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The Analysis of Large Dam Impacts on Sediment Grain Size Distribution in a Tropical River System

Mohammad Haroon Hairan [1, 2], Nor Rohaizah Jamil [1, 3*], Mohammad Noor Amal Azmai [4, 5], Ley Juen Looi [3, 6], Ahmad Zaharin Aris [3, 6], Mohd Hafiz Rosli [7]

[1] *Water Resource Laboratory, Department of Environment, Faculty of Forestry and Environment, Universiti Putra Malaysia (UPM), Serdang, Malaysia.*

[2] *Department of Natural Resources Management, Faculty of Environment, Kabul University, Jamal Mena, PD. 4, Kabul 1006, Afghanistan.*

[3] *Aquatic Ecosystem and Management Laboratory, International Institute of Aquaculture and Aquatic Sciences (i-AQUAS), Lot 960 Jln Kemang 6, Port Dickson 71050, Negeri Sembilan, Malaysia.*

[4] *Department of Biology, Faculty of Science, Universiti Putra Malaysia (UPM), Serdang, Malaysia.*

[5] *Aquatic Animal Health and Therapeutics Laboratory, Institute of Bioscience, Universiti Putra Malaysia (UPM), Serdang, Malaysia.*

[6] *Department of Environment, Faculty of Forestry and Environment, Universiti Putra Malaysia (UPM), Serdang, Malaysia.*

[7] *Laboratory of Food Safety and Food Integrity (FOSFI), Institute of Tropical Agriculture and Food Security (ITAFoS) Universiti Putra Malaysia (UPM), Serdang, Malaysia.*

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Abstract

Sedimentation is a natural phenomenon of rivers that is enhanced by modification of the river basin. The presence of dams delays the exchange of sediments, nutrients, and organisms between the terrestrial and aquatic environments. This article assesses the impact of the Selangor dam on the sediment grain size distribution and its association with river velocity and discharge. The fieldwork for sampling is conducted in the normal and rainy seasons. The samples were analyzed through a sieve analysis procedure to determine the particle size of the sediments. After the sieve analysis technique, GRADISTAT analysis was performed on the output. The GRADISTAT analysis classifies the sediments between sandy gravel and sand, and the median grain size (D50) ranges from 4.00 to 0.18 mm. The spatial distribution of the D50 shows that the bed-load sediments of the upper Selangor River are becoming fine-grained downstream. The skewness of the sediments differs from 0.86 to 8.44, which indicates that the sediments are poorly to moderately well sorted. The Spearman's correlation of the D50 and river velocity and discharge determine no association of the D50 with river velocity and discharge. The stations near Selangor Dam have high slopes and receive "sediment hungry" water that washes small-sized sediments; therefore, the upper stations have a more significant amount of gravel and large sand.

Keywords: Sedimentation; Particle Size Distribution; Selangor River; River Morphology; River Discharge.

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1. Introduction

Most of the world's large rivers are dammed to fulfil the increasing human demand for efficient and inexpensive electricity [1], navigation, recreation, flood control, water supply, and irrigation [2, 3]. The valuable economic services and commodities provided by such river systems to societies are of great importance and are widely recognized [4]. In

* Corresponding author: norrohaizah@upm.edu.my

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addition, according to Wohl (2015) [5], there are three sets of human activities that can reduce or eliminate sedimentation within rivers. The first set of activities is changes in land use land cover within the upstream that reduce the supply of sediments to the river channels by trapping and storing them in upstream dams and reservoirs. The second set of activities can increase sediment transport within the river channel by increasing the water supply to the channel. These activities include flow regulation that increases channel discharge or minimizes channel complexity. The third set of activities breaks the connection of channels with floodplains; examples include levees and the removal of within-channel obstructions such as logjams and beaver dams [4, 5]. The presence of dams can affect the river ecosystems in many ways, such as alteration of the natural flow cycle, modification of physical and biological features of the river channel and floodplain, and fragmentation of the river's continuity. The delay of sediments, nutrients, and organism exchange among the terrestrial and aquatic environments due to restrictions on overbank floods in a dammed river is also among the possible impacts [2]. Apart from modifying the timing [5], magnitude, frequency, duration, and rate of change of flow [6], dams alter the natural flow by changing the transport of riverine sediments, nutrients, and biota. The reservoirs block sediments and nutrients that reduce the water storage capacity, eventually affecting downstream floodplains by receiving fewer nutrients and organic matter [7].

One of the most severe and extensive global environmental problems is soil erosion, which is increased by tillage, overgrazing, land-use change [8], construction, and unsustainable agricultural practices [9]. The critical parameters for identifying soil erosion processes are rainfall characteristics, rates of infiltration and surface runoff, properties of soil, and surface features, such as steepness and length of slope [10, 11]. Therefore, it is believed that more soil erosion will cause an increase in the sedimentation in the river.

Sedimentation is a natural phenomenon of rivers, increased by land-use changes that introduce sediment deposition anthropogenically. Other than that, mineral extraction, construction, and excessive agriculture can also increase suspended solids and sedimentation in rivers and streams, which are among the leading causes of decline in habitat quality [12]. The role of sediment transport in large rivers is enormous in the earth’s surface’s chemical, biological, and geological processes [13]. Dams affect sediment transport along with water discharge, which depends on the reservoir size; the larger the reservoir, the more significant sediment will be trapped [3, 14]. Large reservoirs are more than 99% efficient in trapping sediments, while the smaller ones are tiny. The reservoir's location also impacts sediment trapping; i.e., the aquatic ecosystems both upstream and downstream of the reservoir are frequently disturbed by greater amounts of soil erosion, especially in the arid and tropical regions. Trapping most of the sediments in a reservoir does not mean the downstream water of the dam will be relatively more transparent. Density currents released from dams with high sediment loads can increase the turbidity, but because of the finer size of the sediments, they do not take part in shaping the stream channel. Moreover, the high sediment loads downstream of a dam may be caused by soil erosion by the tributaries of the main channel joining downstream of the reservoir [3].

The regulation of flow in dry and wet seasons through large dams for water consumption and flood control can lead to sediment fluxes to the sea. For example, in Lake Nasser, extensive barrages and irrigation channels on the Nile River trap the sediments; therefore, Egypt's Mediterranean Coast receives no sediment. Similarly, the Manwan reservoir, built in the Mekong River's upper reaches, sequesters most of the sediment in Vietnam [14], despite sediment being the essential element of rivers and their linking waterways. As the flux of sediments controls the deposition rate in a delta, the processes of sediment transport receive greater attention from researchers due to climate change, human activities, and sea-level rise. At the same time, the concentration of suspended sediments affects the water quality and sunlight penetration through the body of water [15, 16].

In conclusion, grain size plays a vital role in arranging sediment supplied by a high-gradient river system, from sand to large boulders. The supplied sediments of many rivers are sorted vertically; the coarse grains are placed on the bed surface, while the fine sediments are in temporary storage [17]. The particles of finer sizes are carried away more efficiently than the coarse particles because of their low settling velocities. Hence, as the distance from the source materials increases, the sediments are increasingly enriched in clay and silt particles [18]. Moreover, this significantly impacts the ecology, geomorphology, and engineering of the aquatic environment [15]. The texture and composition of sediment characteristics are considered essential characteristics of the sedimentation process because they can reflect the river basin’s geologic, climatic, and hydrographic conditions [19]. This study aims to assess the effects of the Selangor dam, river velocity, and discharge on the downstream sediment grain size distribution.

1.1. Sediment Grain Size

Grain size is one of sediments’ most critical and essential physical characteristics of in sedimentology. It is widely used to quantify sediment size, composition, and texture, to help understand the geochemical characteristics and sediment transport and sorting dynamics [20-23]. In addition, in a wide area of research in sedimentology, it is extensively used as an indicator of hydrodynamic conditions. The reconstruction of past variations in precipitation patterns and wind from varied sediments of fluvial and aeolian origin in ocean basins and the variation in the bottom currents of the ocean are based on grain size [22]. The grain size analysis is essential for defining the sediment size fractions within a watershed context, which are transported from the river upstream to the downstream and marine environment. These particles can influence the clarity of the water in the river in both flood and normal conditions [20].

The changes in the particle size distribution of fluvial sediments are affected by soil redistribution. Grain size is the fundamental characteristic of fluvial sediment in the determination of bed-load transport, deposition, and suspended sediment prediction, as it provides some of the essential information regarding the fundamental properties of sediments, such as physical characteristics in managing the morphology of channel and stream hydraulics [24, 25]. The erosion and transportation of clay and silt particles which lead to the enrichment of sediments, attract chemical pollutants very easily. The fining process downstream is affected by coarse and fine-size fractions of the sediments, as the sorting can be continuously enhanced downstream, where higher fining rates can occur [24].

Many reputable techniques and methods have been developed to measure and analyse sediment grain size [20]. These techniques help researchers conduct grain size distributions or particle size distribution studies. As a fundamental physical property, the particle size distribution (PSD) or grain size distribution (GSD) is used to classify soil and estimate hydraulic properties. PSD is presented as a percentage of the total dry weight of soil occupied by a given size fraction [26]. Several methods are available for determining sediment GSD [27, 28]. The sand-sized or greater particles can be determined using the sieving method. The sieve is defined by the diameter of the mesh hole through which a particle can pass [26]. The sieve analysis method is used for sand-sized particles, although silt-sized particles can also be sieved [29]. There are various available scales of grain size that are divided into different categories, which are shown in Table 1.

Table 1. Scale of grain size adopted from various standards [21]

Grain Size	Descriptive Terminology			
mm/µm	Udden (1914) and Wentworth (1922)	Friedman and Sanders (1978)	GRADSTIT Program	
64 - 32 mm		Very Coarse Pebbles	Very Coarse	
32 - 16 mm	Pebbles	Coarse Pebbles	Coarse	
16 - 8 mm		Medium Pebbles	Medium	Gravel
8 - 4 mm		Fine Pebbles	Fine	
4 - 2 mm	Granules	Very Fine Pebbles	Very Fine	
2 - 1 mm	Very Coarse Sand	Very Coarse Sand	Very Coarse	
1 mm - 500 µm	Coarse Sand	Coarse Sand	Coarse	
500 - 250 µm	Medium Sand	Medium Sand	Medium	Sand
250 - 125 µm	Fine Sand	Fine Sand	Fine	
125 - 63 µm	Very Fine Sand	Very Fine Sand	Very Fine	
63 - 31 µm		Very Coarse Silt	Very Coarse	
31 - 16 µm		Coarse Silt	Coarse	
16 - 8 µm	Silt	Medium Silt	Medium	Silt
8 - 4 µm		Fine Silt	Fine	
4 - 2 µm		Very Fine Silt	Very Fine	
2 µm	Clay	Clay	Clay	Clay

2. Material and Method

2.1. Study Area

The study was conducted in the Selangor River Basin, and the samples were collected from the main Selangor River and its tributary, the Tinggi River (Figure 1). The Selangor River basin is situated in the western part of Peninsular Malaysia in the state of Selangor. The Kelang basin surrounds the river basin from the south and the Bernam basin from the north. The basin falls between the latitude and longitude of 3 ° 45″ N, 101° 50″ E, and 3° 15″ N, 101° 10″ E [30-32]. The catchment area of the river basin is 2200 Km^2, almost 28% of the total area of Selangor state [33], [34]. Hulu Selangor, Kuala Kubu, Batang Kali, Kerling, Hulu Rening, Sungai Tinggi, Rantau Panjang, Rawang, Tanjung Karang, and Kuala Selangor are the sub-basins of the Selangor River basin [35, 36]. The source of the Selangor river is at an altitude of 1500 m from MSL, in a natural forested area, and it flows in a southwesterly direction at a distance of about 110 km before draining into the Straits of Melaka [37, 38]. Since the river basin serves as a source of public water supply for the state of Selangor and the Federal Territory of Kuala Lumpur, therefore, two large dams named Tinggi and Selangor Dams were constructed in this basin in 1996 and 2002, respectively [39], which generate 2500 million liters water per day [38]. Many agricultural activities include palm oil cultivation, vegetable farms, rubber and maize plantations, and freshwater fish aquaculture farms for human consumption in the river basin. However, still, a large part of the basin (70%) is covered by natural forests [38, 39].

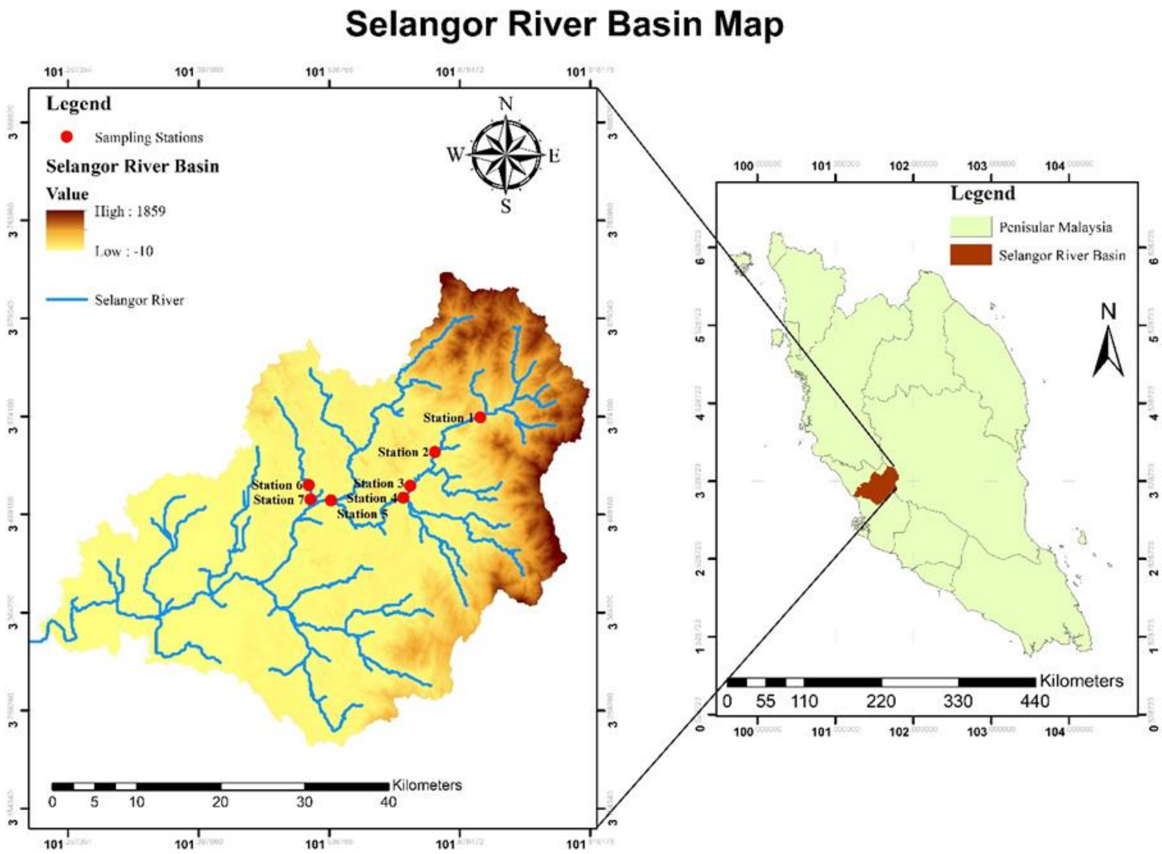

Figure 1. Selangor River Basin Map

Like the other river basins worldwide, the Selangor basin can also be divided into upstream and downstream. The relief of the basin is very diverse. The upstream part of the river has fast-flowing streams in the mountainous region formed by granite and some small isolated areas with sedimentary bedrock, which also have several waterfalls. The downstream of the river flows in a fluvial plain where it becomes a low-gradient and meandering river. The altitude of the river in its last 30 – 40 km is nearly touching zero, and at some points, it becomes below zero meters [40]. While the midsection of the basin is formed by meta-sedimentary faces of Carboniferous rocks, which make the most prominent geologic features near Rawang [46]. The river's flow has a seasonal variation that depends on the rainfall. The flow increases to 122 m^3/s and falls below 23 m^3/s [40]. In contrast, during the dry season, when the natural flow is less than the abstraction, 3.47 m^3/s of residual flow is released from the dam as environmental flow to conserve the downstream ecosystems [33]. Selangor river and its tributaries provide raw water for many water treatment plants (WTPs) in the river basin. The average flow received by the streams throughout the year is 20 m^3/s and has a slight variation throughout the year. The treatment plants include Batang Kali WTP, Rasa WTP, Rantau Panjang WTP, and the Selangor river water supply scheme [35].

2.2. Sampling and Data Collection

The sediment samples for this research were collected in the upstream part of the Selangor River basin during the normal and rainy seasons in April and October 2021, respectively. Three samples, each from the river's right, middle, and left banks, were taken from each station. There are 21 samples collected during each fieldwork (normal and rainy seasons). The Ekman Grab Sampler was used to collect sediment samples from the bottom of the river, and roughly 1 kg of the sample was collected at each sampling point. The grab sampler can collect the solely transported suspended material along with the sediments during the sampling procedure [24].

The samples were stored in zip-lock plastic bags, properly labelled, and brought to the laboratory for analysis. The samples were dried in an oven at 104 °C for 24 hours before sieving [41]. After 24 hours of drying (Figure 2), the samples were gently crushed in a mortar jar [26]. The samples were then taken to the sieve analysis procedure, where nine numbers of sieves, i.e., 8.0 mm, 4.0 mm, 2.0 mm, 1.0 mm, 0.63 mm, 0.50 mm, 0.20 mm, 0.16 mm, and 0.075 mm were used in descending order [41]. A pan and lid were placed on the bottom and top of the sieves set, and then the complete set was placed on the mechanical shaker for 10 minutes [24]. After shaking the sediment sample, the retained amount of sediment on each sieve and pan was weighed using an electronic digital scale [29]. The logbook was completed, and the percentage of retained weight and percentage finer of each sieve were calculated using the following equations:

$$\% \text{ Retained on a Sieve} = \frac{W_s \times 100}{W} \quad (1)$$

$$\% \text{ Finer} = 100 - \text{Cumulative } \% \text{ Retained} \quad (2)$$

Figure 2. Sediments samples after drying in Oven

Ws is the weight of sediment retained on a particular sieve, and W is the total final weight of the sediment sample. After calculating the percentage finer of the sediments, the samples' median diameter (D50) was calculated and plotted on the graphs [41].

Moreover, the water depth and velocities were also measured using a current meter and measuring pole in all sampling stations during the fieldwork (Table 2). The collected data on water depth and water velocities were used to calculate the river discharge using the following equation:

$$Q = V \times A \quad (3)$$

where Q is the discharge of water, V is the average velocity, and A is the cross-section area. The complete flowchart of the methodology is shown in Figure 3.

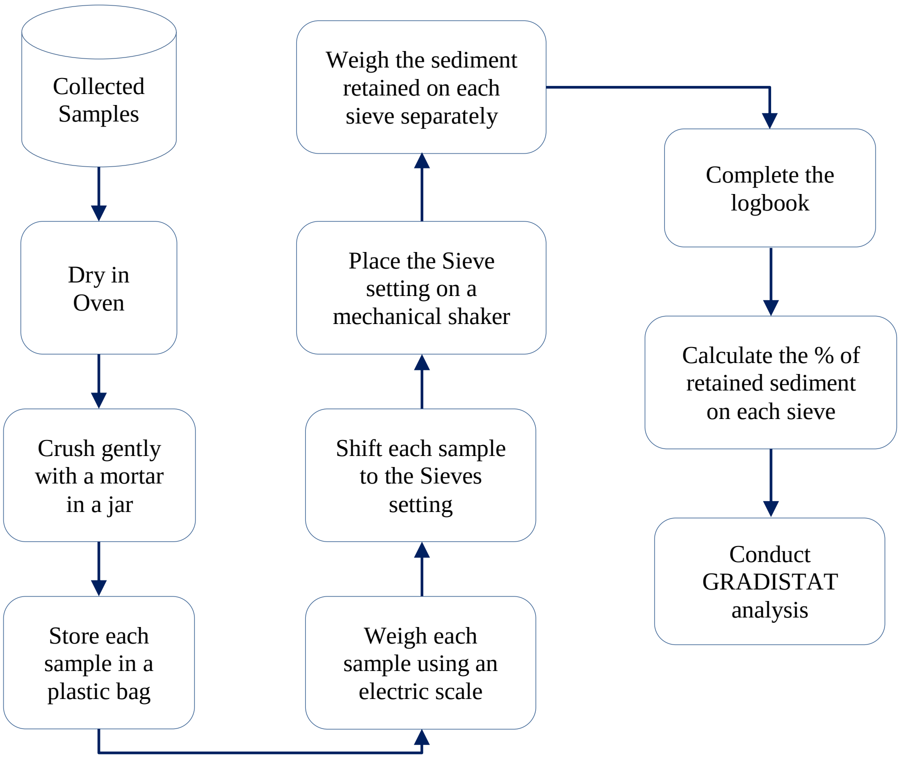

Figure 3. Workflow of the methodological process

Table 2. Substrate grain size percentage in different flow conditions

Percentage of Substrate Type in Sampling Stations									
Substrate Type		**Silt**		**Sand**		**Fine Gravel**		**Gravel**	
Station	**Bank**	**Normal Flow**	**High Flow**	**Normal Flow**	**High Flow**	**Normal Flow**	**High Flow**	**Normal Flow**	**High Flow**
Station 1	Right	0.1	0	36	21.19	60.9	32.71	3	46.1
	Middle	1	0	42	32.75	47	44.64	10	22.61
	Left	0.1	0	65	29.64	34	55.68	0.9	14.68
Station 2	Right	1	0	90	67.55	9	31.2	0	1.25
	Middle	1	0	69	48.42	30	44.22	0	7.36
	Left	0.7	0	95.8	74.56	3.5	22.54	0	2.9
Station 3	Right	3	15.13	80	78.47	17	6.4	0	0
	Middle	11	0.05	88	26.7	1	56.38	0	16.87
	Left	5	5.97	94	88.9	1	5.13	0	0
Station 4	Right	1.5	0.04	88.5	99.7	10	0.26	0	0
	Middle	8	0.08	90	97.92	2	2	0	0
	Left	11	0.56	85	99.1	4	0.34	0	0
Station 5	Right	12	12.98	80	82.84	8	4.18	0	0
	Middle	13	4.25	78	94.44	9	1.31	0	0
	Left	15	5.2	79	94.6	6	0.2	0	0
Station 6	Right	17	2.15	82	96.37	1	1.48	0	0
	Middle	6	7.65	85	91.11	9	1.24	0	0
	Left	3	5.58	97	93.74	0	0.68	0	0
Station 7	Right	7	1.5	92	97.25	1	1.25	0	0
	Middle	6	0.19	93	93.41	1	6.4	0	0
	Left	2	0.52	97	99.33	1	0.15	0	0

2.3. GRADISTAT Analysis

Sediment analysis is a laborious technique that has been applied in this research. Besides that, GRADISTAT, which is a computer-based program for the analysis of grain size of sediments that can calculate various statistical properties arithmetically and geometrically [21], is also used for sediment analysis in this article.

2.4. Statistical Analysis

The statistical analysis of collected data from river bed sediments and the hydrology of the river flow are statistically analyzed using SPSS software. The data were tabulated and arranged according to the grain sizes of the sediments based on sampling time and locations. All the data are primary and based on a field investigation of the river, which focuses on river flow characteristics, such as velocity, depth, and discharge, as well as river bed sediments.

The relationship between sediment grain size, river discharge, and velocity has been studied. Therefore, since the data of two variables (D50 and discharge) is not normally distributed, a non-parametric analysis called Spearman's correlation test was conducted to study the relationship between the variables [42].

3. Result and Discussions

3.1. Textural Distribution

The results of GRADISTAT textural analysis of river bed sediments of the upper Selangor River show that they have a sandy nature. The sediments were classified between sandy gravel and sand, with the median grain size (D50) between 4.00 mm and 0.18 mm. The largest size of the D50 was recorded at the uppermost sampling station (station 1), while the smallest size was recorded at the lowermost station (station 7) (Figure 1). Therefore, from the spatial distribution of the median grain size or D50, it can be noticed that the bed-load sediments of the upper Selangor River are becoming fine-grained towards the downstream (Figure 4). Figure 4 also indicates that the D50 grain size of the river bed sediments is bigger in the rainy season compared to the dry season.

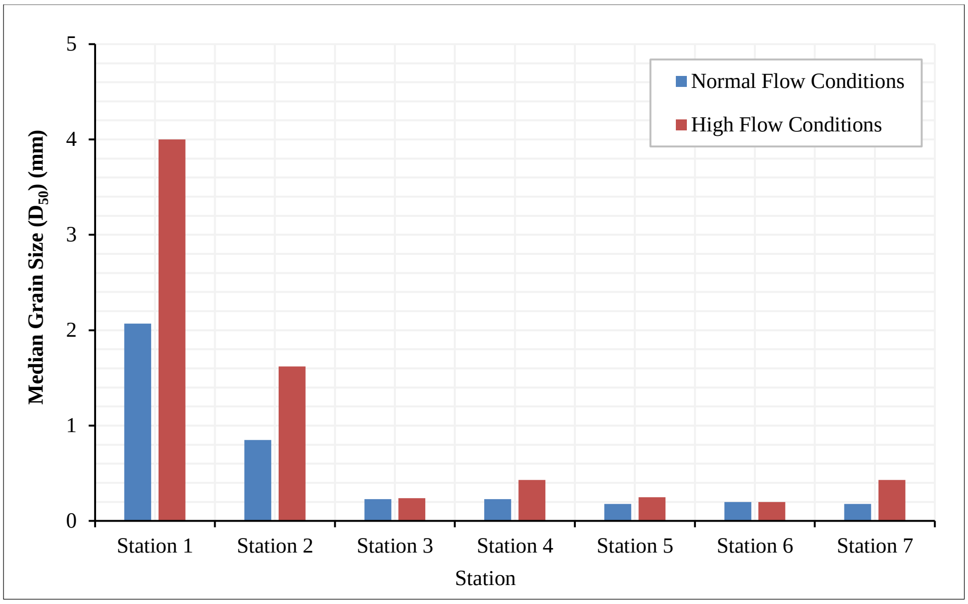

Figure 4. Median of sediment grain size (D_{50})

The sorting of the sediments can be determined by the skewness of the sediments' grain size [19]. The skewness of the sediments differs from 0.86 to 8.44, which indicates that the sediments are poorly to moderately well sorted throughout the stations under both climatic conditions. The higher the skewness, the lesser the variation in grain sizes and the smaller the D50 with good sorting (Table 3). One of the probable reasons behind the poor sorting of the sediments is the width of the river, which varies in different areas. In some areas, the width of the river channel is smaller compared to other areas, which causes higher velocities of the river flow and leads to river bed weathering. As a result, the smaller sediment is washed out downstream.

Table 3. GRADISTAT statistics of river bed sediments

Sampling	Station	Sample Type	Textural Group	Sorting	Skewness
Normal Flow Condition	Station 1	Unimodal, Poorly Sorted	Sandy Gravel	Poorly Sorted	0.86
	Station 2	Unimodal, Poorly Sorted	Gravelly Sand	Poorly Sorted	2.28
	Station 3	Unimodal, Poorly Sorted	Gravelly Sand	Poorly Sorted	3.38
	Station 4	Unimodal, Poorly Sorted	Gravelly Sand	Poorly Sorted	3.06
	Station 5	Bimodal, Very Poorly Sorted	Gravelly Muddy Sand	Very Poorly Sorted	2.01
	Station 6	Unimodal, Poorly Sorted	Slightly Gravelly Sand	Poorly Sorted	4.09
	Station 7	Unimodal, Moderately Sorted	Slightly Gravelly Sand	Moderately Sorted	8.44
High Flow Condition	Station 1	Unimodal, Moderately Well Sorted	Sandy Gravel	Moderately Well Sorted	0.62
	Station 2	Unimodal, Poorly Sorted	Sandy Gravel	Poorly Sorted	1.25
	Station 3	Bimodal, Very Poorly Sorted	Gravelly Muddy Sand	Very Poorly Sorted	2.42
	Station 4	Unimodal, Moderately Sorted	Slightly Gravelly Sand	Moderately Sorted	3.35
	Station 5	Unimodal, Poorly Sorted	Slightly Gravelly Sand	Poorly Sorted	4.84
	Station 6	Unimodal, Moderately Sorted	Slightly Gravelly Sand	Moderately Sorted	6.86
	Station 7	Unimodal, Moderately Sorted	Slightly Gravelly Sand	Moderately Sorted	3.06

The soil texture diagram of the river bed sediments of all stations of the samplings was also plotted using GRADISTAT (Figure 5). The samples have a sandy texture and vary from sand to sandy gravel. The texture of about 50% of the samples was slightly gravelly sand. Moreover, the remaining 50% of the samples had the texture of sandy gravel, gravelly sand, gravely muddy sand, and sand. So from this figure, it can be concluded that the river has a gravelly sandy texture because of the high gradient of the upper parts of the Selangor River compared to the lower part. Upon going downstream, the sediment grain size decreases and gains a sandy, silty nature, as this argument is supported by many pieces of literature [43].

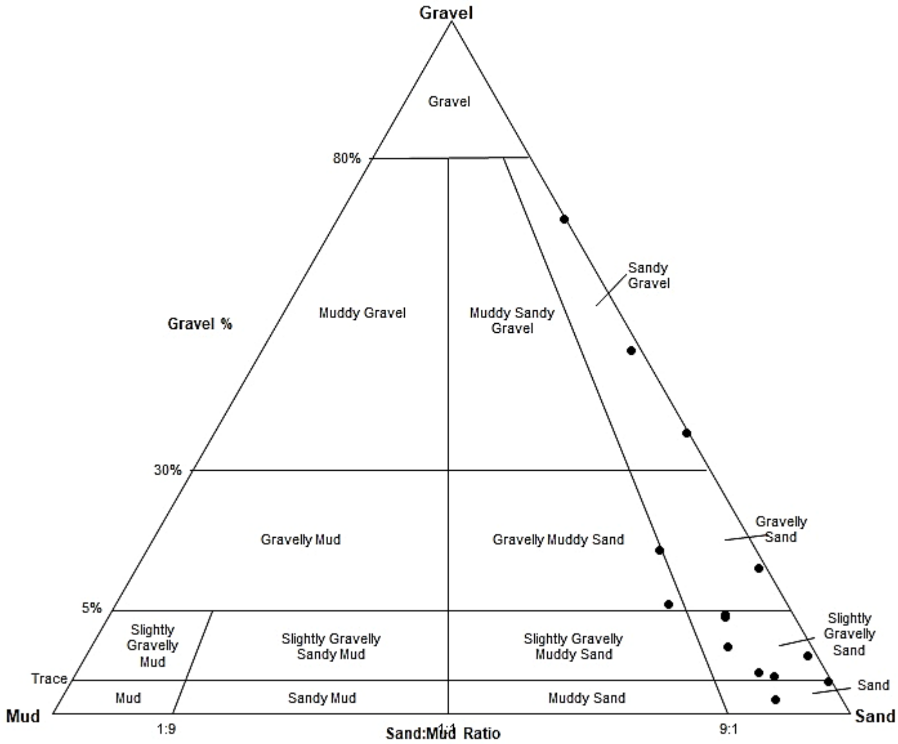

Figure 5. Soil texture of the Selangor river bed sediments

3.2. Statistical Analysis of Sediment Grain Size

Two separate Spearman's rank correlation coefficients were conducted between D50 and river velocity and D50 and river discharge to determine the relationship between sediment D50 and river velocity and river discharge. The H0 claims no association between D50 and river velocity and river discharge, while Ha claims that there is an association between D50 and velocity and D50 and river discharge variables. So, the results of the relationship between D50 and river velocity (r(14) = 0.024, *p* = 0.934) indicated that the *p*-value is higher than the alpha level (α= 0.05). We, therefore, fail to reject the null hypothesis that there is no correlation between D50 and river velocity variables (Table 4).

Table 4. Result of Spearman's rho Correlations between D_{50} and Velocity

Correlations				
			D_{50}	Velocity
Spearman's rho	D_{50}	Correlation Coefficient	1	0.024
		Sig. (2-tailed)	.	0.934
		N	14	14
	Velocity	Correlation Coefficient	0.024	1
		Sig. (2-tailed)	0.934	.
		N	14	14

The result of relationship between D50 and river discharge, (r(14) = 0.004, p = 0.988), indicated that the *p*-value is higher than the alpha level (α= 0.05). We, therefore, fail to reject the null hypothesis that there is no correlation between D50 and river discharge variables (Table 5).

Table 5. Result of Spearman's rho Correlations between D_{50} and Discharge

Correlations				
			D_{50}	Discharge
Spearman's rho	D_{50}	Correlation Coefficient	1	0.004
		Sig. (2-tailed)	.	0.988
		N	14	14
	Discharge	Correlation Coefficient	0.004	1
		Sig. (2-tailed)	0.988	.
		N	14	14

Figures 6 and 7 also confirm the dispersion of D50 and its relationship with the discharge and velocity of the river flow. Since the *r* values are very small near zero, therefore it can result that the grain size of river bed sediments of the Selangor River has very weak or no association with river discharge and velocity.

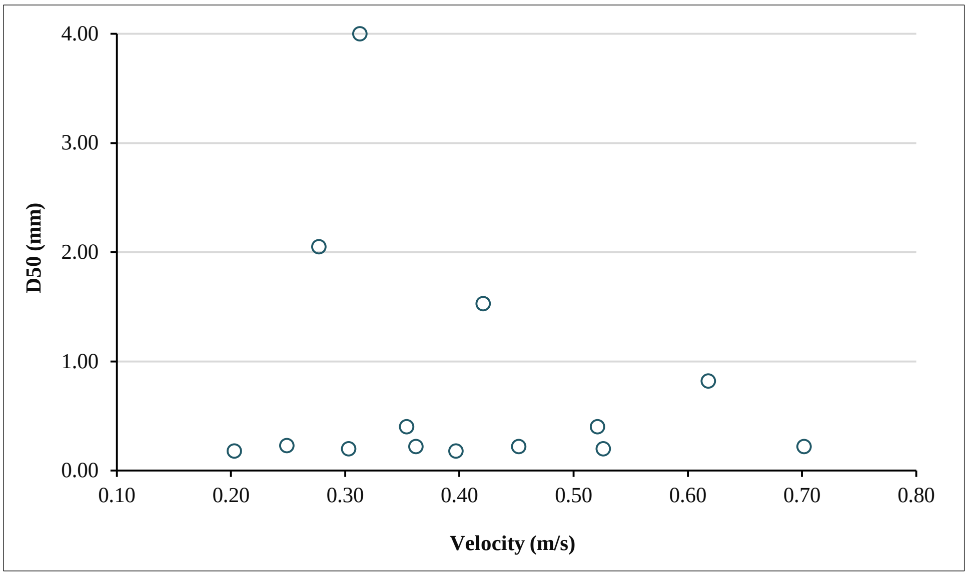

Figure 6. The relationship of D_{50} and river velocity in the Selangor River

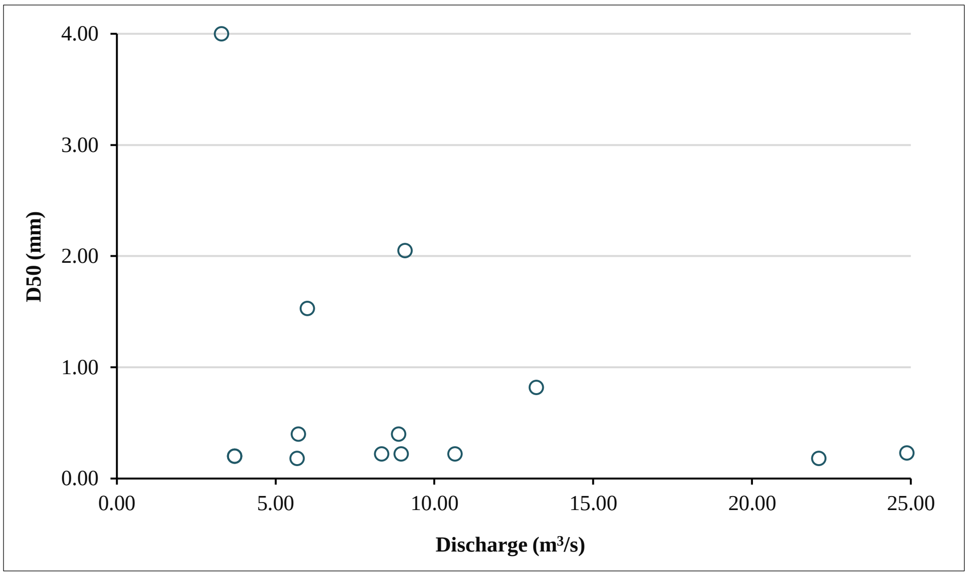

Figure 7. The relationship of D_{50} and river discharge in the Selangor River

4. Conclusions

The aim of this study is to determine the grain size distribution of the sediments in the upper Selangor River and associate the D50 of sediments with the river velocity and discharge throughout the normal and rainy seasons. The river bed sediments were collected from seven sampling points in both the rainy and normal seasons of the year. The sediments were analyzed using the sieve analysis method, and then their statistical analysis was conducted through the SPSS and GRADISTAT programs. After conducting Spearman's correlation test, it was determined that the river velocity and discharge have very little or no effect on the grain size distribution of the Selangor River. Since the slope gradient between the sampling points is very high, the maximum D50 of the sediment grains was noted at the uppermost sampling point, station 1 (4 mm).

In contrast, the minimum D50 of the sediment grains was noted at the lowermost sampling points, stations 5 and 7 (0.18 mm). The maximum D50 was recorded in the rainy season, while the minimum D50 was recorded in the year's dry season. From the study conducted, it can also be concluded that the Selangor dam, located just above sampling point 1, has also had effects on the river bed sediments, as the suspended and smaller-sized sediments were noted to be less in the stations near the dam. The far we went, the more suspended sediments and smaller grain sizes were observed in the river.

The textural analysis of the riverbed sediments is also conducted using GRADISTAT software, where the sediment type, textural group, sorting, and skewness of the sediments are classified. The classification of the sediments determined that about 85% were unimodal, while the remaining 15% were bimodal, ranging from poorly sorted to moderately well sorted. Since the water released from dams is considered "sediment hungry", therefore, it is more common for this water to degrade the river banks and wash the river bed downstream [44]; the same happened in the case of the Selangor river as well, as the stations near the Selangor dam have more gravel and coarse sand. However, as we go farther, the sediments become smaller. In conclusion, we recommend that further research be conducted on the effects of sediments trapped by dams on the aquatic biodiversity of the river. Also, future research might look at how the tributaries affect how sediment moves through the main river.

5. Declarations

5.1. Author Contributions

Conceptualization, M.H.H., and N.R.J.; methodology, M.H.H., and N.R.J.; software, M.H.H.; validation, N.R.J., M.N.A.A., L.J.L., and A.Z.A.; formal analysis, M.H.H.; investigation, M.H.H., N.R.J., and M.H.R.; resources, N.R.J., M.N.A.A, L.J.L., A.Z.A., and M.H.R.; data curation, M.H.H., M.N.A.A., and M.H.R.; writing—original draft preparation, M.H.H.; writing—review and editing, N.R.J., M.N.A.A, L.J.L., A.Z.A., and M.H.R.; visualization, M.H.H., and L.J.L.; supervision, N.R.J.; project administration, N.R.J.; funding acquisition, N.R.J., and A.Z.A. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

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5.4. Conflicts of Interest

The authors declare no conflict of interest.

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