

Geological Characteristics Analysis of Cimanuk Watershed towards Flood Disaster Mitigation

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SUMMARY

The study area is located in Upper Cimanuk Watershed, Garut and Bandung Regency, West Java Province. This watershed was the second biggest river in West Java Province. Regional physiography of this watershed included in several zones and formations. These things make the environmental mitigation need some method to make it balance. So the aim of this study is to know the detailed of geological condition of Upper Cimanuk Watershed to know how to treat the environmental.

The methodologies of this research are desk study, field work, and laboratory work. Desk study consists of literature review, topographic analysis, and Digital Elevation Model (DEM) analysis. Field work consists of geological mapping, outcrop analysis, geological structure analysis, petrology analysis, measured section, and rock sampling. Laboratory work consists of petrography analysis and morphometric analysis.

Cimanuk Watershed area has the characteristics of different rock. Based on lithological and stratigraphy Cimanuk watershed area Cimanuk Watershed belonging Twenty-eight formations and dominated by volcanic rocks. This various formation in the region affects the stability of different environments in a particular place. Thus we must be aware of these conditions to prevent disasters such as floods and landslides in the region of watershed Cimanuk

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1. INTRODUCTION

Geology is a branch of science that study about earth, including the form of the earth, the process and the history of the earth until now, it materials, the structures, earth surface, and the process of the earth in the past, present, and future. Upstream Cimanuk watershed has a complex geology processes, such as the lithology and tectonic variations. Regional physiography of this watershed included in several zones and formations.

Cimanuk River has been contaminated because of people activities in Cimanuk watershed so the water surface becomes higher. Watershed management and the utilization of land use that not integrated and unplanned better can cause flood disaster that can trigger water issues in Cimanuk watershed. Sinukaban (1995) said the utilization of natural resources in watershed that did not pay attention on the environmental eternal and ability will cause water ecosystem issues and land use that can impact on flooding. So the aim of this study is to know the detailed of geological condition of Upper Cimanuk Watershed to know how to treat the environmental towards flood disaster mitigation.

Based on van Bemmelen in Martodjojo (2003), West Java physiography is divided into four zones (Bogor Zone, Bandung Zone, Southern Mountanious Zone, and Jakarta Bay Zone) . The research area is the part of Bogor Zone, Middle Depression Zone, Volcanic Quarter Zone, and Southern Mountanious Zone.

Upper Cimanuk Watershed occupy in the zone that consists of material that is deformable. This condition can increase the erosion in hill slope and in the river steep slope. If the erosion increases, it will affect to the sedimentation so the shallowness of the river will become faster.

Based on Geology Regional Map sheet Bandung, Arjawinangun, Tasikmalaya, Garut, and Pameungpeuk, stratigraphy regional of the research area consists of twenty eight formations. Generally, this formations consists of sediment rocks, volcanic rocks, plutonic rocks, and alluvial. The age variety of rock formations starts from Oligocene – Miocene until Recent. The physical properties of the rocks is vary from the unconsolidated to consolidated rocks.

2. METHOD

The methodologies of this research are desk study, field work, and laboratory work. Desk study consists of literature review, topographic analysis, and Digital Elevation Model (DEM) analysis. Field work consists of geological mapping, outcrop analysis, geological structure analysis, petrology analysis, measured section, and rock sampling. Laboratory work consists of petrography analysis and morphometric analysis.

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Geology Regional Map with scale 1 : 100,000 that include Upper Cimanuk Watershed are:

- 1) Sheet Garut and Pameungpeung scale 1 : 100,000 (Alzwar et. al., 1992)
- 2) Sheet Bandung scale 1 : 100,000 (Silitonga, et. al., 1996)
- 3) Sheet Tasikmalaya scale 1 : 100,000 (Budhitrisna, 1986)
- 4) Sheet Arjawinangun scale 1 : 100,000 (Djuri, 1995)

3. RESULT AND DISCUSSION

Geology of Upper Cimanuk Watershed is varying from geomorphology, tectonic, and lithology. Geomorphology of Cimanuk watershed is mountainous and hills that the top and the valley are functioned as watershed boundary in the North and Middle part of the research area. The inclination of the slope is vary too, from flat until steep slope. The drainage patterns of the research area are sub-radial to radial in the mountains and hills slope, sub-dendritic to dendritic, sub-parallel to parallel, sub-rectangular to rectangular, sub-trellis to trellis, and anastomotic. This drainage patterns show the tectonic activity in their development. Lineaments interpretation from Digital Elevation Model (DEM) is done to know the type of the geological structure in the research area. Structure lineaments are the result of the geology structure in an area and it shows in ridges and depression zone.

Based on the past research, the lithology of the Cimanuk watershed consists of twenty seven formations. Many of that lithology can be grouped in the volcanic rock, plutonic rocks, sediments rocks, and alluvial. Spatial distribution of these formations can be seen in the Geological Map. The age variety of rock formations starts from Oligocene – Miocene until Recent. The physical properties of the rocks is vary from the unconsolidated to consolidated rocks, like lava and intrusion.



Figure 1. Geomorphology of Upper Cimanuk Watershed that angle of view is from west



Figure 2. Geomorphology area Cimanuk



Figure 3. Valley of the Cimanuk watershed with the background is mountainous and hills geomorphology in the west of the research area

Generally, The old rocks (Pre-Tarsier – Tersier) is sediment rocks that intercalated with fine grain materials and coarse grain materials, and plutonic rocks is intrusion and hornblende andesite. Sediment rocks are grouped into Cinambo Formation, Halang Formation, Subang Formation, Kaliwangu Formation, and Citalang Formation. That physical properties of the sediment rocks relative resist of the erosion especially the coarse grain sediment rocks. This lithology take place in the downstream of the upper Cimanuk watershed, and opened in Tomo, Cadasngampar, Pamoyanan, Darmaraja, Wado, Ciherang, and Situraja.

The younger rocks (Pleistocene) are dominated by the volcanic products. This spreading of the rocks are relative cover all of the area in the upstream Cimanuk Watershed. Volcanic products in this area consist of volcanic breccia, lava, basaltic lava, tuff, and the other pyroclastic rocks.

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Volcanic rocks that are more solid take place in the mountainous and steep slope hills morphology. Besides, the volcanic rocks that is softer (fine grain materials) commonly take place in the flat and slightly slope hills morphology. Many of this lithology are resisting of the deformation so it is easier to broken up and scrapped by the surface water flow. The spread of this lithology is take place in the southern, middle, and western part of the research area. The spreading area administratively included in Cijapati, Cimalaka Wanaraja, Sukawenang, Pengeureunan, Malangbong, Limbangan, Ciherang, Cipeundeuy, Rancakalong, Sumedang, Paseh, Leles, Cipanas, Pamoyanan, Cijeungjing, Cisarupan, Pamegatan, and Warungsimpang.



Figure 4. The outcrop of the clay stone of Kaliwangu Formation in the Cimanuk River slope around Darmaraja



Figure 5. The outcrop of the volcanic breccia in the slope and base Wado

The youngest lithology (Holocene – Recent) is dominated by the pyroclastic rocks and alluvial. Pyroclastic is the product of the young volcanic and some of them are still active

(Papandayan Mountain). Whereas the alluvial consists of alluvium, colluvium, and lake alluvial. If these materials take place in the steep slope or the hills slope, it is so susceptible of the erosion. Like the one that spread in the southern part of the research area. There is not many alluvium take place in the big valley, especially Cimanuk River with the flat morphology.

Based on the analysis, it can be know the factors that can cause flood disaster in the Garut – Sumedang Regency especially in the Cimanuk watershed. Flood threat in the upper Cimanuk watershed has been known from the morphometric characteristics, land use changing, and the range of debit volume that relative high that has been measured by the contour.

The debit volume can be known from the data in every sub-district (Cimanuk – Bayongbong, Cimanuk – Leuwigoong, Cimanuk – Cibatu., Cimanuk – Wadom Cimanuk – Tomo). The data that used in the Tomo show the rise of the debit volume in the late 2012 around 272.7 m³/s. That means this area is included in the high prone zone.

After we seen in the contour that grouped into several classes, Cimanuk – Bayongbong area (837.5 m – 2,375 m) included in the hills-mountainous area, so this area not included in flood-prone zone. Whereas the Cimanuk – Tomo area (37.5 m – 62.5 m) is lowland area so its included into flood-prone zone. This data can be seen in the Table 1.

Table 1. Classification result of the elevation, slope inclination, and debit bar chart in 2007 – 2012

No	Nama Sungai – Lokasi	Klasifikasi Ketinggian			Debit Maksimum Tahun 2012 (m ³ / detik)
		Meter	Kemiringan Lereng (%)	Keterangan	2012
1	Cimanuk - Leuwigoong	558 – 862,5	55 - > 140	Perbukitan Tinggi	73.8
2	Cimanuk - Wado	225 – 1,425 m	55 - > 140	Perbukitan – Perbukitan Tinggi	37.6
3	Cimanuk - Tomo	36.17 – 162,5 m	0 - 7	Dataran Rendah	272.7
4	Cimanuk - Cibatu	512,5 – 147,5 m	55 - > 140	Perbukitan Tinggi	19.1
5	Cimanuk - Bayongbong	837,5 – 2,375 m	> 140	Perbukitan Tinggi - Pegunungan	6.89

In the measurement of the morphometric characteristics, stream order analysis in done as comparison between one stream order with the other stream order that has higher number. This analysis called bifurcation ratio. The higher bifurcation ratio it means that river has a lot of sub watershed. Bifurcation ratio of a stream is three, it means the stream receive flow from three upper

stream. This value directly shows the abundant of the flood that can be receive by the river. The higher bifurcation ratio, the flood fluctuation is higher.

The measurement of bifurcation ratio in the twenty biggest sub watershed in the Cimanuk watershed show that almost all of the sub watershed have bifurcation ratio value under three. It means that rivers have high flood fluctuation whereas the descent is going slow. If we look at the river model, in the twenty biggest sub watersheds there are three sub watersheds that have birds feather shape, four sub watersheds that have radial shape, six parallel, and eight complexes.

The result of the research we get three group zones: high flood-prone zone, low flood-prone zone, and free-flood zone. Some of the area of Cimanuk watershed has been known as flood-prone zone is Cimanuk – Tomo. This thing proves that upper Cimanuk watershed generally has a low flood threat than the lower watershed area.

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