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## Morphoconservation analysis on Kali Garang as a river conservation effort

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**Abstract.** The main problem of Kali Garang is that when there is rain in the upstream area there will be a flood. The high population growth in the upstream area cause problems waste, erosion and sedimentation. The purpose of this study was to find out the community's concern for the river and apply morphoconservation analysis for river utilization, protection and preservation. The research was carried out on the banks of the Kali Garang at the upstream, middle and downstream sections. The data were collected through observation, interview and measurement. The analysis data used was morphoconservation analysis. Morpho aspect analysis was based on upstream, middle and downstream regions. While the conservation aspect is based on activities of utilization, protection and preservation. Community care for the river is good enough. The existence of village work activities is a form of river care. In the upstream, the concerned people utilize the river for their daily needs. In the middle, there is no utilization activity because of its large flow and its location far from the settlement. Downstream area is used for mining with the reason that it is an effort to protect the river from silting. River conservation must be carried out together in order to create a sustainable river.

### 1. Introduction

In Indonesia have 5,950 watersheds. 70% of Indonesia's rivers are polluted. Central Java is one province in Indonesia with 128 watersheds, 35 watersheds are in critical condition and are urgently needed to be handled. Almost all critical watersheds have the same problem, namely changes in upstream land management to areas along the river flow. Garang watershed is one of the critical watersheds in Central Java.

The main problem of the Garang watershed is that in the upstream watershed there has been a rapid change in residential and industrial land use. Besides that, there was an erosion process on the cliffs of the Kaligarang River due to a heavy scouring of water, amounting to 53,001 tons/ha/year, so that the Garang River sedimentation was predicted to be 124,944.13 tons/year. The sedimentation condition has exceeded the sedimentation tolerance value for Garang River, which is 26,426.36 tons/year [1]. Setyowati, et al said that tingkat kesadaran masyarakat Kali Garang masih rendah dalam memanfaatkan, melindungi, dan memelihara sungai [2]. According to Willem (2015), generally the problem in water resources management are floods, droughts, deforestation, erosion, sedimentation and development of urban areas.

Upper Garang watershed has a very important and strategic role in the lives of the people at Semarang and Semarang districts. Flood events characterize the Garang river. Floods usually occur when the rain come with high intensity or the occurs of rain more than one hour. Menurut Suhandini in Setyowati [2] the flash floods events had occurred in 1963, 1990, 2000, 2002, 2008, and 2010. The flash floods in 1990 was the worst flood event. The flood drowned the surrounding and surrounding areas with water levels reaching 2 meters and the water flow reaching 942 m<sup>3</sup> / second. The flash flood killed 47 people, 25 houses collapsed, and 126 houses and 5 public facilities were damaged.

The emergence of critical land in DAS Garang is caused by many factors, one of which is the management of land that is not in accordance with the conditions of the land. Based on data from the



2014 Garang Watershed Management Action Plan the area of critical land in the upper Garang watershed reaches 1,190.89 ha where 1,002.31 ha is outside protected areas.

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The damage to the Garang watershed is caused by human intervention in inappropriate land management activities resulting in a decrease in land conditions in the Upper Garang watershed. Increasing the population in the Garang watershed area has resulted in increased land for settlements and agriculture. Decreasing green land results in reduced water catchment areas. Increasing residential land will also reduce land use for farming. This condition forces farmers to use land that is not suitable as a farming place to be a place of farming activities, such as land located on steep slopes and very steep. Farming land which has limitations from physical aspects. If land management is carried out improperly, it can accelerate damage to farming land. Increased housing area will be followed by changes in other land uses, such as reduced forests, mixed gardens, open land and agricultural land [3].

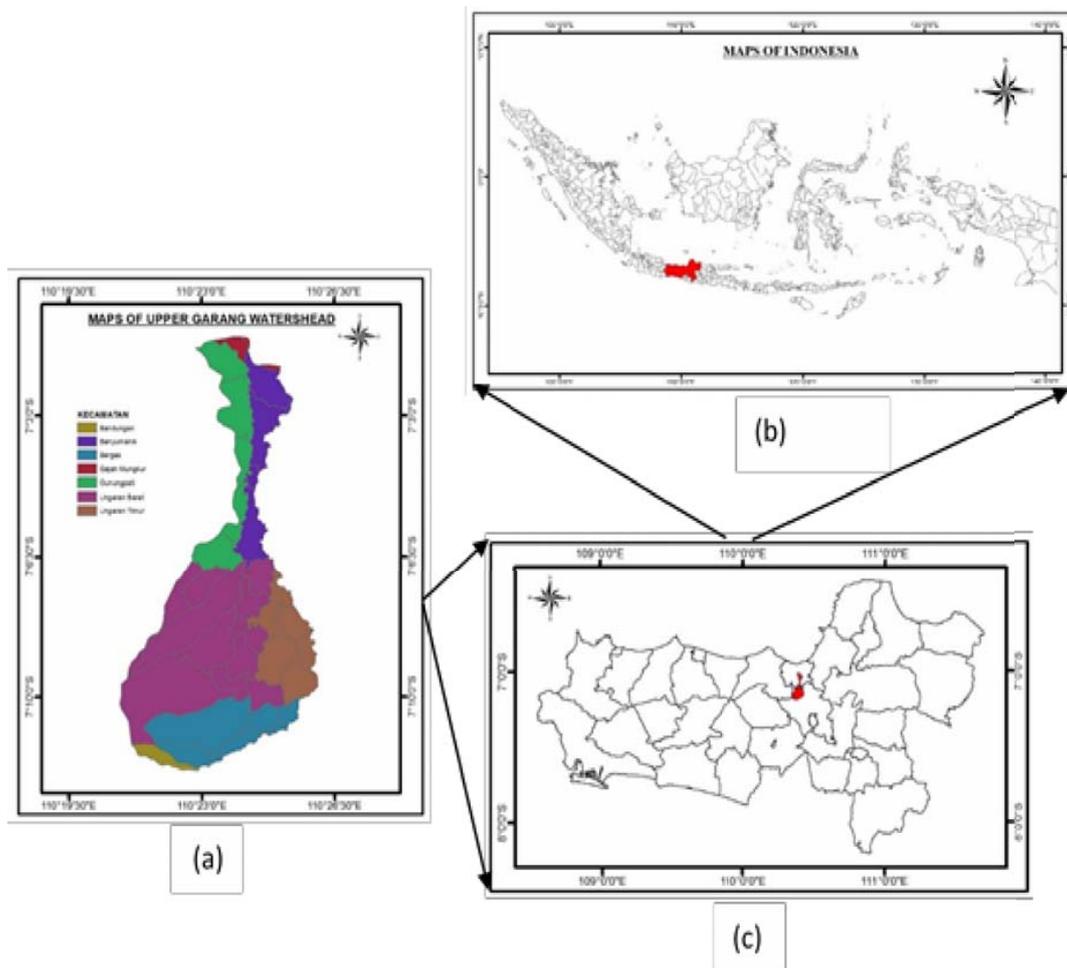
The emergence of a variety of problems is not only caused by natural factors, but also the factors of humans who do not have the awareness to maintain the river. To develop the realization and awareness of river conservation, community activities and the current conditions of the river area need to be explored and integrated into the community in conserving rivers. Based on the current condition of Garang River which has damage to river water quality needs to be addressed through conservation efforts, one of which is through morphoconservation. These activities can be realized in the form of ideas, ideas and processes in the effort to conserve natural resources, especially conservation of the Garang river region.

The role of the community in maintaining river areas is very important. The emergence of caring behavior of the river must be realized starting from the awareness of the people who live in the watershed area in managing household waste. Awareness of maintaining and preserving rivers must be educated to the community from an early age. In addition, the role of the government in facilitating the community in business and conservation efforts must be done well.

The aim of the study was 1) to determine the community's concern for Garang river including attitudes and behavior in maintaining river cleanliness, 2) to determine the river morphoconservation efforts that have been carried out by the community

## 2. Methods

Research carried out in the Upper Garang watershed covers the upstream, middle and downstream sections (Fig. A). Observations were made at the observation points scattered in the Upper Garang watershed area. The sample locations were 16 observation points spread throughout the watershed area. Determination of sample location points using *perposive sampling technique* taking into account the area of the watershed, the order of the river, the shape of the land, and the distance to the location of the settlement. These considerations it aims to find out secera can accurately represent all the existing conditions of the river basin.



**Figure 1.** Maps of The Research Location

Morphoconservation means morpho landform (BL) and conservation (Utilization, Protection and Maintenance). The morphoconservation analysis technique is an analysis technique that combines Morfo analysis and Conservation analysis. Morpho analysis can describe the results of observations based on upstream, midstream and downstream with consideration of the terrain, slopes and river order. Conservation analysis is an analysis of conservation efforts carried out by communities living in the river area around the location of the observation which includes utilization, protection and maintenance. Morphoconservation analysis describes the condition of the river and conservation efforts carried out by the community around the river observation site.

Morphoconservation analysis techniques can be formulated into:

$$Mf = f [ BL , U , P , M ] \quad (1)$$

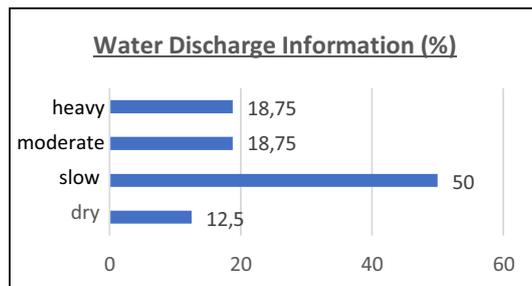
Information: MF= Morphoconservation; BL= Form Land; U= Utilization; P= Protection, M= Maintenance

### 3. Results and Discussion

In general, the physical condition of Garang river began to be well organized. This condition is evidenced by the building check DAM, warning board and appeals do not dispose of waste, and build embankment and concreted banks of several locations observation. At some points of observation the Garang River condition can be said to be poorly maintained or tend to be damaged. Factors that cause development activities and human activities that cause these problems. Disposal of household waste in the river is normal. This condition is exacerbated by the absence of the role in the local government in dealing with the problem. People assume that they do not need to care because they do not wear.

#### 3.1 Water discharge

Water discharge is the volume of water flowing through a cross section of a river carrying river material measured per unit time, in units of m<sup>3</sup> / second [4]. Observation of debits is done by simple measurements. That is by using a bottle buoy and stopwatch.



**Figure 2.** River Debit Graph Figure

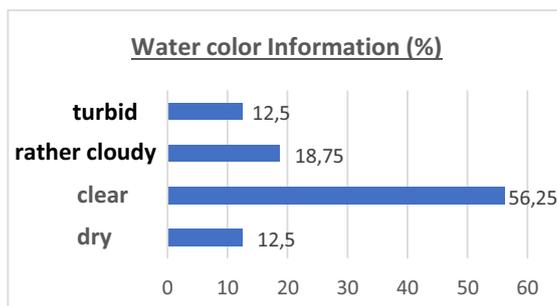
(Source: Data Processing Results, 2018)

**3.** Condition of River Discharge

The condition of water discharge at 16 location observation points shows that in general the water discharge is relatively slow with a percentage of 50% of the 16 observation locations. This condition occurs in areas with relatively flat topography, especially in the downstream area. Dry flow conditions occur in the upstream area with relatively steep topography and dry water sources. The percentage of this condition is 12.5%. Percentage of heavy water flow of 18.75%. The percentage of moderate water flow is 18.75%.

*a. Water Color*

Clear water indicates that the water is in good condition. Water color is very influential in water ecosystems. The clearer the color of the water, the better the water. But on the contrary, if the color of the water is cloudy, it is necessary to manage the water so that the water can be maximized [5].



**Figure 4.** Water Color Percentage Graph

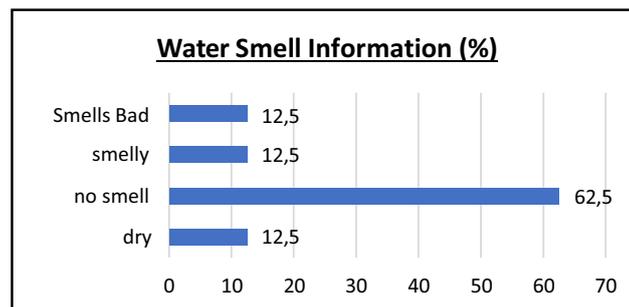
**Figure 5.** River Water Color Conditions

Source: Data Processing Results, 2018.

The dry season greatly affects the color of water. In general, the color of Garang river water in the dry season tends to be clear, but in some observation locations, the water color tends to be cloudy and even black. The condition is caused by human activity and waste littering the stairs Ruma h Garang river resulting flow of water becomes turbid and the color becomes blackish - brown.

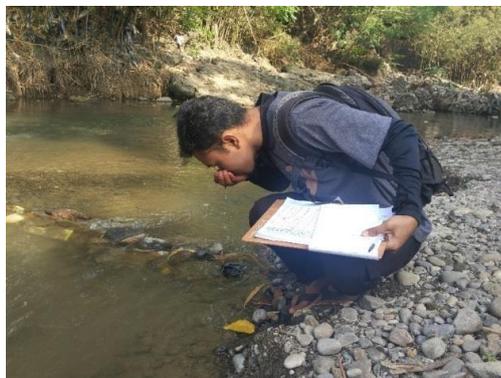
### 3.2 Smell

Smell is one of the parameters in determining water quality. Water quality is a measure of water conditions that can be seen by its physical, chemical and biological characteristics [6].



**Figure 6.** Smell Percentage Graph with Observation Location  
Source: Data Processing Results, 2018.

In general, the Garang river condition does not smell. 65% of the 16 samples of Garang river water do not smell. 12.5% foul-smelling, 12.5% smelly and 12.5% in dry conditions. The smell that arises in water is the result of decay of waste that is disposed of by people who do not care about the river.



**Figure 7.** Checking smell in water

Smelling water shows that the water is not suitable for consumption. The smell of water is caused by the decay of garbage and household waste which is directly thrown into the river. The poor condition of Garang river water can be a serious problem.

### 3.3 Basic Material

Rivers from upstream to downstream have different characteristics. The differences in river characteristics can be seen from river morphology and flow strength. River morphology and flow strength (hydrodynamic) are two controllers in the dynamics of river sediments [7]. Factors that influence sediment dynamics include gravity, river gradients, river discharge, sediment characteristics and the presence of dams or buildings built by humans [8].

Sedimentary material that is incapable or temporarily not carried away by the flow of water will be deposited on the riverbed. Material that settles on the riverbed is called *bed material*. Basic material grains from upstream to downstream of the river will have a gradual pattern of change. The upstream

part of the river will tend to have large base material grains [9]. The more downstream the size of the grain of the basic material will be smaller [10].

The riverbed material affected by the aerial base of the Garang River is divided into four type is land, sand, gravel, and crack. These materials are formed due to the influence of the former activity of old Ungaran mountain.

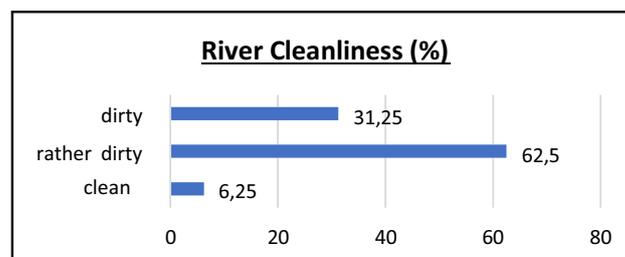


**Figure 8.** Riverbed Material

Some of the communities around Garang River use stone and gravel materials for sale . Mining of rocks and sand is carried out in the downstream area. The community conducts mining in the rainy season. This is done because the quality and quantity of stones and sand is better

#### 3.4 River cleanliness

The cleanliness of the river is a reflection of whether the river is well managed or not. The cleanliness of the river is reflected in the absence of garbage along the river, the flow of water is clear and smellless.



**Figure 9.** Graph of River Hygiene Percentage with Observation Location

*Source: Data Processing Results, 2018.*

In general, Garang River is a less clean river. The habit of disposing of garbage in sungai is a habit that is still commonplace even though some people are aware of the importance of maintaining the river. The existence of a waste bank is one of the efforts made to accommodate the garbage problems of people living in the Upper Garang watershed area. However, the importance of public awareness of the importance of maintaining river cleanliness is still lacking.

#### 3.5 Flood

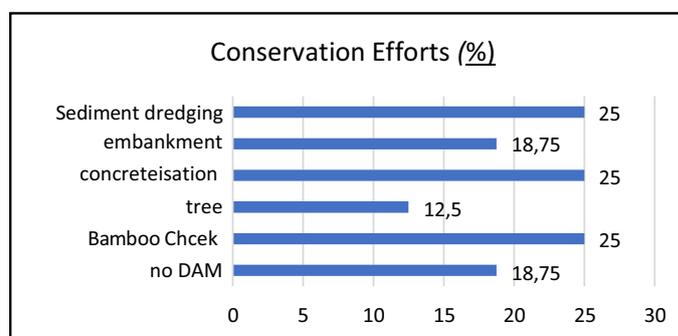
Flooding is an event that occurs when excessive water flows soak the land [11]. Floods in the Upper Garang watershed are runoff floods that occur due to high rainfall intensity and full infiltration capacity [12].

Floods that occur in the Garang watershed occur in two locations, namely in the upstream and downstream areas. Upstream flooding occurs because the watershed area of the upstream area is smaller

compared to the downstream area. The causes of the reduction in river capacity are narrow river conditions, siltation of rivers and the large number of residential housing in the upstream area. Upstream flooding occurs due to reduced green land, poor river network systems and the habit of disposing of garbage in the river. Another reason is that the slope of the slope is quite steep resulting in easy runoff. The Garang river flood occurs in the upstream and downstream areas. Water level between 10 - 100 cm. The worst flooding occurred in the downstream area that occurred in 1990. The upstream flooding had a water level between 40-50 cm. Floods usually occur when the intensity of rainfall is high and the duration of rain is more than one hour. The upstream floods cause flooding in the downstream area. Water level during flooding between 10-100 cm.

### 3.6 Conservation Efforts

The Garang river management that began to improve was shown by the conservation efforts carried out by the agencies and related agencies and the community which were realized with various businesses including the construction of DAM check buildings, river bank concretization and responsibility and several other businesses.



**Figure 10.** Percentage of Conservation Business Graph  
Source: Data Processing Results, 2018.

Conservation efforts carried out by the government or related institutions in the Upper Garang watershed area are among others 18.75% are river bank. Activities, 25% are bank concrete concrete activities, and 25% are DAM check payment activities. Conservation efforts carried out by the community include 25% of the activity of dredging sediments, and 12.5% in the form of planting bamboo trees. Meanwhile, 18.75% of the area there is no river conservation effort.

**Table 1.** Floods, Water Height and Conservation Efforts

NO	Location	Flood	Water level	Conservation Efforts
1	Location 1	Yes	10-100 cm	Dredging of Sedimentation and Tanggulisasi
2	Location 2	Yes	10-100 cm	Pembul Embankment and Bamboo Tree Planting
3	Location 3	Not	0 cm	Dredging of Sedimentation and DAM Checks
4	Location 4	Not	0 cm	Yes no
5	Location 5	Not	0 cm	Check DAM and Betonization Edge
6	Location 6	Not	0 cm	Yes no
7	Location 7	Not	0 cm	Check DAM and Betonization Edge
8	Location 8	Not	0 cm	Sediment dredging and concrete edge
9	Location 9	Not	0 cm	Check DAM and Betonization Edge
10	Location 10	Yes	10-40 cm	Sediment dredging, Concrete edge
11	Location 11	Yes	10-40 cm	Yes no
12	Location 12	Yes	10-40 cm	Embankment

13	Location 13	Yes	10-40 cm	Yes no
14	Location 14	Yes	10-40 cm	Sack Embankment Contains Sand
15	Location 15	Yes	10-40 cm	Bamboo Tree Planting
16	Location 16	Yes	10-40 cm	Concrete edge

Source: Data Processing Results, 2018.

### 3.7 Community Concern for the River

The assessment of the awareness of the people living on the banks of the river was carried out by using an observation sheet to determine the attitudes and behavior of the community in river conservation efforts which included efforts to maintain the cleanliness of the river through not disposing of garbage, family environmental sanitation and family waste management.

**Table 2 .** Community care in river conservation

No.	Score	Criteria	F	Percentage
1.	26,0 - 30,0	Very high	4	15%
2.	21,0 - 25,0	High	7	27%
3.	16,0 - 20,0	Is being	9	35%
4.	10,0-15,0	Low	6	23%
$\Sigma$			26	100%

Source: Data Processing Results, 2018.

Based on the results of data processing, it can be seen that the level of concern of the people of Garang River is mostly moderate, with a percentage of 35%. Community awareness at a low level of 23% is due to the habit of residents who still dispose of litter and do not use existing waste banks. The level of concern of the Garang river community which is included in the high category is 27% and very high at 15%.



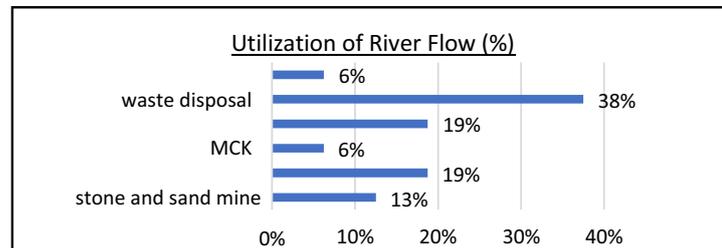
**Figure 11.** Private Smash Place

One form of community concern for Garang river is not to dispose of garbage in the river. The form of activity is by having a private trash can and a garbage bank that picks up trash from every house.

### 3.8 Community Role in Conservation Efforts

#### 3.8.1 Utilization

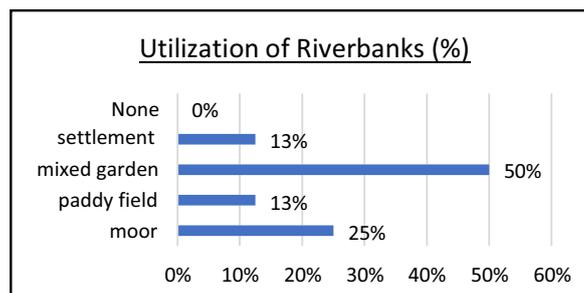
The use of Garang River in general is for household waste disposal. This is certainly a serious problem and must be addressed.



**Figure 12.** Graph of Percentage of Flow of Utilization

Most people still use the Garang river to waste, which is 38%. Furthermore, other river utilization activities include; 19% for irrigation activities, 19% for fishing, 13% for rock and sand mining, and 6% for MCK activities. Of all existing activities, rock and sand mining, irrigation and fishing are activities that do not damage the river.

Utilization of the riverbanks for businesses mixed garden is one of the riverbank protection efforts. Mixed gardens can prevent erosion occurring in the river basin. Agricultural activity is one of the utilization activities that can accelerate the rate of erosion. Agricultural crops has roots that are less strong so erosion can occur easily.



**Figure 13.** Graph of Percentage of Expenditure Utilization

Utilization of riverbanks in the form of mixed gardens and moor is the activity that dominates the use of the Garang River. 50% of the Garang river river is used for mixed gardens, 25% for dry fields, 13% for settlements, and 13% for rice fields.

### 3.8.2 Protection

River protection activities in the Garang watershed area, especially around the banks of the Garang river, are still very few, but efforts to protect Garang river have started.



**Figure 14 .** Their's private trash at home

The problem in the Garang river protection activity is the lack of good coordination between the government and the community. Communities sometimes do not know about the existence of extension activities or such activities whose destination is the protection of the Garang River . Communities sometimes carry out their own service in accordance with the awareness of each house in protecting and maintaining the river .

### 3.8.3 Maintenance

One form of maintenance for Garang River is river clean and sediment dredging. The activity of dredging sediments in the downstream area has become their livelihood. The results of dredging of sediments in the form of rocks and sand they can sell or they use themselves as building materials. Other river maintenance is concreteisation of river banks, building check dam and planting of hard plants such as bamboo is an effort to reduce and inhibit the flow of water so it does not get too tight so that erosion can be reduced.



**Figure 15 . DAM Check Building**

### 3.8.4 The condition of the Garang watershed

The uneven Garang river management, low awareness of river care and the habit of disposing of garbage in the river is a problem that must be handled together. The condition of Garang river which is not good at some observation sites is a top priority in river management.

**Tabel 3. Garang River Condition**

NO	Location	Part	Debit	Water Quality		Basic Material	Utilization	Conservation		Conservation Effort
				Color	Smell			Protection	Maintance	
1	Location 1	Downstream	Slowly	Clear	Smelly	Soil, Sand, Gravel	Yes	Yes	Yes	Good
2	Location 2	Downstream	Rather Slow	Slightly Cloudy	No Smell	Gravel, Cracks and Sand	Yes	Yes	Yes	Not Good Enough
3	Location 3	Downstream	Slowly	Clear	No Smell	Gravel, Cracks and Sand	Yes	Yes	No	Not Good Enough
4	Location 4	Downstream	Rather Slow	Clear	Smelly	Gravel, Cracks and Sand	No	No	No	No Good
5	Location 5	Middle	Slowly	Turbid	Bad Smell	Soil and Batuan Kompak	Yes	No	No	No Good
6	Location 6	Middle	Heavy	Clear	No Smell	Gravel, Cracks and Sand	Yes	Yes	Yes	Good
7	Location 7	Middle	Heavy	Slightly Cloudy	No Smell	Soil, Gravel, Sand and Cracks	Yes	Yes	Yes	Good
8	Location 8	Upstream	Heavy	Clear	No Smell	Gravel, Cracks and Sand	Yes	Yes	Yes	Good
9	Location 9	Upstream	Slowly	Clear	No Smell	Sand and Soil	No	Yes	Yes	Good
10	Location 10	Upstream	Rather Slow	Clear	No Smell	Gravel, Cracks and Sand	Yes	Yes	Yes	Good

11	Location 11	Upstream	Slowly	Clear	No Smell	Soil and Cracks	Yes	Yes	Yes	Good
12	Location 12	Upstream	Slowly	Clear	No Smell	Soil, Sand, Gravel	Yes	Yes	Yes	Good
13	Location 13	Upstream	Dry	Dry	Dry	Soil, Gravel, Sand and Cracks	Yes	Yes	Yes	Good
14	Location 14	Upstream	Dry	Dry	Dry	Soil, Gravel, Sand and Cracks	Yes	Yes	Yes	Good
15	Location 15	Upstream	Slowly	Turbid	Bad Smell	Sand, Gravel and Cracks	Yes	No	No	Not Good Enough
16	Location 16	Upstream	Slowly	Slightly Cloudy	No Smell	Soil, Gravel, Sand and Cracks	Yes	Yes	Yes	Good

Source: Data Processing Results, 2018.

In general, the condition of Garang River is included in good condition. The results of the study showed that 10 research locations were well managed. 2 observation sites experienced poor river management. The cause of the problem is the poor condition of the river and no conservation efforts carried out by the community. The conditions at the 4 points of the observation location showed no good. The cause of the uneven management of rivers is the low public awareness in maintaining and preserving rivers.

#### 4 Conclusion

The level of public awareness of Garang river is still very low. The role of the community in maintaining and maintaining the river is still lacking. The habit of disposing of trash and waste in the river stream is a natural thing assuming that the waste will disappear carried away by the river when the rainy season comes. Some caring people are people who still use the Garang River. The people around Garang River who care about the Garang River believe that the Garang River has benefited life. The upstream part is the catchment area and rainwater infiltration which should be used in the village spatial planning for conservation areas. River maintenance and protection are two important concerns in river conservation activities. Prokasih program (clean river program), counseling on awareness of maintaining Garang river is a program that needs to be implemented in an effort to increase public awareness in maintaining rivers. The application of morphoconservation efforts is one form of conservation that can be carried out in accordance with the Garang River conditions in the area.

#### Acknowledgement

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