Social Network Interaction Mapping and the Impact of Land Use Change in Malino Tourism Area, Gowa Regency, Indonesia

Jamilah Abbas ^{1*}, Sumbangan Baja², Risma Neswati³, Muhammad Yamin⁴ and Syaeful Rahmat⁵

¹ Doctoral Program in Development Studies, Graduate School, Hasanuddin University, Makassar Indonesia

² Department of Soil Science, Faculty of Agriculture, Hasanuddin University, Makassar Indonesia

³ Department of Soil Science, Faculty of Agriculture, Hasanuddin University, Makassar, Indonesia

⁴ Department of Development Studies, Graduate School, Hasanuddin University, Makassar, Indonesia

⁵Study Programs Remote Sensing and Geographic Information System, Faculty of Vocational, Hasanuddin University, Makassar, Indonesia

*E-mail: abbasj22p@student.unhas.ac.id

Abstract. In recent years, Malino has experienced rapid development as a tourist destination. This is characterized by the increasing number of visitors and the development of tourist infrastructure. With its development as a tourist destination, Malino has experienced significant land use changes. Forests and agricultural land are transformed into inns, restaurants, and other tourist infrastructure. The loss of flora and fauna habitat, damage to biodiversity, erosion, sedimentation, a decrease in water quality, and environmental pollution are a long list within the scope of the environmental crisis that occurs. Not only related to the environmental crisis, the impact of land use change can also cause social conflict between communities related to access to natural resources, as well as the loss of livelihoods for people who depend on the agricultural and forestry sectors. In this study, we want to see how the dynamics of land use change that occur in the Malino tourist area affect the structure and dynamics of social networks between actors and the impact of land use change on environmental, social, and economic aspects. The method used in this research is a field survey with in-depth interviews and participatory mapping using the Arcgis Survey123 platform from Esri to visitors, local residents, and tourism managers with 130 respondents. The spatial approach was carried out to determine the extent of the dynamics of land use change identified in the scheme of village areas included in Malino tourism in Gowa Regency, including 7 villages, including Bonto Lerung Village, Bulutana Village, Kanreapia Village, Gantarang Village, Manimbahoi Village, Pattapang Village, and Malino Village. Based on the results of the field survey, 32.37 percent said that the role of the community in managing the tourist area was very important, as well as the argument that the economic impact on tourism revenue increased by about 3.62% of the usual income. However, the rate of land use change from high-density secondary dryland forest to shrubs in the last 9 years increased to 327.01 hectares. The rate of land use change from forested to vacant and abandoned land is 62.00 hectares, and from forested to tourist support infrastructure is about 2.72 hectares. This shows that the growth of tourism affects the loss of forest in the Malino tourism area.

1. Introduction

Along with the times, population growth also continues to increase every year. This certainly affects the increase in human needs, especially the need for land. Increased human needs for land encourage changes in land use, which have an impact on changes in land capability. land use change that is now unavoidable due to limited natural resources causes changes in land cover conditions. Land cover is a real representation of the physical appearance of the earth's surface, so that land cover itself is one of the important components in supporting the life system in an area. An area will directly affect the high value of biodiversity if the type of vegetation cover is also good.

Social network mapping has become an increasingly important tool in understanding land use dynamics. (Rudolph et al. 2020) revealed that, the use of social network analysis in the context of land use can reveal patterns of interaction that may not be visible through conventional research methods, thus providing new insights into how land use decisions are made and implemented. On the other hand, land cover change is one of the factors that affect environmental quality. Land cover change can be caused by human activities or naturally occurring changes. Land cover change can be defined as a process of change from a previous land cover to another cover that is permanent or temporary. The logical consequence of land cover change is the growth and transformation of changes in the socio-economic structure of developing communities for both commercial and industrial purposes (Suryono, 2019). Research that focuses on social interactions in land use change has the advantage of uncovering the complexity of human decision-making. According to (Meyfroidt et al. 2022), this approach enables a deeper understanding of how values, norms and social relationships influence land use decisions. In contrast to approaches that only look at physical aspects, social interaction analysis can explain why land use change occurs even when physical conditions do not change significantly.

The phenomenon of land conversion in the Malino Tourism Area, Gowa Regency, which is currently rampant, where the existing conditions occur land conversion of conservation protected areas to the function of cultivation areas. Where in the Regional Spatial Plan of Gowa Regency, Tinggi Moncong Sub-district is designated as a Protected Forest Area that protects the area below, but in reality the construction of buildings with cultivation functions such as villas, culinary and settlements are often built by local communities because of land tenure owned by local communities that are included in Protected Areas (Latief, 2022).

Understanding the patterns and trends of land cover change is essential for formulating effective policies and strategies for regional management. The integration of land cover information into the planning unit is a crucial step so that social network mapping activities are carried out. The intended activity in this case is to find out the situation of the community around the Malino Tourism Area and find out the needs of the community that can be provided so as not to become a nuisance in the future. In addition, with the social mapping, it is hoped that it can be an input for the company so that it can take a stand and deal with it in a targeted manner.

The purpose of this study is to determine the pattern of social interaction, land cover change in Malino Tourism Area in the interval 2015-2023 and see the relationship of social interaction to land use change that allows to see the tendency of social interaction to land cover change in each class of planning units.

2. Study area

This research was conducted in the Malino Tourism Area of Gowa Regency which administratively consists of seven villages, including Pattapang Village, Kanreapia Village, Malino Village, Bonto Lerung Village, Gantarang Village, Buluttana Village and Manimbahio Village. which is administratively located in Gowa District, South Sulawesi, Indonesia. Data processing is carried out at Development Studies, Graduate School, Hasanuddin University. The research map can see in Figure 1.



Figure 1. Research Loation Map.

3. Material And Methods

The tools used for this study are a laptop with geographic information system software applications and Microsoft Office, GPS, cameras, recording devices, and writing stationery. The materials needed are the Malino Tourism Area boundary map, Sentinel-2 Imagery in 2015-2023, population data of the Malino Tourism area, and research questionnaire field survey data on people's perceptions of the Malino tourist area.

This research was analyzed using descriptive qualitative approach and supported by quantitative. The stages of data analysis include field surveys by interviewing several respondents, then analyzing social interactions by involving the mapping by community method with geographic information system tools, followed by overlapping analysis of interview locations with maps of forest areas, making spatial distribution of social interactions and trends in social interactions, analyzing land use change and trends in land use change and overlaying land cover change data with social interactions in the Malino tourist area.

3.1 Field data collection

Field data collection is the process of collecting information directly at the research location. The data obtained is very important to support more accurate analysis, research, and decision-making. Social data collection was conducted using mapping by community approach using Arcgis Survey 123 tools. Field data collection to socio-economic conditions, biophysical conditions of the environment that have implications for the practice of spatial irregularities that have an impact on land use change and how the impact of land use change is viewed from the intensity of disaster risk based on community perceptions which include local residents, tourist visitors, and village civil apparatus. social data collected included population distribution, social welfare level, and activities in Malino tourism area.

3.2 Data Analysis

3.2.1. Social interaction mapping

Social interaction mapping : process of identifying, visualizing, and analyzing the relationships and interactions that occur between individuals, groups, or organizations. Conducting interviews with individuals or groups to learn about how they interact with each other. bserving interactions happening directly in the field. The social interaction approach enables the identification and analysis of conflicts and potential collaboration in land use management. In contrast to physical aspects that tend to be static, social interactions are dynamic and can change over time. Research by (Cumming et al. 2020) demonstrates how an understanding of social interactions can help in designing conflict resolution strategies and building effective partnerships in land management.

3.2.1. Landuse Change Analysis

To create the land cover map, satellite images were visually interpreted. This was done by using software to delimit each land cover class by depicting the satellite image on a computer screen (on-screen digitization). In addition, the principle of interdependence was also used in the interpretation, meaning that the results of the previous year's land cover interpretation served as a reference for the interpretation activities conducted in the current period. With this method, only areas that have undergone changes are reinterpreted. The 2015 and 2023 land cover maps were created through image interpretation. The Indonesian National Standardization Agency provided the basis for determining the land cover class used in Sentinel image interpretation.

After processing the data from the interpretation of land use data that has been defined based on the type of land use, then analyzed land use change with Land-use Planning for Multiple Environmental Services (LUMENS) software, then applied the Pe-Quest library to analyze the trajectory of land use change, and visualized land use change using Sankey Diagrams.

3. Results and Discussion

3.1 Interview Point Centralization and Information Influence

Based on the field survey, the concentration of respondents occurred in Malino Village with a high category. It also shows that the highest interaction occurs in the Malino urban village area. This shows how the phenomenon of social interaction develops and interacts with its environment. In this study, point density mapping aims to visualize and analyze the spatial distribution patterns of various phenomena, especially field data collection. which is then juxtaposed with the spatial pattern map of the Gowa Regency spatial plan and the forest area map. The survey results show that 70 respondent points are included in other use areas, 59 respondent points are included in the Conservation Forest area, and 10 respondent points are included in the

limited production forest area. from the results of the visualization of the concentration of respondent points, it shows that social interactions are centered in the conservation forest area which is indeed a tourist spot. For more detail, it can see in Figure 2.



Figure 2. respondent distribution map.

3.2 Population Distribution and Social Interaction

Population distribution refers to the spread or dispersion of individuals in a population in a given area. It is not just about the number of individuals, but also about how they are spatially distributed. These distribution patterns can provide important clues about the environmental, social, and economic factors that affect the life of a population. Malino tourist area has an uneven distribution of population, Moncong Tinggi sub-district which includes Malino Pattapang sub-district has the highest population density, which is 137 people/km². This is because this sub-district has a government center and several popular tourist attractions, such as Takapala Waterfall and Malino Nature Park. Uneven population distribution can have a significant impact on land use change. Unbalanced population distribution can increase pressure on natural resources, including land, leading to shifts in land use from agricultural to non-agricultural. The population distribution map can be see in figure 3.

The social interaction approach has the advantage of supporting community participation and empowerment in land use planning. Research by Reed et al., 2018; Guerrero et al, 2020) shows that an understanding of social structures and communication networks can inform environmental decision-making processes, including participatory approaches to land management, including land use decisions.. This can increase the legitimacy of land use decisions and encourage more sustainable implementation, an aspect that is difficult to achieve by focusing only on the physical characteristics of the land.



Figure 3. Population Distribution Map.

Social interaction has a complex and significant influence on land use change (Meyfroidt, P., et al., 2021; Ornetsmüller, C., et al., 2019; Malek, Ž., et al., 2019). based on the results of social interaction analysis by looking at population density and the influence of accessibility, activity centers in Malino Tourism Area have high social interaction, especially in Malino Village, Kanreapia Village, and Pattapang Village. Understanding how social interactions affect land use change in Malino is crucial to knowing Community groups with greater power and influence may have more control over land use change. Government policies on tourism and land management can influence how communities use land. Local communities' dependence on the tourism sector may encourage them to change land to meet tourists' needs. Population growth and the demands of society often influence land use change. it can see in Figure 4.



Figure 4. Population Distribution Map.

Research that takes into account social interactions is better able to capture aspects of resilience and adaptation in social-ecological systems. (Rocha et al. 2020; Barnes, M. L., et al., 2020) showed that social network analysis can reveal how communities adapt to environmental change through the exchange of knowledge and resources. These adaptive aspects are difficult to identify just by looking at the physical characteristics of the land, but are very important in the context of climate change and other environmental pressures.

The Malino area, which is famous for its beautiful natural attractions, has complex social dynamics. the role of multi-stakeholders is key in the sustainable management of natural resources in the Malino tourism area. based on the results of social network analysis, local residents play a vital role in the sustainability of tourism. There are 6 actors who are interrelated in the dynamics of managing the Malino tourism area, including local residents, government, non-government, tourist visitors, employers, and micro small and medium enterprises. each has a role. local Local residents have a very important role in social network mapping because they have a deep understanding and direct knowledge of their community. details of social interaction can be seen in the figure 5.



Figure 5. Population Distribution Map.

3.2 Land Use and Land Cover Change

Based on the results of the classification of land cover in Malino Tourism Area consists of eight classes, namely high-density secondary forest, fields, plantations, rice fields, shrubs, settlements and activities, bare land and rivers with different areas. The class and area of land cover in the research location can be seen in Table 1.

It can be seen in the table above that the condition of land cover in the Malino Tourism Area from 2015 to 2023 is dominated by land cover of High Density Secondary Forest and moor / field. While the land cover that has the lowest area is the river. The condition of land cover in Malino Tourism Area has changed both the addition and reduction of area. The addition of area occurs in the class of fields, plantations, shrubs, settlements and activities, vacant / bare land, and river land cover.

Land use/land cover Type	Extensive (Ha)		Extent of Change
	2015	2023	(Ha)
High Density Secondary Forest	533.277	494.001	-39.276
Farm/Field	219.405	224.874	+5.469
Plantation	194.802	197.934	+3.132
Paddy fields	102.715	100.285	-2.430
Shrubs	63.631	93.305	+29.674
Settlements and Places of Activity	53.785	57.077	+3.292
Empty/Bare Land	40.851	40.957	+106
River	8.135	8.168	+33

Table 1. Extent of Land Cover Change in 2015 and 2023

Descrption

(+) = Increase in area

(-) = Area reduction

The largest reduction in land cover area occurred in the high-density secondary forest class of 39,276 ha. This change was followed by an increase in the area of several other land coverings, including conversion to shrubs and plantations. The largest decrease in the area of secondary dryland forest turned into shrubs, indicated by the disturbance of the area in the form of land clearing by the community to be converted into agricultural land but abandoned so that it was overgrown with shrubs for a certain time. This condition is a land degradation event that degraded land in other definitions is often called unproductive land, critical land, or idle land that is left uncultivated and generally overgrown with shrubs (Wahyunto and Dariah, 2014; Indrihastuti. D et al., 2016; AustinK,G., et al., 2019). On the other hand, the increase in the area of land cover of shrubs with a good enough density can reduce the occurrence of erosion compared to turning into bare land. This is because land use in the form of shrubs / ground cover plants when viewed in terms of soil and water conservation is quite good, because it can reduce the rate of erosion and surface flow which can increase water absorption into the soil (Pratama and Yuwono, 2016; Qi. Z., et al., 2024).

Changes in high-density secondary forest land cover to plantations are caused by the increasing needs and dependence of the community on land, with community activities in managing land to increase plantation yields without paying attention to land suitability and conservation rules so that it can cause a decrease in land productivity. According to Senoaji (2011) and Rudel. T.K., et al (2019), plantation land as a food producer has a limited area, so the main alternative to fulfill food needs is to convert forest and non-forest land into agricultural land. This is also in accordance with the statement of (Rusdi dkk, 2013; Curtis. P.G., et al., 2018) that continuous exploitation of land for plantations without paying attention to conservation principles can lead to decreased land productivity, both temporary and permanent which will then have an impact on environmental change.

Based on village administration in the Malino tourism area, land cover change in each area is also different. In Bonto Lerung Village and Pattapang Village, the largest land cover change occurred in high-density secondary forest land cover into shrubs. Meanwhile, three villages including Malino, Buluttana and Gantarang villages were dominated by changes in land cover from high-density secondary forest to plantations. Land conversion that occurs in a number of villages in the Malino tourism area can result in a decrease in the ability of the forest to carry out its ecosystem functions so that it can cause serious environmental impacts such as climate change, reduced biodiversity, availability of water resources, and soil erosion (Abdul, 2009; Gatti. L.V., et al., 2021).

This phenomenon can be overcome by applying the concept of forest management. A local ecosystem is essentially not closed, but is part of a larger ecosystem and is in an order of interaction with a number of other ecosystems in a unified landscape. Thus, human actions on a local ecosystem have the potential to cause an accumulation of impacts on the landscape and will ultimately affect a certain region. For this reason, forest management should not be based solely on a forest ecosystem perspective, but should be based on a landscape perspective. The involvement of stakeholders in forest management is also absolutely necessary to better ensure the achievement of targets in the formulation of a balance of ecological, economic and social functions of the forest ecosystem. In this regard, stakeholders can be involved in determining the objectives to be achieved, analyzing the situation, as well as solving problems and developing improvement efforts. The following is a comparative picture of land cover in the Malino Tourism Area in 2015 and 2023 which can be seen in Figure 6.



Figure 6. Land Cover in Malino Tourism Area in 2015 and 2023.

3.2.1. Land Use Flow Analysis (FAO)

Malino tourist area also undergoes changes in accordance with its land use. In contrast to land cover which refers to the biophysical characteristics of the earth's surface, land use itself is defined as intervening activities by humans on the environment, usually used to meet daily human needs. Based on the classification of land use change, the Malino area consists of seven land use classes including permanent natural forest, loss of vacant and abandoned land, loss of agricultural land, agroforestry restoration, infrastructure loss, forest restoration and other land uses. The following is a table of land use and its area in the Malino Tourism Area which can be seen in Table 2.

No.	Land Use	Extensive (Ha)
1	Stable natural forest	492.258
2	Loss to bare land and abandoned	34.066
3	Loss to cropland	6.364
4	Recovery to agroforest	4.165
5	Loss to infrastructure	2.233
6	Recovery to forest	1.743
7	Other	675.772
Total		1.216.601

Table 2. Land use area in Malino Tourism Area

The table above shows that the largest land use area in Malino Tourism Area is natural forest with an area of 492,258 hectares followed by land use due to land conversion into bald and abandoned land of 34,066 hectares. The smallest area in the Malino Tourism Area is the use of forest recovery land which only has an area of 1,743 Ha. If the activity of converting vegetated land into bare and abandoned land occurs continuously, it can cause increased surface flow on the ground. According to (Allen et al, 2019; Zhao. B. et al, 2019) on open land, there is no barrier at all so that rainwater goes directly to the soil surface. The energy of falling rainwater can damage the soil structure and turn into runoff if the soil is saturated. This is also in line with Raharjo (2009) that the more open land in an area, the land's ability to hold runoff water will be narrower, so that with the condition of the area that has a small open land area, the effect of flow is also smaller. Meanwhile, the land use included in the designation of forest recovery is not comparable in area to other land uses in the Malino tourism area. Forest recovery refers to efforts to restore forest ecosystems that have suffered damage or degradation. This forest recovery area is needed because it plays a role in improving the function of forests and land to increase their carrying capacity, productivity and role in maintaining the life support system. The following is the distribution of land use in the Malino Tourism Area which can be seen in Figure 7.



Figure 7. Population Distribution Map.

3.2.2. Land Use Flow Analysis (Deforestation and Degradation)

Based on land use in the Malino Tourism Area, the classification of land use that occurs at that location is carried out. The results of the land use flow analysis found that there are deforestation and reforestation activities. Deforestation and reforestation are two important phenomena in land use change that have an impact on environmental sustainability. Deforestation is the condition of a decreasing forest area caused by land conventions for infrastructure, settlements, agriculture, mining, and plantations (Wahyuni & Suranto, 2021). Meanwhile, reforestation is the process of replanting trees on previously deforested or degraded land (Asrin et al., 2019). The following is the extent of Land Use in the malino natural tourism area which can be seen in table 3.

No.	Land Use	Extensive (Ha)	Presentase (%)
1	Stable forest	492.258	40,46
2	Deforestation	34.012	2,80
3	Reforestation	1.743	0,14
4	Other	688.588	56,60
	Total	1.216.601	100

Table 3. Land Use (Deforestation and Degradation) in Malino Nature Tourism Area

Malino is dominated by other land uses with a total area of 688,588 Ha. Other land uses in this case are activities outside the forest area that are intended for community land use. Although it dominates the research location, the largest area is followed by stable forest land use whose area remains unchanged. Stable natural forest land use has an area of 492,258 hectares or 40.46% of the total area of the study site. This forest is characterized by a relatively stable forest structure, so that the lower plant species have adapted over a long period of time. Land use that has experienced deforestation in the Malino Tourism Area obtained an area of 1,743 Ha or 2.80% of the total area of the Malino Tourism Area. This is due to the fact that there are many forest land use changes and the construction of buildings with cultivation functions such as villas, culinary and settlements are often built by local communities because of the control of land owned by local communities that are included in protected areas so as to reduce the biodiversity of trees in the Malino area and make climate change on a micro scale not occur.

The reforestation activities that occur are actually not proportional to the area of deforestation that continues to take over the forest area. The area of land undergoing reforestation is only 0.14% of the total area of the Malino Tourism Area or only 1,743 Ha. In its implementation, reforestation involves all activities, including reforestation, that help restore the forest to a healthy condition. Reforestation can be done not only by replanting but also by natural regeneration or direct human-induced conversion from non-forest land to forest land through planting, sowing, and/or promotion. In reforestation, the treatment pattern should be aimed at accelerating forest recovery by accelerating the success of reforestation can be known through monitoring the success of reforestation. The soil indicator is a very important factor for plant growth, so assessing the soil index is very important to monitor the success of reforestation. The distribution of land use (Deforestation and Degradation) in Malino Tourism Area can be seen in Figure 8.



Figure 8. Land Use Map (Deforestation and Degradation) in Malino Tourism Area.

3.3. Tendency of Land Use Change towards Social interaction

The change of land use is a phenomenon that is very dynamic and complicated, and is often affected by factors like population growth, urbanization, industrialization, and climate change. These changes affect not only the physical environment but also the social interactions of the community. Land use change is a highly dynamic and complex phenomenon, and is often influenced by factors such as population growth, urbanization, industrialization and climate change. These changes affect not only the physical environment but also people's social interactions. Understanding land use change trends is crucial as it has far-reaching implications for human life and the environment. These changes can alter the physical landscape of an area, which in turn will affect the social interaction patterns of the community. With respect to malino tourist area, the development of tourist areas can increase the income of local communities, but it can also change social and cultural structures, as well as increase interactions with tourists.

Social interaction is a major driving force in land use change. Social interaction is a very influential factor in driving and shaping land use change. The needs, aspirations and social dynamics of the community will directly influence how land is utilized. An indication of high social interaction is the massive land change that occurs. high social interaction intervention causes the rate of land use change to increase, both forests and from agriculture to settlements to fulfill life needs. High population density can lead to land use changes that have negative impacts, such as a decrease in vegetation. This can lead to changes in the global environment, changes in surface water, and lowering of the water table (Mubarok Et al. 2022).



Based on the diagram above, it shows that high interaction supports land change from other land cover to settlements and other gathering places, in this case the need for land to settle is high. In the context of tourism in the Malino area, an increase in public interest in tourism can encourage changes in land use from agriculture to tourist areas, which in turn can change the social and economic structure of the local community. Not only that, but population concentration occurs in certain areas, this is influenced by the uneven process of social interaction which causes the distribution of the proportion of public facility development in the manilo tourist area to be uneven as well. The denser an area, the greater the demand for public facilities, this encourages changes in land use from open areas to residential and commercial areas. Changes in people's lifestyles become very important, for example the increasing awareness of the importance of recreation, will encourage the demand for green open spaces, parks, and sports facilities.

4. Conclusion

Social interactions in Malino play an important role in shaping land cover change. The impact can be both positive and negative, depending on the context and factors involved. Understanding how social interactions influence land cover change in Malino is critical to developing effective strategies to manage land sustainably and equitably. Based on the classification of land use change, the Malino area consists of seven land use classes including permanent natural forest, loss of vacant and abandoned land, loss of agricultural land, agroforestry restoration, infrastructure loss, forest restoration and other land uses. Land use change shows that the largest land use area in Malino Tourism Area is natural forest with an area of 492,258 Ha followed by land use due to land conversion to bare land and vacant land with an area of 34,066 Ha. The smallest land use in Malino Tourism Area is forest recovery land use which only has an area of 1,743 Ha. Land use that experienced deforestation in Malino Tourism Area obtained an area of 1,743 Ha or 2.80% of the total area of Malino Tourism Area and Reforestation activities that occur are not proportional to the area of deforestation that continues to take over forest areas. The area of land undergoing reforestation is only 0.14% of the total area of Malino Tourism Area or only 1,743 Ha. Social interaction is a very influential factor in driving and shaping land use change. The needs, aspirations and social dynamics of the community will directly influence how land is utilized.

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