Analysis of the North Toraja Regency spatial plan by GIS analysis: Recreation ecosystem and ecotourism

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Abstract. Recreation and ecotourism as ecosystem services are pleasures that come from nature. Quantification and mapping as one of the key elements needed to improve the recognition and implementation of ecosystem services into decision making. Mapping of recreational and ecotourism ecosystem services as material for evaluating the RTRW of North Toraja Regency. The results of the evaluation of the RTRW become the basis for the development of tourist areas and plans for the development of infrastructure for the Toraja Regency in the future. This study aims to identify tourism object ecosystem services and analysis of services to the RTRW of North Toraja Regency. The value of ecosystem services is obtained from the weighting and scoring of geomorphology, natural vegetation, and land cover derived from expert opinion and analyzed by the AHP method. Land cover was identified using SPOT 6-7 Year 2019 imagery. 9 geomorphologies are dominated by volcanic mountains made of outer igneous rock with an area of 82,974.92 Ha. Natural vegetation is known that the vegetation of the lower monsoon forest (monsoon lower mountain forest) dominates with an area of 93,809.14 Ha. The mainland cover is secondary dryland forest with an area of 46,803 ha. The results showed that the index value of recreational and ecotourism ecosystem services was dominated by very high class with an area of 5,5014.82 ha. The harmony of tourism objects, ecosystem services and spatial patterns resulted in 10 tourist objects with a very low index. These 10 attractions are then directed as material for evaluating spatial patterns. Land with land cover that is difficult to change is adjusted to its closure. The closure of plantation land, agriculture and dry land agriculture is directed to become a horticultural area. Meanwhile, tourism objects prone to disasters are directed to be protected areas.

1. Introduction
North Toraja Regency has experienced a significant increase in the number of domestic and foreign tourist visits each year [1]. Seen in the Lovely December event, people's income has increased by 90 % [1]. In addition to experiencing an increase in the number of tourist visits, North Toraja Regency has also experienced an increase in the number of tourist attractions. Regional Spatial Plan (RTRW) contains strategic plans for economic areas that focus on tourism activities. The condition of increasing tourism and recreational activities will encourage land clearing activities in the form of building roads, hotels, and expanding agricultural land which will have a negative impact on the environment. So that tourism areas need to be analyzed starting from culture, recreation, also ecotourism.
Recreational and ecotourism ecosystem services are the result of specific landscape features or sites favored by visitors, as well as from biodiversity [2]. Recreational ecosystem services and ecotourism are positively related to other ecosystem services such as water supply, carbon storage, and erosion control which are influenced by the exchange of ecosystem service products [3].

Currently, recreational cultural ecosystem services and ecotourism are less spatially defined and visualized [4]. This is because the assessment is still subjective for each individual or each group that has different value systems and demands [5]. Quantification and mapping as one of the key elements needed to improve the recognition and implementation of ecosystem services into decision making [6]. The application of geographic information system (GIS) based methods is easier to map recreation and ecotourism as ecosystem services [6].

Based on this, it is necessary to map out recreational and ecotourism ecosystem services which are part of cultural services. Mapping of recreational and ecotourism ecosystem services as material for evaluating the spatial plan of the North Toraja Regency. The results of the evaluation of this spatial plan will be the basis for the development of tourist areas and plans for the development of infrastructure for North Toraja Regency in the future.

2. Material and methods

2.1. Research site

This research will be carried out from February to May 2021 in North Toraja Regency, South Sulawesi Province. Geographically, North Toraja Regency is located between 2° 40' South Latitude - 3° 25' South Latitude and 119° 30' East Longitude - 120° 25' East Longitude.

2.2. Research approach and Type

This research is based on mapping with the category of non-experimental research using survey methods and GIS analysis. Spatial analysis using land cover data, natural vegetation and geomorphology to produce a map of ecosystem services. The data on ecosystem services is the basis for describing the harmony of spatial patterns with recreational and ecotourism ecosystem services.

2.3. Data collection

Primary data include: (1) questionnaires/expert opinions, (2) image interpretation to produce land cover maps, (3) direct observation of image interpretation results (4) direct observation of tourism locations in North Toraja Regency. Secondary data is collected from several agencies according to the attributes to be studied. The data includes administrative spatial data, land cover maps, natural vegetation maps and spatial pattern maps as well as tourism object data in North Toraja Regency. The list of spatial data, sources, and scale is presented in Table 1.

| No | Type of Data                  | Source                                                                 |
|----|-------------------------------|------------------------------------------------------------------------|
| 1  | Administration and road map   | Indonesia Geospatial Portal 1:50.000 (tanahair.indonesia.go.id)        |
| 2  | Landcover map                 | SPOT 6-7 Image 2019                                                    |
| 3  | Geomorphological map          | Directorate of environmental impact prevention for regional and sector policies, Director of forestry plan and environmental management, Ministry of Environment and Forestry in 2017 |
| 4  | Natural vegetation map        | Directorate of environmental impact prevention for regional and sector policies, Director of forestry plan and environmental management |
2.4. Research procedure

2.4.1. Geomorphological and natural vegetation mapping. Mapping is done by cutting geomorphological maps and maps of natural vegetation sourced from the directorate of environmental impact prevention, regional and sector policies, directorate general of forestry planning and environmental planning, the ministry of environment and forestry in 2017 with the boundaries of the North Toraja district to produce geomorphological and vegetation maps in North Toraja Regency.

2.4.2. Land cover mapping. Image interpretation is done manually based on the characteristic pattern of color/hue, texture, shape, size, and pattern. The image used in this study is the SPOT 6-7 image in 2019. The land cover classification used is from the Indonesian National Standard (SNI) 7645-1:2014 on land cover classification. SPOT 6-7 image interpretation is done by manual digitization. Then it is verified through a ground check to determine the accuracy of the interpretation results.

2.4.3. Mapping the locations of tourism objects in North Toraja Regency. The mapping of the location of this tourist attraction aims to see the distribution of tourist objects in North Toraja Regency. This mapping is done by visiting each tourist attraction location in North Toraja Regency where the tourist attraction can represent each existing tourist area. The method used is purposive sampling or random sampling where the consideration of sampling is based on accessibility and representing each tourism area, then taking the coordinates of tourist objects using a GPS receiver. Data on the tourist objects visited came from the tourism office of North Toraja Regency.

2.4.4. Recreational and ecotourism ecosystem services analysis. Recreational ecosystem services and ecotourism analysis were carried out using the Analytical Hierarchy Process method, namely by carrying out a weighting assessment of the role and contribution of geomorphology, natural vegetation, and land cover. This assessment is carried out by experts/experts from academic circles (Hasanuddin University lecturers) who have expertise in geomorphology, land cover and natural vegetation related to ecosystem services. The determination of the expert is done by means of a literature study by looking for a track record of experience and the predicate of the person whose willingness will be asked.

The expert assessment is carried out using the scoring method, the expert will provide a scoring scale for ecosystem services for each type of geomorphology, natural vegetation and land cover on recreational and ecotourism ecosystem services through a questionnaire instrument. The questionnaire contains a table that describes the weights and scores of ecosystem services on geomorphology, land cover and natural vegetation with a range of 1 – 5. Assuming that the numbers 1 (very low), 2 (low), 3 (medium), 4 (high), and 5 (very high) [7].

The results of the expert scoring are then processed to produce an ecosystem service index value. The results of the value of the ecosystem services index are then processed to produce the value of the performance of ecosystem services. The value of ecosystem service
performance is a relative value obtained from the multiplication of the geomorphological ecosystem service index value, natural vegetation and land cover. The performance value of ecosystem services will essentially represent the ability of a land type or geomorphology in providing ecosystem services to support the livelihoods of living things based on a range of values, which can be seen in the following equation:

\[
f(r) = (w_{bl} \times s_{bl}) + (w_{veg} \times s_{veg}) + (w_{pl} \times s_{pl})\
\]

Information,

- \( w_{bl} \): geomorphological value
- \( s_{bl} \): geomorphological score
- \( w_{veg} \): vegetation value
- \( s_{veg} \): vegetation score
- \( w_{pl} \): landcover value
- \( s_{pl} \): landcover score

The results of the calculation of the performance of recreation and ecotourism ecosystem services are then described through tables and maps. Where ecosystem services have a varied range of classes which are then classified into 5 levels of ecosystem services. The determination of the level of ecosystem services is determined based on the higher the coefficient value of ecosystem services, the higher the value of its importance in environmental management. After obtaining the distribution of ecosystem service coefficient values, it will be presented into a geometric interval classification in GIS software with a classification class as shown in Table 2.

| Classification | Description | Class Range |
|----------------|-------------|-------------|
| Class 1        | Very Low    | Red         |
| Class 2        | Low         | Orange      |
| Class 3        | Middle      | Yellow      |
| Class 4        | High        | Light Green |
| Class 5        | Very High   | Dark Green  |

Ecosystem services in this study are ecosystem services that are directly related to the priority issue of spatial planning in North Toraja Regency. The selected ecosystem services are recreation and ecotourism ecosystem services. The results of this analysis will produce a map of the ecotourism and recreation ecosystem services index of North Toraja Regency.

2.4.5. Suitability of spatial patterns for ecosystem services. The suitability of existing spatial patterns and tourism objects to recreational and ecotourism ecosystem services is obtained by overlapping/overlaying spatial data. The spatial data comes from maps of spatial patterns, maps of existing tourist objects and maps of recreation and ecotourism ecosystem services. The results of the overlap/overlay will present data on the suitability of tourist attraction points in a spatial pattern based on the ecosystem service index. So that it can be seen the value of the ecosystem service index of each tourist attraction location and its position in the spatial pattern.
2.4.6. **Strategy for recreational space patterns and ecotourism.** The direction of the pattern of recreation and ecotourism is prepared based on the results of the overlay analysis of the suitability of the spatial pattern for ecosystem services. This directive aims to optimize land use in accordance with the highest ecosystem service index value, so that the harmony of spatial patterns with ecosystem services can be maximized. These results will be used as evaluation material to be able to see the ability of the land to produce ecosystem services, where ecosystem services are used as a reference to assess the suitability of land for tourism objects based on the value of recreational and ecotourism ecosystem services that are in the spatial pattern of North Toraja Regency.

3. **Result and discussion**

3.1. **Ecotourism and recreational ecosystem services**

Ecosystem services are the benefits that humans can get from various natural resources and processes that are jointly provided by an environment. The higher the value of ecosystem services, the higher the ability of the environment to provide the benefits of its ecosystem services to humans. In this study, the assessment of the role of ecosystem services for each type is obtained from three assessments, namely geomorphology, land cover and natural vegetation, where the assessment of the role of each assessment is carried out by experts who are competent in their fields. In this case, geomorphology is intended to represent the abiotic aspects of the ecosystem, while natural vegetation and land cover represent biotic aspects and also reflect the results of interactions between components in the ecosystem. Based on the results of data processing, recreation and ecotourism ecosystem services are very low to very high. The ecotourism and recreation ecosystem service index of Toraja Regency can be seen in Table 3 and Figure 1.

| No | Ecotourism and Recreational Ecosystem Services Index | Interval | Total Area (Ha) | % |
|----|-----------------------------------------------------|----------|----------------|---|
| 1  | Very Low                                            | 1.00 – 1.80 | 609.22 | 0.46 |
| 2  | Low                                                 | 1.81 – 2.60 | 11,679.23 | 8.85 |
| 3  | Middle                                              | 2.61 – 3.40 | 28,186.85 | 21.36 |
| 4  | High                                                | 3.41 – 4.20 | 36,443.26 | 27.62 |
| 5  | Very High                                           | 4.21 – 5.00 | 55,014.82 | 41.70 |
|    | **Total Area**                                      |          | 131,933.39 | 100.00 |

| Table 3. North Toraja Regency Ecotourism & Recreational Ecosystem Services Index |
3.2. Suitability of spatial patterns for ecosystem services

The results of this alignment evaluation show that there are 10 ecosystem services that fall into the low and very low class range. In this study, low and very low ecosystem services are the material for evaluating the spatial pattern of North Toraja Regency. This is done to increase the ability of the environment to produce ecosystem services or to maintain the environment so that it does not experience a decrease in the ability to produce the benefits of ecosystem services needed by humans. Ecosystem services that have a low class, there are 6 attractions and 4 attractions with a very low class. The very low class is dominated by the spatial pattern of urban residential areas. To see the distribution of tourism objects and ecosystem services can be seen in Table 4 and Figure 2.

![Figure 1. map of ecotourism and recreational activities](image-url)
| Ecotourism          | Natural Vegetation                                      | Geomorphology                          | Landcover              | Ecosystem Service Index | Spatial Plan   | Suitability     | Recommendation                                                                 |
|---------------------|---------------------------------------------------------|----------------------------------------|------------------------|-------------------------|------------------|----------------|-------------------------------------------------------------------------------|
| Pasiliran Baliu'   | Mountain limestone forest vegetation in karst landscapes | Solutional karst hills made of carbonate sedimentary rocks | Dryland agriculture    | Low                     | Horticulture     | Suitable       | The development of Tourism Ecosystem Services is carried out by adjusting the spatial pattern and land cover. |
| Salib Gunung Singki' | Freshwater swamp forest vegetation in karst landscapes  | Alluvium fluvial valley                | Shrubs                 | Low                     | Tourism          | Not Suitable   | Development follows the spatial plan                                          |
| Batu Piak           | Monsoon lower mountain forest vegetation                | Volcanic hills with pyroclastic material | Dryland Farming Mixed with Bush | Low                     | Horticulture     | Suitable       | The development of Tourism Ecosystem Services is carried out by adjusting the spatial pattern and land cover. |
| Bori' Kalimbuang    | Freshwater swamp forest vegetation in karst landscapes  | Alluvium fluvial valley                | Dryland Farming Mixed with Bush | Low                     | Cultural Heritage | Not Suitable   | Development follows the spatial plan                                          |
| Permandian Air Panas | Monsoon lower mountain forest vegetation               | Volcanic hills with pyroclastic material | Dryland Farming Mixed with Bush | Low                     | River            | Not Suitable   | Development follows the spatial pattern by taking river conservation actions Adjusting the Spatial Pattern, by carrying out rehabilitation actions for landslide mitigation. |
| Benteng Batu        | Monsoon lower mountain forest vegetation                | Volcanic mountains made of outer igneous rock | Shrubs                 | Low                     | Landslide Prone Protected | Not Suitable   | Adjusting the Spatial Plan                                                    |
| Batu Sarong         | Mountain limestone forest vegetation in karst landscapes | Solutional karst hills made of carbonate sedimentary rocks | Dryland Farming Mixed with Bush | Very Low                 | Urban Residential | Not Suitable   | Adjusting the Spatial Plan                                                    |
| Buntu Laang         | Mountain limestone forest vegetation in karst landscapes | Solutional karst hills made of carbonate sedimentary rocks | Dryland Farming Mixed with Bush | Very Low                 | Urban Residential | Not Suitable   | Adjusting the Spatial Plan                                                    |
| Kolam Alam Limbong  | Mountain limestone forest vegetation in karst landscapes | Solutional karst hills made of carbonate sedimentary rocks | Dryland Farming Mixed with Bush | Very Low                 | Urban Residential | Not Suitable   | Adjusting the Spatial Plan                                                    |
| Kondongan           | Mountain limestone forest vegetation in karst landscapes | Solutional karst hills made of carbonate sedimentary rocks | Shrubs                 | Very Low                 | Urban Residential | Not Suitable   | Adjusting the Spatial Plan                                                    |
3.3. Spatial plan recommendations for tourism objects based on ecotourism and recreation ecosystem services

Spatial Plan Recommendations for tourism objects based on ecosystem services are prepared with the aim of optimizing land use in accordance with ecosystem services. In this study, recommendations for spatial pattern directions will be described for low and very low-class recreational and ecotourism ecosystem services. In achieving these objectives, the following criteria are formulated:

1. Spatial patterns that are in line with land cover and have very high, high and moderate criteria for ecosystem services are directed to be maintained.
2. Land with land cover that impossible to change, such as settlements, industrial buildings is directed to be an area that is suitable for its closure. In the 2018-2023 North Toraja Regional Regulation it is stated that residential development is carried out vertically to optimize increasingly narrow urban spaces.
3. Alignment between spatial plan and appropriate land cover that has a low and very low ecosystem service index, namely Pasiliran Baliu’ and Batu Piai tourism objects, further development is recommended in the future following the existing spatial plan, namely horticulture.
4. Spatial plan that have low and very low criteria for ecosystem services that have a match between land cover and spatial plan that do not match will then:
   a. The Mount Singki Cross tourist attraction is a tourist attraction located at the top of a hill by presenting a panoramic view of the city of Rantepao and a large cross statue. The land cover in this tourist attraction is shrubs and the spatial pattern of the tourist area, so the
resulting directions do not match the existing land cover and the spatial pattern. Furthermore, the recommendation that is proposed is to follow the existing spatial pattern, namely the tourist area. Land with land cover that is difficult/impossible to change such as built tourism objects, settlements, industrial buildings is directed according to its closure.

b. The tourist attraction of Bori' Kalimbuang is a tourist place that displays a panorama of menhirs and graves typical of the Toraja people. This tourist attraction is based on the existing land cover for dry land agriculture and the spatial pattern of the cultural heritage area. To maximize the use of tourism, the recommendations that are suitable for this tourist attraction are in tourist locations following the existing spatial pattern, namely the cultural heritage area. Where for further development this area still pays attention to the current use of existing land, namely dry land agriculture according to its function and can then be developed as a horticultural area by paying attention to existing tourist attractions.

c. This hot spring tourist attraction is a tourist attraction located on the river border. According to the government regulation of public works and public housing number 28/PRT/M/2015 if the river border has already been used for city facilities, buildings, roads, or other public facilities, the minister, governor, regent and/or mayor in accordance with their authority can determine the allocation. the existing ones as permanent will not be changed due to historical reasons or other reasons that provide greater benefit to the public interest, they will not be changed and will be maintained as long as there is no reason that is more important than their current use. The buildings that have been standing on the river border are declared status quo, meaning that they cannot be changed, added, or repaired. New building permits will no longer be issued. For this reason, recommendations for the development of tourism objects in the future are developed by paying attention to soil and water conservation in the river border area. Types of bamboo plants Gigantochloa atter and Bambusa vulgaris have a very tight rhizome root system, the clumps are also very dense and the canopy shape rounded. Both types of bamboo are recommended to be used as soil and water conservation plants in river borders.

d. The stone fort is a tourist attraction that displays grave on a cliff. The spatial pattern of this tourist attraction is in a protected area with the existing land cover of shrubs. The direction of recommendations that are in accordance with this tourist attraction is to follow the pattern of space as a protected area so that for future development, it can be done to develop tourism objects by carrying out soil conservation. One of the appropriate conservation measures is vegetative conservation by using plant roots as a barrier to runoff and preventing damage to soil structure. The types of plants that are recommended for vegetative conservation are fast-growing plants, cover crops, or by maintaining plants that already exist/growing wild in the area [8].

e. The attractions of Batu Sarong, Buntu Laang, Limbong and Kondongan natural ponds are natural attractions that present beautiful natural panoramas. The discrepancy between the existing land cover and the spatial pattern leads to further development as a horticultural area by considering the aspects of tourism objects that have been built.

4. Conclusions
North Toraja Regency is dominated by geomorphological landforms originating from volcanic mountains with external igneous rock material with an area of 82,974.92 ha or 62.89%. The land cover in North Toraja Regency is dominated by Secondary Forest with an area of 46,803.37 ha or 35.47%. Meanwhile, natural vegetation is dominated by monsoon lower
mountain forest with an area of 93,809.14 ha or 71.10%. Recreational ecosystem services and ecotourism in North Toraja Regency are dominated by very high and high classes. The results of the regional spatial plan evaluation are based on recreational and ecotourism ecosystem services, there are ten tourist objects that are classified as low and very low.

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