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The vulnerability analysis of catchment areas using rapid assessment method (case study in Universitas Indonesia, Depok)

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Abstract. Catchment area of aquatic system in Universitas Indonesia (UI) campus has a function as groundwater recharge for Depok area, which is the buffer zone of Jakarta. This catchment area has high level of imperviousness as a consequence of increasing population. The high imperviousness implicates in the degradation of the catchment area health. For that reason, the vulnerability assessment of UI catchment area is needed to arrange of restoration recommendation. This research applies Rapid Assessment Method which implements eco-hydrological concepts including aquatic and riparian condition as well as imperviousness of catchment area. Locations of the research are Kenanga and Agathis catchments area. The result of initial classification based imperviousness both catchment areas are categorised as Non-Supporting, where the imperviousness of Kenanga and Agathis is 31,0% and 77,18% respectively. Based on the assessment on aquatic and riparian condition as well as future land use, the final classification of both catchment areas is Restorable Non-Supporting catchment area.

1 Introduction

The availability of water resources in terms of quantity and quality tends to be critical and become a worldwide problem [1]. Sustainability of water resources is determined by watersheds functioning as catchment areas. Since watersheds are formed by inseparately ecosystem interaction from upstream to downstream, the healthiness of catchment areas is important to be considered. It can be done by measuring the quality of the water located in water bodies which are parts of catchment areas such as lakes, rivers, and others. [2] stated that catchment areas damage indicators could be recognised by hydrological behaviour shifts such as high frequency of flood, more erosion and sedimentation, as well as decreasing water quality. Therefore, catchment area management should be done through sustainable natural resource utilisation [3].

Human activities and the needs of space implicate on land covering conversion from pervious to impervious cover. Increasing number of impervious land covering strongly affected on the change of water quality and ecosystem especially for small scale catchment areas within 13 – 77 km² [4,5]. Excessive impervious land covering brought bad impacts on the healthiness of catchment areas [6].

This paper will discuss the vulnerability assessment of catchment areas in UI campus namely Kenanga and Agathis using Rapid Assessment Method. Both catchment areas are characterised by education and residential uses. Estimates of impervious cover using

GIS technology by digitizing land cover features, water quality data [7] and aquatic [8] used derived from previous studies [9]. The result of this study is expected to be a foundation to formulate necessary recommendations which finally aim to do conservation and increase environmental carrying capacity of UI campus and surrounding areas.

2 Methodology

2.1 General Description of the Study Area

Kenanga catchment area is astronomically located in 106°49'44,66"-106°49'51,51" East Longitude and 6°21'56,96"-6°22'04,64" South Latitude. Meanwhile, Agathis catchment area is located in 106°49'28,47"-106°49'29,69" East Longitude and 6°22'5,75" LS-6°22'9,18" South Latitude.

2.2 Analysis Procedure

Watershed vulnerability assessment can be done by Tools 12 of Watershed Vulnerability Analysis proposed by Zielinski in 2002. This method aims to classify watershed condition. Furthermore, watershed vulnerability analysis basically illustrates eight steps to create planning for watershed, to figure sub-watershed out, to forecast land covering based on existing condition, and to identify factors causing a change on initial sub-watershed classification. There are three

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Table 3. The Result of Physical and Chemical Parameters Test on Kenanga Pond

No.	Parameter (Unit)	Result		Average	Standard
		Inlet	Outlet		
1.	Total Suspended Solid (mg/L)	67,5	19,20	43,5	50
2.	Turbidity (NTU)	5,11	2,66	3,88	25
3.	pH	6,19	6,37	6,28	6,5-9
4.	BOD (mg/L)	3,0	0,26	1,63	3
5.	DO (mg/L)	3,39	5,61	4,5	5
6.	Temperature	30,4	30,5	30,45	Deviation 3°C

In addition to researching water quality, riparian zones were also observed about existing plants around it. The function of the riparian zone is the ecological function that is as a food source, as a nutrient filter, and habitat [12]. As a habitat, riparian zones affect the abundance of macroinvertebrates. Riparian buffer zones can significantly reduce the impact of deforestation on tropical flows. Macroinvertebrates are animals sensitive to existing pollution.

Furthermore, final classification of Kenanga and Agathis based on the assessment of river corridor and land use is categorised as *Restorable Non-Supporting Watershed*. This is because both lakes still have five assessment criteria of riverbank and two assessment criteria of sub-watershed scale. Some indicators show Kenanga and Agathis catchment areas can be classified as vulnerable catchment areas because there is an increasing trend of impervious cover, polluted water, and the extinction of some water plants. Moreover, future conditions of land cover were projected to decide appropriate rehabilitation efforts and priority scale of measures. The result of this projection is illustrated by these following figures.

Table 4. The Result of Physical and Chemical Parameters Test on Agathis Lake

No.	Parameter (Unit)	Result		Average	Standard
		Inlet	Outlet		
1.	Total Suspended Solid (mg/L)	6,10	5,50	5,80	50
2.	Turbidity (NTU)	1,68	0,86	1,27	25
3.	pH	6,14	6,20	6,17	6,5-9
4.	BOD (mg/L)	1,10	1,60	1,35	3
5.	DO (mg/L)	2,43	1,79	2,11	5
6.	Temperature	29,30	27,60	28,75	Deviation 3°C

Table 3 and 4 above show that water quality based on Physical and chemical parameters of Kenanga and Agathis ponds are still in the standard interval except pH. UI cascade-pond damage due to levels of excessive pollutant solute resulted in decreased water quality, reduced aquatic animals and border ecosystems [8]. Some parameters have been tested to investigate pollutant indicators in UI cascade-pond [9]. Those parameters are BOD, COD, Ammonium, and Phosphate which exceeded the standard interval. In addition, these results were strengthened by the result of Pinasti's research conducted in 2017 as it was shown in table 3 and 4, which explains that the Kenanga pond is heavily polluted and polluted on moderate in Agathis pond.

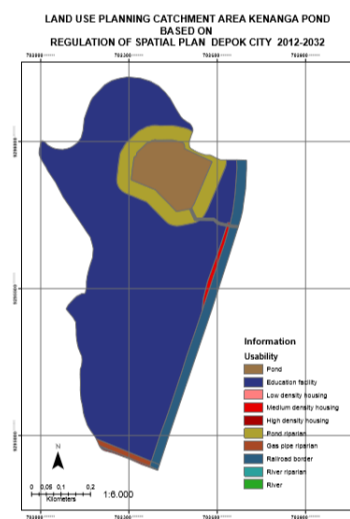


Figure 3. Spatial Planning Map of Kenanga Pond

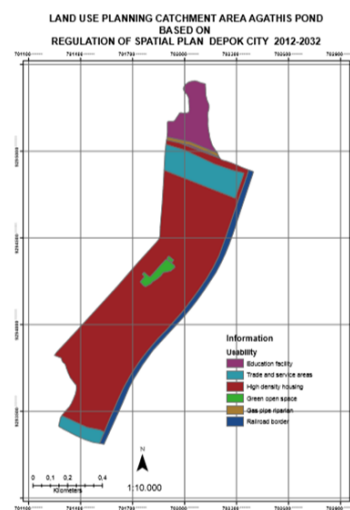


Figure 4. Spatial Planning Map of Agathis Pond

These two figures show that both catchment areas are dominated by educational areas. Land use Agathis catchment area is also dominated by residential and commercial uses. According to the Spatial Planning of Depok City 2012-2023, development planning proposed in Kenanga catchment area is to develop educational and governmental facilities in UI campus. However, there are still some areas dedicated to green open spaces. Therefore, impervious cover decreases to 29,57%. The same trend also occurs in Agathis catchment area. In this location, impervious cover decline to 73, 48%. To be more detail, the data is presented in Table 5.

Table 5. The percentage of Impervious Cover Based on the Spatial Planning of Depok City 2012-2032

No.	DTA	Impervious Cover (Ha)	The Large of DTA (Ha)	Percentage (%)
1.	Kenanga	16,16	54,67	29,57
2.	Agathis	59,02	80,33	73,48

From the table above, it is estimated that up to 2032 there is a percentage of land cover with a downward trend, although only less than 5%. It is possible there are restoration efforts made by the government based on Spatial Plans (RTRW) which has been made by the government of Depok City.

4 Conclusion

Based on rapid assessment conducted in this research, it can be concluded that Kananga and Agathis catchment areas is vulnerable. It is indicated by the percentage of both catchment areas, which are 31,0% in Kenanga and 78,18 in Agathis. Since the percentages are more than 25%, the vulnerability classification can be categorised as Non-Supporting. From the existing condition of water quality, water biota, riverbank and the projection of impervious land cover, both Kenanga and Agathis catchment areas can be classified as Restorable Non-Supporting. The estimated is a decrease in percentage of land cover (<5%) from the GIS calculation of 2017 condition compared with the condition according to RTRW Depok City 2012-2032.

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