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Rawapening Lake Buffer Zone Management

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Abstract. Rawapening Lake is located in Semarang District, Central Java. The decreasing of Rawapening lake function due to its many problems caused by environmental degradation which has happened for almost three decades. Buffer zone determination is a very important basic action to safe Rawapening Lake. This research is to determine Rawapening lake buffer zone and its management. Hydraulic, topographic analysis was conducted within the research along with identification of buffer zone condition. A clear buffer zone area act as boundary for Rawapening lake utilization to support the sustainability of its function in the future.

Keyword: buffer zone, determination, management, sustainability

INTRODUCTION

Lake occupies relatively small area on earth surface, but it is very beneficial for the ecosystem and human being. One of the water resources in Indonesia is the Lake [1]. To meet human needs, the environment around lake is changed to accommodate their habitation. Activities carried out by humans around the lake environment can cause pollution and damage to lake water body [2]. The space and land around lakes were changed into various forms such as settlements, road infrastructure, household sewerage, agricultural land, plantation, recreation and so on [3]. Since, lakes are indeed important part of environment, their preservation is necessary for sustainability of the environment. Utilization of lakes as natural resources must be balanced as they have limited size and bearing capacity for living organism, so the environmental pollution on lakes must be prevented. The responsibility to maintain the sustainability of the lake must be shared by all responsible stakeholders such as central government, regional government, entrepreneurs and community [4].

Types of lakes are as follows [5] :

1. Vulcanic Lakes are formed by vulcanism event. The examples of these lakes are Kelimutu Lake in Flores, Segara Anak Lake in NTB, Kawah lake in Kelud East java
2. Tectonic lakes are formed by tectonic events. The examples of these lakes are Poso and Towuti Lake in Sulawesi, Singkarak lake in Sumatera.
3. Tecto vulcanism Lake are formed due to tectonic and Vulcanic forces. Example of these lakes: Toba lake, Ranau Lake and Kerinci Lake in Sumatera
4. Kars Lakes are located in limestone mountain due to chemical dissolution process
5. Glacial lakes are formed due to glacial erosion. The examples of these lakes are Michigan Lake, Superior lake, and Ontario Lake in The USA and Canada
6. Dam Lakes can occur because of the river flow that blocked by lava due to volcanic eruption, examples of these lakes are Air Tawa Lake, Tondano Lake

7. Artificial Lakes are from river flow which is dammed. The examples of these lakes are Gajah Mungkur Dam, Karang Kates Reservoir.

Water from Lake is a potential water resource that has not yet widely used. Indonesia has so many water resources, but many of them, particularly lakes, have not been well managed. Most of Indonesia's lakes are in severe condition due to a lack of environmental management. [1] and Rawapening lake is one of them.

Rawapening Lake located in Central Java Semarang District has watershed size of 250,79 km^2. awapening Lake, the largest lake in central Java, is precisely situated in the Tuntang River's upstream region. Rawapening Lake is used for a variety of purposes, including irrigation, fisheries, water storage, tourism [6] [7].

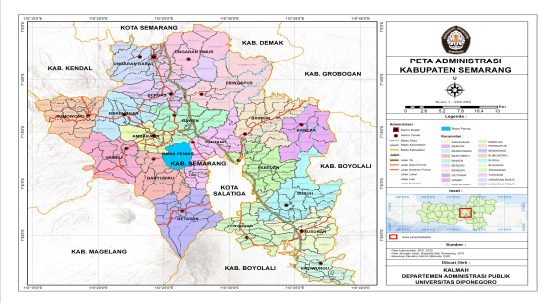

FIGURE 1. Rawapening Lake Location – District of Semarang [6]

Since roughly three decades ago, Rawapening Lake's functionality has been deteriorating. Rawapening Lake's decreasing lake storage capacity is the issue. [8]. Rawapening Lake is heavily sedimented due to the large number of aquatic weeds like water hyacinth in its water body and the harming upstream area brought on by a shift in land use. The lake's water level dropped as a result of this issue. [9]. In Since 1990, Rawapening lake boundary marked by wooden stakes, and they functioned as boundary management in Rawapening lake. There used to be hundreds of wooden stakes surrounding the lake, but now we can hardly see them anymore [6]. There are no clear limit or boundary to control the utilization of Rawapening lake, meanwhile it has so many functions such as: irrigation, fisheries, water storage, hydropower, tourism [10]. These conflicting issues have caused problems, such as to the lake boundaries. Therefore, this research is aimed to determine Rawapening Lake buffer zone area and its management.

METHODS

This research carried out within three steps as follows:

1. Preparation stages
   This stage was conducted to determine the study area and secondary data collection needed
2. Data Collection
   Hydrology and hydraulic data, topographic data, socioeconomic data (population and land ownership data), identification and inventory data, lake conditions (building and utilities), land use data, regional spatial planning (RTRW), regulation, previous studies of Rawapening Lake.
3. Data analysis
   Hydrological analysis, topographic analysis, Hydraulic analysis, Socioeconomic analysis.

RESULT AND DISCUSSION

A. Determination of Rawapening lake buffer zone area

The establishment of lake buffer zone limit is designed to protect and control the usage of lake existing resources [10]. The functions of lake buffer zone limit are as follows [12]: (a) The function of the lake is not to be disturbed by the activities that develop around them. (b) Utilization activities and effort to increase the benefit value of the existing

lake are to provide optimal result while maintaining its preservation. (c) To limit the destructive power of water to the environment.

The starting point of Lake Buffer zone area is determined from the highest water level that had ever occurred and surrounding the lake with minimum length of 50 meter. [11]

1. **Highest Water Level**
   Highest water level was determined from Jelok Weir (as shown in the graph) it is recorded that the highest water level is 463,32 m and the lowest is 462.30 m

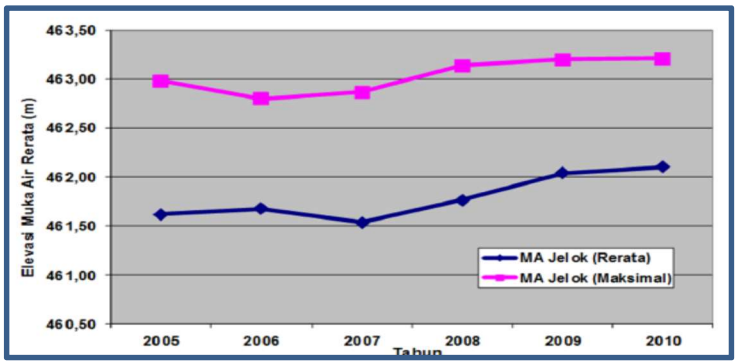

FIGURE 2.. Water level Jelok Weir 2005-2010 [8]

The installation of sign board of the highest water level that has ever occurred is +463,30 and there will be no further development of the areas and buildings at this boundary level [12].

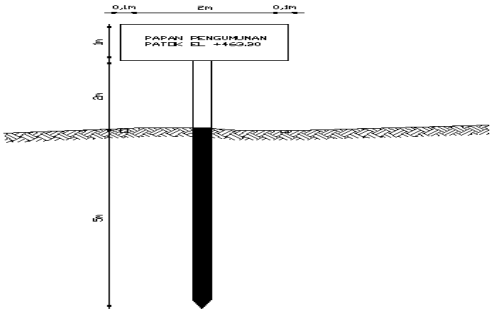

FIGURE 3. Highest water level Sign

2. **Dike Level**
   Flood analysis was carried out in three locations, including Siblobok river in Asinan Village and Panjang River in Bejalen and Ngaglik River in Tambakboyo Village. The HECRAS was used the flood analysis. The purpose of this analysis was to determine the flood capacity of the existing rivers using discharge of 5 year and 10 years return period to determine parts of the rivers which are unable to accommodate the occurrence of flood in calculated period. The following is the result of the calculation of the existing river capacity of Panjang river.

TABLE 1. Discharges in Panjang and Siblobok Rivers

No	Panjang River		Siblobok River	
	Discharge	M3/det	DIscharge	M3/det
1	Q_{2yr}	90.720	Q_{2yr}	30.72
2	Q_{5yr}	120.375	Q_{5yr}	44.75
3	Q_{10yr}	136.610	Q_{10yr}	50.78
4	Q_{25yr}	154.014	Q_{25yr}	57.25
5	Q_{50yr}	165.121	Q_{50yr}	61.38
6	Q_{100yr}	174.908	Q_{100yr}	65.02

Following is the result of existing capacity recapitulation of Panjang River. The river longitudinal profile of the existing condition can be seen in the picture. There is a significant difference in height between sections in the riverbed.

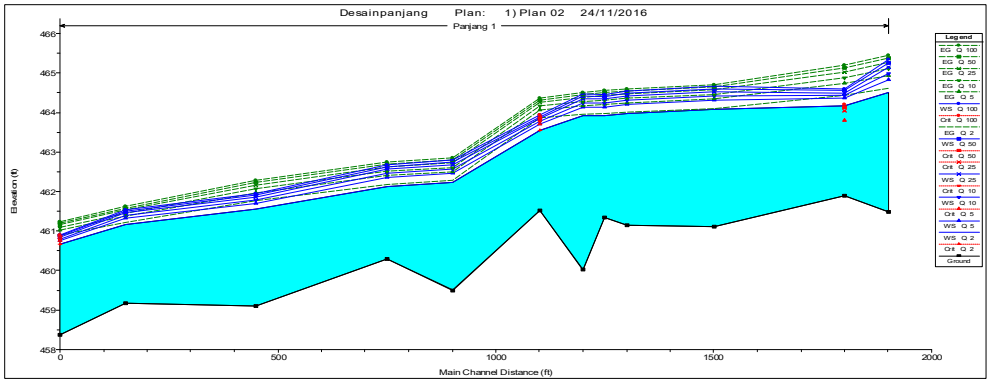

FIGURE 4. Upstream Longitudinal section of Kali Panjang

In upstream area of this river, named RS 10 section or cross B2, the cross section of the river has experienced flooding with return period of Q_{2yr} with water level of +464.07. Q_{5yr} happened at elevation of +464.31. Original ground elevation is +463.78 and existing riverbed is +461.12.

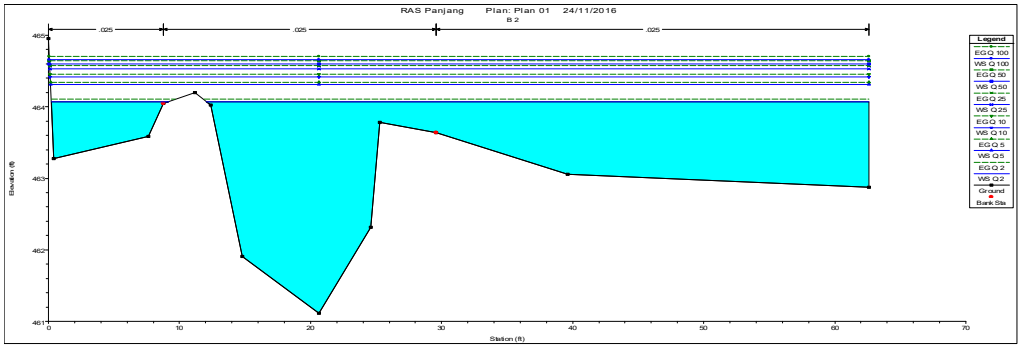

FIGURE 5. Upstream Cross section of Kali Panjang

With the discharge of return period of Q_{2yr} and Q_{10yr}, the river has experienced flooding. This condition will affect the settlement on the right side of the riverbank.

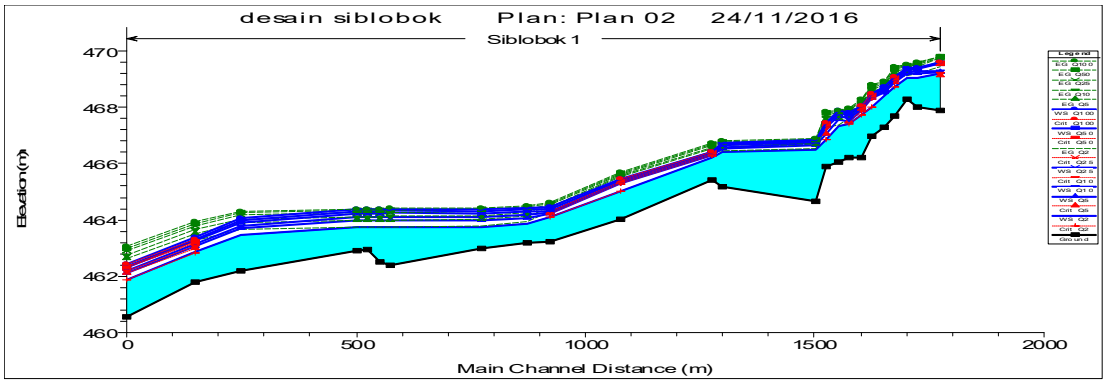

FIGURE 6. Long section of Kali Siblobok

The upstream part of Siblobok River, RS 16 or cross B32 section, the river cross section has experienced flooding with water level Q_{10yr} at elevation of +468.06 with original embankment elevation of +468.00nand exiting riverbed of +466.05

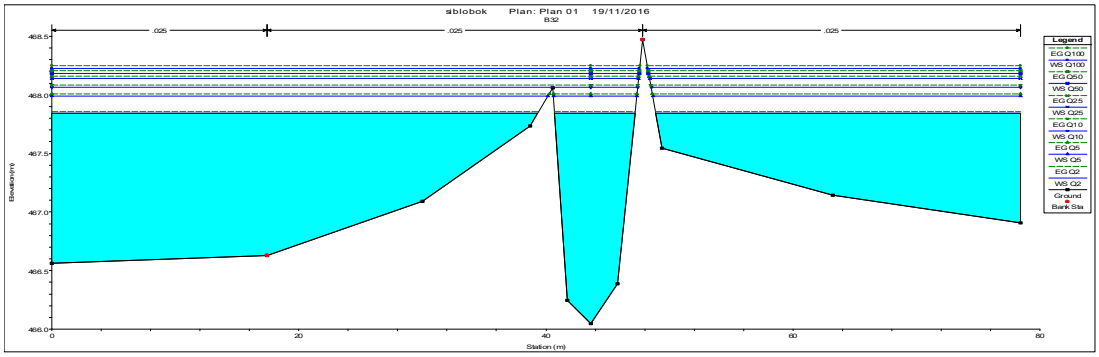

FIGURE 7. Cross section of Kali Siblobok

In Panjang River area in Bejalen Village, flood discharge of 10 years return period, it can be seen that all sections are flooding. It can also be seen from the calculation result where the water level is higher than ground elevation. In Siblobok River, the flood occurrence within 10 years return period discharge is named B32 with length of 100 m has experienced significant rise in water level. Based on the calculation result, the design of dikes will be using the discharge of return period 10 years and the flood management design uses two ways, such as: [13] [14]

1. Excavation of the rivers is to increase their capacity
2. Dike as flood protection for residentials area.

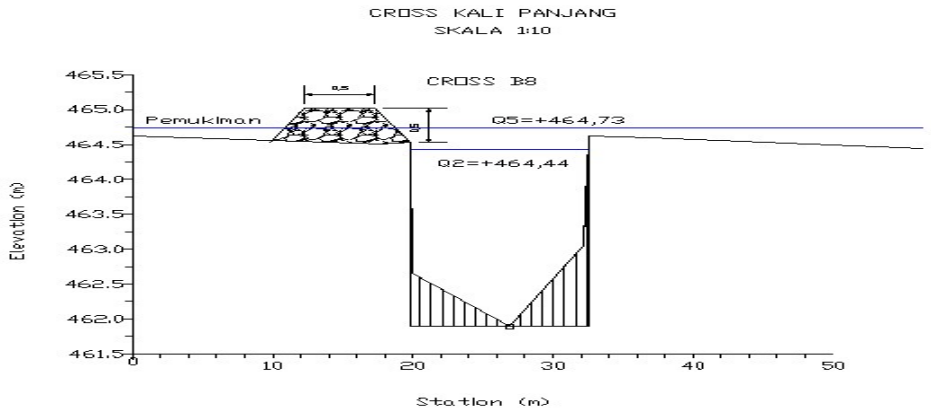

FIGURE 8. Dike protection Design in Panjang River

The dimension of the dike as flood protection of residential areas is 0.5 m and 0.5 m tall

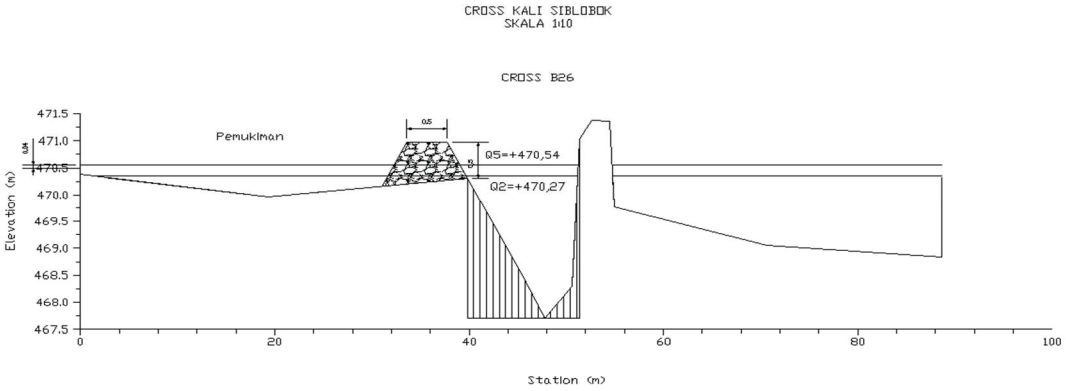

FIGURE 9. Dike Protection Design in Siblobok River

B. Zoning of Rawapening lake buffer area

Identification of land cover in Rawapening Lake buffer zone is based on the interpretation of aerial photo view by identifying the existing land coverage. It is very useful to determine the maximum flood risk, so the effort can be made to organize and plan the area surrounding Rawapening Lake [15] [16]. Zoning is also to ensure the sustainability of Rawapening Lake environment. The Rawapening lake buffer zone consists of two zones which are green belt and flood plain exposure. The zoning of water utilization consisted of fisheries, tourism, hydroelectric power plan and springs.

TABLE 2. Land Coverage in Lake Rawapening Buffer zone [17]

No	Category	Width (Ha)	%	Description
1	Rice field	730.09	66	Below the elevation of +463,3 toward the water
2	Housing	15.58	11	Below the elevation of +463,3 toward the water
3	Grass	16.41	5	
4	Forest	31.77	18	
	Total	**103.64**	**100**	

The management will be arranged for settlement around the lake, Kampung Rawa Restaurant (which is a famous restaurant by the lake), and the road network

FIGURE 10. Settlements in Rawapening Lake buffer limit

Meanwhile settlement Settlement management in Rawapening buffer zone area are as follows:

1. Alternative 1 all settlements in Rawapening buffer zone area will be relocated especially those with no permits [18].

2. Alternative 2 relocation of the settlement areas, which will be done by local government [19]. However if the settlements do not have permits there will be review of the land rights and also there will be high taxes given. The relocation can used unproductive land. [20]
3. Alternative 3 the settlement in lake buffer zone area especially in flood plain area will use stilt house design.

However, there already has existed Kampung Rawa Restaurant which was built adjacent to the lake, which was illegal because it is located inside of the buffer zone limit of Rawapening lake. The Restaurant buffer zone must be managed.

FIGURE 11. Kampung Rawa in Buffer zone limit

Kampung Rawa management in Rawapening buffer zone area should be as follows:

1. Alternative 1 Wisata Kampung Rawa will be relocated from lake buffer zone area [18]
2. Alternative 2 Relocation of Kampung Rawa will be acquired by local government, as well as giving incentives. The land has with no permit, so there will be review of the land rights and high taxes may be applied [20].
3. Alternative 3 The relocation can used unproductive land [21] such as agricultural land that is not technically irrigated, and dry land or unirrigated marginal rice farming land.

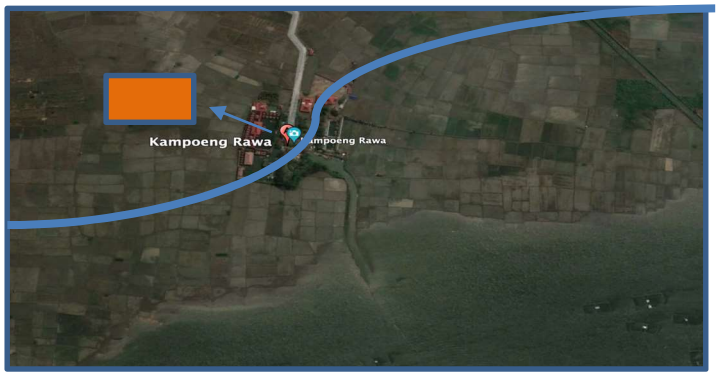

FIGURE 12. Alternative relocation of Kampung Rawa

Road network management in Rawapening buffer zone area:

1. Alternative 1 Improving the existing road network by increasing the elevation of the road from the highest flood elevation. It is aimed to protect the road from flooding. This will be done in all type of road class such as district road, village road [20].
2. Alternative 2 Improvement of road infrastructure can be done with the main priority of roads that connected between sub districts. The main road that surrounded the lake can be used as flood evacuation route when flood disaster shall occur [20].

CONCLUSION

The determination and the zoning of Rawapening Lake buffer zone is important as the basis of the lake management to obtain sustainability of its function. Because lake is one of the most valuable water resources on earth, in managing Rawapening Lake it is important to involve all sectors as its users. Lake management is the responsibility of all sectors especially the users of the sectors. In Rawapening Lake buffer zone management, the government should take initial action in making the regulation and then implemented into a real action along with the involvement of other sectors. Community as the valuable asset should be involved also in Rawapening lake management.

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