THE ROLE OF GEOMORPHOLOGY FOR ANALYSIS OF LANDSCAPE ECOLOGY IN THE LONING WATERSHED, KARANGSAMBUNG-KARANGBOLONG NATIONAL GEOPARK

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ABSTRAK. This location is geologically located in the melange zone due to the subduction of the Australian plate with the Eurasian plate, so that rocks have high diversity. Loning watershed is one of the watersheds located in Karangsambung-Karangbolong National Geopark area. Geopark is an integrated regional concept in protecting geological heritage in a sustainable manner for human welfare. Geodiversity, biodiversity, and cultural diversity are regional elements that aim at conservation, education and tourism. The complex geological process of Loning watershed affects geomorphological variation. Every last unit of geomorphological landforms has different characteristics and functions. The purpose of this study was to analyze the geomorphological aspects related to ecology, so that sensitivity to landscape ecology can be obtained for the carrying capacity of the environment in the Geopark Region. The target to be achieved is the creation of geodiversity and biodiversity conservation area management. The research method used uses a laboratory and field approach. Study of laboratory approaches with digital image processing for analysis of vegetation cover with NDVI formula, geomorphological interpretation, river morphology and other spatial data analysis. Field approach by identifying each altitude segment on biodiversity and geodiversity parameters. The geomorphology in the Loning Watershed is used as a unit of land for landscape ecology. The river order reaches 4 segments, with a level 1 river order amounting to 150. Surface runoff based on the rate of flow density has a value of 4.71 with a bifurcation ratio of 5.73. In the watershed Loning has the characteristics of the river flow through the rock with soft resistance so that the sediment transported by the flow will be greater. The shape of the longitudinal watershed with the peak discharge is long and the decline is also long. Geomorphology is divided into 5 units from upstream to downstream which all have different.

I. INTRODUCTION

Karangsambung-Karangbolong National Geopark has the morphology of hills, plains, karst, dan coastal. Karangsambung-Karangbolong National Geopark area is divided into 3 (three) segments, namely Karangsambung (North), Sempor (Central), and Ayah (South). The Loning Watershed is one of the Upper Lukulo Watersheds located in the Karangsambung Geological Reserve Area. In this region has a complex litology with topography and various landforms.
The oldest rocks in Java which are Pre-Tertiary and are considered as the bedrock of Java Island are exposed in the Melange Complex of Luk Ulo-Karangsambung (Asikin, 1974), these rocks consist of tectonic mixtures of metamorphic rocks, alkaline igneous rocks and sedimentary rocks pelagic and hemipelagic (Prasetyadi, 2007). Rock outcrops consist of rock accretion complexes known as Luk Ulo Melange Complex consisting of phylite blocks, blue schist, eclogite, ultramafic, ophiolite, basalt, calcilutite and flanges embedded in eroded shale matrix (Asikin, 1974).

Natural problems are not only caused by physical factors, but also by social factors (Raharjo and Ansori, 2009). Damage to watersheds is often triggered by changes in land use due to the high level of human life needs and weak law enforcement. The existence of water resources in an area is generally determined by the physical condition of the watershed, the wider the vegetation cover in the watershed area, the greater the ability of the watershed to collect, store and flowing rainwater into runoff (Saefudin and Raharjo, 2009a).

Disrupted ecosystems due to natural imbalances will have an impact on the function and existence of the environment (Raharjo, 2008). Land use changes often do not match between the functions and conditions of the region, resulting in damage to natural resources in the watershed that will have a broad impact on environmental sustainability (Raharjo, 2009).

Geomorphological analysis is an approach that is carried out to find out the land forms and processes that influence their formation and investigate the relationship between forms and processes in their spatial order (Hardini, 2018). The development of landforms is determined by the processes of weathering and soil development, erosion, soil mass movements, flooding, sedimentation, and biology including humans (Raharjo and Saefudin, 2008). The fluvial process in the Karangsambung area originates from the origin of the structural process that has been exposed to exogenous energy and forms the origin of the denudational process (Raharjo, 2013).

Natural disasters that occur in the Karangsambung Geological Reserve include floods and landslide (Raharjo et al., 2011). The Lukulo Hulu watershed has a rounded watershed where surface runoff can cause river overflow (Raharjo, 2010a). This watershed is also one of the watersheds that has a high erosion rate, heavy erosion has an area of 5.87% with an erosion of 180 to 480 tons/ha/year and very heavy erosion of 5.26% with an amount of 480 tons/ha/year (5.26%) (Raharjo and Saefudin, 2008). The daily sediment load in the Lukulo Hulu watershed reaches 194.43 tons/ha/year (Saefudin and Raharjo, 2009b). The potential for dryness in this watershed is also very high, as seen from the shallow aquifer and the distribution of irrigated rice fields (Raharjo, 2010b).

The most extensive type of land use in the Karangsambung Geological Reserve Area is mixed gardens and forests, while Settlements have a uniform distribution throughout
the region with regular patterns following the existence of river flows (Raharjo and Ansori, 2009). The occurrence of landslide in the Karangsambung area was found 87 points of occurrence which included the type of subsidence, fall debris, avalanche, glide, obstruction, creep, and rock fall. The vulnerability zone of high landslide is found in areas that are generally composed of rock lithology breccia and sandstone Waturandu Formation, rocks in the Melange Complex that have undergone intensive and advanced weathering (Raharjo and Nur, 2013). Slope and rock are the main criteria in triggering landslides in Karangsambung Area, while the physical criteria of land and land use also have an influence but not too high (Raharjo, et al 2014).

The role of geomorphology is very important in controlling the ecological conditions that exist in this region, especially geomorphology. This study aims to analyze the geomorphological aspects related to ecology, so that sensitivity to ecology is obtained, especially in the physical study of land for environmental carrying capacity in the Geopark Region.

II. METHOD

This research was conducted in the Loning Watershed located in Karangsambung-Karangbolong National Geopark Region in the northernmost part. Administratively, most of them are in Kebumen Regency which includes Sadang District and some are in Pagedongan District, Banjarnegara Regency.

Fig 1. Research area in Loning Watershed

In this study includes several stages, namely pre-field, field, and laboratory and analysis. In the pre-field stage is preparation of sampling locations both land and vegetation, interpretation of both digital satellite imagery for classification of vegetation and visual density to determine land units. In the field stage, besides taking soil samples and vegetation, it is also used to measure river segments for each of the ideas. Some parameters needed in this determination are as below:

A Linier aspect
1 River Order: Strahler method (1964)
2 River segment length ($\sum Nu$)
3 Main river length (Lb)
4 Watershed perimeter (P)
5 Branching (Rb): $Nu/Nu+1$
6 Nisbah Percabangan terbobot (WRb): $\sum [(Nu/Nu+1)(Nu + Nu+1)]/\sum Nu$
7 Watershed wide (W): A / Lb

B Areal aspect
1 Watershed area (A):
2 Shape (Rc): $(4 \pi A)/P^2$
3 Drainage density (Dd): $(\sum Nu)/A$
4 Order frequency ratio (Fs): $Nu/A$
5 Flow frequency: (\(\Sigma\) orde-1)/(\(\Sigma\) Orde-2-3-4)
6 Flow texture: (\(\Sigma\) orde-1)/P
7 Elongation Ratio: (\(\sqrt{[4A/\pi]}\)) / Lb
8 Texture rasio (T): T=N1/P N1
9 Length of Overland Flow (LoF): \(\frac{1}{2}\) Dd
10 Constant Channel Maintenence (C): 1/Dd

In this land cover classification process uses vegetation index, namely NDVI transformation (normalized difference vegetation index). The use of NDVI is very effective for monitoring or differentiating vegetated areas from high density vegetation to low density (Jensen, 2005; Mather, 2004; Apan et al., 2002 in Daniels 2006).

NDVI characterizes the spectral reflectance of vegetation by comparing high reflectance in near infrared channels and low reflection on the red channel (Mather, 2004). The ratio that involves the spectral difference of the band between the near infrared channel (NIR) and the red channel (R) will be obtained by a vegetation index, NDVI.

\[
NDVI : (q_{nir} - q_{red})/(q_{nir} + q_{red}) 
\]

Field stages for checking the type of landform and sampling of land. Whereas at the end of the laboratory / studio stage it is used to justify the initial interpretation of the image of the landform and fill in the properties of the permeability parameters and texture of the land in each of landform unit.

**Fig. 2.** Land unit characteristic processes

### III. DISCUSSION

The Loning watershed has an area of around 25.92 km² and the river segment length is around 122 km. order-1 river numbered 150 pieces, order-2 rivers amounted to 37 pieces, order-3 rivers numbered 10, and 4th order river only 1 pieces. Surface runoff based on the rate of drainage density (Dd) has a value of 4.71 with a weighted average branching ratio of 5.73. The total value generated in the DAS priority calculation is 5, this value is a moderate value for the whole in the Upper Lukulo Watershed. On the 4th order the river surface material is in the form of rock with rough channel uniformity. Variations in cross section often change with a high meandering potential. On river channels there are moderate vegetation.

The type of land use around the river is mixed gardens of around 80% (dominant). This location is on a hilly topography with soil conditions pH 4.8 and granular soil structure. In measuring the flow velocity along 500 cm it is found that in d1 has a depth of about 17 cm with time (v1) of about 6.2 seconds; in d2 has a depth of about 28 cm with time (v2) of about 6.3 seconds; in d3 has a depth of about 35 cm with time (v3) around 5.9 seconds; on into d4 has a depth of about 43 cm with time (v4) around 5.3 seconds; and in d5 it has a depth of about 28 cm with time (v5) around 6.2 seconds. This condition is on a channel with a wet cross section of 500 cm and a cross section of 600 cm.
Order-2 The Loning River has rock surface material with rough channel uniformity. Cross-sectional variations show changes (sometimes) with vegetation around a high location. The potential for meandering on the Loning river orde-2 is quite low. The types of land use around the river include around 50% of the forest, around 40% of mixed gardens, and around 10% of bushes. It is on a steep hilly topography with a soil pH of around 4.4 and a granular soil structure. The Loning River which has the order of river 1 has an ephemeral river type on average.

Table 1. Loning morphometry

Bifurcation ratio is the ratio of river branching, bifurcation ratio, RB and the weighted bifurcation ratio, WRB is an important factor in knowing the flow conditions in the watershed. Range values between 3.0 to 5.0 in a Watershed where the geological structure does not change from the flow pattern, Strahler (1964, in Nag, 2011). The low branching ratio means that the characteristics of the watershed are not much disturbed by the presence of structures and also that the existing flow patterns are not controlled by the presence of geological structure.

This branching ratio, if compared, also affects the shape of the watershed which will give meaning of the time of flow concentration (Tc) quickly and slowly. Watershed Loning is a river that has a rapid rise in flood water levels while the decline runs slowly.

Fig 3. Physical conditions in Loning Watershed (A. Vegetation cover; B. Topography)

The condition of 2 soil samples in the upstream section has a moisture content (%) ranging from 58.37% and 49.34% with an average of about 53.86%. Porosity (%) has almost the same value, namely 67.43% and 64.54% with an average of around 65.98%. But the porous numbers give different values for the two samples, namely 2.07 and 1.82. The average soil saturation level is around 75.32% with the highest value of 76.53% and the lowest of 74.1%, this value is not much different. In general, the soil texture in the form of clay is around 12.95%, silt is around 38.80, and sand is around 48.25%, so that in the upper watershed the upper part of the Loning has a texture in the form of loam.

The Loning Watershed at the downstream has a sample of around 6 samples. Water content (%) ranges from 23.12% to 60.82% with an average of around 39.03%. The water level at the downstream is lower than the top. Porosity (%) from 62.41% to 98.38% with an average of about 75.6% porosity higher than the top and an average pore number of 1.19.

The average saturation level is around 72% with the lowest value of 31.25% and the highest of 100.60%. The value of saturation of land at the downstream watershed Loning has a value that is relatively the same as the upstream. In whole clay texture is around 29.28%, silt is around 38.30, and sand is around 32.42%, so that in the downstream Loning watershed it has a general soil texture in the form of clay loam.
In general, the whole of the upstream Loning Watershed even has a high slope, but the ability of water from the porosity side is smaller even though the saturation of the soil is almost the same, so the surface water velocity at the downstream is higher than the top (not considering the slope factor).

Table 2. Physical condition of the soil in Loning Watershed

In the classification of land cover with Landsat-8 image data using the method of maximum likelihood observed, it was obtained between the types of broadleaf vegetation cover / low density needle; Broadleaf vegetation cover medium density needle; Broadleaf vegetation cover/High density needle; The heterogeneous small vegetation field pattern does not border with trees; The bermozaiak vegetation mixes with open land; Open land fluvial area, sandy area on the river bank; and Land is built not isolated, Heterogeneous features are not regular, variations, surrounded by veg / open land.

The majority of the research area is an area with the type of use of land as a mixed garden, even the residential environment sometimes many are disguised by mixed gardens if detected by remote sensing data. These vegetations have a tendency to have canopies that cover the surface of the land below so that houses that are not in groups are very difficult to identify. The type of land cover which is a reflection of the type of land use is one factor that is very dynamic surface conditions. Sometimes it does not depend on the seasons that occur but, the interests of human intervention are very decisive for non-production lands.

In addition, engineering on agricultural lands that continue to impose low and high-yield crop production is also a consideration when patterns of change occur inconsistency. Types of use of paddy fields both in the form of irrigation systems and rainfed rice fields are widely distributed in the research locations. This distribution is not only in the alluvial plain area, but the inter-hilly valley area also has a type of paddy field use.

Table 3. Land cover in Loning Watershed

Fig. 4. Lanscapes profile in Loning Watershed

In the area above the soil texture in the form of Loam, this land has a relatively balanced composition of sand, dust and clay. Ability in small bonding power in dry or wet conditions and has sufficient nutrients and humus. Soil conditions are crumbly and moist, and easy to bind water and nutrients making it ideal for use in agriculture.

The land cover in the upstream area is in the form of high density vegetation on needle-leaved plants and several broad-leaved plants. Despite the steep slope, the water storage is quite good. While the land cover in the middle area, there is vegetation cover with needle leaves from medium to high density with lower plants in the form of bushes / litter relatively high. In addition, in this central area there are also many settlements. This
indicates the availability of ground water used for daily needs. The soil texture in the downstream area varies greatly, namely: loam, sandy loam, clay loam, clay, and silty clay.

IV. CONCLUSION

Landforms as a reflection of geomorphology greatly affect ecological conditions, especially in physical characters which include density and distribution of plants, physical properties of soil, and river morphometry. Loning watershed is a watershed that is still maintained from the conservation side, it is seen from the side of water resources (surface and groundwater), the percentage of vegetation cover that is still tight, relatively small erosion.

The Loning Watershed is one of the best Lukulo Hulu sub-watersheds in terms of environmental conservation, so environmental sustainability must be maintained for the sustainability of Karangsambung-Karangbolong National Geopark as an "experimental basin".

REFERENCE
Askin, S., 1974. Evolusi geologi Jawa Tengah dan sekitarnya ditinjau dari segi tektonik dunia yang baru. Laporan tidak dipublikasikan, disertasi, Dept. Teknik Geologi ITB, 103 hal.


Table 1. Ionizing morphometry

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<th>WRB</th>
<th>Fs</th>
<th>T</th>
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5,48 - 5

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Clay Silt Sand

| Downstream |
| 53,86      | 65,99    | 1,95    | 75,32 | 12,95 | 38,80 | 48,25 |
Table 2. Physical condition of the soil in Loning Watershed

<table>
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<tr>
<th>X</th>
<th>Y</th>
<th>Water content (%)</th>
<th>Porosity (%)</th>
<th>Soil pores (%)</th>
<th>Saturation (%)</th>
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<th>Silt</th>
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Table 3. Land cover in Loning Watershed (using Danoedoro, 2009 LULC classification)

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<td>C2(1/2)1</td>
<td>Low-density woody broad leaves</td>
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<tr>
<td>C2(1/2)2</td>
<td>Medium-density woody broad leaves</td>
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<tr>
<td>C2(1/2)3</td>
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<tr>
<td>S2222</td>
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</tr>
<tr>
<td>S2311</td>
<td>Mosaic of mixed vegetation</td>
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<tr>
<td>S321</td>
<td>Riverside sandy area</td>
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<td>Irregular with various size blocks, interleaved by vegetation and/or barren</td>
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<td>Land</td>
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Fig 1. Research area in Loning Watershed

Fig 2. Land unit characteristic processes
Fig 3. Physical conditions in Loning Watershed

Fig 4. Landscapes profile in Loning Watershed