Changes in the Land Use Pattern of the Parat River Sub-watershed, Salatiga, Central Java

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Abstract. Rawapening Lake is one of the 15 national priority lakes and a pilot project of the GERMADAN (Gerakan Penyelamatan Danau) Indonesian. The main problems of Rawapening are eutrophication and sedimentation from water catchment area (agriculture, livestock, domestic and industrial waste) and from the water body itself with various changes in land use patterns that occur in the surrounding rivers. Parat River is one of 9 rivers that empties into Rawapening. This study aims to analyze patterns of land use change in the Parat River sub-watershed in the last 25 years, using geographic information systems (GIS) remote sensing applications. The time series used were 1994, 2000, 2003, 2009, 2014 and 2018. The data was interpreted based on the types of land cover and how the changes occurred during that time period. There are seven types of land cover identified in this study. The area increases of plantation land types (1.12%) and built-up land (5.69%), is in line with the decrease in the area of Rice field type (7.78%), savanna (0.44%), swamp grass (0.40%), open land (0.25%) and body of water (0.01%). Changes in the pattern of land use in the Parat River Sub-watershed, in line with the increase in the amount of contamination carried and then will affect the lake where it empties, which is Rawapening.

1. Introduction
Global concern for environmental issues has focused on the sustainability of the availability, management and conservation of freshwater ecosystems. The phenomenon of increasing population growth, urbanization, wastewater management, will affect water quality problems in the future [1]. Since 2010, the Indonesian government has set fifteen lakes to prioritize its management. This is based on the urgency of ecosystem damage due to excess capacity. Rawapening is one of the 15 priority lakes that needs to be saved because of its very poor condition. This happens because of a decrease in water quality, a decrease in water discharge and siltation of lakes due to sedimentation [8].

Rawapening Lake is located in Semarang Regency, Central Java and its area includes a portion of the sub-districts of Jambu, Banyubiru, Ambarawa, Bawen, Tuntang, Getasan [9]. The Parat Sub- watershed is one of the 9 sub-watersheds of several rivers that discharges into Rawapening Lake. Watershed is a land area which is a unit with the river and its tributaries which functions to accumulate, store and flow water from natural rainfall to lakes or to the sea [3].
The Parat Watershed passes through the area in Banyubiru, Tuntang and Getasan Districts. The increasing population and the rapid pace of development in the Parat watershed sub-region has caused changes in land use patterns. Changes in land use patterns in the river areas that lead to Lake Rawapening, of course, will contribute to eutrophication and sedimentation in lakes through pollution of plantations, rice fields, household waste, livestock etc., in this case especially the Parat Watershed, which is very dense settlement and livestock.

Remote sensing techniques for satellite systems are now widely used for various studies including watershed management and coastal areas. The advantage of using Landsat imagery is the acquisition of multi-temporal object information, so that it can be reviewed and analyzed for its development. The image of the object on the lancet image also helps us to think spatially so that it helps in the analysis of the interrelationship between spaces which in this case is the link between the processes that occur in upstream to watershed [7], as well as how to manage and conserve the area later. GIS (Geographic Information Systems) is developing very rapidly and is an effective tool for use in geographical analyzes. Data sources that can be used as inputs in this system are field surveys (field measurements), maps and data from remote sensing. Identification of vegetation and non-vegetation cover in remote sensing images can be done manually and digitally (using satellite images).

Identification of land cover relating to land use in the watershed is key to the monitoring program, namely in an effort to gather information needed for evaluation purposes to ensure the achievement of watershed management goals and objectives. Data collection needs to be done regularly by utilizing the development of existing instrumentation, information and communication technology. For processing and analyzing data as well as presenting the results of monitoring and evaluation of watershed performance, the Remote Sensing technology and Geographic Information System (GIS) can be utilized for this research [2].

2. Method
The initial stage is the collection of geographical data (coordinates) of the Parat River sub-watershed obtained from BP-DAS Pemali Jratun, Central Java. The coordinates are then used to see maps of Landsat Imagery using ArcMap Ver.10.2 geographic information system (GIS) remote sensing applications. The data on land use change are available, then used as time series based on the preliminary analysis, is 1994, 2000, 2003, 2009, 2014 and 2018. Image data was taken to produce a map of the appearance of patterns of land use change and their respective area values each in the years that made the time series. Classification types of land use visually, carried out using colors found on the map produced. After obtaining the value of the area of each type of land use in those years, an analysis of the increase and reduction of area is carried out. Data is interpreted based on the types of land cover and how it changes over those time span through reading maps and the resulting tables.

3. Result and Discussion
There are seven types of land cover identified in this study. Changes in land use patterns in the Parat River Sub-watershed observed in this study are visualized in the form of a map in Figure. 1, described in the form of numbers in Table. 1 and illustrated in graphical form in Figure. 2 and obtained as follows:
Figure 1. Map of Development of Land Cover Area of Parat Watershed in 1994-2018
### Table 1. Development of Land Cover Area of Parat Watershed in 1994-2018

| Land Cover Type | 1994 Ha | 1994 % | 2000 Ha | 2000 % | 2003 Ha | 2003 % | 2009 Ha | 2009 % | 2014 Ha | 2014 % | 2018 Ha | 2018 % |
|----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Body of water  | 1.35   | 0.03   | 2.71   | 0.06   | 12.6   | 0.29   | 0      | 0      | 0.02   | 0.00   | 0.89   | 0.02   |
| Plantation     | 2662   | 60.93  | 2405   | 55.05  | 2440   | 55.85  | 2436   | 55.76  | 2665   | 61.00  | 2711   | 62.05  |
| Built Land     | 194    | 4.44   | 381    | 8.72   | 451    | 10.32  | 412    | 9.43   | 437    | 10.00  | 443    | 10.14  |
| Rice fields    | 1429   | 32.71  | 1410   | 32.27  | 1379   | 31.56  | 1478   | 33.83  | 1248   | 28.56  | 1089   | 24.93  |
| Open field     | 11     | 0.25   | 14.4   | 0.33   | 0      | 0.00   | 43.3   | 0.99   | 11.9   | 0.27   | 0      | 0      |
| Swamp grass    | 23.6   | 0.54   | 19.7   | 0.45   | 11.2   | 0.26   | 0      | 0      | 0      | 0.75   | 0.13   |
| Sabana         | 41.5   | 0.95   | 32.1   | 0.73   | 45.5   | 1.04   | 0      | 0      | 0      | 0      | 22.1   | 0.51   |
| **Total**      | 4369   | 100    | 4369   | 100    | 4369   | 100    | 4369   | 100    | 4369   | 100    | 4369   | 100    |

**Figure 2.** Graph of Development of Land Cover of Parat Watershed in 1994-2018

There is a type of land use in the form of a water body which is on the map is marked in blue at the most downstream. The land type of the body of the water has decreased from 1994-2018, which is 0.0105%. The decrease in area that occurs in this type of land use in the form of a body of water is caused by the condition of the most downstream part of the Parat River sub-watershed undergoing land use change into dominant rice fields and settlements, presumably this occurs along with an increase in population and needs. This change in land use then eliminates the existence of existing land types of waterbodies.

The type of land use in the form of plantations on the map is marked with light green. The type of land use has increased from an area of 1.122% since 1994-2018. The type of land use in the form of plantations is one of the most dominant types of land use in the Parat River sub-watershed from 1994-2018. Based on the visual appearance of the map, the most dominant area is covered by this type of
land use, which is in the upstream and middle areas between the built up land. The area of plantations continues to increase as the community's needs for land are built around it.

The type of land use built on the map is marked in yellow. This type of land experienced an increase of 5.7% from 1994-2018. The use of land type built up is also one of the most dominant types of land use in the Parat River sub-watershed from upstream to downstream. The increase in area from this type of land use, along with the increase in land use types of plantations and rice fields which is a medium for meeting the needs of people who live-in built-up land whose numbers continue to increase.

The type of land use in the form of rice fields on the map is marked with mint color. The type of paddy field use has decreased in area from 1994-2018 by 7.78%. The dominant type of land use after plantations and land is built is the use of rice-type land. This type of land use spreads from upstream to downstream and tends to increase from 1994-2009. But it has decreased since 2009-2018. Based on the appearance of the map, this happened because at some points in the upstream part of this type of land use turned into a type of plantation in those years.

The type of land use in the form of open land on the map is marked in orange. This type of land use has decreased from 1994-2018 by 0.25%. This type of land use since 1994-2018 is not too dominant in appearance on the map visually and the area is not so large. Over time until now, this type of land use has continued to decline and has even disappeared to reach 0% in 2018.

The type of land use in the form of swamp grass, on the map is marked with dark green. Since 1994-2018 the type of swamp land use has decreased by 0.4%. The use of this type of land is only found in the lower reaches of the Parat River sub-watershed. The type of land use in the form of savanna, on the map is marked in light green. This type of land use from 1994-2018 has decreased by 0.45%. From the beginning, savanna type land use was not dominant in the Parat River sub-watershed and the area was very small. This type of land use tends to decline due to land use change into plantations.

Looking at the development of land cover for all types of land use since 1994-2018 in the graph Figure 1, which has the highest area value indicated by a line clearly illustrated in the diagram, starting from plantations, rice fields, built-up land and savannas. As for the type of land use in the form of a body of water, open land and swamp grass on the diagram, the lines of value of the area are not clearly illustrated. This is because the three types of land use have very small area values when compared to the other four types where the area continues to decline due to land conversion.

Referring to Hidayati's research [4] regarding the potential for irregular source pollution load in Rawapening Lake's catchment area, in 2012-2016, the potential volume of livestock emissions and contamination of the livestock sector in Rawapening catchment was very high. Especially for 3 sub-districts which are passed by the Parat River sub-watershed, namely Getasan, Banyubiru and Tuntang. Getasan sub-district, which is the upstream part of the Parat River sub-watershed, has the highest contamination load of 34%. This certainly has the great affects on the condition of the lake and contributes to various contaminations on the Lake where it empties, considering the Sub-watershed of the Parat River is one of the rivers that empties into Rawapening Lake.

During 1984-2013, Semarang district experienced an increase in air temperature of 0.014°C / year [6]. The increase in area later, in 2009-2018 is shown in the diagram (Figure 1), especially for paddy fields, supported by the incessant program to increase the area of agricultural land expansion by the Ministry of Agriculture as one of Nawa Cita's priority agendas namely increasing food sovereignty quality [5].

4. Conclusion

There are seven types of land cover identified in this study, namely in the form of water bodies, plantations, built up land, rice fields, open land, swamp grass and savannas. Increased size of plantation type (1.12%) and built up land (5.69%), is in line with the decline in the area of rice fields (7.78%), savannas (0.44%), swamp grass (0.40%), open land (0.25%) and body of water (0.01%). The type of soil that was originally dominated by natural vegetation such as savannas, swamp grass,
standing water and so on, then after 2000 was replaced by plantation land and standing land. Changes in land use patterns that occur in the Parat River Sub-Watershed are in line with the increase in the amount of pollution that will be carried out and will then affect the places that lead to Rawapening Lake, which will then affect sedimentation and siltation of lakes. Considering the Parat River Sub-watershed is one of the 9 rivers that lead to Rawapening Lake.

5. References
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