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IMPACT OF SUSPENDED SEDIMENT ON PAHANG RIVER DEVELOPMENT USING GEOGRAPHIC INFORMATION SYSTEM

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Abstract

The measurement of different characteristics of a stream, including integrated water resource management, is dependent on sediment transport mechanisms. On the Pahang River, studies explored the spatial interpolation pattern of suspended sediment (SS) and water resource management. Sedimentation issues in the Pahang River have a significant impact on water resource management in the Pahang River basin. Furthermore, it may have an impact on local water consumption, recreational activities, and other factors, causing the river to become shallow and finally flood. This study was conducted to determine the SS pattern in the Pahang River with the approach of the Geographic Information System (GIS) technique and its significant colour based on spatial analysis. In addition, this study also evaluates the factors and effects of sedimentation through water source management. Three sampling stations from the Department of Irrigation and Drainage (DID) for three years (2000, 2004 and 2008) were selected along the Pahang River, where the parameter measured was suspended sediment (ton/year). The results obtained showed that the Pahang River receives a high amount of SS each year, where the higher amount was at the upper station (Sg. Yap), with an amount of 1876575 ton/year (2000), 613850.1 ton/year (2004) and 3458097 ton/year where it may be affected by sediment re-suspension and runoff from two outlets. Meanwhile, the downstream station (Lubuk Paku) received the least amount of SS, while the midstream station (Temerloh) received the most. The transit's speed and current may have an impact. This study's findings are critical in river and water resource management, especially of water resources for domestic use, ecotourism, river biodiversity, and hydrology.

***Keywords**:* Suspended sediment (SS), sedimentation pollutions, geographic information system (GIS), pollution management, Pahang River

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INTRODUCTION

Water is a primary source of livelihood on this earth, especially for humans, the economic sector, food, and the environment (Rasdi et al., 2022; Azinuddin et al., 2022; Kamarudin et al., 2017). However, water quality degradation is impacted by development, agriculture, land use activities, industrial production, and inappropriate use of fertilizer and pesticide, which have a negative effect on the river's sedimentation status (Wahab et al., 2019). Industrial areas, sewage, agriculture activities, and animal husbandry are three of the most prevalent anthropogenic activities that pollute river water (Lee Goi, 2020; Toriman et al., 2012). Thus, it contributed to sediment, which is the process of solid materials that have been transported and deposited in a new area. Contamination occurs in many rivers because of sediment including silt and clay elements, as well as chemical and microbial components. In addition, suspended sediment (SS) in inland water was undertaken to track sediment discharge, erosion, deposition, and biological process impacts (Peterson et al., 2018). It was an important factor in determining the quality of water. As a result, monitoring the geographical distribution of SS in rivers is critical for assessing the impact of human activities and natural disasters as well as ensuring river sedimentation status quantity for river quality preservation.

Sedimentation is the process of transporting eroded materials by water, wind, or glacier (Kamarudin et al., 2017). Sediment movement is a major contributor to a variety of issues relating to river management and care. Monitoring the effects of environmental management on suspended sediment components is indispensable (Duan et al., 2013). Sedimentation in river is an important problem to be considered in water resource planning. Meanwhile, through the suspension movement in the flow, suspended sediment can transport a variety of contaminants with varying concentrations (Al-Mulkhtar, 2019). Suspended sediment plays an important function in water quality regulation, and it can result in a significant loss in stream capacity to handle flood tides (Nguyen et al., 2020). The uneven plate form of small and large suspended sediment, as well as considerable size differences in water suspensions, characterize the small and large suspended sediment. According to the Wang et al., (2019) study on suspended sediment using image J software, where the average of particle diameter of small and large suspended sediment from scanning electron microscope (SEM) image was 10.9 ± 1.2 and 125.4 ± 5.2 µm, respectively. Sediment concentration can contribute to river quality problems that cause turbidity in the body of water and emit unpleasant odors. River usually transports the high volume of suspended sediment which also alters the colour, smell, and quality of the water. Supported by Lim et al., (2020) where the high presence of suspended solids would impact the surface water's turbidity value, turning the water milky or muddy in appearance. This occurrence may have a negative impact on human health as well as aquatic life.

The degradation of river sedimentation status is linked to land use issues such as housing developments, the opening of industrial zones, trade, the building of infrastructural facilities, agriculture, and other activities. Land use land cover (LULC) is defined as the human use of land for economic, residential, conservation, recreational, and government purposes (Camara et al., 2019; Razali et al., 2018). Disposal of industrial waste causes significant changes to the sediment quantity in rivers. Nearly 60% of Malaysia's rivers are controlled for household, farming, and agricultural, industrial sectors, residential, sewage disposal, and urbanization, which are the principal pollution causes affecting the river's balance (Kamarudin et al., 2017). This pollution can also be classified into two, namely point source (PS) pollution and non-point source (NPS) pollution. In general, point source pollution is caused by a source that flows directly into the body of water through a channel that can be seen and detected clearly. Among them are those from sewage and industrial effluent. Meanwhile, NPS pollution is caused by large-scale land use activities, including logging, agricultural, and so on. Where, the cause of the pollution cannot be traced and seen clearly. Among the pollution emitted by the NPS is waste from the agricultural sector, including fertilizer (Liu et al., 2013), herbicides and insecticides (Enciso et al., 2014). Aside from that, soil erosion is the most common and severe non-point source of pollution (Sun et al., 2020). Saby et al., (2021), was supported with an example of NPS contamination from agricultural runoff, urban storm water, and atmospheric deposition, such as nutrients, sediments, and toxins.

Monitoring pollution-induced sedimentation requires an understanding of its movement and information of its destiny in the river. Traditional water quality monitoring needs in situ sampling, which has a time constraint (Saberioon et al., 2020), as well as time-consuming and expensive laboratory work that can only be done for particular regions of water body. to monitor sedimentation pollution, numerous current models are utilized. One of these models is Geographic information system (GIS) and remote sensing. Geographic information systems (GIS) are the most popular technology in monitoring sediment in large area. This is because GIS technology provides suitable information in the spatial and temporal domain and intricate database, which are important for natural resource management (Madloom et al., 2018; Kamarudin et al., 2015). There have several studies that using GIS technology in monitoring the quality of water in a wide area with variable parameter. In the Ganga River, Panwar et al., (2015) used the spatial interpolation and the inverse distance weighted (IDW) methods GIS to forecast the value of the primary parameter quality of water. Many of the primary parameters do not meet the drinking water quality criteria, according to the findings. To estimate average annual soil erosion in terms of geographical distribution and sediment deposition in the Lancang-Mekong River, (Chuenchum et al., 2020) used a revised universal soil loss equation using a GIS approach. The findings point to significant sediment erosion along the mainstream's flow path, which runs from the upper Mekong River to the Mekong Delta. Bashir et al., (2020), used spatial interpolation method through IDW approach in the Lower Jhelum Canal in Pakistan for assess the water quality index. The result indicates most of the water is in the suitable parameter for irrigation purpose and needs a treatment for the drinking purpose. Usali et al., (2010) explore how remote sensing and geographic information systems may be used to monitor water quality measures such as suspended matter, phytoplankton, turbidity, and dissolved organic matter. As summaries, remote sensing, and GIS techniques, in combination with computer modelling, are useful tools for future water resource planning and management, particularly for water quality control plans.

Pahang River is Peninsular Malaysia's longest river, stretching 459 Kilometres from the Tahan mountain range to the South China Sea (DID, 2009) and act as main water sources to the Pahang state. In this study according to (JPS,2022), the stations that involve are located in Pahang state at Lubuk Paku, Sg. Yap and Temerloh. The Pahang River Basin's communities are mostly reliant on agriculture (Mahsuri et al., 2019; Azid et al., 2015; Jaafar et al., 2010) and small businesses. As know, Malaysia had two type of monsoon which is Northeast monsoon and Southeast monsoon (Mohd et al., 2019; Wahab et al., 2019; Hanafiah et al., 2019). Pahang River was placed in the Northeast area where it will be impact toward the Northeast monsoon which happen between Novembers to January (wet seasons) and face a dry season in Jun to July (MET,2022). Due to climate change, it contributes to heavy rains and floods where the amount of suspended sediment also increases due to the changing flow of water currents. Pahang often experiences flood disasters due to high rainfall and extensive land use activities. According to the Lim et al., (2020) study on flood in Pahang River in 2014, where the outcome of suspended solids concentration in the water column rising was likely due to significant rainfalls, which were nearly three times more than the same month in the 2013 flooding seasons. These solids include sediment, silt, and sand as well as plankton and algae that are drifting or floating in the water. However, collecting SS data on a wide range is time consuming and costly. As a result, this study begins with a preliminary investigation to establish the SS pattern in the Pahang River using a Geographic Information System (GIS) method and its significant colour based on spatial analysis. In addition, this study also evaluates the factor and effects of sedimentation through water source management.

METHOD

Pahang river or known as Sungai Pahang in Malay was the largest river basin in peninsular Malaysia with the length 459 kilometres, located at longitude 101° 30' E to 103° 30'E and latitude 3° 00'N to 4° 45' N. it was the major river system in Pahang state, where it started from the Titiwangsa mountain range to the south

China sea. The Pahang River is separated to the Tembeling and Jelai rivers, which meet in Kuala Tembeling, it is 300 kilometers from the Pahang river's estuary. The climate of Pahang basin typically hot and humid, with an annual rainfall ranging from 2,000 mm to 3,000 mm on average. Station that involves in this was located alongside the Pahang River, Sungai Yap station, Temerloh station and Lubuk Paku station. The parameter that has been used in this analysis are suspended sediment (ton/year).

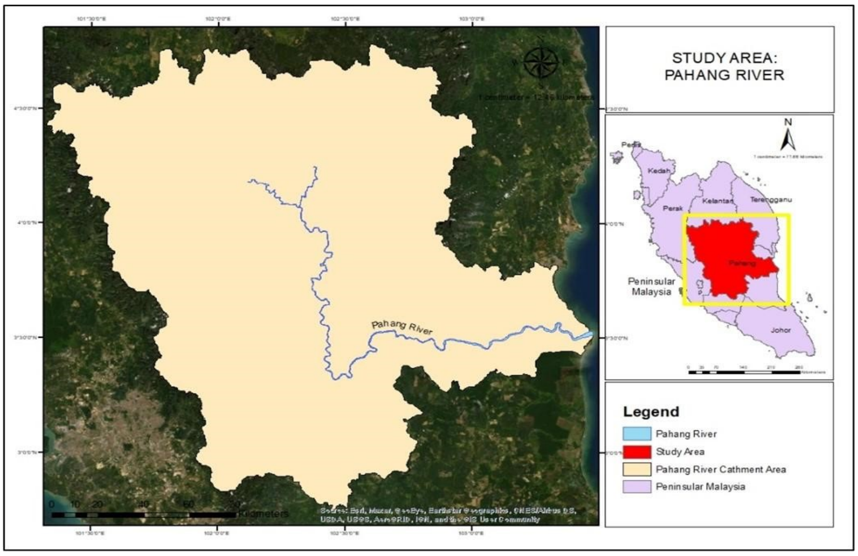

Figure 1: Study area of Pahang River in the state of Pahang

Data Set

The secondary data utilized in this study came from three DID Malaysia stations that were set up to monitor the sediment concentration of the Pahang River. However according to the Hishaam et al., (2016) because of gauge error, inaccuracy in data gathering, and sediment recorders, secondary data has both pros and downsides. Suspended sediment data for three stations at Pahang River was used to evaluate the pattern of suspended sediment in Pahang River, which is Sungai Yap station (upper station), Temerloh Station (middle station) and Lubuk Paku Station (Downstream station). The data used was in the years 2000, 2004 and 2008 for each station. The data that has been used was the current data from Department of Irrigation Malaysia.

Image Classification Technique

The application of Geographic Information System (GIS) method was used to examine the differentiation of Suspended Sediment for Pahang River during this year. Traditional water quality monitoring method can be replaced with the GIS observation because one of its major advantages where they can provide both spatial and temporal information on surface water characteristic, simple and widely used, as a result, it performs well when dealing with large volumes of data (Madhloom et al., 2018). Data processing involves a variety of task, including data preparation, data management, topological mapping, and quality management. The resulting data was analyzed in excel and path of river suspended sediment was modelling by using GIS ArcMap 10.7, analysis tools, and interpolating a raster surface from the point using inverse weighted (IDW) technique. Previous research has shown that IDW has indisputable advantages for data estimation in rivers due to its high accuracy, and it is commonly used in pollution modelling by some authors. Spatial interpolation had been used widely for climatology, physical geography, and geological application, and also in human and economic geography (Lam et al., 2009), and it suitable applied for pollution problem (De Mesnard, 2013), where it easy to understand, easy to used and flexible which make it more popular and commonly used.

Concept of Inverse Distance Weighted (IDW) Interpolation Method

In geostatistical information, IDW is a deterministic spatial interpolation process. This approach uses a linearly weighted combination of sample points to calculate cell values. It's a precise approach that ensures that a point's approximate value is influenced more by close known points than by those further away. All predicted values are inside the range of the known points maximum and minimum values, which is a significant parameter of IDW interpolation. The IDW formula is used to estimate the unknown of the monitoring station value Zˆ(S0) in site S0, using the observed Z values at the sampled locations, where the number of monitoring stations. The formula use in this study are following: -

Where:

$$\hat{Z}(S_0) = \sum_{i=1}^{n} WiZ(Si) (1)$$

$$Wi = doi^{-\alpha} / \sum_{i}^{n} doi^{-\alpha} (2)$$

$$\sum_{i}^{n} wi = 1 (3)$$

Each measurement is multiplied by the inverse of the distance $doi \geq 0$ from the station o to the station i with the exponent α. Then each product is divided by the sum of the term $1/doi^{-\alpha}$ over all the stations i so that the sum of all Wi's for an ensample station will be unity (Equation (3)). Depending on the interpolated variable, the power of the distance must be chosen accordingly (Madhloom et al., 2018).

RESULT AND DISCUSSION

Suspended Sediment by Month

Figure 3 until Figure 5 shows the graph of suspended sediment by month each year (2000, 2004 and 2008) at Sungai Yap station, Temerloh station, and Lubuk

Paku station. Climate change is also one of the impacts of SS concentration becoming higher in the Pahang River basin. As you know, Malaysia has two types of monsoons, which are the Northeast monsoon and the Southeast monsoon. The Pahang River was placed in the Northeast area where it will have an impact on the Northeast monsoon, which happens between November and January (wet seasons) and faces a dry season from June to July (MET, 2022). Due to climate change, it contributes to heavy rains and floods where the suspended sediment amount also increases due to the changing flow of water currents. The trend of suspended sediment graph for the year 2000 (figure 2.0) shows that the higher amount of SS was in January, among other months for Sungai Yap station. This may be because of northeast monsoon phenomena that happen every year and lead to the high transportation of sediment into the river. In the year 2000, the Temerloh and Lubuk Paku station graph pattern was horizontal, indicating that they received less than 10,000 tons per month for each month.

Human and environmental stressors also contribute to the high amount of SS in the river, threatening the quality of the fresh water and the entire ecological system. In the year 2004, the trend of the SS graph for Sungai Yap decreased from February until March. However, it increased from May until December. When compared to decades ago, the impacts of a natural disaster have also increased, with the impacts on humans and the environment more likely to be worse, owing to environmental degradation such as deforestation and increasing population, which causes an increase in land use for development. For Temerloh station, trend of the SS graph decreased from January until December. This may be due to the depletion of sediment that has been reduced. However, at Lubuk Paku station, the trend of the SS graph is still the same as in 2000, which is a horizontal trend. In the year 2008, trend of SS for Sungai Yap station is different from the years 2000 and 2004 because in January the amount of SS was lower than 20,000 tons per month, which led to the increasing pattern for this year until December. Meanwhile, Temerloh and Lubuk Paku stations received less than 10,000 tons of SS per year from January to December of 2008. For the last three years, Sungai Yap has received the highest monthly SS payments. The factors may be due to the receiving sediment from two outlets (Jelai River and Tembeling River), sediment re-suspension, development, and human behaviors. As is well known, the Jelai River carries the output from the highland area, which is Cameron Highland, which is undergoing rapid development because of tourism factors and land opening because of agriculture factors. Furthermore, in many cases of land removal for land use development purposes, droplets have been exposed to the ground surface area (Sisun et al., 2015). Moreover, heavy rainfall also led to a higher amount of SS in the river. Where the rainfall also contributed to the landslide in the high areas such as the Cameron Highlands, Genting Highlands, and Fraser Hills (Samy et al., 2014). The landslide event can contribute to higher SS in the river via rainfall droplets rather than water flow.

Therefore, development and land opening should be considered as they were the main factors for the highest amount of sediment in the river.

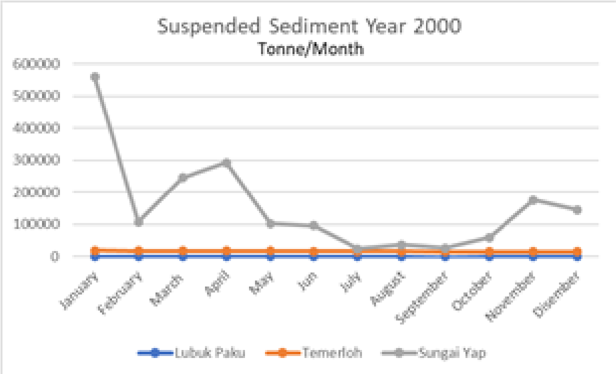

Figure 2: graph of suspended sediment by month in year 2000

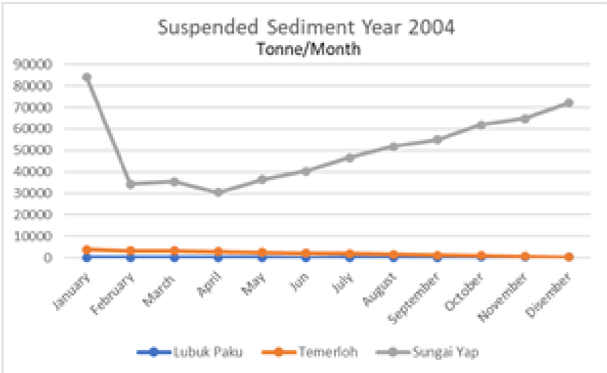

Figure 3: graph of suspended sediment by month in year 2004

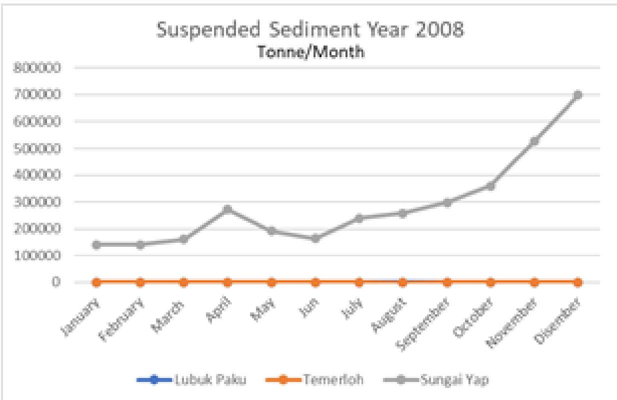

Figure 4: graph of suspended sediment by month in year 2008

Spatial analysis Suspended Sediment by Year

Three year of suspended sediment data (2000, 2004 and 2008) had been plotted and analysed. The table below showed the total of SS values (ton/years) in Pahang River at three stations for year 2000, 2004 and 2008. Total of SS values for these three years show that, the highest was in year 2008, where 3458097 ton/year at the upstream (Sg. Yap station) and the lowest is 1730.48 ton/year at the downstream (Lubuk Paku Station) in year 2004 (Table 1). Upstream shows a high value may be mainly affected by receiving output flow from two outlet, sediment re-suspension, development, and human behaviours.

Table 1: Total Value of SS concentration in Pahang River by years in three stations

	Total values of Suspended Sediment (Tons/Year)		
Years / **Stations**	**2000**	**2004**	**2008**
Sungai Yap (Upper stream)	1876575	613850.1	3458097
Temerloh (middle stream)	206001	25460.7	3320.9
Lubuk Paku (Downstream)	2966.6	1730.48	5930.77

The sorting and analysis results from three stations for three years were imported and process in GIS using spatial analysis technique which is inverse distance weighted interpolation method. Finally, the digital map of SS was produced for three years as shown in figure 5 until figure 7. Three different years of Pahang River SS was mapped using interpolation method for three station which is Sungai Yap (upper stream), Temerloh (middle stream) and Lubuk Paku (downstream) to determine the values of SS along the Pahang River. Pahang river is the longest river in Peninsular Malaysia and receive 1,600 mm/year rate of annual rainfall, the average humidity of 85% and mean temperature between 25°C to 27°C. Historically, largest flood had recorded happen at Pahang in year 1926 and 2014 which submerged and devastated approximately 1800km2 of lowland area (Lim et al., 2020).

Figure 5, figure 6 and figure 7 was showing the spatial distribution analysis of SS during year 2000, 2004 and 2008 where the blue colour represents for the lowest amount and red colour represent the highest amount during that year. Meanwhile, the light green colour represents for the moderate volume of SS. In year 2000, 2004 and 2008, Sungai Yap station receive a high amount of SS which is 1876575 ton/year, 613850.1 ton/year and 3458097 ton/year, respectively. It may be due to the receiving output flow from two outlet, sediment re-suspension, development, and human behaviours where the red colour was appeared in the spatial distribution analysis map. Meanwhile, the blue colour (lowest amount) appears at the Temerloh and Lubuk Paku station for three year of 2000, 2004 and 2008. The amount of SS for Temerloh station for year 2000, 2004 and 2008 was 206002 ton/year, 25460.7 ton/year and 3320.9 ton/year, respectively. Where in Lubuk Paku station the amount of SS for year 2000 was 2966.6 ton/year, year 2004 was 1730.48 ton/year and year 2008 5930.77 ton/years.

Pahang River experienced major flood disaster in November 1994, December until January 1999, and December 2007 (Hishaam et al., 2016). The change of appearance colour in spatial distribution analysis in each year may be due to the major flood disaster a year before which is in year 2007 at Pahang. Where contributed to various impact toward community and river itself as example high sedimentation at downstream area, destruction of properties and so on (Kamarudin et al., 2015). The northeast and southwest monsoons, as well as significant rainfalls, can impact the trend of stream flow and water level in the Pahang River, either indirectly or directly. According to the Lun et al., (2011); Othman et al., (2017) the amount of extreme rainfall is likely to cause overflow, trigger to the landslide events and increase the flood risk in Pahang River. Where this led to the destruction of the physical environment, economic, education sector, social structure, and towards health.

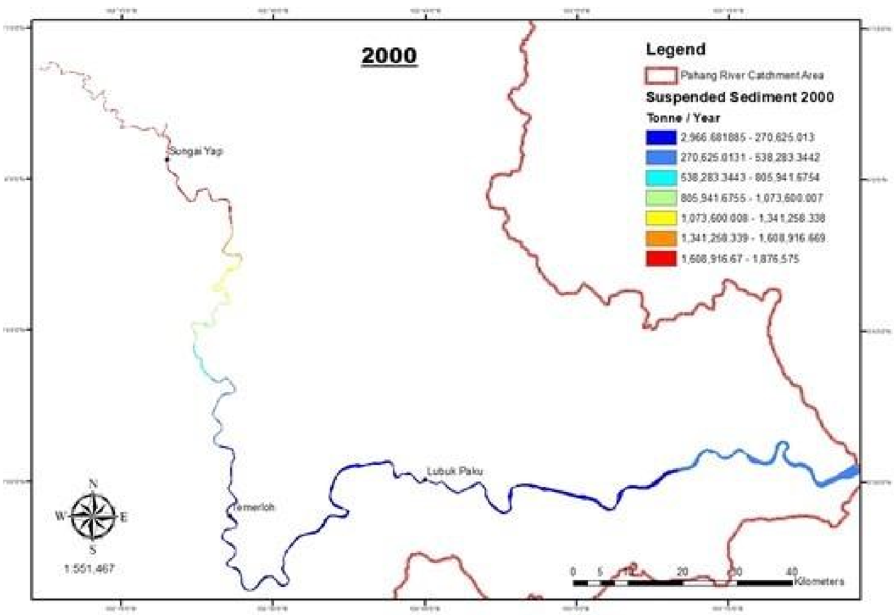

Figure 5: Map of Suspended Sediment year 2000 in Pahang River

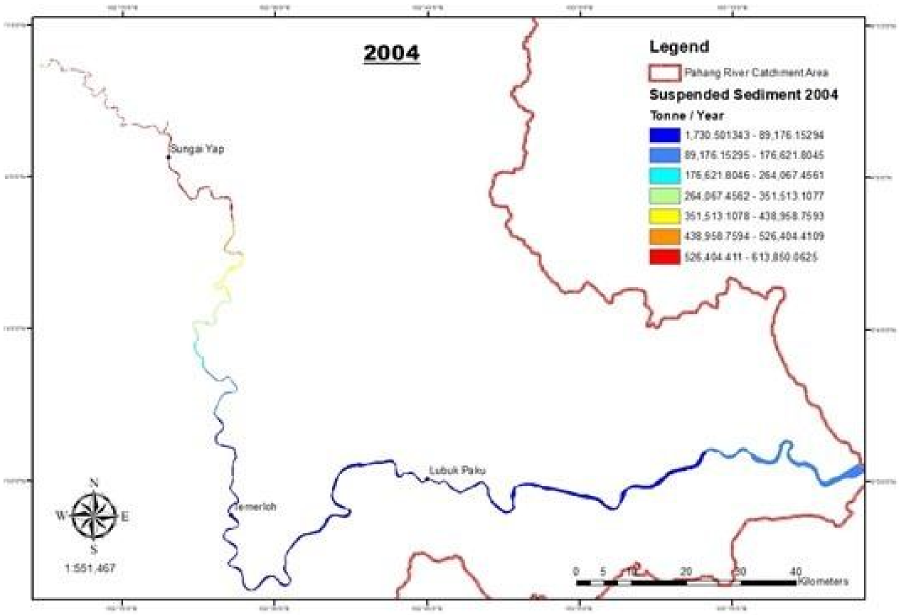

Figure 6: Map of Suspended Sediment year 2004 in Pahang River

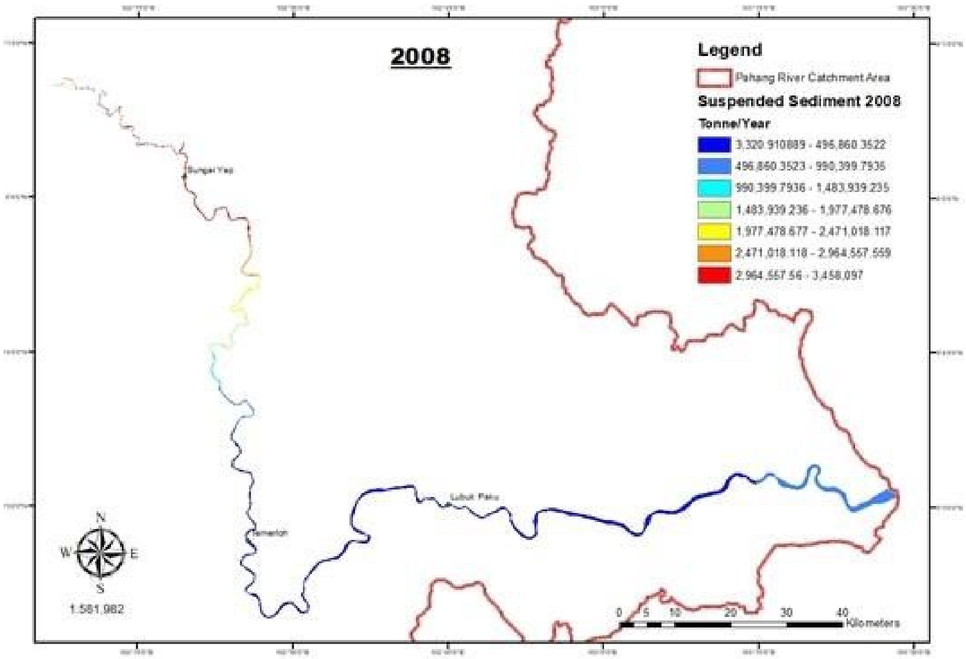

Figure 7: Map of Suspended Sediment year 2008 in Pahang River

Pattern of spatial analysis for the SS in Pahang River mostly the higher receiver of SS amount was Sungai Yap station, which were mainly affected by sediment re-suspension and the runoffs from the outlet of Tembeling river and Jelai river. Meanwhile for both Temerloh and Lubuk Paku station mostly receive low amount of SS. Sungai yap was located in Kampung Guai in Pahang and 62m above the sea water level. Even though it located in the rural area, it receives water from two sources, resulting in sediment dumping at the same time. According to the Lee et al., (2017), river water quality at the upstream was worse than downstream area because of the low inflows from small tributaries than the area downstream which close to the open ocean and directly affected by the tide. The flow of sediment into rivers comes in various forms, among them is the management of source and non-source resources that can cause the shallowness of the river and affect the quality of water resources. According to Toriman et al., (2012) shallow rivers and lakes can also occur due to the occurrence of large sedimentary reservoirs, which thus make it possible for the area to experience flooding. Therefore, efficient management of water resources in terms of water supply to humans and aquatic life must be adequate and meet the standards in terms of water quality and it is very important.

Point source management

The main cause of point source pollution can usually be seen clearly (Toriman et al., 2012). When harmful substances are pumped directly into a body of water, this is known as point source pollution. The "end of pipe" discharge from any known or identifiable sites throughout the water body indicates this. Through regular monitoring at specified river locations, point source pollution is extremely straightforward to analyses and reduce (Chen et al., 2014). For example, the construction site and livestock area, where the silt will be carried from the original location to the replacement line system, pollute the water. However, in China the basin, contamination from point sources such as industrial wastewater and municipal household wastewater has been effectively reduced (Sun et al., 2020). Point source pollution management is very important in ensuring the developer's compliance in implementing mitigation measures to reduce the quantity of sediment that enters the river.

This can disrupt economic, social activities, and human well -being in the long run, especially if it involves water treatment plant areas. However, many researchers suggested to implement and tightening the EIA application in order to achieve the effective water conservation and management. Some mitigations to tightening Environmental Impact Assessment (EIA) regulations, where developers may be restricted, such as creating buffer zones for development and deforestation, making major rivers restricted zones, prohibiting large-scale deforestation in the highlands, restricting mining in forest reserves and water bodies, and applying sediment management to all types of development, are necessary to better cope with global change. The most efficient technique for forecasting and then limiting the effects of sediment is to use sediment management measures that have been stated in the EIA. Where the developers can receive guidance on how to reduce the sediment load entering the mainstream. As a result, policymakers and decision makers in the water resources management field must grasp the processes of sediment transport and yield, as well as their effects on sedimentation in reservoirs, shallow harbours, and channels (Choubin et al., 2018).

Non-point source (NPS) management

In general, non-point sources (NPS) are due to large-scale land use activities, which are difficult to specify the area of pollution waste production. NPS pollution was the most important source of water pollution where it mostly comes from agriculture (Enciso et al., 2014). Saby et al., (2021), also supported the finding of NPS pollution was from agriculture, meanwhile there has another factor that contribute to the NPS which is urban stormwater and atmospheric deposition. Another finding of NPS pollution factors by (Chen et al., 2014), was sporadic due to erratic climate conditions and human actions where it has the potential to significantly impair water resources. Rivers provide 98 percent of the water used, and the agricultural industry uses 70 percent of the water available (Lee, 2020). The growing tendency of converting land usage into agricultural land increases the amount of eroded soil that enters water basins. According to Liu et al., (2013) agricultural non-point source pollution is influenced by a variety of factors including land use, conservation tillage, cover crops, fertilization rate and timing, biocontrol, buffers strips, watershed management structures, grass rivers, and parallel terraces (ANSP). Pesticides and heavy metals from agricultural soil were washed into bodies of water during the soil erosion process. The research of open vegetable farming had the highest erosion rate, estimated at 82 t/ha/year, and the runoff, which delivered a substantial quantity of nutrient and heavy metals to the water bodies flow, was 69 percent by rainfall (Razali et al., 2018). Heavy rainfall releases energy sources that can erode the soil surface and flow into water bodies. Supported by Toriman et al., (2012) which is stated that the energy produced by raindrop impacts on the soil surface causes soil erosion.

Among the measures in the mitigation of non-point sources is the practice of Best Management Practices (BMPs) that have been used by most countries. BMPs are management measures, either structural or non-structural, that are aimed to decrease the negative impacts of agricultural operations on water quality, and it can regulate ASNP in a systematic manner. Where it also covers fertilization management and contour farming management, which will help in reducing ANSP. According to the Liu et al., (2013) when compared to straight tillage, conservation tillage and shape farming, can reduced the runoff by 15.99% and 9.16% respectively. Meanwhile, rehabilitation and management from the aspect of forest management can also help in dealing with soil erosion, where a thick canopy cover can help in reducing the erosion energy produced by rainwater droplets on the soil surface. In addition, the grip of the tree roots on the soil can also help in reducing erosion and sediment flow into the water body. Supported by Kamarudin et al., (2015) which stated that tree roots and existing plants can control naturally the process of surface runoff. Mitigation through the replanting of grass on soil terraces can also help in reducing soil erosion.

CONCLUSION

Pahang is one of the places in Peninsular Malaysia that is affected by the Northeast monsoon every year. This study tries to understand and classify the SS of the Pahang River this year and the factors that contribute to the SS amount in the river flow. SS flow to the river was contributed by point source and non-point source pollution with different movements such as rainfall and velocity speed. Overall, based on this study, using the IDW spatial interpolation method, the upstream of the Pahang River receives a high amount of SS every year. It may be due to the effect of sediment re-suspension and the runoff from the outlet of the Tembeling river and Jelai river. It's difficult to entirely enhance the quality of water because of the combined effects of point source (PS) and nonpoint source (NPS) pollution on the environment.

Water resources are an important component to humans, so measuring and monitoring the quality of water are very important for further decision making and actions. However, Pahang River gets a very high concentration of SS, resulting in water contamination and contributing to the prevalence of health concerns among Pahang residents. Another way to avoid a high amount of sedimentation status is through the appropriate management and treatment of industrial and municipal wastewater.

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