Land Cover Change of Kawatuna Sub-Watershed in Central Sulawesi

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Abstract - The management of watersheds around Palu City is very complex, both in activities and land cover changes, reducing watersheds' performance. The phenomenon of land cover change continues to develop, and spatial modeling of land cover change is needed to minimize interventions in the impact of of land cover changes with a mathematical trend model. Our findings indicate a decrease in performance in the Kawatuna Sub-Watershed, with a significant change in land cover from 1990 to 2021. The decline in forest land decreased to 30%, while the area of land cover that increased was shrubs-bushland by 50% and barren land by 7%. The government needs to improve the quality performance of the ecosystem in the Kawatuna Sub-Watershed so that environmental benefits can be maintained in meeting human needs.

Keywords **-** watershed Performance, Land Cover

I. INTRODUCTION

In the past few decades, a number of research on land cover change (LC) in watersheds have been documented. [1], essential to comprehend the effects of changing land cover and the consequences for growth and land needs in the Watershed Kawatuna area. The method uses land cover trend analysis from spatial analysis results using geoprocessing techniques in geographic information system (Quantum GIS) software. The performance of the Kawatuna Sub-Watershed is represented in the form using sustainable development practices. Changes in land use have an impact on water quality, particularly because surface runoff from open space and agriculture degrades the quality of surface waters [2], [3].

The main causes of the degradation of watershed natural resources are population growth and community activities related to supplying basic needs [4]. Reduced capacity of forests to maintain watershed performance results from changes in land cover from forest to non-forest area in the watershed system [5], [6].

Observing land change that continues to develop in an area requires land change modelling based on spatial analysis predictions [7]. Spatial analysis as an intervention approach in minimizing the impact of land change dynamics on an area. LC dynamics have important implications for changes in

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environmental performance in meeting human needs. This study aims to compare the changes in LC in the Kawatuna Sub-watershed represented in the form of land cover changes with a mathematical trend model over several periods.

II. MATERIALS AND METHODS

The Kawatuna Sub-watershed (Figure 1) used as the site of the research because it offers a level of advantage for the water provider in meeting the requirements of the community. The Kawatuna Sub-changes watershed's in land cover were identified, classified, and evaluated using a method and analysis that used a spatial modeling approach to LC change, specifically an unsupervised classification strategy. The developmental phenomenon of LC was analysed over the last 30 years. Data and information are in the form of LC of the Kawatuna Sub-watershed from 1990, 2000, 2010 and 2021, combined with terrestrial methods in the form of ground checks.

Spatial data development analysis using Quantum GIS software includes: (i) digitization of watershed boundaries, (ii) geometric and georeferenced corrections, and (iii) mechanisms to explore, estimate, and measure land cover changes [10], [11]. Therefore, selecting a suitable sampling strategy is an essential step of LC trend analysis [12], [13]. Visualization of land cover change was analyzed using a Sankey diagram. This diagram illustrates the complex interaction of land use categories on the size and direction of flow in an LC change system [14].

III. RESULTS

In interpretation for LC, we convert the LC typology to fit by combining the five classes. Some adopted the LC classification (Figure 2) from land cover classification and mapping data sources, including aerial photographs, satellite imagery, and maps of various local government attributes [15].

TABLE 1. TYPES OF LC AND THEIR DESCRIPTIONS.

LC Class	Description
water body	Permanent open water areas (Streams and canals, rivers and shallow water areas)
shrub-bushland	An open area overgrown with grass, dominated by natural shrubs
forest	Areas that are overgrown and dominated by woody plants
built area	Residential areas, land covered by buildings, roads and manufactured structures
cultivated	Agricultural areas, plantations, farming land and green open spaces
barren land	Areas with open soil, sand or rock and not having more than 10% cover.

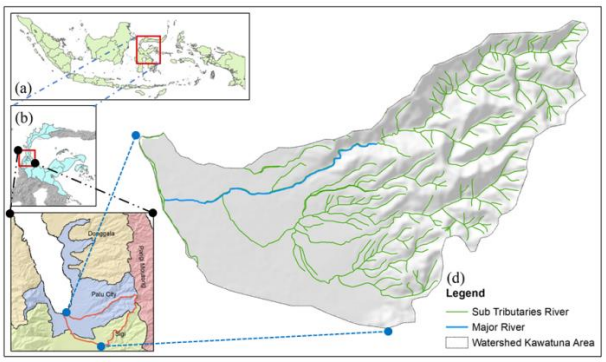

Figure 1. Kawatuna Sub-Watershed: (a) Research location in Central Sulawesi on the Indonesia map (b) Kawatuna Sub-Watershed in Central Sulawesi (c) The position of the Kawatuna Sub-Watershed in Palu City and Sigi Regency (d) Kawatuna Sub-Watershed

The evaluation of the main limitations of this study is related to the accuracy of the classification of LC changes for the 1990-2000 period obtained from detailed mapping results sourced from the forestry service so that it has an accuracy level below 70%. However, the agency is declared legitimate and valid as a provider of LC spatial data. Even though the LC classification is below the required standard, we consider it valuable data and information related to the analysis of the development of LC changes for the future.

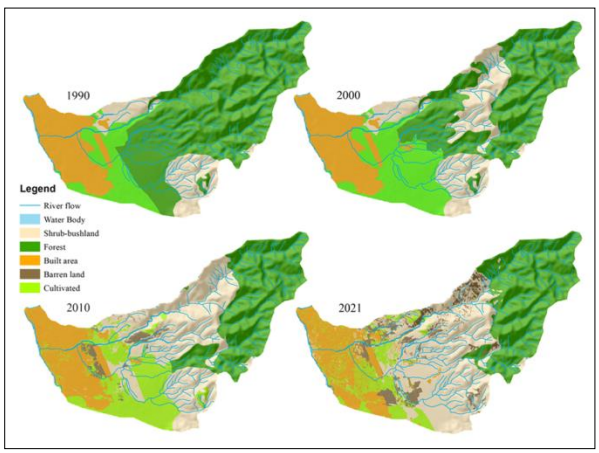

Figure 2. Distribution of LC changes from 1990 - 2021

The results of LC change differed in appearance between the three time periods: 1990–2000, 2000–

2010 and 2010–2021 (Figure 3). Nearly thirty years into the trend analysis of the study period, the forest area has decreased by 30%, the area has consistently increased by 50% of shrub-bushland and the presence of new LC in the form of barren land by 7%. In 2021 there will be an increase in the area of the water body by 0.19% due to the natural flood disaster.

As a result of the human activities of the Kawatuna Sub-Watershed, the community has made the transition to utilizing existing resources, clearing other land that has income certainty, taking forest products and using forest land will have an impact on changes in land cover (Figure 4), both directly and indirectly [13], [16].

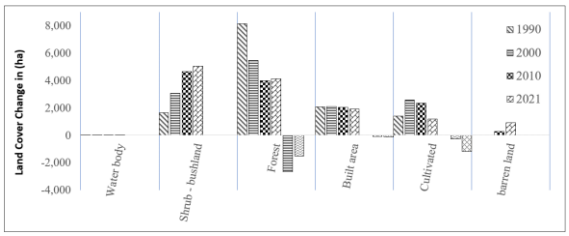

Figure 3. The trend of the LC Sub watershed in Cabauna between 1990 – 2021

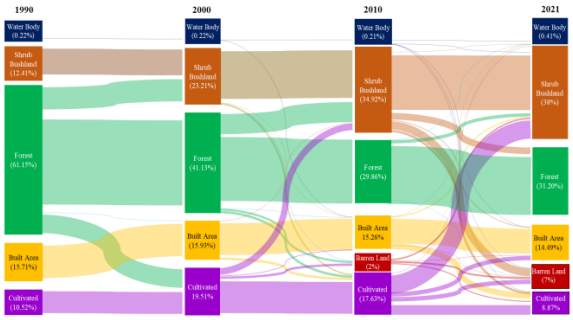

Figure 4. Sankey diagram of LC changes for the period 1990-2021

From 2003 to 2011, rainfall in the Kawatuna Sub-Watershed was less than 729 mm or an average below normal, so some water body areas experienced dryness. Drought conditions have resulted in some water body areas being utilized by the community as building areas. However, after 2011 rainfall in the study area was above normal with an average rainfall value of above 729 mm, so there was a risk of flooding, increasing the area of the water body in the Kawatuna Sub watershed [17].

During the 1990-2000 period, shrub-bushland saw an increase in the clearing of forest land for firewood collection and the felling of trees to collect wood for household needs [13]. From 2000-2021 there has been an increase in the area of shrub-bushland from forest land and cultivated land. That year, urban development occurred, resulting in forest land clearing. Besides that, there is a shift in community work due to mining processing [18], so people leave their agricultural land and become shrubs [19]. LC changes that occurred over 30 years. Forest destruction continues to increase, driven by local people who have no other skills other than clearing forest land to make land cultivated (cultivated) [16].

The development and increase in built-up land from 1998 to 2008 because most of the Kawatuna Sub-Watershed has a level of land suitability for built-up land [13], [20]. However, from 2010-2021 there has been a decrease in the area of built-up land into cultivated land, and shrubs due to natural disasters [13], [21]. Since 2010 there has been a new LC, namely barren land due to a large amount of cultivated land that has been abandoned due to changes in work to gold mining which is managed in the Kawatuna Village [13], [18].

Weak policy strategies and law enforcement for land use protection and use have caused local communities to develop an open access mentality in Kawatuna Sub-Watershed. The current population growth trend continues along with the expansion of cultivated land, and barren land due to gold mining. A conservation intervention strategy should be set up for community activities at the Kawatuna Sub-Watershed to demonstrate the best watershed conservation and mitigation measures to help protect against further degradation.

IV. CONCLUSION

As a result of changes in LC, this study demonstrates a conversion of forest land into cultivated land, scrubland, and barren land. The growth of the city and the presence of mining operations have led to a decrease in the number of woods, and a great deal of cultivated land has been abandoned, turning it into scrubland and barren land. Weak law enforcement and land protection policies have resulted in the degradation of the Kawatuna Sub-Watershed. This research suggests integrated management of Kawatuna Sub-Watershed, including proper land use planning and management interventions with the active participation of the local community, to prevent unwanted LC changes.

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