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Analysis of land use patterns in the upper Cimanuk river basin and its relationship with irrigation water discharge in Majalengka Regency, Indonesia

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ABSTRACT

Land use with increasingly high intensity and not well planned, such as land conversion from agricultural land to residential and industrial areas has the potential to cause damage to watersheds indicated by a decrease in hydrological conditions. This land use change is an important phenomenon for every planner and regional policy maker. This research was conducted for seven months at the Cimanuk River Basin. This study aims to determine the pattern of land use in the Upper Cimanuk Watershed and the impact of land use in the Upper Cimanuk Watershed on irrigation water discharge in Majalengka Regency. The research method in this study used the image classification method, namely the process of dividing the coverage area based on image data with the use of certain symbols. In it there was an unsupervised classification and a guided classification. The results showed that Land use patterns in the Cimanuk River Basin are dry land agriculture by 30.02%, rice fields by 19.01%, production forest by 14.34%, and bush area by 0.32%. The average annual discharge in 2020 in the upstream of the Cimanuk River Basin that flows into the Rentang and Kamun dams were 125.32 m/s and 355 m/s.

Key word : Average annual rainfall, Kamun dam, land use, Rentang dam, watershed

INTRODUCTION

Population growth continues to accelerate over time resulting in an area growing. The factor that supports this development is the increase in population activity, and this increase in human activity will result in a loss of balance between humans and nature. Regional development progress and population growth affect land use changes (Firmansyah and Koesoemawati, 2020; Muthumperumal and Ramachadran, 2021).

The dynamics of comprehensive land use are currently increasing (Bensemann *et al.*, 2018; Nanjia and Xiao, 2020). In Nigeria there was also a change in land use from 2000 to 2016 for built-up land, forest land, and mixed land (Izah *et al.*, 2018). This land change is due to urban expansion and non-agricultural development (Zehang *et al.*, 2018). The consequences of changing land use with increasing intensity and unplanned land use have the potential to cause damage to land. watershed indicated by a decrease in hydrological conditions. This land use change is an important phenomenon for every planner and regional policy maker (Wijaya, 2015). Changes in land use and land cover have a significant effect on local climate variables such as temperature and rainfall (Kenenbayev and Jorgansky, 2018). Several research results explain the relationship between changes in land use, increased flow rates and changes in the hydrological characteristics of the watershed (Nugroho *et al.,* 2018). Water pollution is positively correlated with agricultural land and residential industrial areas are negatively correlated with water and

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grassland, so land use patterns affect water quality (Cui *et al.*, 2016; Uke and Haliru, 2021). Evaluation methods need to disclose sustainable land use and efficient land use as is the case in China (Chenchen *et al.*, 2017), so the evaluation of land use changes needs to be carried out (Hassan *et al.*, 2016). Changes in land use can greatly alter spatial patterns and the overall value of ecosystem services (Wang and Xiaofang, 2016).

The land use conditions and the hydrological response of the Cimanuk watershed need to be known for the sustainability of the watershed environmental services provided. In addition, indications of damage must be identified early so that problems can be prevented or minimized. Seeing the existing phenomena, it is necessary to do research. The purpose of this study was to examine the land use pattern of the Cilutung sub-watershed and its impact on the hydrology of the watershed, especially river discharge. It is hoped that based on this research it can be known how the conditions of land use in the Cimanuk watershed so that it can be used as material for planning watershed management in the future.

MATERIALS AND METHODS

The research was conducted in the Upper Cimanuk Watershed which is administratively connected to Majalengka Regency from March to September 2020. The ArcGIS 10 software, Microsoft office, Global Positioning System (GPS), data storage (hard disk) with visual maps were used in the course of study. Bumi Indonesia in the Upper Cimanuk Watershed in 2020 at a scale of 1:300,000, Landsat 7 OLI / TIRS (Operational Land Imager/Thermal infrared Sensor) satellite imagery in 2020 and rainfall data in 2020 taken from the Kamun and Rentang dams. The process of assessing the accuracy

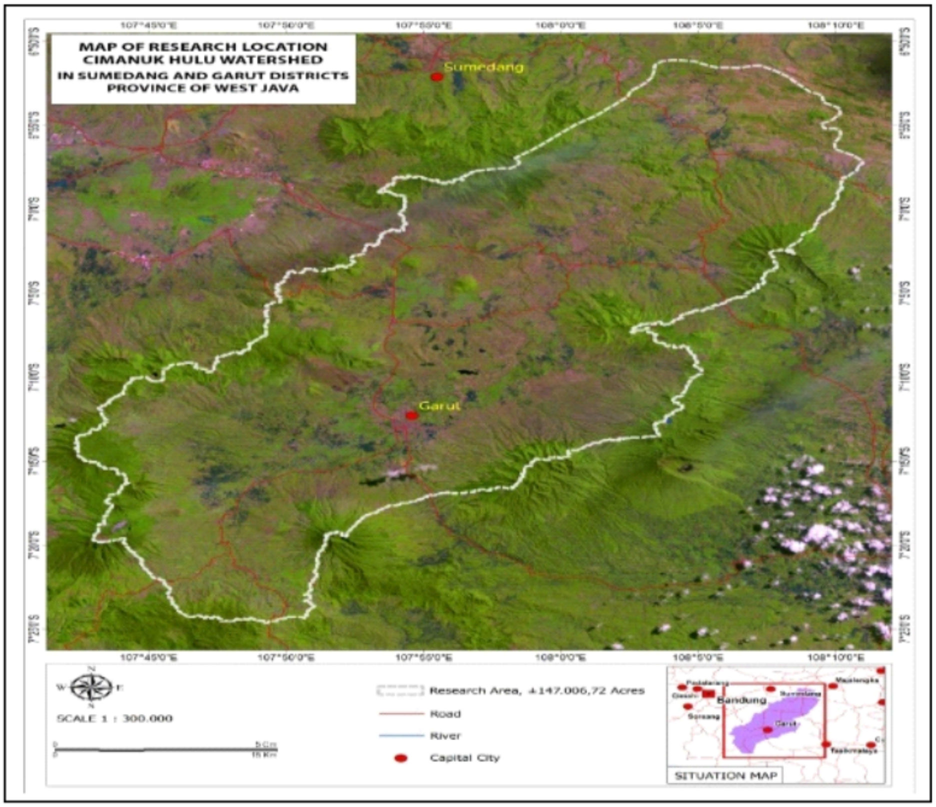

Fig. 1. Research location map.

of the classification of satellite imagery elements is very important in land classification, it can also assess forest changes (Sentongo *et al.*, 2018).

The research method in this study used the image classification method, namely the process of dividing the coverage area based on image data with the use of certain symbols. In it there is an unsupervised classification and a guided classification. Unsupervised classification is a grouping of data with cluster analysis automatically and re-calculated average land use class while guided classification with grouping of data with training areas for each represented land use class.

The stages of data management included Geometry correction, colour composites, mosaic, cropping, training areas and classification of land cover types. Map of the location of the Upper Cimanuk watershed research (Fig. 1) is attached as a model.

RESULTS AND DISCUSSION

Land Use Patterns in the Upper Cimanuk Watershed

Land use patterns identified from the classification of land cover classes include primary dry land forest, secondary dry land forest, plantation forest, shrubs, settlements, open land, dry land agriculture, dry land agriculture mixed with shrubs, rice fields, water bodies, and plantations. The percentage of land use classes in the Upper Cimanuk watershed in 2020 is shown in Table 1.

The land use area based on Table 1 which dominates the Cimanuk watershed is dry land agriculture at 30.02% of the watershed area, the second largest land use is rice fields around 19.01%. Most of the people in the Upper Cimanuk watershed rely on agricultural products. The area of shrubs is the smallest area in the Upper Ciamanuk watershed at 0.32% of the total area of the Upper Cimanuk watershed. while the area of plantation forest is around 14.34%. This area is considered insufficient according to the law. No. 41 of 1999 concerning forestry that the proportion of forest area in a watershed is determined to be at least 30% of the total watershed area, and the area of forest land use is divided into a relatively small and uneven area. The land use map for the Upper Ciremai watershed can be seen in Fig. 2.

Annual Average Debit Calculation

Discharge The average discharge in this processing is carried out on two dams, namely the Kamun and Rentang dams which are downstream of the Cimanuk watershed, precisely in this study located in the administrative area of Majalengka Regency. Cisanggarung. From the results of field calculations carried out in 2020 the average annual discharge of the Upper Cimanuk watershed at the Kamun and Rentang dams is 355.0 m/s and 125.32 m/s, respectively.

Based on Fig. 3. it is known that in the Kamun Dam in the first month to the fifth month the water discharge experienced a significant increase, then in the sixth month to the eleventh month the water discharge decreased. Similar to the Kamun dam, the range of water discharge increased in the first month to the fourth month and decreased in the following month until the 11th month. Both dams experienced an increase in discharge

Table 1. Land Use in the upper Cimanuk watershed in 2020

No.	Location name	Location description	2020 Land use	Large (ha)	(%)
1	CIMANUK Upstream	Watershed	Primary dryland agriculture	1,177.11	0.80
2	CIMANUK Upstream	Watershed	Secondary dryland farming	9,037.61	6.15
3	CIMANUK Upstream	Watershed	Plantation forest	21,077.59	14.34
4	CIMANUK Upstream	Watershed	Settlement	18,672.88	12.70
5	CIMANUK Upstream	Watershed	Plantation	950.00	0.65
6	CIMANUK Upstream	Watershed	Dryland Farming	44,133.23	30.02
7	CIMANUK Upstream	Watershed	Dryland Farming Mixed with Shrubs	18,290.16	12.44
8	CIMANUK Upstream	Watershed	Ricefield	27,953.01	19.01
9	CIMANUK Upstream	Watershed	Shrubs	463.07	0.32
10	CIMANUK Upstream	Watershed	Open Ground	1,639.28	1.12
11	CIMANUK Upstream	Watershed	Body of water	3,612.79	2.46
			Amount	147,006.72	100.00

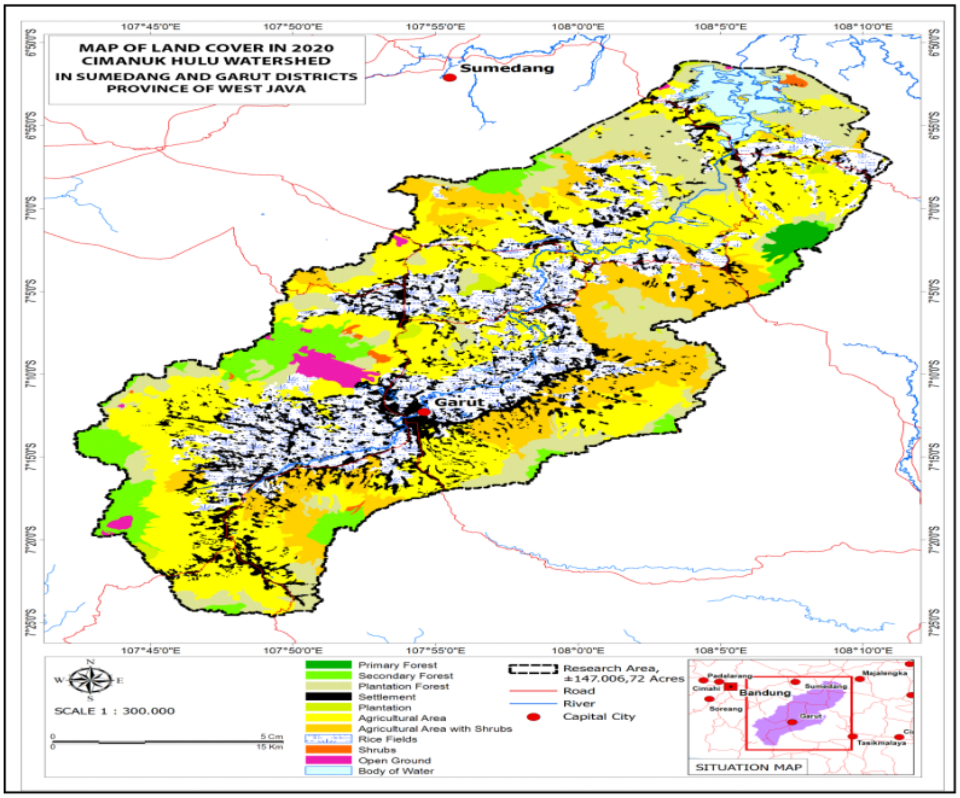

Fig. 2. Map of upstream land use in the Cimanuk watershed.

in the twelfth month.

The maximum annual average discharge in 2020 is 81,032 m/s at the Kamun Dam in May and 241.64 m/s at the Rentang dam in April, then the minimum annual average discharge occurs in November with a magnitude of 616.50 m /s and in the dam the range is 38.76 m/s in September. Water discharge has a directly proportional relationship with rainfall, when the rainfall in a place increases of course the resulting water discharge will increase (Pribadi *et al.*, 2020).

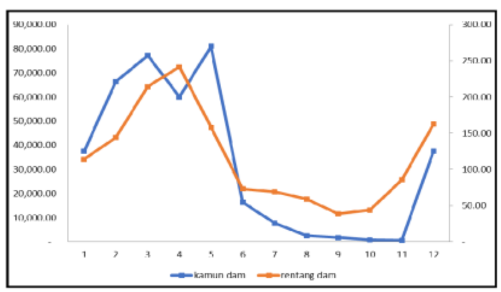

Fig. 3. Average annual discharge of the upper Cimanuk watershed.

Impact of Land Change on Rainfall Water Discharge

Land use has an impact on water flow in a watershed, if land use is fulfilled and covered by trees it will increase rainfall by about 5-6%, while urban activities will cause an increase in rainfall even by 5-6%. 10%, this increase in rainfall will result in an increase in water discharge (Staddal *et al.*, 2016). Thus, the form of land use in an area greatly affects the water discharge (Pribadi *et al.*, 2020). Therefore, in tackling watershed damage, it is necessary to handle such management directions for clearer land use by adding vegetated areas (Harifa *et al.*, 2020). With the maintenance of the Upper Ciremai watershed, the increase in water discharge will be well controlled.

CONCLUSION

Land use patterns in the Cimanuk River Basin are dry land agriculture by 30.02%, rice fields by 19.01%, production forest by 14.34%, and bush area by 0.32%. The average annual discharge in 2020 in the upstream of the Cimanuk River Basin that flows into the Rentang and Kamun dams is 125.32 m/s and 355 m/s. The maximum average discharge at the Rentang and Kamun Dams and the range occurring in April and May is 81.032 m/s and 241.64 m/s. The minimum average discharge at Rentang and Kamun dams occurs in September–November, which is 38.76 m/s and 615.50 m/s.

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