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REVIEW OF THE NATURAL PHENOMENON AND HUMAN INTERVENSION THAT AFFECT THE CONDITION OF RIVER PERFORMANCE AND INFRASTRUCTURE

Tommy Kurniawan[a], Mohammad Bisri[b], Pitojo Tri Juwono[b], and Ery Suhartanto[b]
[a]Doctoral Program in Department of Water Resources, Faculty of Engineering, University of Brawijaya, Jl. MT Haryono No 167 Malang, Indonesia, email: tommy_ccme@yahoo.co.id
[b]Department of Water Resources, Faculty of Engineering, University of Brawijaya, Jl. MT Haryono No 167 Malang, Indonesia, email: mbisri@ub.ac.id, pidiaa@yahoo.com, erysuhartanto@yahoo.com

Abstract
The river ability in flowing water has been there naturally. The benchmarks of river ability in carrying out the function is mentioned as the river performance, however the benchmarks of river infrastructure ability in carrying out the function is mentioned as the river infrastructure performance. This study intends to review some aspects on the previous researches that are inter-related to the river performance and infrastructure. The study is conducted on Babon watershed, Indonesia. The methodology consist of data secondary collecting, literatures, and data analysis. The analysis performed with Digital Elevation Models (DEM) was conducted to obtain some aspects which have been proved influencing the river performance and infrastructure. The physical condition of the watershed will determine the physical condition of the river where both are part of the hydrological cycle that has been running for a long time. The result shows that there are four categories as follows: technical aspect (river, infrastructure, flood) that was calculated by DEM as well as spatial aspect (land used and covered area), social aspect (residential density, human activity, and loss impact), and legal aspect. These aspects have not been found in previous research or even in legal document**.**

Keywords: river performance, river infrastructure performance, Digital Elevation Models (DEM), Babon

摘要

关键词:

I. INTRODUCTION

Indonesia has abundant nature resources including water. Nature and water resources are are highly needed for supporting all the life aspects. One of the water resources that is often met in Indonesia is river. Based on the Indonesian Government Rule No. 35 (1991), river is defined as places, containers, and water flowing network from water spring until estuary that is in the right and left side and along the flowing limited by boundary line. Broadly, river can be defined as a limited long basin where becomes as the water flowing place from high place into low place.

As water recources that becomes as one of the spciety main demand, the river has to be well maintained and treated wholly without causing a loss for the society. According to Adam [1], river that is poorly maintained can cause the disaster and there is happened the decreasing of river function value. However, it is caused by poorly citizen's awareness that will be decreasing the river performance overall. Therefore, the determination of criteria design and performance index are very important in helping to assess the river performance due to the means and infrastructure including the water structure along the river.

River is functioned as the means to store water and naturally flow from upstream to downstream. Based on its water spring, the rivers in Indonesia including the rain river because the water spring of river is come from the rainfall. After dropping in land by the precipitation process, the water will flow as the run-off and part of them seep into soil through the infiltration process. This is as the natural cycle that has accordingly happened in the hydrological cycle. However, if it is categoried based on the water volume of river, so the rivers in Indonesia including the periodical river which the water volume of river overflow on the rainy season and drying up on the dry season.

River as natural resources means that is in nature, however, by the development of the times, it is directly or indirectly influenced by human intervention. The condition of watershed very affects to the soil ability and river in absorbing and flowing water. The watershed that is still covered by vegetation and the slope is well maintained will has good river performance. Watershed which the land use has been affected by more development and only has less vegetation in its area, will affect bad river performance in water availibility as well as river ability to store and to flow the water. The land use change will trigger the change of river type due to the mediais not too enough to absorp water that causes the increasing of run-off. Therefore, the condition of river and surrounding it will produce the different impact in affecting the next hydrology cycle until the water reaches the estuary.

According to Triadmodjo [2], hydrology cycle is a process of water moving continuously from earth towards atmosphere and then it is back again towards earth. The hydrology cycle is started by the water evaporation to the air. The evaporating water then experiences the condensation process on air and then it forms lumps that is known as cloud. The cloud will become as rain through the process of precipitation and taking water towards the earth, as presented in the Figure 1. The hydrology cycle has been introduced for a long time through some researches that have been carried out by the hydrology expert. A cycle that illustrate the beginning of rain, the process of rainfall, etc until it is back to evaporate to air is happened naturally.

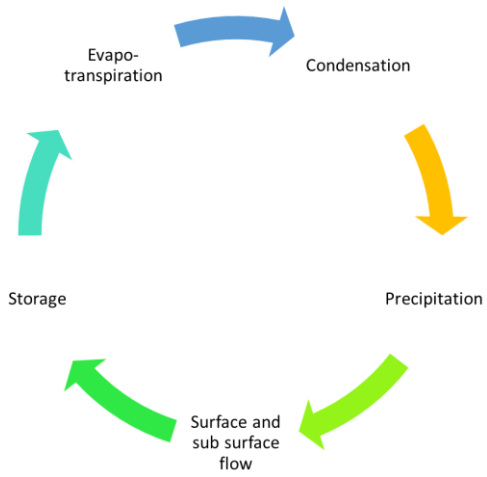

Figure 1. General hydrology cycle (concept modification)

This study aimed to find relevant aspects to evaluate the river performance and its infrastructure by utilizing DEM on Babon Watershed. These aspects are highly recommend to maintain the river for its performance.

II. MATERIAL AND METHOD

The methodology consist of literatures and data analysis. The data used in the study were secondary data which inter-related to the performance of river and infrastructure.

A. Limitation of Study

Limitation of this study consist of : 1) concept evaluation of performance methods used to develop in this study were the common methods implemented in Indonesia, such as evaluation of infrastructure of irrigation. 2) method of this study base on previous research, secondary data, and legislation of legal aspect. 3) the study is conducted on Babon Watershed, Indonesia. This location chosen due to data availability. 4) this study tries to combine several disciplines related to river management, such as water resources science, geography science, and social science. It is very important to find some physical aspect of the river performance and infrastructure. Utilization and quality of river water are not included in this study. 5) data analysis from spatial data by using DEM dan mixed method (quality and quantity analysis).

B. Data Collecting

The methodology is to collect previous research, secondary data, and legislation of legal aspect. In this study, the factor that is related with the physical and river function performance will be selected and collected. The main subject in this study are some aspects that affected the physical performance and functional performance of infrastructure. The research locations are rivers in all of the world that have been carried out the research there about the aspect that affects to a river condition. The secondary data is minimal one sample for the factor or aspect that can affect the physical and river functional performance. Some aspects are classified in two categories such as technical and non technical aspect.

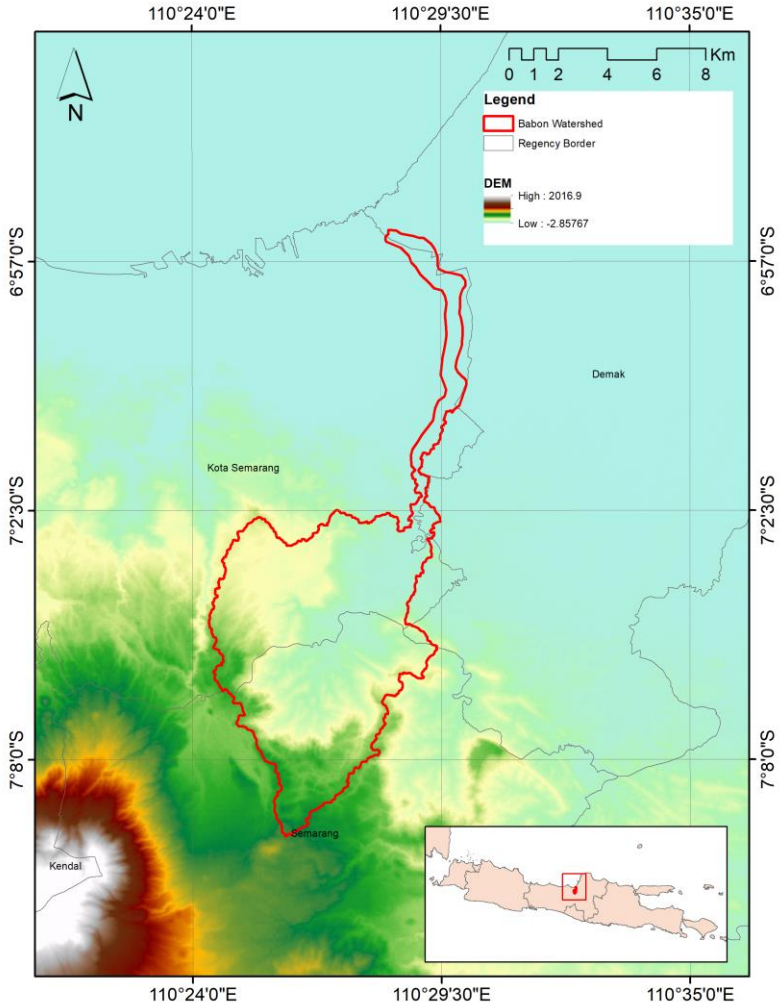

Figure 2. DEM of the research area (source : BIG data (open source) modification)

C. Technical Aspect

In this study, technical aspect means the aspect which has technical characteristic or aspect that is related with river physics and directly affect the physical as well as functional river performance. It means that the aspect can be related with the river capacity as well as affect the discharge on the river, as when the river flow and success in storing water is affected by how big the river capacity and sedimentation in the river bed. The technical aspect is as the impact from the natural situation of a river that was received from digital elevation model (DEM) data which had been obtained from Geospatial Information Agency (BIG). The DEM of the research location as shown in Figure 2.

D. Non-technical Aspect

Non-technical aspects are some aspects that out of the category of technical aspect such as the aspect that indirectly can affect the physical as well as functional river performance. The non-technical aspect is basically as an aspect that come from out of the river. The aspect can be related with the social or culture condition in surrounding or along the river like when the river function in flowing water is hampered by pile of trash on a part of the river. The trash is not naturally in the river, however it is caused by the social behaviour of the population in surrounding river. The non technical aspect can be as the effect of human intervension. The other aspect are spatial and legislation of legal. The spatial aspect means indirectly can affect the physical by sorrounding the river area.

III. RESULT AND DISCUSSION

Nowadays, the development progress and the human activity give the effect in the hydrology cycle, mainly on the change of watershed condition from upstream to downstream which will give the different impact in hydrology cycle.

The happenning process of rain, run-off, and infiltration are affected by the land cover due to the human activity. There are much area in the upstream has been function changed so the water is more overflowed than being absorped through the infiltratin process. It is happened regarding with the research result that is carried out by Adhi [3] which expressed that the increasing of human activity and population growth is compared straight with the load that is taught by the soil. The increasing of human activity will be increasing the level of land slope stability.

The other impact of human activity is as has been researched by Weng *et.al.* [4] which expressed that the effort of back greening (to restore the forest function) affected the groundwater absorption and a lot at least the run-off. It can cause the positive or negative effect on the hydrology cycle mainly in the river.

The river quality is also affected by the behaviour of population at surronded it. The population behaviour in maintaining water availibility and usage is very affected by the strengthern or leadership from a formal or informal community [5]. Along by the increasing of human activity that affects the hydrology cycle, the effort as well as the community very affected the hydrology cycle that towards the positive or negative direction. There are many things that are made by human for managing the watershed and the environment, but the handling has not still intergrated mainly in operation and maintainance of river, mainly about the determination of land use that during the time it is based on the administrative map – interest factor, absorption well making. That is shown that how big the government role in surrounded river.

Besides it, the indicator shift of baseflow that is as one of the development impact is which an intermitten river (river type or condition where the river flow or discharge of river is in the stable condition without being significantly affected by climate or seasonal change), is changing as perenial river (the condition that the river flow or the discharge of river is significantly up and down based on the climate or seasonal change).

The banchmark to the river ability in carrying out the function is mentioned as the river performance, however, the banchmark to the ability of river infrastructure in carrying out the function is mentioned as the river infrastructure performance. Along with the time, human carries out some changes to the river and environment at surrounded it so it is influencing the river and infrastructure performance. Some previous researches have been carried out to study the aspect that affects the river performance separately. However, the river performance can only be determined by the river condition overall. The river performance cannot be said good or bad based on the one or two aspect that affects the river. The river performance can be determined after the river is reviewed overall from upstream to downstream by using the whole aspect that affect the river condition. For example, a river is flooding due to the erossion in the upstream and sedimentation in the downstream, and then causes the inundation in the boundary line that is used as the residential area. The aspect that causes the river flood consists of the aspects of erossion, sedimentation, and residance density. In the other

word, the river flooding is as the impact of bad river performance condition. The condition of river performance becomes bad not only being caused by one aspect, but by some aspects [6].

In the previous research, the researchers have proved some theories about the effect of some aspects to the functional and infrastructure-means of river performance. Sequentially, the aspects have separately described the slope, river morphology, infiltration, erosion, sedimentation, vegetation at the surrounding river, land use, residence density, trash, operation and maintenance of river, human activity, and government policy. This hierarchy is adopted from the geomorphological perspective development (Passarge, 1914; International Geography Union (IGU), 1968; Verstappen and Van Zuidam, 1991). These first five aspects require a digital elevation model (DEM) that will be generated to digital terrain model (DTM) and digital surface model (DSM) for extracting the physical profiles or identify the at-risk elements for other mentioned aspects (Japitana et al., 2019 [7]; Terekhov, 2019 [8]; Trihatmoko et al., 2019 [9]). The DEM also functioned to assess those five related physical aspects precisely and those aspect are included in the technical aspect.

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A. Erossion

The landslide in the part of river can be caused by two things that are the hydraulic flow that burdens the channel so that it causes the erossion and aerial erossion due to the channel that is not too strong to hold the flow which transports the material. This is very depended on the rainfall intensity and soil strength in surrounding river in holding the flow discharge as well as the material that is transported by the flow [10]. Yusoff [10] is also explained that the erossion will be closely related with the sedimentation and it causes the problem that is inter-related from the upstream to downstream. Through DEM data, the hillshades can be detected as well as the flow direction (Figure 3). Based on this explanation, this aspect is included in the technical aspect.

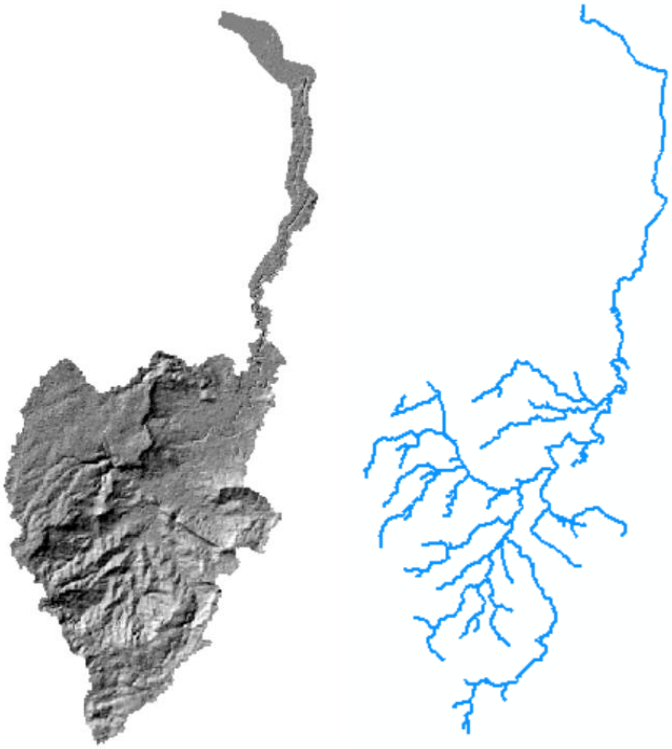

Figure 3. Hillshade (right) and flow direction (left) through river ordo of Babon Watershed (source : BIG data (open source) modification)

B. Sedimentation

According to Lovelock [11], the higher of sediment volume can cause acression and the increasing of Porong river bed. This expression is supported by Yusoff [10] which in his research showed that the erossion that is happened in the river bank will cause the degradation in the part of river trough and it causes the happening of particle flow and sediment enter into the river body. The particles that are in the part of river bed and the particles that come from the river bank will be separated from their group and they are transported by river flow. The particles that are transported will be moved and will be piled up in the downstream part of river. The process of particles transportation will cause the happening

of some technical and environmental problems if thereis not compensated with the well control program on a regular basis. Based on this explanation, this aspect is included in the technical aspect.

C. Slope

The river slope is closely related with the happening of sedimentation and erossion on the slope in the river region. Zhao [12] in her research said that the erossion caused scouring alon 0.5 until 0.8 m per-year, the scouring caused the instability of slope and it affected the mechanism of sediment transport in the river estuary. By conducting 3D slope modeling, the river management judgement can be implemented properly (Figure 4). Based on this explanation, this aspect is included in the technical aspect.

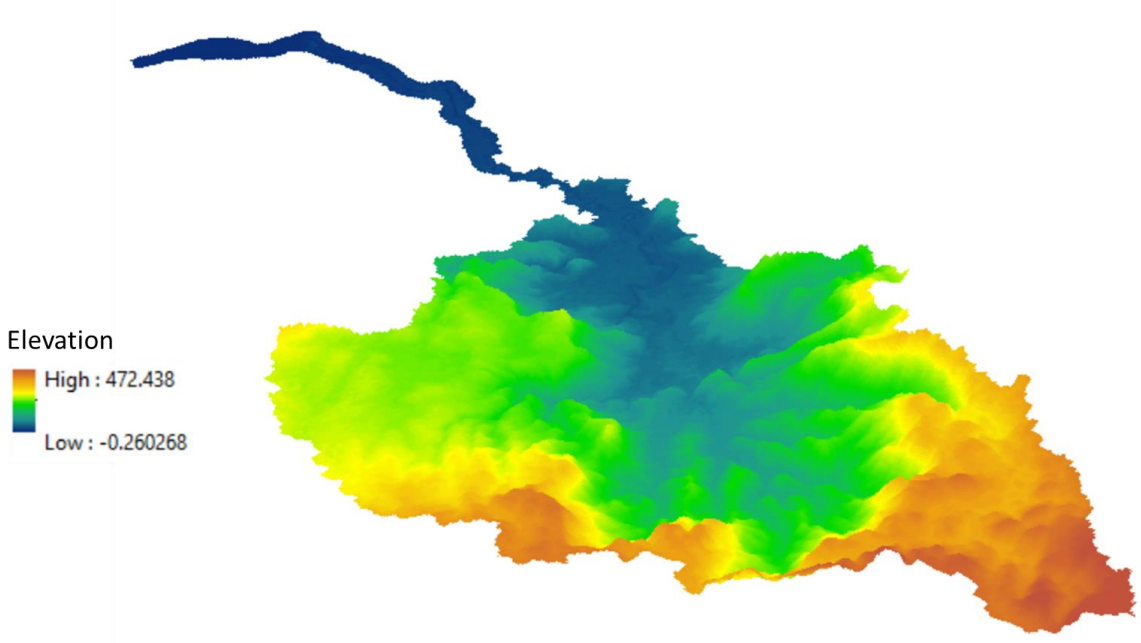

Figure 4. Slope modeling of the Babon Watershed (source : BIG data (open source) modification)

D. Infiltration

Asdak [13] said that the rainfall which seeps into soil in the certain limit will give impact to the water availibility that is produced through the evapotranspiration process. In the dry season, the baseflow can be increased by increasing the velocity of infiltration process and widening the infiltration area. It is proved by the research of Wigati [14]. In her research, Wigati [14] expressed that the more number of absorption well will give impact to the less volume of flooding. Based on this explanation, this aspect is included in the technical aspect.

E. River Morphology

River morphology affects the sediment moving and flow discharge. In the research of Vermeulen [15] said that the happening process of erossion and deposition in Mahakam river is closely related with the sharp meandering in the river. In the river with less meandering, outer edge of river experiences erossion, however inter edge of river is the vise versa. In the river with sharp meandering, there are sediment pile in the outer edge of river and happened the erossion in the inter edge of river. This research supports the previous research which has been carried out by Hodskinson and Ferguson [15] which expressed that the flow on the edge corner of river is affected by the meandering in the river and topography of the river. Based on this explanation, this aspect is included in the technical aspect.

F. Vegetation at Surrounding River

The vegetation at surrounding river affects the physical and functional river performance as being shown in the research of Kalinowska *et.al.* [16]. This research showed that the river region that is natural and full of vegetation can slow down the river flow when the flooding begins to inundate. The vegetation at surrounding river helps in providing a flood capacity in the river section and protecting the river from the erossion risk. Based on this explanation, this aspect is included in the spatial aspect.

G. Land Use

In Natakusumah [17], the decreasing of river absorption capacity is affected by the land use change that is caused by the increasing of surface

run-off rate, mainly if it is reviewed by using the proportional of agriculture area change in the area of upstream Komering watershed. Then, according to Prasetyorini [3], the agriculture and village can affect the slope stability in the Ambang river, mainly in the effort to decrease the quantity of erossion and sedimentation, and the decreasing to the risk of landslide soil disaster. Based on this explanation, this aspect is included in the spatial aspect.

H. Residence Density

The infrastructure of river have each duty and function. The condition of river means and infrastructure can affect the physical and functional river performance. The residence density mainly in surrounding river, very affects the quality of river performance and have an important influence in efforts to conserve rivers. According to Wahyuni [18], the commitment and attitude of the people who care about the river has a very high impact in improving the quality of the environment. Also in the research of Vollmer *et.al.* [19], it showed that the residence density that is not well controlled will increase the risk of flooding disaster in the rainy season and risk of drought due to the lossing of water reserves in the river mainly in the dry season. Besides it, river with good performance quality is marked by there is opened space in the means and infrastructure of river. The flooding area or boundary line area where are full of population residences will increase the risk of healthy problem, water quality, and sanitation damage during flooding. As in the research by Islam [20] with the research location in the flooding area along the Gangga river in Bangladesh, the risk and damage in surrounding river during the flooding, is very high. Based on this explanation, this aspect is included in the social aspect because of sorrounding river.

I. Trash

The available problem of trash in the upstream and midstream of river will be inter-related with the problem in the downstream of river. The research of Clark *et.al.* [21] has reviewed the trash in the downstream of river. The trash slowly causes the abrassion in the coastal area. However the piled up of trash in the coast is caused by the some plastic trash is transported from the river watershed and from the river trough. Also the problem of waste has had a negative impact on the environment, especially on river bodies. It is the same as being research of Oktaliana [22] that a case in the Kakap River that the community has a habit of throwing garbage in the river which is difficult to change because it has become a culture, even though the community uses the river for their daily needs. Based on this explanation, this aspect is included in the social aspect.

J. Human Activity

Human activity in surrounding river can affect the physical as well as functional river performance. Pan *et.al.* [23] said that the human activity is proved to be very affecting the river discharge and the quantity of sediment in the river. The activity in this research means as the intentional activity that is the activities of deforestation and reclamation. The both activities can decrease the sediment in the river bed during 26 years. The more human activities that use the river including the boundary line as well as the river trough, will more increasing the damage risk of flooding. It is the same as being expressed by Pasternack [24] in his research. Pasternack has reviewed about the need of river restoration. Based on this explanation, this aspect is included in the social aspect.

K. Government Policy

Ferreira *et.al.* [25] has researched about the effect of hydrology regulation and land use change to the river morphology. In this research, it has been proved that the hydroloy regulation and land use change effect the form of river morphology which then it is related with the river degradation. Based on this explanation, this aspect is included in the legislation of legal aspect.

The hierarchy aspects is adopted from the geomorphological perspective development and have separately described above. Finally, the explanation proves that river management is inseparable and requires the cooperation of all relevant stakeholders.

According to Anggraini et.al. [26], rivers in Indonesia mainly in Kalimantan are used by society, one of them is used as the means for throwing away the household waste so that it can affect the water quality of the river. It has to be followed with the acitivity of river maintenance for keeping the water quality of river in order to keep clean so that it can be used for some needs mainly for daily life of the society in surrounding river itself. In this case, the Indonesian government has a great role in carrying out the operation and maintenance in the big rivers so that the rivers can be well functioned as before polluting. Beside that maintenance activities of the river can reduce the incidence of flooding. Some times, infrastructure development on rivers is one way to prevent flooding and to protect the impact of flooding.

In order to maintain the river, those aspects are grouped into four aspects which is new way to evaluate performance of the river and its infrastructure.

IV. CONCLUSION

Based on the review and discussion which have been carried out, it can be concluded that the technical aspect that effects the river and river infrastructure performance consists of erossion, sedimentation, slope, infiltration, morphology, and vegetation in surrounding river. The non-technical aspect that effects the river and river infrastructure performance consists of spatial aspect (land use & vegetation), social aspect (residence density, human activity, trash), and legislation of legal aspect (government policy). In evaluating the quality of means and infrastructure river performance, the technical and non-technical aspect has very important effect and inter-related. Due to the technical and non-technical aspect affect the quality of physical, means function, and infrastructure river performance as a unit and it can be evaluated as the individual aspect. Technical and non-technical aspect that effect to the river and infrastructure river performance can be become as a basic reference in implementing the maintenance activity of river. The author suggests for the next research is aimed to develop statistical models of river performance index.

IV. AKNOWLEDGEMENT

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