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DETERMINATION ON VISCOSITY VALUE OF RIVER FLOW AS THE POTENTIAL INDICATORS FOR FLASH FLOOD - CASE STUDY IN SADDANG RIVER

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ABSTRACT

Recent global climate change has turned out to have an impact on the accumulation of high rainfall in a short time. Flash flood is a short flood occurrence in about 6 hours which is caused by rain with very high intensity. This study aims to analyze the value of viscosity as an indication of the potential for flash flood. The form of this research is survey research. This research was conducted in 3 locations on the Saddang River namely Saddang River upstream (Buntu Batu River), Saddang River middlestream (Mata Allo River) and Saddang River downstream (Pekkabata River). The type of test material for measuring viscosity is a bad load sample measuring 2 - 10 cm in diameter and releasing material that is attached to the bad load and then put it in a measuring cup filled with water. Then testing the digital viscometer. Test material for measuring turbidity is in the form of River water samples taken at each point of the study site using 3 tubes with different turbidity levels and measured using a turbidity meter (turbiditymeter AMT 21). Based on the relationship between turbidity parameters, velocity and discharge temperature indicate the viscosity value increase from 97.5 MPa.second (97,500 kg/mm.second) to 203 MPa.second (203,000 kg/mm.second) as an indication of the potential for flash floods in the Saddang River.

Keywords: Viscosity, Flash floods, Saddang River

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1. INTRODUCTION

Recent global climate change has turned out to have an impact on the accumulation of high rainfall in a short time, with relatively the same annual rainfall, but with a short duration will have an impact on increasing the intensity of the flooding that occurred. Natural disasters in Indonesia are also increasingly common now, such as whirlwinds, storms, floods, extreme rain or high intensity rain. In general, flooding is an event where the water in a channel increases and exceeds its capacity.

There are various floods namely; water flooding, tidal flooding, flash flooding, lava flooding, mud flooding. Flash flood is a flood that not only carries water but other materials such as garbage and mud. Usually this flood is caused by a broken water dam, this flood has a higher level of danger. Flash flood is a short flood occurrence in about 6 hours which is caused by rain with very high intensity. This flash flood has the characteristics of the rapid rise in water levels in Rivers/canals. In the process of a flash flood event, a landslide is the first one that is triggered by rain, then a flash flood is the next event as a continuation of a landslide event (Larsen *et al* ., 2001).

Saddang River is located in the Saddang watershed in South Sulawesi Province which covers the administrative area of Enrekang regency, Sidrap regency, Pinrang regency. Saddang River is a river that is not unconnected from the possibilities floods, and is the longest river in the watershed Saddang, gathering is Saddang River 189.5 km, an average width of 80 m. Erosion and sedimentation in the upperstream Saddang watershed reach 60.88 tons/ha/yr, causing sedimentation problems, 9.93 tons/ha/yr, thereby causing the potential to reduce the capacity of irrigation channels, Rivers, reservoirs and at River mouths (Management Pattern Saddang River Region Pompengan Jeneberang Great Hall).

Flash floods occurred in the Saddang River in 2016 and in 2017. The high rainfall intensity in Tana Toraja and Enrekang Regencies made the Saddang River often overflow which resulted in the inundation of people's homes. In addition to Saddang River, another large River in Enrekang is Mata Allo River, and the River dead end stone. River flow can carry many particles. Especially in the flow of the Saddang River that is strong enough any particle can be carried, starting from *large boulders* to *clay*.

The flash flood disaster is part of a hydrometeorological disaster that is indicated to have a significant impact on life and property. The main factor of flash flood is triggered by extreme rainfall intensity. At least 10 flash floods occurred in Indonesia. In 2012 which resulted in 15 fatalities and property damage in each disaster event. Flash floods at least have the characteristics (YPM & JICA, 2011): 1) Come suddenly, 2) Caused by heavy rain that does not stop stopping , 3) The duration of flooding is relatively short , 4) Viscosity of high flow, 5) High standing water between 3 to 6 meters , 6) Bring some other material.

There are many characteristics of flash floods. Viscosity is an early sign of river flow that arises from a possible flash flood event. Viscosity is the resistance carried out by a layer of fluid against another layer. The nature of viscosity itself is owned by every fluid, gas, or liquid. The viscosity of a pure liquid is an index of fluid flow resistance. Viscosity shows the level of resistance of a liquid to flow. Fluid viscosity level is expressed by the coefficient of viscosity (h). The inverse of the viscosity coefficient is called fluidity, which is a measure of the ease of flow of a fluid (Whilem, 2007).

Viscosity is measured by various types of viscometers and rheometers. A rheometer used for liquids cannot be defined by a single value of viscosity and therefore requires more parameters to be adjusted and measured than is the case for a viscometer. For some liquids, viscosity is constant over various shear levels (Newtonian fluids) and a fluid without constant viscosity (non-Newtonian fluid). Non-Newtonian liquids show a variety of different

correlations between shear stress and shear rate. This study aims to analyze the value of viscosity as an indication of the potential for flash flood.

2. MATERIAL AND METHODS

2.1. Research Location and Time

The location of this research was carried out in the Saddang River which consisted of 3 research sites. Location 1 is the Saddang River upstream (Buntu Batu River and Mamasa River). Location 2 is the Saddang River middlestream (Mata Allo River and Kabere River). Location 3 is the Saddang River downstream (Pekkabata River). The time of the study was held for a year, from June 2017 to June 2018. Figure 1 shows a map of the research location.

Figure 1. Research location

2.2. Form and Type of Research

The form of this research is survey research, where research is conducted on large and small populations, but the data studied are sample data taken from these populations, so that relative events, distribution and relationships between variables are found, with a method of determining the value of viscosity the results of measurements in the field, then in connecting with continuity formula Q = A . V, where V is obtained using observations at the research location. From the graph of the relationship between the value of viscosity and the magnitude of flow velocity, it is obtained an indication of the occurrence of flash floods that may occur in a River, with the influence of the dominant parameters of measurement results including the level of turbidity of water and water level.

2.3. Research Design

Testing is done with three main groups, namely; 1) Observation in the upstream area of the Saddang River upstream (Buntu Batu River), 2) Observation in the middle of the Saddang River (Mata Allo River) and 3) Observation in the downstream area of the Saddang River (Pekkabata River). Each of the three groups was carried out by measuring the level of water viscosity, measuring the level of water turbidity, measuring flow velocity, water temperature of river flow and discharge at the same time of observation.

2.4. Experimental Apparatus

The study was conducted by various methods/ways and using various tools, namely:

1. Flow velocity measurements at each cross-section location are done using the *Sontek Hydro Surveyor*'s *Acoustic Doppler Current Profiller* (ADCP) *tool* that can measure flow velocity and water quality/viscosity (Figure 2).

Figure 2. Flow velocity measurement

2. Measurement of water viscosity and turbidity is carried out at each cross section at 3 sections (downstream and middle cross section of the River). Measurement of water viscosity using *Digital Viscometer* NDJ-8s (Figure 3).

Figure 3. Water viscosity and turbidity measurement

3. Measurement of water turbidity is done using AMT21 *Turbidity Meter* (Figure 4)

Figure 4. Water turbidity measurement

4. Topographic measurements with River bathymetry use the *Sensefly eBee (UAV Mapping Drone)* (Figure 5).

Figure 5. Topographic measurements with River bathymetry

3. RESULTS AND DISCUSSION

3.1. Saddang River Flow Velocity

Saddang River flow velocity is divided into 3 observation locations, namely:

Location of Saddang River Upstream (Buntu Batu River)

At the point of Buntu Batu River (3 ° 28'59.02 "LS; 119 ° 45'07.86" E) shows the average width of the River 30.411 m with wet cross section of the River 15.394 m^2, the average speed of flow 0.918 m/sec, water discharge 40.685 m^3/sec, maximum River depth of 5.548 m, maximum flow velocity of 2.334 m/sec. The cross section of the upstream Saddang River is shown in Figure 3.

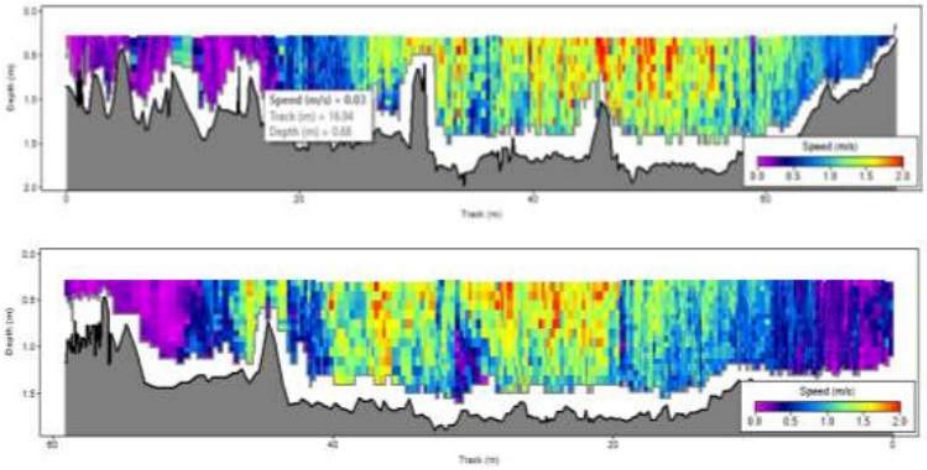

Figure 3. Cross section of the Saddang River upstream

Location of Saddang River Middlestream (Mata Allo River)

At the point of Mata Allo River (3 ° 33'23.61 "LS; 119°46'44.32" E) shows the average width of the River 27.170 m with a wet cross-sectional area of the River 44.907 m^2, the average speed of the flow of 0.309 m/sec, water flow 4.920 m^3/sec, maximum depth of River 1.045 m, maximum flow speed of 1.291 m/sec. Saddang River cross sections are shown in the central part of the Figure 4.

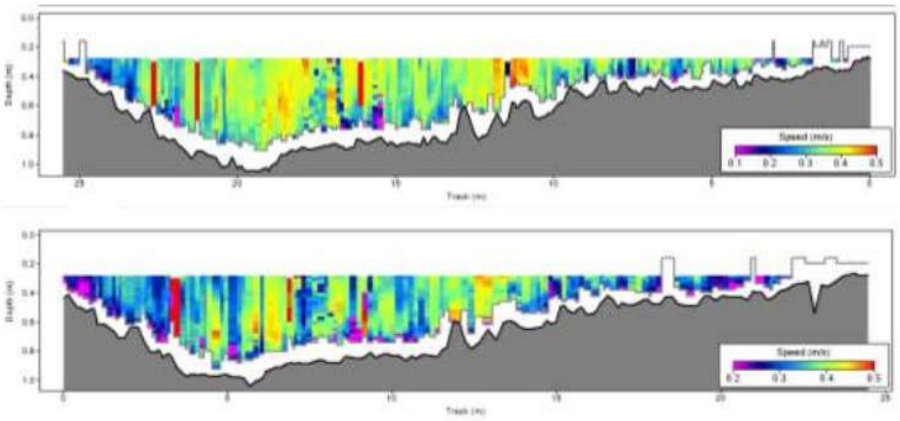

Figure 4. Cross section of the Saddang River middlestream

Location of Saddang River Downstream (Pekkabata River)

At that point in the Pekkabata River (3 ° 42'03.75 "LS; 119 ° 33'50.15" E) shows the average width of the River 201.09 m with a cross-sectional area of the River wet 193.37 m^2, the average speed of the flow of 0.54 m/sec, water discharge 104.12 m^3/ sec, maximum River depth 2.75 m, maximum flow velocity 2.5 m/sec. The cross section shown Saddang River downstream of the Figure 5.

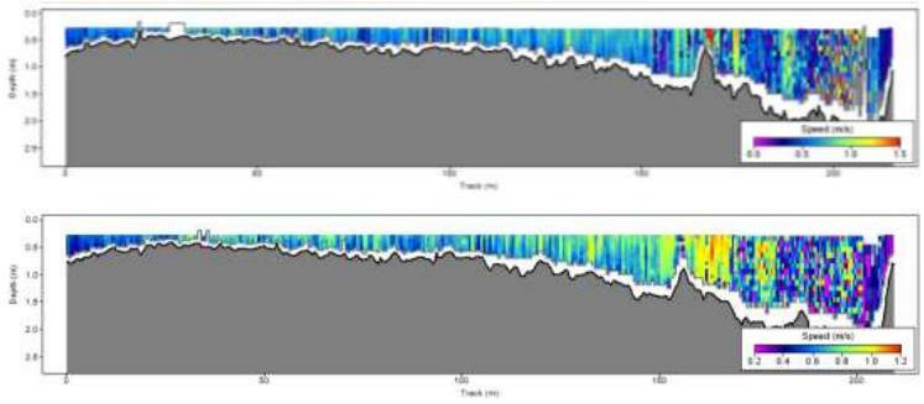

Figure 5. Cross section of the Saddang River downstream

3.2. Turbidity of the Water in the Saddang River

From the results of measurements for 24 hours and recording data every hour by using the tool turbiditymeter, it is known turbidity level of water in the Saddang River upstream (Buntu Batu River) reached 13 NTU - 15.6 NTU, in Saddang River middlestream (Mata Allo River) which reached 9 NTU - 17.6 NTU. In the downstream part of the Saddang River (Pekkabata River) which reaches 11.9 NTU - 20.3 NTU. The results of measurements of water turbidity in the Saddang River are shown in Figure 6. Figure 6 illustrates that the lowest turbidity level in the middle of the Saddang River (Mata Allo River) is more fluctuating at around 13 NTU, while the highest is at the Lower Downstream (Pekkabata River) at 20 NTU.

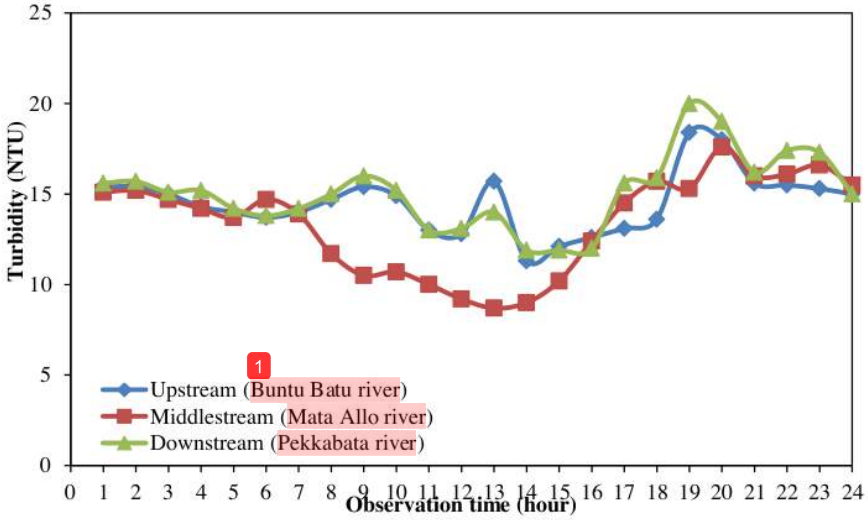

Figure 6. The degree of turbidity at the Saddang River observation site

3.3. Viscosity in the Saddang River

Figure 7 shows the level of viscosity at the observation site.

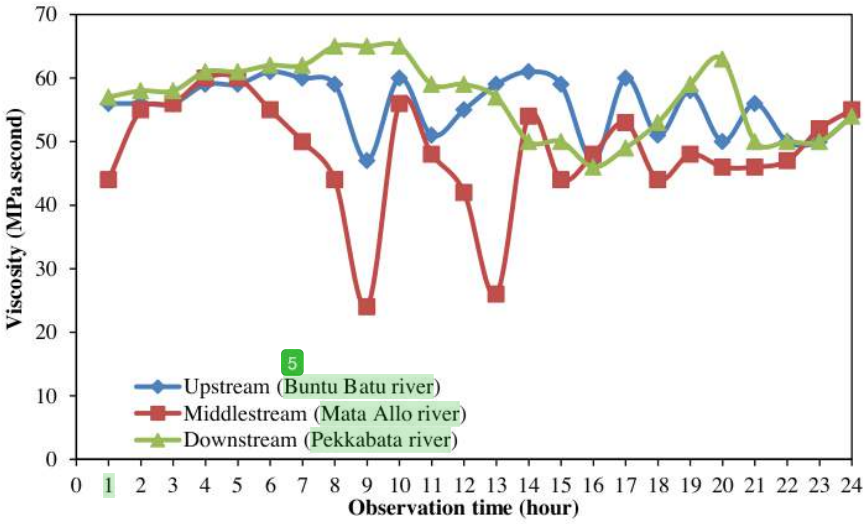

Figure 7. Viscosity at the Saddang River observation site

Based on the results of viscosity measurements at the location for 24 hours by recording every one hour, obtained viscosity data in the Saddang River upstream (Buntu Batu River) of 47 - 61 MPa.second, while the results of measurements at the location of the Saddang River middlestream (Mata Allo River) amounting to 24 - 60 MPa.second, whereas at the location of the Saddang River downstream (Pekkabata River) it has a viscosity of 46 - 65 MPa.second. The graph gives an illustration that the viscosity in the middlestream of the Sadang River is

more volatile in the range of 24 - 60 MPa.second lower than the viscosity of upstream and downstream Rivers which is around 46 - 65 MPa.second

3.4. Determination of the Saddang River Viscosity Value

To determine the value of the viscosity of the Saddang River during floods, valid data trends are used, starting from secondary data series obtained from the results of recording and supporting data during a flood, then linked to the data series measured in the field. The recorded flash flood events occurred twice, firstly on October 29, 2016 at the location of the upstream Saddang River, and on May 8, 2017 at the middlestream Saddang River. The two events related to the regression results between viscosity and related parameters, where the most complete parameter data is flow velocity (V).

Supporting data that can be used are flowrate, water level, water quality and temperature, where the estimated data shows that an indication of a flash floods is likely to occur if extreme surges occur from some parameters of the river's current state. The extreme spike in these parameters averaged 50 – 100 percent more on average. The cross section and flow velocity in the Saddang River research are as follows:

a. Buntu Batu River can be seen on Figure 8 The average velocity in Buntu Batu River is 2,184 m/s and the higher velocity in Buntu Batu River that is in 30 m - 50 m from River edge (middle side).

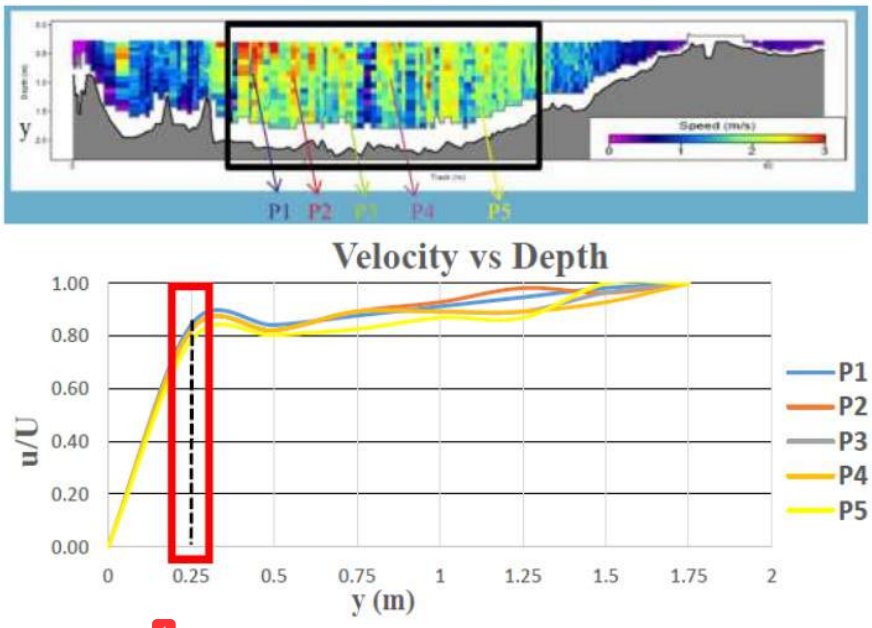

Figure 8. The cross section and flow velocity in Buntu Batu River (upstream)

b. Mata Allo River can be seen on Figure 9 Mata Allo River has average of velocity 0,379 m/s. The higher velocity in Mata Allo River that is in River left side.

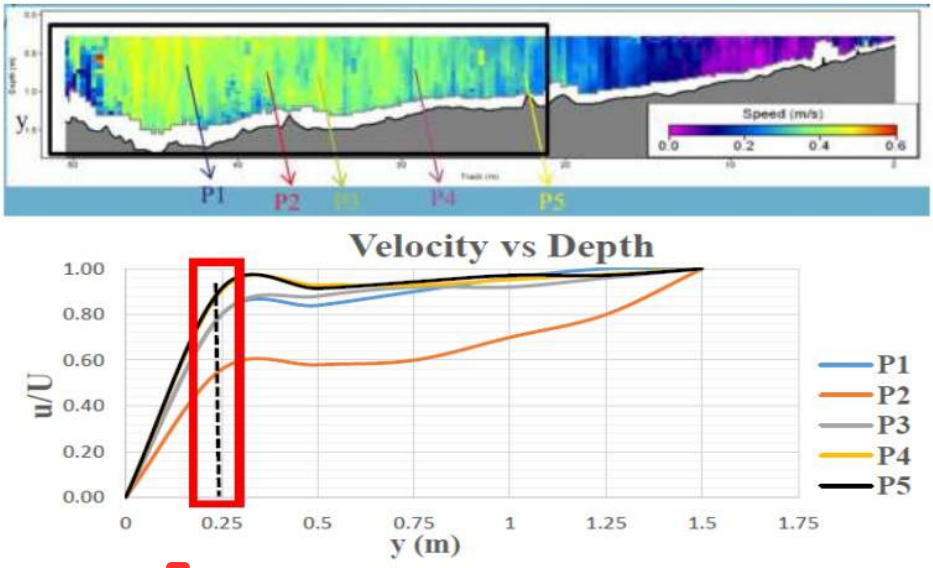

Figure 9. The cross section and flow velocity in Mata Allo River (middlestream)

c. Pekkabata River can be seen on Figure 10 Pekkabata River has average velocity of 0,614 m/s. The higher velocity in Pekkabata River that is in River right side.

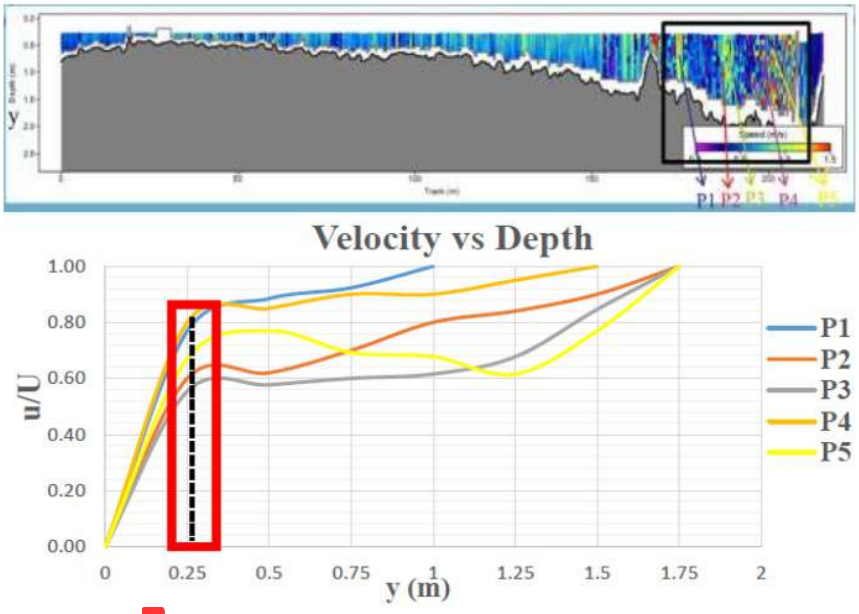

Figure 10. The cross section and flow velocity in Pekkabata River (downstream)

4. CONCLUSION

The results showed that the relationship between flow velocity and depth at each study location, showed an unstable flow (unsteady flow) so that it greatly influenced the value of viscosity.

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