Acoustic Doppler Current Profiler Measurement of River Discharge at Sungai Perak, Bota Kiri

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Acoustic Doppler Current Profiler Measurement of River Discharge at Sungai Perak, Bota Kiri

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Abstract. Nowadays, the mining of sand resources from rivers areas especially in Perak state is a common practice and may lead to destruction of public assets as well as impacts or increase stress on commercial and noncommercial living resources that utilize these areas. This study was carried out to determine possible river sand removal capacity and their consequences towards Sungai Perak. Acoustic Doppler Current Profiler (ADCP) is utilized to make river profiler in term of velocity meshes and river bed depth. It also could measure the total discharge of a particular cross-section. In this study, 8 locations of the river were chosen to analyze the river discharge profile either symmetrical or non-symmetrical. From the result and analysis, only one out of eight location showed symmetrical profile. This result showed that the flow of water in the river was not in a good condition and river sand mining in a controlled condition need to be conducted to improve the quality of the river. Other than that, the average flow of Sg. Perak at Pendiat (7770 km^2) is 220 m^3/s which is same magnitude that was reported by Department of Irrigation and Drainage. Based on this result, it is possible to mine sand island and this activity will reduce local scouring.

1. Introduction

River sand and gravel have long been used as aggregate for construction of roads and building. Today, the demand for these sources has increased in a gretaer amount aligned with the rapid growth of construction and building. The main activity to extract these sources is by the activity of sand mining [1]. Sand mining is the removal of sand from their natural configuration. Rapid activity of sand mining could give impact to the environmental and cause bad impact to the ecosuystem. Environmental problems occur when rate of extraction of sand, gravel and other material exceeds the rate at which natural processes generate these materials. Excessive removal of sand may significantly distort the natural equilibrium of a stream channel The magnitude of the impact basically depends on the magnitudes of the extraction relative to bed load sediment supply and transport through the reach.

Many Perak streams, rivers and their floodplains have abundant quantities of sand and gravel that is mined conveniently and economically for a variety of uses. In recent years, rapid development has led to an increased demand for river sand as a source of construction material. This has resulted in a mushrooming of river sand mining activities which have given rise to various problems that require urgent action by the authorities [2]. However, unregulated and unmonitored sand mining has taken place without a clear regulatory framework and this has aggravated environmental problems. In addition, sand prices have increased several times over thanks to a ban imposed on traditional sources of supply. Elevated sand prices have driven the exploitation of sand from fragile and remote places, causing more damage to the road infrastructure due to heavy loads carried on weak rural roads. This situation has been further complicated by politics. No tangible benefit can be derived from current institutional activities unless there is a mechanism that meets both demand for sand and the need for conservation goals. In addition, the needs of the rural poor, who benefit from river sand mining, need to be considered [3].

Therefore, there is an urgent need to identify appropriate policy guidelines that guarantee environmental protection with minimum regulatory costs and high levels of public cooperation [4]. This paper discuss and explain on the appropriate method to handle the sand mining activity to recover and improve the quality of Sungai Perak, Bota Kiri and highlighted the usage of ADCP as one of the important parameters and instruments to determine the allowable amount of river sand that can be extracted based on the data collection.

2. Acoustic Doppler Current Profiler

An Acoustic Doppler Current Profiler, or Acoustic Doppler Profiler, is often referred to with the acronym ADCP. The instrument is used to measure how fast water is moving across an entire water column. An ADCP anchored to the seafloor can measure current speed not just at the bottom, but also at equal intervals all the way up to the surface. The instrument can also be mounted horizontally on seawalls or bridge pilings in rivers and canals to measure the current profile from shore to shore, and to the bottoms of ships to take constant current measurements as the boats move. In very deep areas, they can be lowered on a cable from the surface. ADCP discharge measurements are made from moving boats; therefore, the boat velocities must be subtracted from the ADCP measured water velocities. Figure 1 shows the evaluation of acoustic doppler current profiler measurements of river discharge ADCP's can compute the boat speed and direction using "bottom tracking" [5].

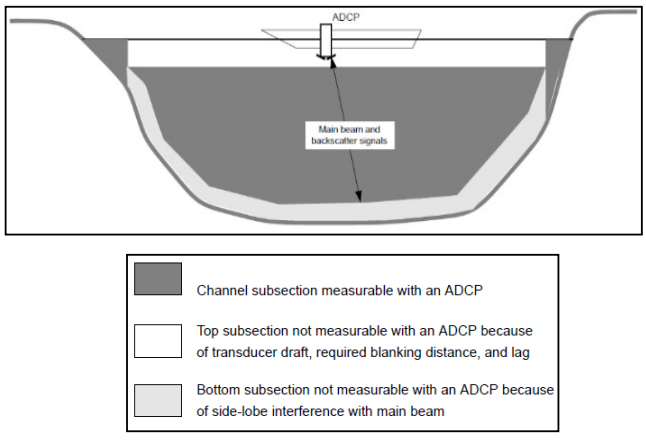


Figure 1. Evaluation of acoustic doppler [5]

3. Design of Experiment Setup

In this study, eight different locations were chosen to be analysed using the ADCP instruments. The eight locations were shown in Figure 2 below. These locations were chosen randomly to measure the average flowrate and also to determine the quality of flow of the river weather symmetrical which indicate good flow or non-symmetrical which indicate bad flow due to improper management of sand mining. All data were collected and analysed for all locations.

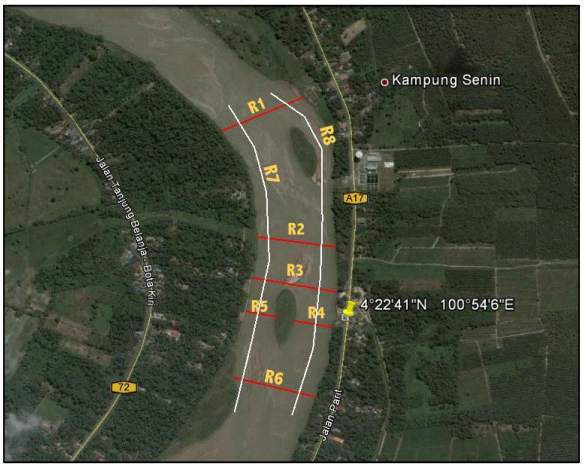


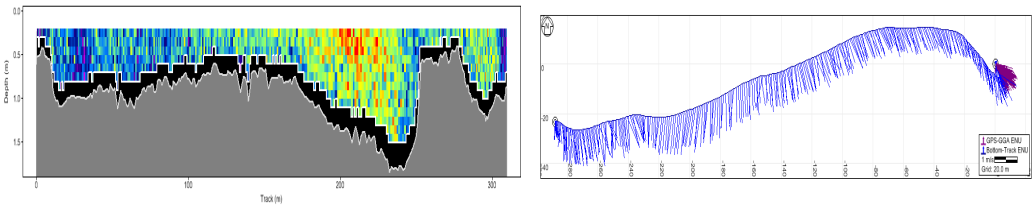
Figure 2. Eight Location of ADCP lines

4. Results and Discussions

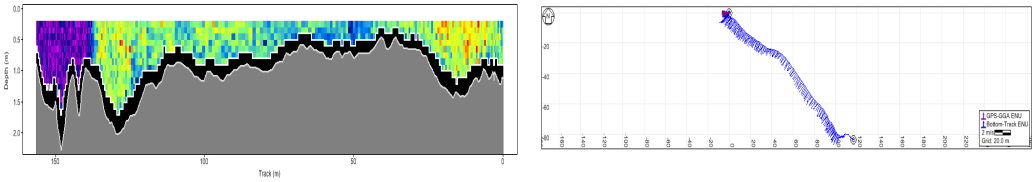
4.1. Results

Figure 3 shows several ADCP data taken along the Sungai Perak, Bota Kiri. These data were selected based on the consistency of the data and their influences toward the result of this research. Line R1LB, R4RB and R5LB are the most crucial data for this study. These locations illustrate the real behaviour of the river and sediments underneath. R1LB located at the upstream of the site area. Meanwhile line R4RB and R5LB were located between a river island. Based on the data, the average flow of the river was 220 m^3/s.However for line R4RB and R5LB, the flow recorded for each line was half of the average flow of the river. This was due to the existence of the river island which divided the total flow in half. The average depth of the river is 1.50 m. The maximum flow of the river had affected the rate of the sediment transport proportionally.

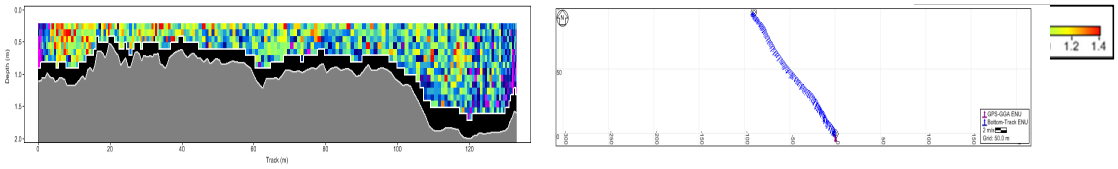
The shape of river cross section is not symmetrical. Furthermore, most of the data collected shows that the maximum flow of the river didn't occur at the centre of the river cross section. This is caused by a poor river management and uncontrolled developments and mining by the sand operators and local authorities. Therefore, appropriate river sand mining can be done in a specific area which is needed to be diminished (supported by the result of this research) in order to improve the quality of the river



R1LB River Profile and Alignment



R4RB River Profile and Alignment



R5LB River Profile and Alignment

Figure 3. ADCP result for three different lines

5. Conclusions

From this study, it is concluded that the discharge flow for this river is non-symmetrical which considered as low quality river management. Most of the data collections showed the maximum flow of the river didn't occur at the centre of the river cross section. The average flow of the river was 220 m^3/s. However, line R4RB and R5LB, the flow recorded for each line was half of the average flow of the river. This was due to the existence of the river island which divided the total flow in half. All of these issues occur due to poor river management and uncontrolled developments and mining by the sand operators and local authorities. Therefore, appropriate river sand mining should be conducted in controlled condition to improve the river quality.

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