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# Research Article
# Mapping of Protected Forests and Cultivated Area in North Luwu South Sulawesi, Indonesia

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## Abstract

**Background and Objective:** North Luwu regency is located in the Northern part of South Sulawesi. This region continues to perform development to meet and improve the community economy. This study aims to map the protected areas, buffer and cultivated areas in North Luwu. To determine the function of the area, this study using three key variables namely topography, soil sensitivity to erosion and the amount of rainfall. **Methodology:** Furthermore, the spatial analysis by using tools that were used in the study were Geographic Position System (GPS) type garmin 76, a digital camera and a set of Computer Processor (PC) supported any software such as ArcGIS version 9.3 and Global Mapper. **Results:** The results showed that the study area is dominated by a buffer zone is more than 44.230 ha or 56.39%, cultivation zone has more than 22,000 ha or 6.28% and protected zone has more than 12,200 ha or 15.5%. Therefore, obtained protected zone with total area is 2,200 ha. **Conclusion:** Protected zone region which is determined as the main function to protect the environment preservation including natural and artificial resources. Defending protected forest is one of efforts to maintain Green Open Space (GOS) in order to keep climate equilibrium in a region especially in North Luwu. Therefore, this study try to show overview about regional function as a protected zone in this area.

**Key words:** Protected zone, cultivation zone, land use, North Luwu, green open space (gos), ArcGIS, dan Global Mapper

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Land is a physical environment including soil, weather, topography, hydrology and vegetation in which those factors may influence their potency[1]. Land use has different meaning with land cover. According to Malingreau and Christiani[2] land use is human of interest neither permanently nor periodically toward land which has an aim to fulfill daily needs of human such as material and spiritual. Whereas, land cover is vegetation and artificial construction which cover all land surface[3]. Rapid population growth will increase the people's needs for land, subsequently resulting in a conflict of interest over land use and the occurrence of a mismatch between land use designation plan[4]. Furthermore, this study aims to provide the appropriate use directives so that no environmental damage due to improper land use.

Most changing of land uses are already happened worldwide including Indonesia. It is one of countries which has many number of environment problems such as deforestation and burning fores which are every year getting worse neither in land nor watery. Those problems can spread many negative effects against ecosystem equilibrium including climate change and global warming, one of the problems which becomes its main factor is land management which is excessive in order to never did consider and care about ecosystem equilibrium. Therefore, government must take a part to arrange spatial planning such as which one is protected zone and cultivation zone in order to human can deal with environment. Besides, there are also land classifications which classify land to be two zones, they are non cultivation and cultivation zone. Non cultivation zone is region which determain as function to preserve living environment including living natural resource and non living natural resource. Whereas, cultivation zone is region which can be utilized its land or has function such as agriculture, plantation and livestock etc[5].

Protected or non cultivation zone was determined with mainly function to protect conservation of living environment including natural and unnatural resource, whereas cultivation zone is an area which determined as its function to cultivate natural, unnatural and human resource potency[5]. Addition to, there is also buffer zone, it is an area which determined as function to support existence of protected zone. This zone is a border between protected and cultivation zone. Land management which allowed in this area is plantation and agroforestry which have minimum effort to utilize. Therefore, this study aims to provide an overview of the direction of proper utilization so, there is no environmental damage due

to improper land use. In addition, this study also analyzes changes in protected areas change over time.

## MATERIALS AND METHODS

This study was quantitative. Data that were used primary that taken by observation to object directly such as topography data, soil of type and permeability of soil toward erosion data. There was though secondary data namely data collection from institute such as daily rainfall data, soil of type data and permeability of soil data. Materials that were used in this study were North Luwu topography map taken from bank map, landcover map, rainfall data from meteorology and climatology institute and type of soil map. Whereas, tools that were used in study were Geographic Position System (GPS) type garmin 76, digital camera, a set PC supported any software such as ArcGis version 9.3 and Global Mapper.

Criteria zone function in this study are based on protected forest procedure stipulated by the Regulation of the Minister of Forestry No. 837/Kpts/Um/11/1980, No. 683/Kpts/Um/8/1981 and [6]Presidential Decree No. 0.48/198. Based on the decision, there are three factors were assessed namely topography, soil type and the daily rainfall[7]. The criteria for each of these factors can be seen in Table 1-3.

Table 1: Grade slope

| Slope (%) | Criteria | Scores |
|---|---|---|
| 0-8 | Flat | 20 |
| >8-15 | Sloping | 40 |
| >15-25 | Somewhat steep | 60 |
| >25-45 | Steep | 80 |
| >45 | Very steep | 100 |

Rahim[8]

Table 2: Type of soil and its susceptibility to erosion

| Type of soil | Sensitivity against erosion | Scores |
|---|---|---|
| Aluvial, gleisol, planosol, hidromorf gray and laterite of soil water | Not sensitive | 15 |
| Latosol | Less sensitive | 30 |
| Brown forest soils and soil mediterranean | Sensitivity being | 45 |
| Andosol, laterit, grumosol, podsol and podsolic | Sensitive | 60 |
| Regosol, litosol and rensina | Highly sensitive | 75 |

Rahim[8]

Table 3: Rainfall intensity

| Intensity (mm/hari) | Description | Scores |
|---|---|---|
| 0-13,60 | Very low | 10 |
| >13,60-20,70 | Low | 20 |
| >20,70-27,70 | Moderate | 30 |
| >27,70-34,80 | Height | 40 |
| >34,80 | Very high | 50 |

Rahim[8]

After classifying each score into a polygon including soil type, topography and rainfall, there are several steps that must be passed. The first is to determine if any data has scores will be combined in the overlay section. Second, overlay any data that has been provided. According to Purwadhi and Hardiyanti[1] known three regional distribution criteria zone that protected forest areas, buffer zones and the cultivation area as shown in Table 4.

Lastly, after overlay has done, classtifiying each score becomes land planning category which one is protected, buffer and cultivation zone. Data processing land planning classification that used was overlay technique. It was one of spatial analysis that create new spatial data which must have atleast two data spatial that would become its input. Overlay technique may be used to maps that have had the same format and scale. The next step is to match mapping result against the real in field to look at how much the land out of the line.

Table 4: Classification of land use planning

| Classification of land use planning | Scores |
|---|---|
| Protected zone | >175 |
| Buffer zone | 125-174 |
| Cultivation zone including (annual crop, seasonally crop and housing zone) | <125 |

Rahim[8]

## RESULTS

The study result showed that there were three zone functions such as protected, buffer and cultivation zone. Analyze result mentioned that based on scoring of the which is gained on morphology analyze spatial map (Fig. 1) a map of soil types (Fig. 2) and average rainfall (Fig. 3).

Overview study topography of the region shown in Fig. 1 that most of the study area in the Northern part of an area with a steep slope of 15-25%, even there are some areas that reach the slopes >25%. However, this region also has a slope of <8% in the Southern part of the study area.

Figure 2 shows that the type of soil in the study area is dominated by brown forest soil type soil and breadth podsolic with respectively 35% of the area. The soil type is brown forest soil in the middle and surrounded by soil type podsolic on the outside. Furthermore, alluvial soil types arriving in the Southern part of the study area with the level of approximately 20% of the area. The rest is land latosol, litosol, mediterranean and grumosol scattered in the Eastern part of the whole breadth was limited or less than 10% of the area.

Factors rainfall is one of the influential factors in the determination of protected and cultivation areas. Figure 3 shows the state of the rainfall in the study area consists of three classifications, namely: <13, 20-27 and >27 mm day$^{-1}$,
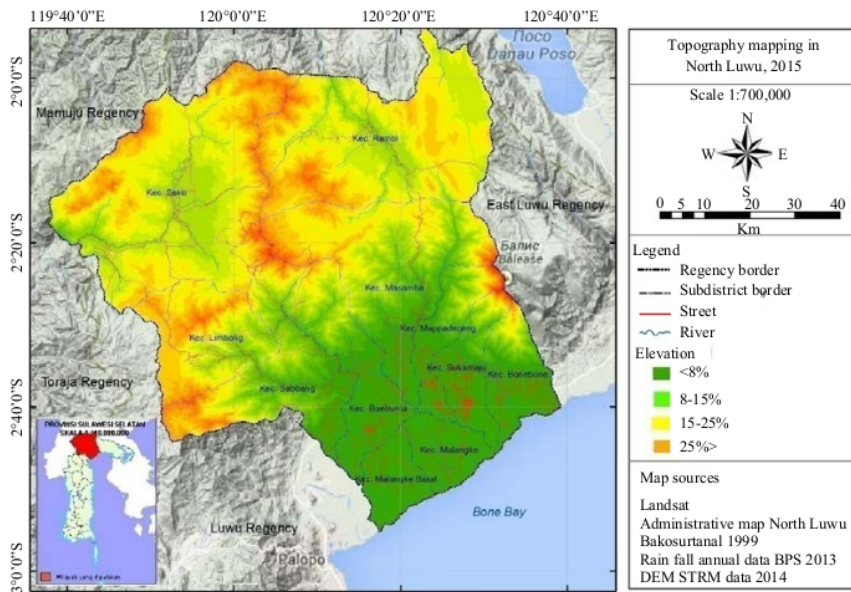


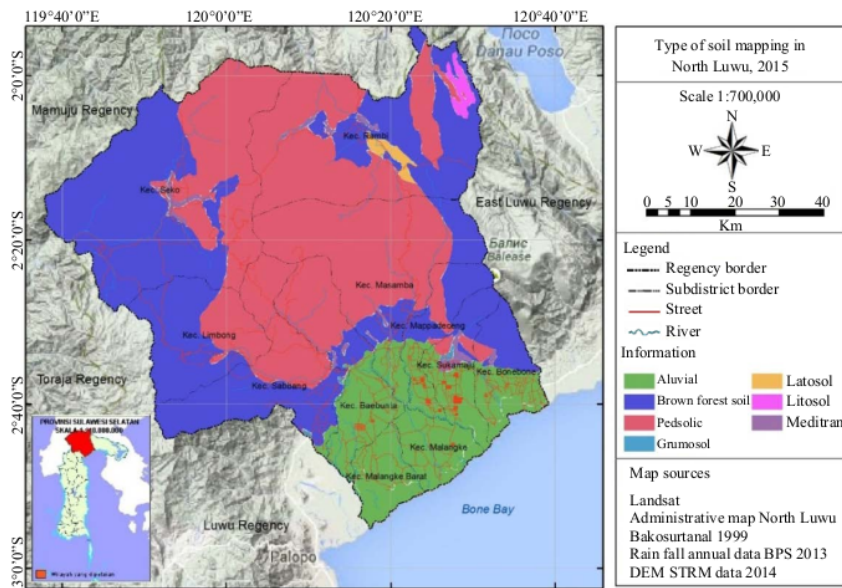Fig. 1: Map of topography in North Luwu
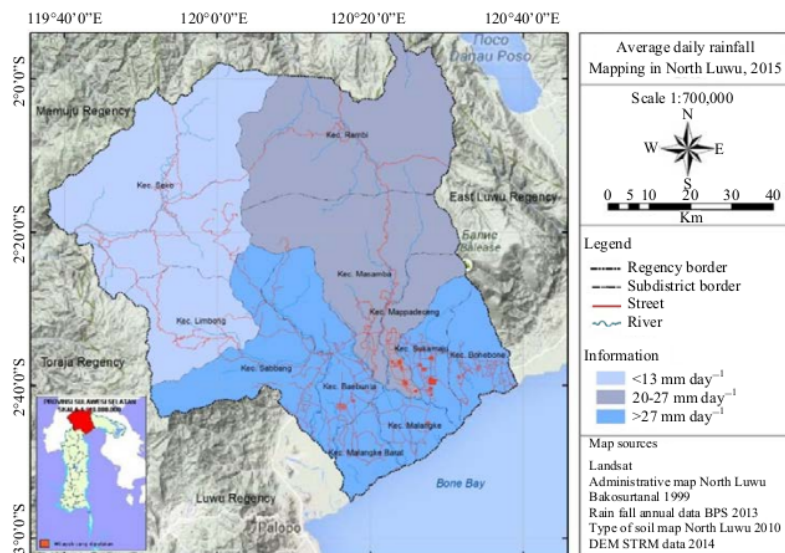
Fig. 2: Map of soil type in North Luwu



Fig. 3: Map of the average daily rainfall in North Luwu

with a breadth of each are almost the same. Rainfall <13 mm day$^{-1}$ dominate the Western region (subdistrict of Seko and the district of Limbong) then the criteria precipitation with 20-27 mm day$^{-1}$ dominate the Eastern part of the region (district of Rambi, Masamba and Mappedeceng). Meanwhile, rainfall >27mm day$^{-1}$ dominate the Southern part of the region that includes the district of Sabbang, Baebunta, Malangke and West Malangke.
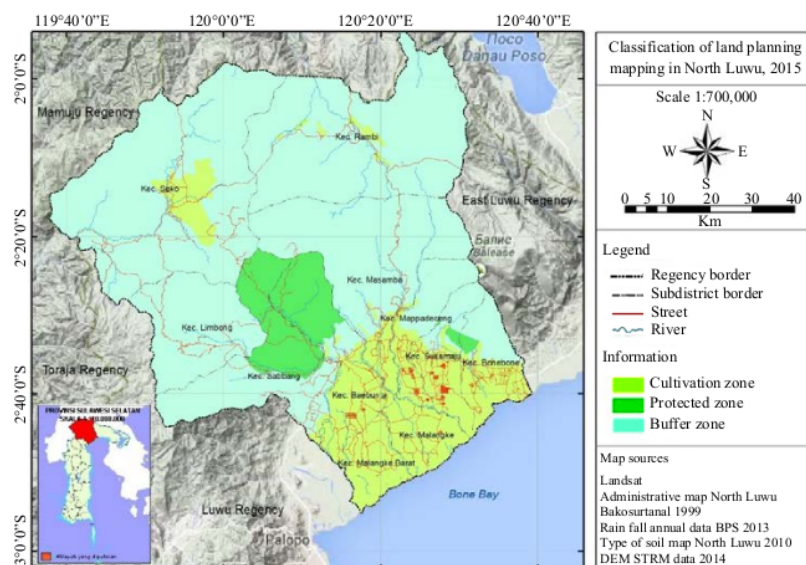
Fig. 4: Classification of land use planning

Table 5: Protected zone and its scope zone

| Subdistrict | Protected zone (ha) | Percentage (%) | Scope zone |
|---|---|---|---|
| Sabbang | 1150 | 52.27 | Pararra, TulakTallu, Tandung and Malimbu village |
| Baebunta | 850 | 38.64 | Sassa, Lero and UPT Buso village |
| Bone-Bone | 125 | 5.68 | Patulon and UPT Bantimurung village |
| Sukamaju | 75 | 3.41 | Tamboke and UPT Pongkase village |
| Total | 2,200 | 100.00 | |

Source: Results of the data analysis, 2015

The results of the analysis of several thematic maps are maps of geomorphology, maps of soil type and maps of rainfall suggesting that this area has variation. Therefore, determining land use should be suitable with criteria that not only has a different value and score but also has different bandwidth. To see each zone in North Luwu bandwidth can be looked at Table 5 and Fig. 4.

Figure 4 shows that the region is dominated by the North Luwu buffer that is more than 44,230 ha or 56.39%, cultivation zone has more than 22,000 ha or 28.06% and protected zone has more than 12,200 ha or 15.5%. Therefore, obtained protected zone with total area is 2,200 ha (Table 5).

In detail, this study showed that is subdistrict which has width protected zone widest is Sabbang subdistrict that has more than 1150 ha or 52.27% in order to, its scope zone are Pararra, Tulak Tallu, Tandung and Malimbu village. Meanwhile, Baebunta subdistrict that has width its area more than 850 ha or 38.64% in order to, its scope zone are Sassa, Lero and UPT Buso village. Furthermore, Bone-Bone subdistrict that

Table 6: Area of protected forest area (protected zone) in Luwu Utara District 2008-2014

| Years | Area protected forest (ha) |
|---|---|
| 2008 | 419 |
| 2011 | 354 |
| 2014 | 320 |

Source: Department of Forestry, 2016

has width its area more than 125 ha or 5.68% in order to, its scope zone are Patulon, UPT Bantimurung village and Sukamaju subdistrict that has width its area more than 75 ha or 3.41% in order to, its scope zone are Tamboke and UPT Pongkase village.

The study results showed three types of function of the area, namely protected areas, buffer and aquaculture. The function of these areas have been established based on criteria specified in the methods of assessment factors such as rainfall, slope or topography and soil sensitivity to erosion.

In addition, this study also found that there has been a change in function of the area from time to time. Table 6 shows that the breadth of the protected forest area

experienced a reduction from year to year. Proven in 2008-2011 experienced a reduction of 64 ha. Furthermore, from 2011-2014 also experienced a reduction of 34 ha.

## DISCUSSION

Based on analysis result which mentioned that after scored each data such as morphology, soil type and daily rainfall. Having obtanined, if in this area (North Luwu) has three zone namely protected, buffer and cultivation zone (Fig. 4, Table 5).

According to Anonymous[5] protected zone maintained as zone which keeps and preserves living environment including living natural resource and non living natural resource. Meanwhile, cultivation zone maintained as zone in which natural resource potency can fully be utilize to be such as agriculture, plantation and livestock etc. Otherwise, there is also what we called buffer zone which has a function as transition zone to keep and to support protected zone in order to its function stay keeping. Determination of the area function is carried out to preserve the environment including avoiding excessive soil erosion in the region[8].

Based on this study, it is known that changes in land use that occurred in North Luwu regency is very significant. The changes that have occurred exceeded the capacity of the land capability. As the studies that have been done by Khadiyanto[9] and Suryanto[10] in the watershed Beringin. The study found that half of the 10 villages in the watershed Beringin which has a population large enough to experience a development that goes beyond the capacity of the land capability. One reason is the increasing development, but do not pay attention to environmental sustainability. It also occurs in industrialized countries such as in Eastern Europe[11]. The study saw that how quickly the pace of construction is happening nowadays, but sometimes not based on careful planning. Thus, there exist some problems such as roads that are too narrow, the reduction of protected areas and others. It also occurs in North Luwu as an area of study.

In addition, the study results indicate that development in protected areas continues. Therefore, it can give greater impact to the change on forest ecosystems[12,13], natural disasters such as landslides and reduced fresh water[14-17] and the others. Furthermore, it would lead to changes in the micro and macro climate[18,19]. It also explained that changes in land use had an impact on the increase in temperature[20]. This is consistent with studies that have been conducted in several big cities In Indonesia and Jakarta in 2012-2013 by Maru and Ahmad[21] and in Makassar in 2014 and 2015 by

Maru *et al.*[22] showed that the land use change and anthropogenic activities impact largely to climate change, especially rising temperatures. Although, the study was conducted in the city but have similarities in terms of the change, the change of land use should be as green area or the protected area turned into an open area or region awoke. Both also have another thing in common, namely the phenomenon of land use change were the result rather than anthropogenic activities. Therefore, outcomes rather than this study provides a problem-solving solutions in the form of a land use map direction (Fig. 4, Table 5). This map is based on various factors, topography, soil type and rainfall.

Maintaining protected areas is an effort to keep the green open spaces particular in rural areas. This will give greater impact to the handling of greenhouse gases in the atmosphere. This phenomenon has become a national and international issues[20-22]. Handling such phenomena have discourse, as studies that have been carried out in Central Java province[23] in 2020.

Results of previous studies show three types of function of the area, namely protected areas, buffer and aquiculture. The existence of the three functions of the region need to get serious attention from the government and private sector to keep each district with their respective functions. Thus, the environment will be maintained.

In comparison, the reduction of protected areas in the second period, namely from 2008-2011 with 2011-2014, it is known that there has been an increase in the speed of change from year to year. This was caused by the increasing number of population. Furthermore, this situation led to an increase in basic needs such as housing, food and other amenities. If this is allowed, it will have an impact on the environmental damage that will eventually lead to disaster such as floods, landslides, local and global climate change.

## CONCLUSION

Protected zone or non cultivation is an area that cannot be utilized by society because this zone has function as a protected zone to conserve living environment that included natural and unnatural resource. Some of areas that include protected forest in North Luwu were Sabbang subdistrict (Pararra, Tulak Tallu, Tandung and Malimbu village) Baebunta subdistrict (Sassa, Lero and UPT Buso village), Bone-bone subdistrict (Patulo and UPT Bantimurung village) and Sukamaju subdistrict (Tamboke and UPT Pongkase village). The main protected forest that is exist in Rongkong watershed including Sabbang and Baebunta subdistrict.

In addition, the results of this study also indicated that there has been acceleration of the reduction of protected areas from time to time. If this is not handled properly, it will give a bad impact to the environment.

## ACKNOWLEDGMENT

## SIGNIFICANT STATEMENTS

• This study becomes information material for the government and society in forest management and policy making
• In addition, this study provides an idea that there has been a pattern of forest management, which should be as protected areas but now it has become a cultivated area
• Utilization of protected forest as cultivation area has an impact on environmental and ecological damage

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