in height and also ferns and vines. This plant is quite dense and covers the soil surface so that it can function as an erosion barrier and enhance water absorption [20,21]. Shrub in the landsat images show a relatively subtle texture than the forest, having a lighter green color than the forest. Based on Table 1, there were no pond in 2009, whereas in 2019 there were pond with an area of around 2.34 ha over a ten years period. pond is defined as a body of water, naturally occurring or man-made. One of the functions of pond for aquatic ecosystems is the enrichment of aquatic biota. The
increase in the types of biota comes from the introduction of cultivated biota. The types of pond in Indonesia include: intensive pond, semi-intensive pond, traditional pond and organic pond.

Table 2. Matrix of land cover change in Panjang Island over ten years period

| Used land 2009 | Used land 2019 | 
|----------------|----------------|
| Open land      | Mangrove       | Settlement | Shurb | Pond | Total  |
| Mangrove       | 0.44           | 429.43     | 3.51  | 2.34 | 435.72 |
| Settlement     | 2.37           |            |       |      | 2.37   |
| Total          | 0.44           | 429.43     | 3.51  | 2.34 | 438.09 |

Figure 2. Used land map in 2009 at Panjang Island, Pangkalan Susu Sub-district

Figure 3. Used land map in 2019 at Panjang Island, Pangkalan Susu Sub-district

Mangrove forest is a forest coastal ecosystem consisting of groups of trees that can live in a high salt environment. One of the characteristics of mangrove plant is has roots sticking out of the surface.
Mangrove forests provide economic, ecological and social benefits. Various functions of mangrove forests, such as: protecting the stability of the coastline, protect the beach from abrasion, retain sediment, the buffer zone for the intrusion process, oxygen generator and carbon dioxide absorber, waste treatment, a source of food for animals, nursery ground, stopover areas and endangered animal habitats, germplasm, wood producer, paper industry raw materials, tourist area, educational area. These communities generally grow in intertidal and supertidal areas which receive adequate water flow and are protected from large waves and strong tidal currents [22]. The mangrove area change matrix in Panjang Island can be seen in Table 2. Used land map in 2009 and in 2019 at Panjang Island as is shown in Figure 2 and Figure 3.

One of definition od used land is any form of antropogenic on land in order to meet the needs of life need such as material and spiritual purpose, while changes in land cover are more about changes in vegetation [20]. Used land change has impacted to bio-physical and socio-economic [2-4].

Thus, overall life activities tend towards natural resource utilization systems are decreased carrying of capacity (COC). On the other hand, the demand for land continues to increase due to pressure from population growth and increased per capita consumption [4].

4. Conclusions
Types of land cover in 2009 at Panjang Island, Pangkalan Susu Sub-district, Langkat Regency were mangrove (99.46%) and settlement (0.54%). In 2019, there were five types of land cover in Panjang Island, namely: open land (0.10%), mangrove (98.02%), settlement (0.54%) pond (0.53%) and shrub (0.80%). Over a ten years period, there was a decrease in mangrove area by 6.29 ha in Panjang Island. Changes in mangrove land cover into 0.44 ha of open land, into shrub of 3.51 ha and into pond of 2.34 ha. During a ten years period, the settlement in Panjang Island did not changes.

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