



## **Spatial Analysis of the Level of Accessibility of the Bobo Village Community in the Lore Lindu National park Area**

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**Abstract.** This research aims to determine the level of community accessibility in the Lore Lindu National Park Conservation area and determine the level of community accessibility in reaching areas that have been selected based on the provisions of the Cooperation Agreement (PKS) between Lore Lindu National Park and the Bobo Village Government in 2021. This research uses spatial analysis with five variables: land use, slope, and distance from roads, rivers and settlements. Determining the weight of each variable uses the Analytical Hierarchy Process (AHP) method with sources from the Bobo Village community and the Bobo Village Conservation Management Institute. The research results show that with the AHP method, land use has a significant effect on the level of community accessibility with a weight of 52.3%, followed by other parameters, namely slope of 26.8%, distance from the main road of 11.3%, distance from the river is 3, 4%, and distance from settlements is 6.2%. Furthermore, three classes of accessibility levels for the Bobo Village community were obtained: low level covering an area of 390.94 ha (96%), medium level covering an area of 17.76 ha (4%) and high level surrounding an area of 0.11 ha. (0%).

**Keywords:** Accessibility, Community, Conservation area, Analytical Hierarchy Process

*(Received 2024-01-01, Accepted 2024-01-12, Available Online by 2024-02-08)*

### **1. Introduction**

As one of the largest archipelagic countries in the world, Indonesia has extraordinary natural wealth [1], including forest areas that play an important role in preserving the environment and human life. People's dependence on forest areas in Indonesia is reflected in various aspects of daily life. Economically, forests provide abundant natural resources, such as wood, non-timber forest products and traditional medicinal plants [2]. Local communities often depend for their livelihoods on activities such as agriculture, plantations and grazing around forest areas [3].

Community access to forests is important in maintaining the balanced use of natural resources. According to [4], communities around forests often have rights and traditions in utilizing forest

resources to meet their daily needs. However, it should be noted that forest use that is not well managed can contribute to higher deforestation rates [5]. Legal access to the community refers to recognizing access rights to natural resources as regulated by applicable laws or regulations [6]. This step is carried out to regulate and facilitate the community's use of natural resources per established regulations.

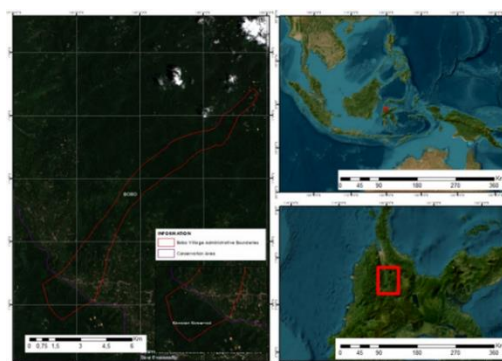
The level of accessibility of forest communities is an important factor that enables communities to efficiently manage and utilize the natural resources available in forest areas [7]. Communities around forests often face challenges with accessibility to forest resources, which can affect their welfare [8]. Several findings show that the lack of community access to forests, the large amount of critical land that has not been utilized in and around forest areas [9], and the lack of incentives provided by the government to forest communities can cause poverty in villages around forests to continue [10].

Based on the Decree of the Minister of Forestry Number SK.869/Menhut-II/2014, Lore Lindu National Park (TNLL) is located in Central Sulawesi and has an area of around 215,733.7 Ha [11]. TNLL applies the concept of community-based collaborative management as a reference in managing conservation areas as outlined in the Decree of the Director General of KSDAE Number 456/KSDAE/SET.REN.2/8/2017. In 2018, through a conservation partnership program, the Lore Lindu National Park Center provided the community access to non-timber forest resources and environmental services in the conservation area [12]. In 2021, the TNLL Center, with the support of Forest Program III Sulawesi, became a facilitator by taking a conservation partnership approach so that 56 Conservation Partnership Cooperation Agreements (PKS) were established between the village government and the Lore Lindu National Park Center [13].

Bobo Village is a village in Palolo District, Sigi Regency, Central Sulawesi Province and is one of the supporting villages of Lore Lindu National Park [13]. Bobo Village has collaborated with the TNLL Center, which regulates conservation partnerships in the context of community empowerment through providing access to the collection of Non-Timber Forest Products, namely sugar palm and candlenuts and Traditional Cultivation in the traditional zone of Lore Lindu National Park [14]. This aims to increase community income without disturbing the sustainability of conservation areas [15].

Communities around conservation areas need to be considered because the community still depends on conservation areas. [12] stated that the use of forest resources by local communities in the Lore Lindu National Park conservation area is still relatively high even though formal regulations prohibit the exploitative use of forest resources. The presence of the community is a threat factor in the management of conservation areas, such as encroachment, shifting cultivation, gold mining without permits (PETI) and so on [16].

This research on spatial analysis of the level of community accessibility is important to determine the level of community accessibility in the Lore Lindu National Park Conservation area and to assess the extent of community accessibility in reaching areas that have been determined by the provisions of the Cooperation Agreement (PKS) using the Geographic Information System (SIG) [17]. This research can evaluate whether the community accesses the Community Conservation Agreement (KKM) area by the agreement or whether there is a tendency to carry out activities outside the area boundaries stipulated in the agreement.



**Figure 1.** Map of research location  
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## **2. Research methods**

### *2.1 Research Location and Time*

The research location covers the administrative area of Bobo Village, which is geographically located at 120°00'11.0" East Longitude and 1°07'18.1" South Latitude. The area of Bobo Village is 408.83 ha. The research was conducted from August to December; the stages began with distributing questionnaires to respondents, processing data, and writing up research results.

### *2.2 Tools and Materials*

The tools used in this research were writing tools, calculating tools, and a set of computers, ArcGIS version 10.8, Global Positioning System (GPS), camera, and Microsoft Office. The material used is Sentinel imagery. Other data used are a digital map of Bobo Village's landform, an administrative map of Bobo Village, a road access map, and a slope map.

### *2.3 Data Collection and Analysis*

Data collection in this research is by field measurements/observations and interpretation of maps. The types of data are land use data sourced from Citra Sentinel 2A, slope sourced from DEMNAS, distance from roads sourced from the Indonesian Earth Map (RBI), distance from rivers sourced from the Indonesian Earth Map (RBI), and distance from settlements sourced from the Indonesian Earth Map (RBI).

Data analysis includes analysis of variables assessing the level of accessibility of the Bobo Village community in the Lore Lindu National Park Area, spatial analysis, and attribute analysis. Analysis of variables evaluate the level of accessibility of the Bobo Village community in the Lore Lindu National Park area was carried out by analyzing Sentinel 2A imagery and buffer analysis of the Indonesian Earth Map (RBI) map in the Lore Lindu National Park area, which consisted of distance from the road, distance from the river and distance from the settlement. Spatial analysis and attribute analysis include classifying each variable, giving a score, then overlaying a map of the analysis results of each variable using the specified formula. The final result of the analysis is a map of the accessibility level of the Bobo Village community in the Lore Lindu National Park Area based on the formula used.

### *2.4 Analysis of Accessibility Level Variables*

#### *2.4.1. Land Use Analysis*

Land Use Analysis is an interaction between humans and the environment, which is characterized by human efforts to utilize land for their lives and needs [18]. Land use classification can determine the type of land use in an area and assess the level of community accessibility through activities carried out in a location based on area Community Arable land. Land use classification seen from Sentinel 2A Image, which was downloaded on the website <https://scihub.copernicus.eu/> on July 8, 2023, then processed using ArcGIS 10.8 with composite band 432 (natural color). The classification results are cut based on the research area. The community accessibility level classes from the scoring can be seen in Table 1.

#### *2.4.2. Slope Analysis*

The specific height difference on the ground surface that forms an area is called the slope [4]. Research [19] shows that the slope can influence people's accessibility to conservation areas; the flatter or sloping an area is, the more dominant people are in carrying out activities in that area. The class levels of community accessibility to the slope can be seen in Table 1.

#### *2.4.3. Distance Analysis from the Road*

One factor that influences the level of accessibility is road infrastructure. The existence of a road network around or within the area allows people to access and participate in various activities within the region. [20] research results show that the proximity of forest areas to the road network

influences community accessibility. The following classes of community accessibility levels regarding distance from the road can be seen in Table 1.

#### 2.4.4. Distance Analysis from the River

Rivers are one of the factors for community accessibility in national park areas. The existence of a river system around or within the area can open access for the community to engage in various activities, such as agriculture, plantations, and others [21]. The following classes of community accessibility levels regarding distance from the road can be seen in Table 1.

#### 2.4.5. Distance Analysis from Settlements

The existence of settlements around national parks can affect people's accessibility to the area. Settlements act as the main access or starting point for people to enter the national park. The existence of settlements close to the area encourages and makes it easier for people to carry out activities [22].

**Table 1.** Community Accessibility Level variable assessment

Land Use		Slope		Distance from Road	
Class	Scoring	Class %	Scoring	Class (Meters)	Scoring
Settlement	5	0-8	5	0-600	5
Dryland farming	4	8-15	4	600-1200	4
Plantation	3	15-25	3	1200-1800	3
Bushy bushes	2	25-40	2	1800-2400	2
Primary Forest	1	>40	1	>2400	1

Distance from River		Distance from Settlements	
Class (Meters)	Scoring	Class (Meters)	Scoring
0-600	5	0-600	5
600-1200	4	600-1200	4
1200-1800	3	1200-1800	3
1800-2400	2	1800-2400	2
>2400	1	>2400	1

#### 2.4.6 Variable Weight Analysis Using Pairwise Comparison

In this research, determining the weight of each variable will be carried out using the Pairwise Comparison method, taking into account the impact of each variable on community accessibility in Lore Lindu National Park through the views of a number of experts or stakeholders using a questionnaire. Some of the parties who were resource persons in the research were the Bobo village community, who have activities in the Lore Lindu National Park, and members of the Village Conservation Management Institute.

### 2.5 Weighting of Community Accessibility Level Variables

The process of weighting each parameter uses the AHP (Analytical Hierarchy Process) method, which involves ranking and rationality comparison. This method requires a hierarchical structure or solid feedback network, including criteria for various influences, stakeholders, and decision alternatives to determine the best choice [23]. In the context of this research, weighting is carried out by evaluating the influence of the parameters Land use, Slope Slope, Distance from roads, Distance from rivers, and Distance from settlements. The determination of weights is based on an analysis of the influence between parameters on the Accessibility Level of the Bobo Village Community in the Lore Lindu National Park Area.

The hierarchical consistency evaluation process is carried out through a consistency test, which involves calculating the Consistency Index (CI) and Consistency Ratio (CR). CR functions as a determinant of whether the calculation is consistent or not. There are two classifications of CR values:

- If  $CR < 0.10$ , it indicates a fairly rational level of consistency in pairwise comparisons.
- If  $CR \geq 0.10$ , it indicates inconsistency in the assessment, and it is recommended that a repeat

questionnaire survey be carried out.

Next, the Random Index (RI) value is determined based on the matrix order that has been created, and the RI value for a particular matrix order can be seen in Table 3.

**Table 2.** Random Index Value

N	1	2	3	4	5	6	7	8	9	10
(RI)	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

### 2.6 Analysis of community accessibility levels

To determine the level of community accessibility, the vector data for each Variable is scored by multiplying the score by the weight of each Variable, and the scoring results are added to a new field in the attribute table. Then, the spatial vectorization results are overlay analysis by combining the vector layers of each Variable into one vector layer. The overlay results are classified based on the level of community accessibility by adding up the results by multiplying the scores and weights for each Variable.

$$Accessibility\ Level = Kb.Kp + Sb.Sp + Pb.Pp + Jb.Jp + Lb.Lp \quad (1)$$

<i>K</i>	= Slope	<i>L</i>	= Land Use
<i>S</i>	= Distance from River	<i>b</i>	= Weight Value
<i>P</i>	= Distance from Settlements	<i>p</i>	= Parameter Class Score
<i>J</i>	= Distance from Road		

The interval value of the level of community accessibility uses the Sturges formula by dividing the largest data value and the smallest data value [24];

$$Interval\ Class = \frac{(Xt - Xr)}{k} \quad (2)$$

<i>Xt</i>	= Largest data	<i>Xr</i>	= Smallest data	<i>K</i>	= Number of classes
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## 3. Results and discussion

### 3.1 Community Accessibility Level Parameters

#### 3.1.1 Slope

The slope of the slopes in the Lore Lindu National Park (TNLL) area dominates in the range of >40% covering an area of 280.47 Ha; 25-40% covering an area of 81.53 ha (20%); 15-25% covering an area of 29.29 ha (7%); 8-15% covering an area of 13.36 ha (3%); and 0-8% covering an area of 4.18 ha (1%). The steep condition of the area causes low accessibility because it creates topographic conditions that are very steep and difficult to access. Physically [25] states that the steeper the slope, the lower the level of accessibility. Significant slopes can hinder vehicle and pedestrian movement and limit community access to natural resources and local economic activities.

#### 3.1.2 Distance to Road

With adequate road access, the level of community accessibility will be higher. [13] stated that the closer the TNLL area is to the road, the easier it will be for people to access it. Based on the analysis results, it was found that the distance between 0-600 meters covering an area of 195.44 ha (48%), 600-1200 meters covering an area of 132.37 ha (32%), 1200-1800 meters covering an area of 71.06 ha (17%), 1800-2400 meters covering an area of 9.96 ha (2%).

The distance from the road to the TNLL area between 0-600 meters has a percentage of 48% or an area of 195.44 Ha. Even though the distance from the road is relatively short, field facts show that a footpath is the only road access available. This indicates that even though they are geographically close, people still experience difficulties accessing these locations due to the lack of adequate and accessible road infrastructure.

### 3.1.3 Distance to River

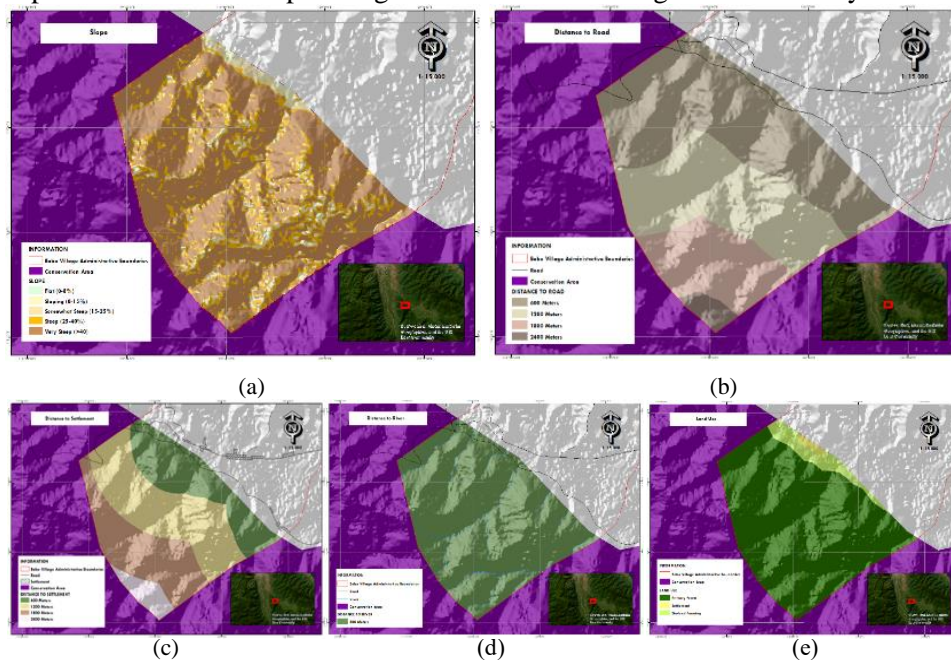
The closer an area is to a river or water source, the higher the possibility of access [26]. However, based on survey results from the Bobo Village community, it was found that the closer they were to the river, the more people did not carry out activities along the river. This is due to the fact that the source of clean water for the people of Bobo Village comes from a conservation area. The Conservation Area has many river networks, so the analysis results show that the entire Conservation Area is at a distance of less than 600 meters.

### 3.1.4 Distance to Settlement

The distance between settlements and the Lore Lindu National Park area influences the community's access to non-timber forest products. The research results show that the area with a distance of between 600 to 1200 meters from the settlement is a fairly large area with an area of 159.76 ha (39%), and the distance from 0 to 600 meters is 111.67 (27%), 1200-1800 meters each covering an area of 114.39 ha (28%), 1800-2400 meters covering an area of 23.02 ha (6%). Distance from settlements influences the extent to which community access is adequate. This is by the statement [27] that the closer an area is to a settlement, the easier and wider public access will be.

### 3.1.5 Land Use

The analysis results show that the Lore Lindu National Park area is dominated by primary forest land use of 92% with an area of 376.98 Ha. Significantly, the level of difficulty of accessibility in this area indicates limited potential for human interaction with the forest [28]. Despite this, around 7% of the land is used for dryland agriculture, while settlements only account for 1% of total land use. These results reflect the complex dynamics between forest conservation, agricultural needs, and settlements, which are important to consider in planning natural resource management and ecosystem sustainability.



**Figure 2.** Map of community accessibility level parameters: slope slope (a), distance from roads (b), distance from rivers (c), distance from settlements (d) land use (e)

### 3.2 Parameter Weighting

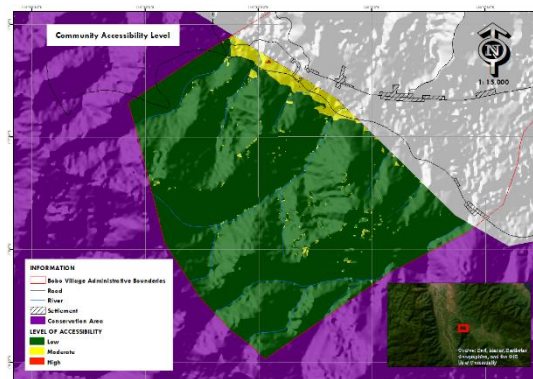
Parameter weighting is an analysis in decision-making. This analysis focuses on all parameters, namely the slope map, distribution map of non-timber forest products, residential buffer distance, road buffer distance and river buffer distance, to determine the level of community accessibility in the Lore Lindu National Park Area, which was obtained using the AHP method. The comparison results were

obtained from a questionnaire filled in by seven respondents. The questionnaire data collected was processed using Microsoft Excel to determine the priority weight of each parameter with an inconsistency limit of  $\leq 0.1$ .

The weighting results that will be used are based on the criteria for consistency provisions with the Consistency Ratio (CR) value that must meet the CR requirement  $\leq 0.1$ . Consecutively, the weight of each parameter is land use at 52.3%, slope at 26.8%, distance from the road at 11.3%, distance from settlements at 6.2%, and distance from the river at 3.4%. The results of weighting each parameter of the level of community accessibility that has met these requirements with an inconsistency value of  $0.01 > 0.1$ .

### 3.3 Community Accessibility Level

The level of community accessibility in the Lore Lindu National Park Area is analyzed based on scoring and determining the weight of each parameter, namely slope, distance from rivers, distance from settlements, distance from roads and land use, then overlaid, which can be seen in Figure 3.



**Figure 3.** Community Accessibility Level Map

The community accessibility level classes that have been analyzed consist of low, medium and high, which can be seen in Table 3.

**Table 3.** Level of Community Accessibility in TNLL

No	Accessibility Level	Area (Ha)	Persentase (%)
1.	Low	390.94	96%
2.	Medium	17.77	4%
3.	High	0.11	0%
Total		408.83	100%

Based on the results of an analysis of the level of accessibility of the Bobo Village community in the Lore Lindu National Park Area, it was found that 96% (390.95 Ha) of the population was in the low category, while only 4% (17.77 Ha) was in the medium category, while the one in the high category had an area of 0.11 Ha (0%). These findings indicate that the majority of residents around the Lore Lindu National Park area face significant obstacles in utilizing resources in accordance with the Cooperation Agreement (PKS) between the Lore Lindu National Park Center and Bobo Village.

The parameters used in this research indicate that the Lore Lindu National Park (TNLL) area is located in an area with very steep slopes and is difficult to access physically. Even though it is geographically close, people still experience difficulties in accessing this location; this is because the only road available is a footpath, so people still have difficulty accessing it. In addition, the distance between settlements and TNLL is relatively close, providing a good opportunity for the community to utilize available resources. However, a striking finding is the existence of rivers within the TNLL area, which results in limited community activities along the river borders because people still depend on rivers as a source of clean water.

Apart from that, the non-timber forest products that can be utilized by the community are very limited, so community activities are not optimal. These findings provide valuable insights for formulating policies and strategies aimed at increasing community accessibility and preserving ecosystems contained in Community Conservation Agreements.

#### 4. Conclusion

The level of accessibility of the Bobo Village community in the Lore Lindu National Park (TNLL) area consists of 3 categories, namely low, medium and high. Of the total research area of 408.83 Ha, 390.95 Ha (96%) is included in the low category, and the level of accessibility is medium at 17.77 Ha (4%). The research results show that the level of community accessibility in the Lore Lindu National Park Area is relatively low. This fact shows the lack of community activity in the Community Conservation Agreement which should be an active area. Therefore, it is necessary to carry out a feasibility study and consultation with the local community in the process of selecting the KKM area so that the community can participate in efforts to utilize the resources controlled and preserve the area.

#### Acknowledgments

Thank you to the entire academic community of the Faculty of Forestry, Tadulako University, and the Independent Campus Learning Program (MBKM), as well as to the Forestry Student Research Institute (SETMA), which supported this research.

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