# DETERMINATION OF SEDIMENT TRANSPORT AT RIVER SYSTEM

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**ABSTRACT.** *A lot of natural rivers facing sedimentation problems either caused by erosion or human activities, but some are related to river management that arise from the adequate prediction of sediment behaviour. This study was carried out at Punggor river to determine the relationship between sediment transport and flow rate; and between suspended solid and turbidity. In-situ measurement and laboratory analysis were done to obtain data for river system. Result found that relationship between suspended solid and turbidity; and flow rate and sediment load are directly proportional where $R^2$ equal to 0.96 and 0.72 respectively. As a conclusion, flow rate has played as major part in transporting the sediment load to other section of river based on changes of river profile.*

**KEYWORDS.** suspended load, turbidity, sediment transport and river system

## INTRODUCTION

Sediment transport plays a major role in the evolution of river beds and estuaries; consequently it exerts a great influence on the topography evolution of earth's surface (Yang, 2005). A lot of natural rivers facing sedimentation problems either caused by erosion or human activities, but some are related to river management that arise from the adequate prediction of sediment behaviour. Any persistent changes of sediment in the rivers transport capacity, due to natural activity will promote erosion and/or deposition as the river responds to those conditions. (Bhuiyan et al, 2009). Sedimentation study is more acquaint with the behaviour of sediment load in a river where it is depends on the types of river bed and migration of bed forms such as ripples and dunes (Gui and Jin, 2002; Van Rijn, 2007).

The transport of bed material particles may be in the form of bed load or bed load plus suspended load depending on the size of the bed material particles and the flow conditions (Van Rijn, 2007; Buono and Shimizu, 1999). According to Yang (2003), the bed load transport rate of a river is about 5 – 25% in suspension. However, for coarse materials, higher percentage of sediment may be transported as bed load.

Yang (2005) stated that relationship between flow strength and sediment discharge exists in a wide range of flow conditions in the paper related to sediment transport. The determination of relationship between suspended load and turbidity; and between sediment load and flow rate are the purpose of this study in obtaining the transportation of sediment along the river. This study has been carried out at the Punggor River (Figure 1) which is located about 35 km from Batu Pahat town. The length of river is 2.05 km and nearby with agricultural land and village.


**Figure 1** Location of study area

## METHODOLOGY

At the preliminary study, distributions of soil particles at the Punggor River are determine as fine sand and silt clay. Furthermore, the specific gravity varies between 2.03 to 2.63. In this study, two phases were carried out in achieving this study which are in-situ measurements and laboratory analysis. 5 stations have been set up along the estuary as shown in Figure 2 for data collection within December 2009 to February 2010 (twice for each month).

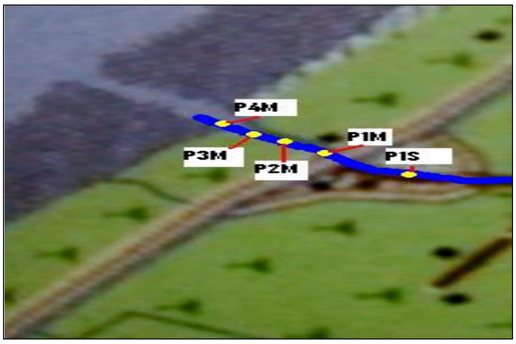


**Figure 2** Location of sampling stations

The in-situ measurement was carried out and divided into three works. *River profiles:* Cross-section of 5 stations have been measured to obtain the river profile such as cross section of river, width of river, depth of water. *Velocity and Flow rate:* Current meter (Valeport BFM001) was selected to measure the velocity of river. The depth of water is less than 0.5 m, therefore velocities were measured at 0.6 of water depth. The flow rate of river can be calculated by velocity-area method. *Water sampling:* A grab sampler has been used to collect samples of water and soil in the river to determine the sediment characteristics, turbidity and suspended solid.

Laboratory tests were carried out to determine the suspended solid and turbidity from sediment samples which is collected at the bed channel at each station. *Suspended solid:* Organic and non-organic particle with a 0.001 mm size are called suspended particles (Yang, 2003). Determination of suspended solid is to identify the volume of suspended sediment in the river (organic and inorganic particles) that is transported by water. Photometric method or Nonfilterable Residue has been used to determine the value of suspended solid using HACH DR 890 apparatus. Total suspended solid was used to determine the sediment rate in $m^3/s$ or tonne/day. It can be computed by Bouno and Shimizu (1999),

$$Q_s = \frac{QS}{\rho 1000^2} \tag{1}$$

Where, $Q_s$ = sediment transport ($m^3/s$)
Q = flowrate ($m^3/s$)
S = suspended solid (SS) mg/L
$\rho$ = density ($g/cm^3$)

*Turbidity:* turbidity measure water's ability to scatter and absorb light by suspended material in water. The particle that cause the turbidity vary in size between 1 nm and 1 mm. Sample of water has been tested by using HACH DR 2010 to determine the water turbidity in NTU unit. Usually, turbidity is caused from the erosion of colloidal material or erosion process at the riverbank and rainfall.

## RESULT AND ANALYSIS

From in-situ measurement, the width of each station was determined as 10 m, 21 m, 25 m, 31 m and 35 m for station P1S, P1M, P2M, P3M and P4M respectively. Figure 3 shows the average flow rate of river which ranging between 0.025 to 0.9 $m^3s$. Beside that, 0.4 $m^3/s$ and above was recorded at all date of sampling for station P4M and P1M, P2M and P3M at 8 Dec 2009 an 31 Jan 2010.

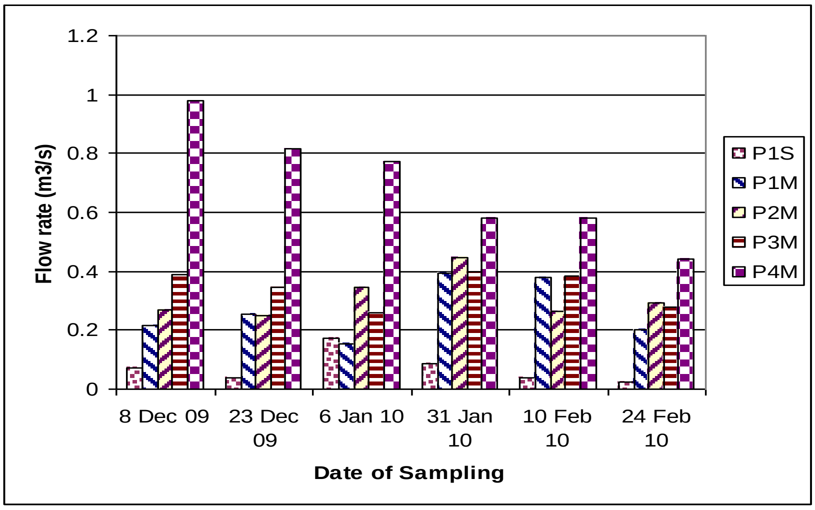


**Figure 3** Flow rate data for sampling stations

Figure 4 illustrate the river profile (cross section) at sampling stations. The bed level (measured from water surface) was found ranging between 0.5 to 2.5 m. Referring to the figure, deposition of sediment loads were occured at all station and accumulated depends on the flow rate and tides flow.

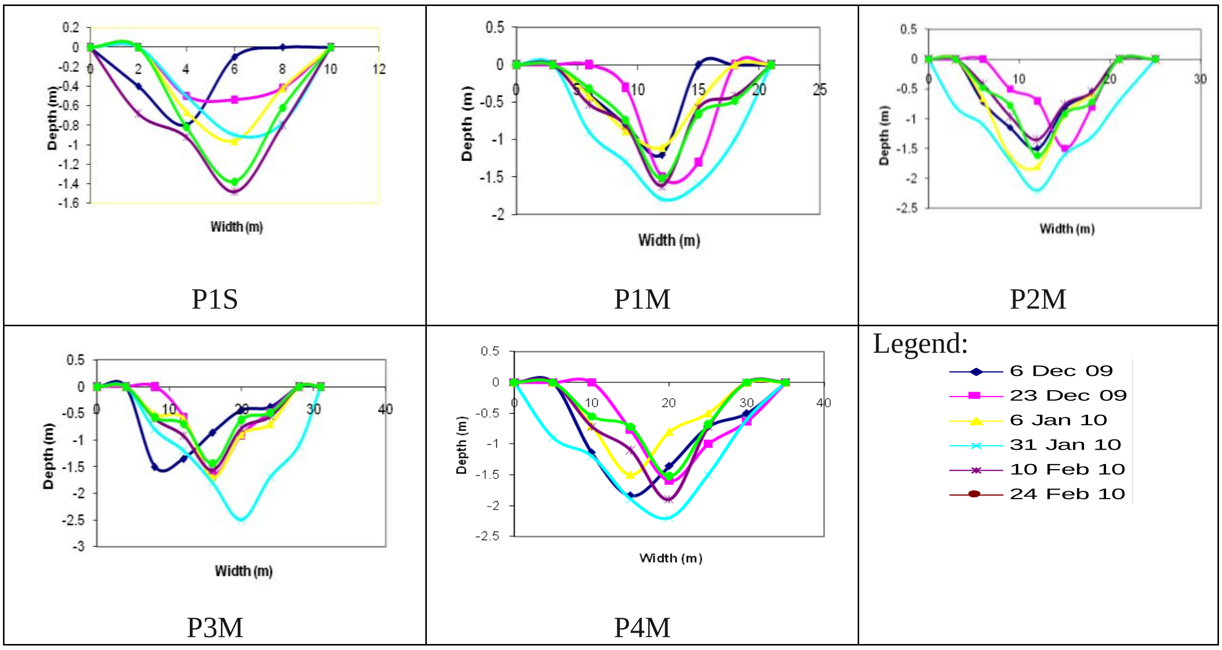


**Figure 4** The profile of channel cross section at all stations

Figure 5 and 6 show the analysis of suspended solid and turbidity at sampling stations. The turbidity values are recorded between 11 NTU to 363 NTU. Value more than 100 NTU was figured at all station when the sampling was carried out in February 2010 which is contrast in January 2010 (less 100 NTU). Data of suspended solid are ranging between 6 mg/L to 289.7 mg/L. The distribution of data is similar with turbidity where all data reached more than 50 mg/L in February 2010. Station P2M and P4M recorded more than 150 mg/L and 200 NTU for suspended solid and turbidity accordingly in December 2009 and February 2010.

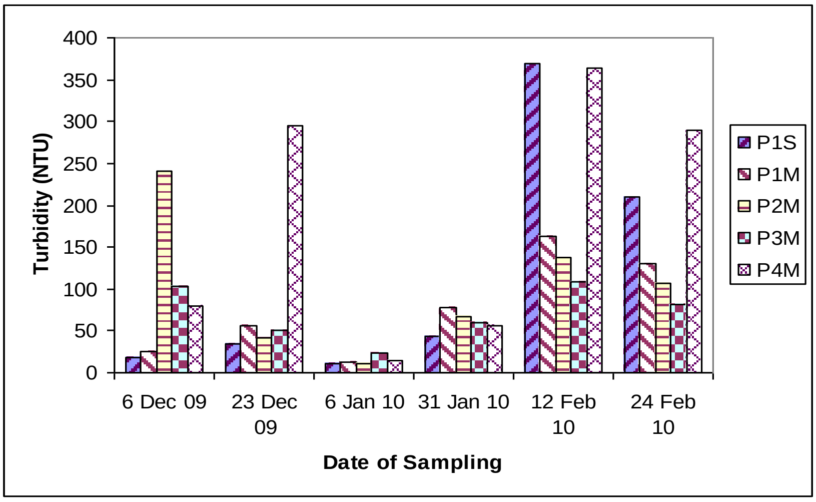


**Figure 5** Turbidity (NTU) for Sampling Stations

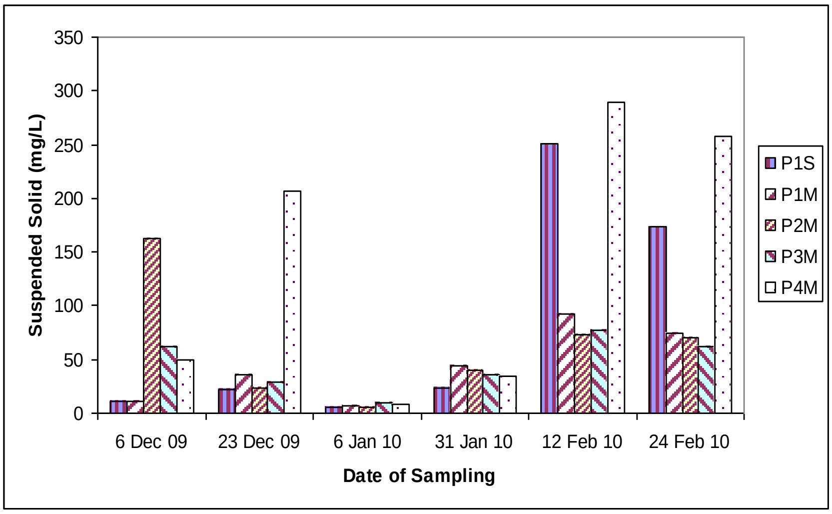


**Figure 6** Suspended Solid for Sampling Stations

The relationship between turbidity and suspended solid shows in Figure 7 indicates that the relationship is directly proportional and depends on each others where $R^2$ equal to 0.9612. Furthermore, the relationship can be formulated as y = 1.2673x +14.28.

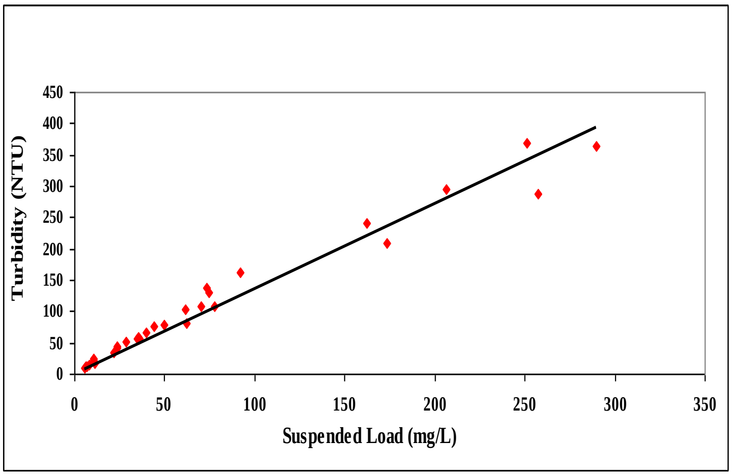


**Figure 7** Relationship between suspended load and turbidity

Sediment load in tonne/day has been calculated all stations as shown in Figure 8. Station P4M recorded more than 0.2 tonne/day of sediment load except in January 2010. The relationship of flow rate and sediment transport is directly proportional where $R^2$ equal to 0.72 as shown in Figure 8. Hence the relationship can be formulated as y = 0.1027x – 0.0138.

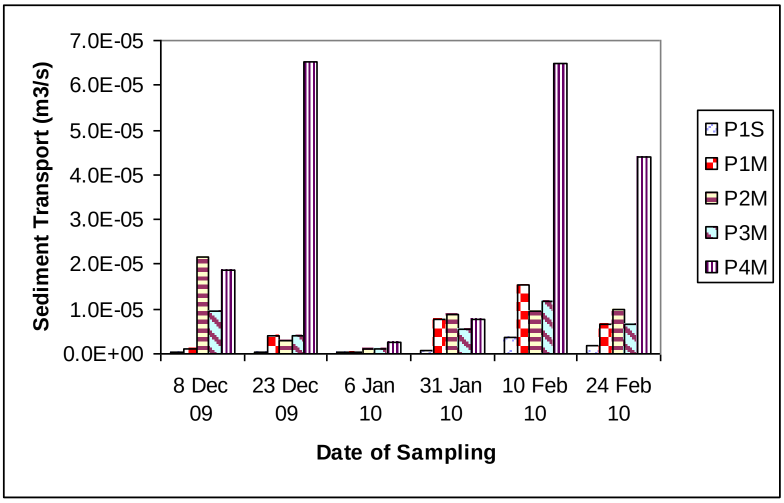


**Figure 8** The sediment load according to stations in tonne/day

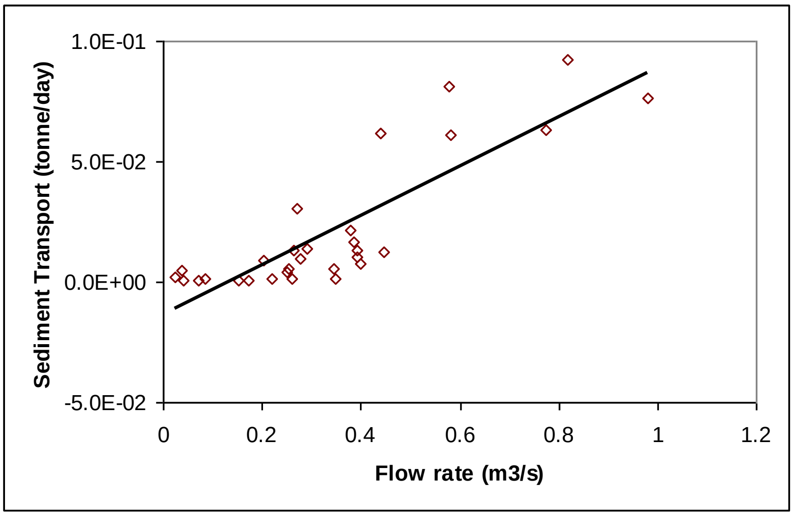


**Figure 9** Relationship between sediment transport and flow rate

## CONCLUSION

As a conclusion, the bed level and cross section of river have changed within three months observation. This study demonstrates the turbidity of water is directly proportional with the suspended solid and also flow rate with sediment transport in tonne/day. The flow rate has played as major part in transporting the sediment load to other section of river based on bed level and the cross section of the river changes.

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