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A study of water quality for Sungai Perlis during high tide and low tide

Ain Nihla, K.[1*], Nur Shahidah, M.N.[1], Mohd Faizal, A.J.[2], Roslaili, A.A.[1]

[1]School of Environmental Engineering, Universiti Malaysia Perlis, 02600 Arau, Perlis
[2]State Department of Environment, 2nd Floor, KWSP Building, Jalan Bukit Lagi, 01000 Kangar, Perlis

ABSTRACT

Sungai Perlis is the main river in Perlis with length is approximately 9.55 km from Kangar city to Kuala Perlis before discharged to the sea. The size of the Sungai Perlis basin is approximately 310 km^2. The objectives of this study are to establish the pollutants profile along Sungai Perlis during high tide and low tide based on physical, chemical and biological parameters. The analysis involved in-situ measurement (pH) and laboratory analysis (SS, BOD, COD, AN and E- Coli). During high tide, the high concentration of pollutant load for pH is 7.77, SS is 128 mg/l, BOD is 4.5 mg/l, COD is 35.2 mg/l, AN is 1.28 mg/l and E-Coli is 1011.2 MPN/100ml. During low tide the high concentration of pollutant load for pH is 6.96, SS is 228 mg/l, BOD is 8.6 mg/l, COD is 56.5 mg/l, AN is 1.58 mg/l and E-Coli is 1011.2 MPN/100ml. Along Sungai Perlis, there are residential area, agriculture areas, recreational park and squatters located at Kuala Perlis, aquaculture ponds and Kangar wet market which are directly and indirectly affect the water quality of Sungai Perlis during high tide and low tide.

Keywords - *Pollutants profile, High tide, Low tide, Land use, Water quality.*

INTRODUCTION

Sungai Perlis is a symbol of productive economic resource of Perlis State. Sungai Perlis has a total length of about 9.55 km from Kangar city to Kuala Perlis before it's discharged to the sea. The size of the Sungai Perlis basin is approximately 310 km^2. There are many tributaries as well as drains which are connected to the river such as Lencongan Utara, Sungai Repoh, Sungai Bakong, Sungai Seriab, Sungai Kayang and Sungai Korok. While, there are more than ten (10) sub tributaries of Sungai Perlis such as Sungai Temenggong, Sungai Batu Pahat, Sungai Kechor and Sungai Santan. Sungai Perlis also provided habitats for aquatic plants, animals and natural resources of food and protein. Besides that, it also has been used for tour-

*) For corresponding e-mail: ainnihla@unimap.edu.my

ism and recreational purpose. The number of people visiting Sungai Perlis are increasing up 10 000 people.

Unfortunately, developing and urbanization along Sungai Perlis have polluted the river itself. Now, the natural state of Sungai Perlis is not persuasive level. The condition of the river can be told by it physical appearance and smell. These adverse effects of water quality are resulting from land uses and human activities at soil surface. Currently, Sungai Perlis is experiencing heavy erosion at the river banks and becoming shallow. The shallow river will cause the depletion of aquatic life and non-accessible by boat. The land uses along Sungai Perlis are residential, agriculture area which is paddy field, Sungai Perlis esplanade, food stalls and the Kuala Perlis fisherman jetty. A landfill located in Kuala Perlis and this directly affects the water quality of the river. There are also squatters located at Kuala Perlis and near the river reserve area are also causing pollution problems. Other point source pollution includes aquaculture ponds and Kangar wet market.

This study also focussed on the changes of river water quality during high tide and low tide. Nor Azman (2006) stated that the difference in water quality is due to the difference in current and flow rate between the high tide and low tide. During low tide the volume and flow rate of the river will be less, therefore, the concentration of pollutants will increase and making the river slightly more polluted. However, during high tide, the flow rate and volume of the river will increase therefore concentration of pollutants will be less. The current and flow during high tide is also stronger and higher during high tide compared to low tide. This will lead to proper mixing and dilution of the water therefore evenly distributing the pollutants and making it less concentrated per volume of water (Wang et. al., 1978). The objectives of this study are; (1) to establish the pollutants profile along Sungai Perlis during high tide and low tide based on physical, chemical and biological parameter; (2) to study the land use along Sungai Perlis and relate it to the water quality of the river.

METHODOLOGY

The water samplings were conducted along Sungai Perlis to determine the pollutants profile along Sungai Perlis. The parameters are divided into three categories which are physical, chemical and biological parameters. These parameters are selected based on Water Quality Classification in Malaysia, Water Quality Index (WQI) Classes and Interim National Water Quality Standards (INWQS) by Department of Environment (DOE). This study involved in-situ measurement and laboratory analysis.

In this study, the sampling points were selected along Sungai Perlis including the phase 1 tributaries that have the potential to pollute Sungai Perlis such as Sungai Repoh and Sungai Kayang. These sampling points are determined using map,

while the coordinate and distance is determined using the Global Positioning System (GPS). These sampling points are divided to upstream, middle stream and downstream as covered along Sungai Perlis as illustrated in Table 1 and Figure 1. This will enable water entering and leaving the site be assessed and evaluated the impact generated from the study area.

Table 1: Coordinate and location of sampling points

Station	Location	Division	Coordinate
P1	Sungai Repoh (Sungai Perlis Phase 1 tributary)	Upstream	6°26'47.87"N 100°13'0.16"E
P2	Sungai Perlis (Kangar City)	Middle stream	6°26'13.74"N 100°11'27.61"E
P3	Sungai Perlis (Pengkalan Assam)	Middle stream	6°26'5.90"N 100°11'6.76"E
P4	Sungai Kayang (Sungai Perlis Phase 1 tributary)	Downstream	6°24'59.71"N 100° 9'8.25"E
P5	Sungai Perlis (Kuala Perlis)	Downstream	6°24'30.20"N 100° 8'27.76"E

Figure 1: Mapping location of sampling point

RESULTS AND DISCUSSIONS

The pollutants profile along Sungai Perlis during high tide and low tide were determined in this study. The physical parameter involved pH and suspended solid (SS). While, for chemical parameters analysis are involved Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Ammoniacal Nitrogen (AN). The biological parameter is E-Coli These profiles involved five sampling locations along Sungai Perlis. Water quality usually linked with land use and human activities.

The profile of pH along Sungai Perlis during high tide and low tide is demonstrated in Figure 2. According to WQI classes, during high tide, all the points are fall under class I except for P2 (Kangar City) lies under class II. During low tide, all points are fall under class II. The minimum pH is recorded at P2 (Kangar City) both during high tide and low tide, which is 6.72 during high tide and 6.51 during low tide. The maximum pH obtains during high tide at P4 (Sungai Kayang) is 7.77 and during low tide at P3 (Pengkalan Assam) is 6.96. The town centre contributes much substance such as domestic waste, food waste and other type of solid waste which will decrease the pH of the river (Whipple and Hunter, 1997). Since, P2 (Kangar City) is the centre of the Perlis, the source of domestic sewage from commercial buildings, residential area and Kangar wet market are the major reason of decreasing pH. From the profile, during high tide the river water tend to be alkaline since the range of pH from 6.72 to 7.77 compared to low tide, the river water tend be acidic since the low range of pH from 6.51 to 6.96. The river is less acidic during high tide because the extra volume of water somehow neutralizing effect on the water (Chipman, 1934).

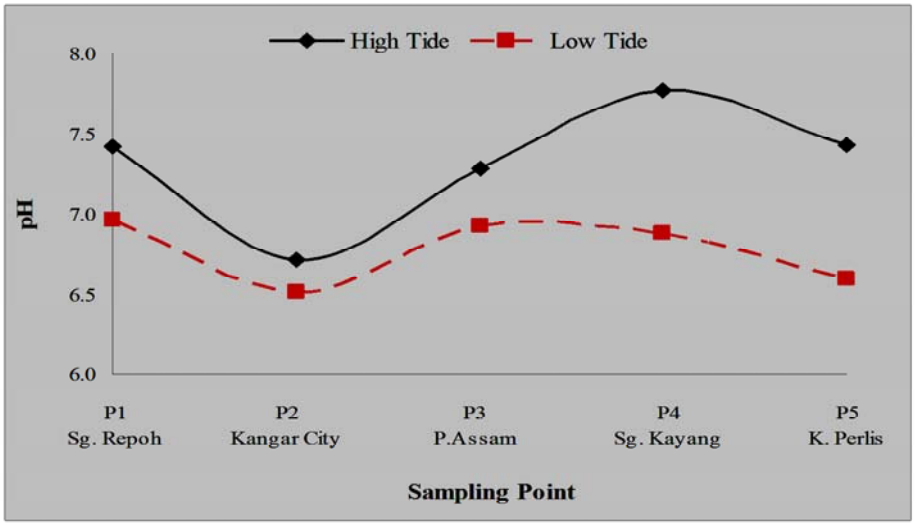

Figure 2: pH profile of Sungai Perlis during high tide and low tide

A profile of SS is illustrated in Figure 3, the WQI class of SS for P1 (Sungai Repoh) during high tide within Class I as it decrease to class II during low tide. For P2 (Kangar City) lies under class II during high tide, and also reduce to class III during low tide. Meanwhile, P3 (Pengkalan Assam) in class I during high tide also decline to class III during low tide. Same goes to P5 (Kuala Perlis) from class III during high tide decreases to class IV during low tide. During both tides, P5 (Kuala Perlis) wrote the maximum concentration of SS with 128 mg/l during high tide and 228 mg/l during low tide, respectively. The concentration of SS gradually increases as it flows to downstream of Sungai Perlis during both tides. The concentrations during low tide is higher compare to high tide because the water flow upstream from the sea during high tide and retreats back to the sea as the tides recedes. Therefore, scouring and deposition of urban derive sediments happens and are carried together with the flow (Williamson and Morrissey, 2000). The lowest concentration of SS is 10 mg/l during high tide at P1 (Sungai Repoh). As the volume of river decrease during low tide, the concentration of SS at P1 (Sungai Repoh) is 25 mg/l. The construction phase by Sungai Perlis has degraded the water quality of the river put in soil erosion and surface run off. As major land use along Sungai Perlis covered by agriculture, surface runoff flow from agriculture area also causing erosion and increase the concentration of SS in the river water (Haliza, 2007). Diurnal boats, ships traffics may increase the concentration of SS to water column especially at downstream by creating a wave and cause the riverbank erosion (Nurhidayah, 2007).

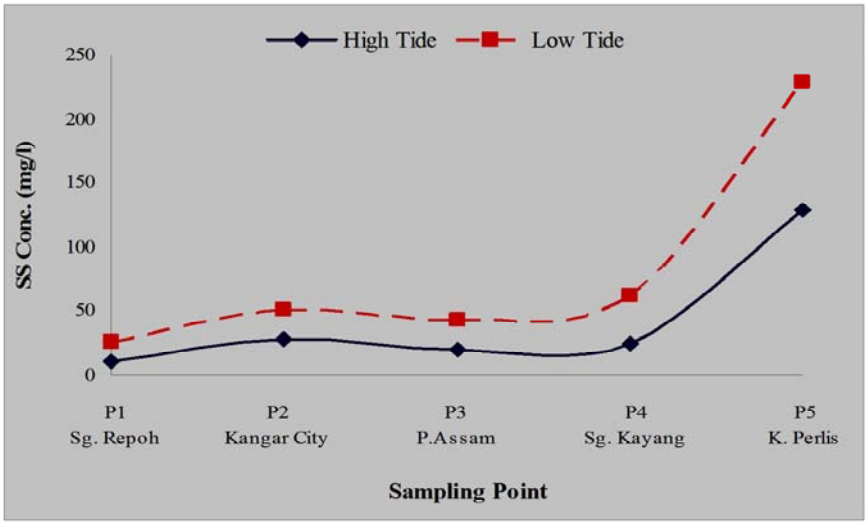

Figure 3: SS profile of Sungai Perlis during high tide and low tide

BOD concentration along Sungai Perlis during low tide is higher compared to high tide as showed in Figure 4. The WQI for BOD parameter for all sampling points along Sungai Perlis during high tide is lies under class III. During low tide, the

WQI of BOD for P1 (Sungai Repoh), P4 (Sungai Kayang) and P5 (Kuala Perlis) were lies within class III. For middle stream, P2 (Kangar City) and P3 (Pengkalan Assam) lies under class IV. The maximum concentration of BOD during high tide is 4.5 mg/l lies at P4 (Sungai Kayang). This happen due to organic materials in sewage discharged directly in the river since there are residential areas along Sungai Kayang. During low tide, the maximum concentration of BOD is 8.06 mg/l at P2 (Kangar City). High BOD value in the river can be attributed to untreated or partially treated sewage and discharged from agro-based and manufacturing industries (DOE, 2007). Land uses activities around Kangar City whether by commercial building as well as residential area also influent the concentration of BOD. These activities contribute to the present of organic debris such as decomposing food and organic materials in sewage causing oxygen depletion in the river system. The minimum BOD concentration during high tide is 3.6 mg/l and during low tide is 4.27 mg/l at P1 (Sungai Repoh). The concentration of BOD during low tide is slightly higher compared to high tide. A low concentration of BOD is an indicator of good quality water, while a high BOD indicates poor water quality and also indicates the presence of a large number of microorganisms, which suggests a high level of pollution especially to downstream user (DOE, 2007).

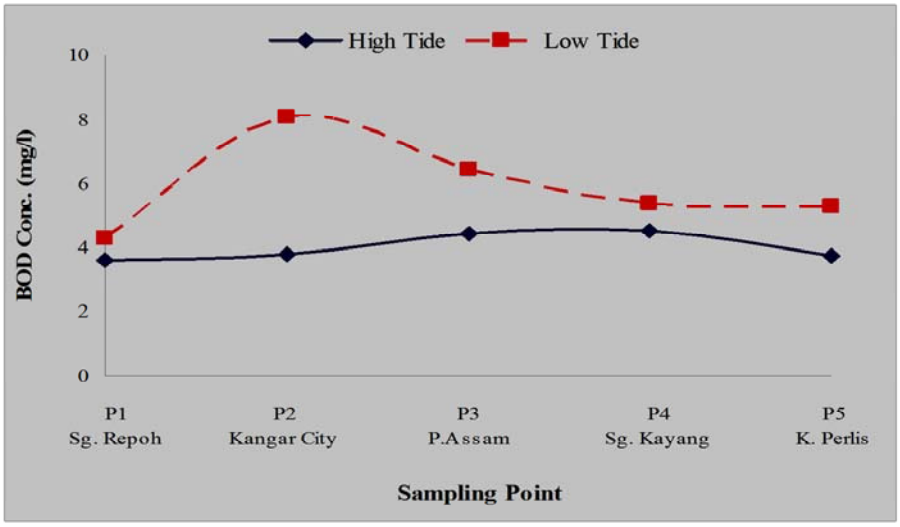

Figure 4: BOD profile of Sungai Perlis during high tide and low tide

COD also one of important parameter in determining the water quality. BOD represents only organic pollutant while COD represent all parameter including organic and inorganic pollutants. As the result COD value is always greater than BOD values and may be much greater when significant amount of biologically resistant organic matter is present (Sawyer, McCarty, and Parkin, 2003). Refer Figure 5, the WQI of COD during high tide for P1 (Sungai Repoh) and P3 (Pengkalan Assam) lies under class II. For the rest of point is fall under class III. During low tide, all

points are lies within class III except for the P2 (Kangar City) is class IV. The maximum of COD concentration during high tide is 35.2 mg/l at P4 (Sungai Kayang) and 56.5 mg/l at P2 (Kangar City) during low tide. The minimum concentration of COD during high tide and low tide were occurred at P3 (Pengkalan Assam) with 21.4 mg/l and 25.4 mg/l, respectively. From P1 (Sungai Repoh) to P2 (Kangar City) the concentration of COD is increasing rapidly for both tides, especially during low tide. This trend occurs due existing of commercial area as well as residential area discharging non biodegradable waste into the river. The concentration of COD was increased back after P3 (Sungai Kayang) as the flow heads to the downstream and directly discharged to the sea due to mixing of salt water (Nor Azman, 2006).

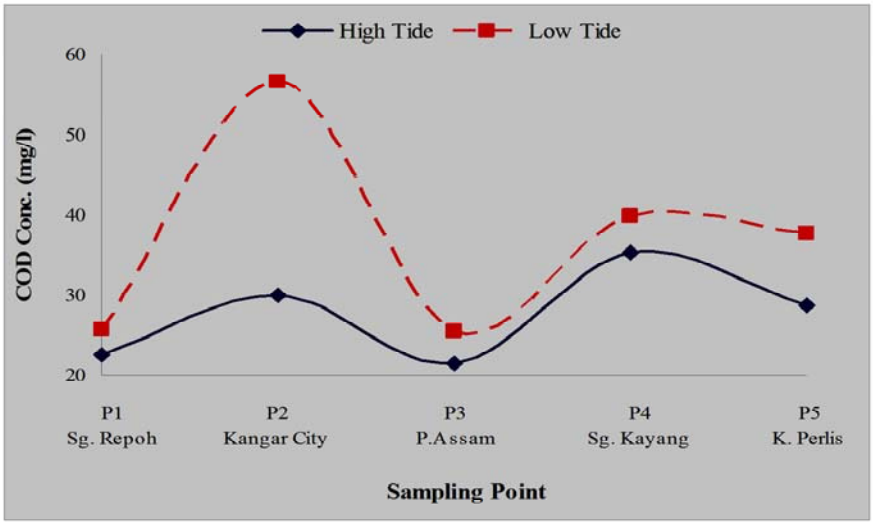

Figure 5: COD profile of Sungai Perlis during high tide and low tide

A profile of AN is established in Figure 6. The WQI of AN for P1 (Sungai Repoh) is lies under class III during both tides. For P2 (Kangar City) and P3 (Pengkalan Assam) are fall under class IV during both tides. As for P4 (Sungai Kayang) within class III during high tide decreases to class IV during low tide and P5 (Kuala Perlis) in class I during high tide drop to class III during low tide. The maximum concentration of AN was occurred at P2 (Kangar City) neither during high tide with 1.28 mg/ l nor low tide with 1.58 mg/l. The minimum concentration of AN during high tide is at P5 (Kuala Perlis) with 0.05 mg/l and P1 (Sungai Repoh) state 0.54 mg/l during low tide. AN concentration starting to decrease as it passed middle stream of Sungai Perlis to the downstream for both tides especially during high tide. The decreasing seaward probably because of increasing of DO concentration especially during day time, aquatic plant add DO to the water due to photosynthesis and oxygen is consumed during night time respiration (Jack, 2006). The higher concentration of AN in Sungai Perlis comes from uses of detergent from commer-

cial area at P2 (Kangar city) included restaurants, wet market and household uses. As the water flow to P3 (Pengkalan Assam), it carried the pollutants away the point containing high of AN. For P4 (Sungai Kayang), AN present due to the storm water runoff which is eventually flows into river carrying with pesticide, fertilizer and others from agriculture areas (Azni et. al., 2004).

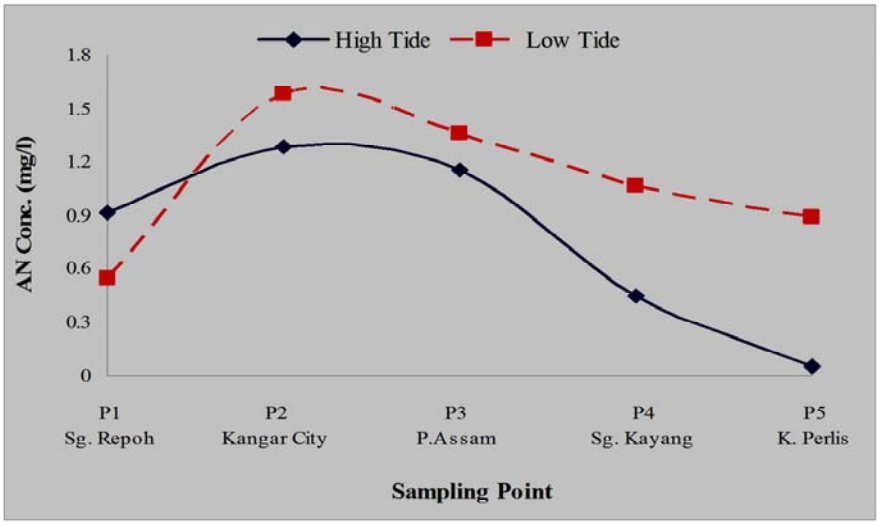

Figure 6: AN profile of Sungai Perlis during high tide and low tide

A profile of this biological parameter has been illustrated in Figure 7. The higher concentration of E-Coli during both tides is located at P2 (Kangar City) with 1011.2 MPN/100ml. Since, Kangar is the main city in Perlis, it contributes more biological pollution parameter than others points. The wet market activities influence the increasing of E-coli in Sungai Perlis due to chicken slaughtering activities, directly discharging contaminated waste water of fish and meat into Sungai Perlis. As well as institutional and commercial building, also residential areas around Kangar City which are having failing septic tank also the main reason the high concentration of E-Coli. The minimum concentration of E-Coli during high tide and low tide were occurred at P1 (Sungai Repoh) with 133.4 MPN/100ml and 88.2 MPN/100ml, respectively. The concentrations slightly decrease as is passed the middle stream. The presence of these indicative organisms is evidence that the water has been polluted with faeces of humans or other warm-blooded animals. Because of the potential consequences of waterborne diseases, microbial contamination is still considered to be the most critical risk factor in drinking water quality. However in river water, the level of microorganisms in the water is a sign of the water safety and indicates the hygienic status. Beside affected health risk, high concentration of E-Coli also contaminated the shellfish growing area and swimming beaches (Rahman et. al., 2009).

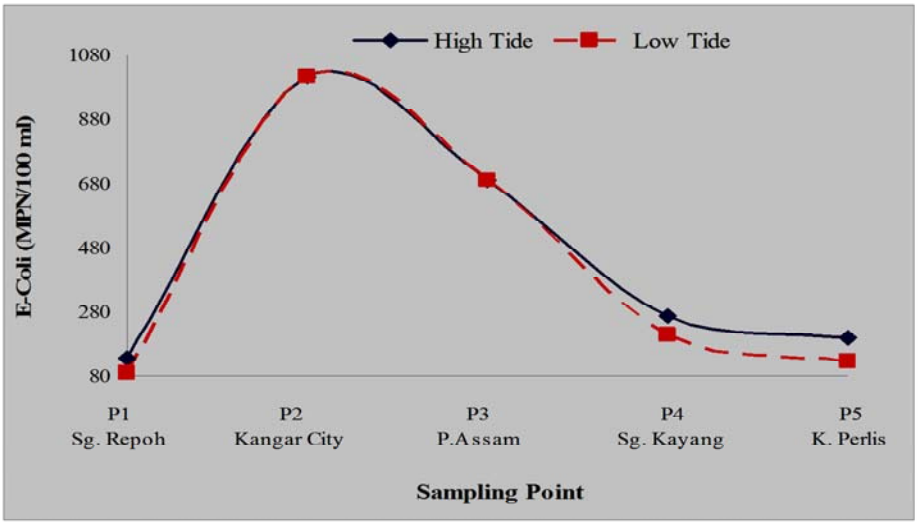

Figure 7: E-Coli profile of Sungai Perlis during high tide and low tide

CONCLUSIONS

The study of water quality for Sungai Perlis during high tide and low tide has achieved its objectives. The land use along Sungai Perlis and it relationship with the water quality of the river also has been deliberated. The higher concentration of water quality parameter during high tide are at P4 (Sungai Kayang) for COD and BOD, while at P2 (Kangar City) for AN. During low tide, water quality of the Sungai Perlis deteriorates at certain point such as P2 (Kangar City). This is because of high concentrations of COD, BOD, AN and E-Coli causing severe micro-biological contamination. P5 (Kuala Perlis) at downstream heavily polluted because of the huge increase of suspended solids. The main reasons for this water quality deterioration during low tide are the volume and flow rate of the river will be less. Therefore, the concentration of pollutants will increase making the river slightly more polluted as well as land use around the sampling point affected the water quality.

The water quality along Sungai Perlis is affected by land use around the river itself. At upstream to downstream of Sungai Perlis, most of residential along the river do not have proper sewage disposal system and leaking to the Sungai Perlis. These included the squatters at Kuala Perlis which also do not have proper solid waste collection system force them to dump the waste in to the river. Malaysian also famous with bad habit littering causing river as a place to litter and it will degrading the water quality of the river. As the flow of the river enter the town, institutional and commercial building such as Kangar wet market contribute to deterioration of water quality of Sungai Perlis due to chicken slaughtering

activities during morning and other land use activities. Kuala Perlis having serious issues with high concentration of suspended solid because of diurnal boats and ships traffics may increase the concentration of suspended solid to water column especially at downstream by creating a wave and cause the riverbank erosion. As the conclusion, the water quality of Sungai Perlis during low tide is significantly decrease compared to high tide. However, during both tides, land use is the great influenced and contributor in increasing of the pollutant in the river water.

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