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Chemical Composition of Sediment in Bernam Catchment, Selangor Malaysia

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Abstract: The main sources of metal pollution are identified and the potential toxicity of dredged materials on agricultural land is estimated by sediment investigations. Here, we investigated chemical composition of sediment in Bernam catchment. Bernam river catchment has been engulfed by certain anthropogenic activities such as urbanization, illicit logging, farming. Serious concerns have been raised by stakeholders and local people because of the level of pollution due to the release of chemicals and sediments into water bodies by these human activities. Chemical composition elements such as Iron, Aluminium, Copper, Total Organic Carbon, Zinc, Potassium, Calcium, Magnesium, Sodium, Chromium, Cobalt, Nikel, Arsenic and Cadmium have been detected in this study. Characterising potential sediment sources by their diagnostic chemical and physical properties and contrasting them with the properties of transported fluvial material are key components of the methodology used to determine the source of the sediment. The methodology focuses on fluvial sampling techniques used in sediment tracing studies and their suitability for various hydrologic and morphologic river conditions. Based on cluster analysis, there are three cluster of group classification in this catchment. From a management standpoint, determining the sediment is essential to putting into practice the right controls to prevent sediment mobilisation and the ensuing siltation of river channels in the sensitive areas.

Keyword: Chemical composition, sediment, Bernam catchment

1.0 Introduction

Rivers carry most of the eroded material that is moved from the continents to the oceans (Jiang et al., 2021). This material is transported by rivers in both suspended and bed load sediment forms or dissolved and solid forms (Jaskuła, 2021). The mobility of the chemical constituents (elements) during weathering and transit determines the relative distribution of elements between the solution and particulate phases and minerals provide vast specific surfaces for the sorption of these elements, trace metals accumulate in soils (Tang et al., 2014). The composition of chemical in river sediments is determined by the combined effects of several pollution sources, natural processes connected to climate and geological conditions, the features of point and non-point pollution sources, their location, and the organisation of land use (Motha et al., 2003).

Because of the variety and dispersion of pollution sources as well as emission rates, each watershed generally has a distinct pattern for delivering all the metals to the water (Magni et al., 2021). Water and sediment contamination are significantly influenced by landuse The diversity and structure of the landscape, in addition to the main landuse categories, are significant factors in the supply of chemicals (Collins et al., 2017). The concentrations in river sediments can vary significantly due to overlapping natural and human influences as well as fluvial processes within even the same river (Tang et al., 2014). Water pollution in Malaysia, present in both solid and liquid states. Ultimately, these pollutants find their way into rivers, runoff water, and terrestrial areas (Camara et al., 2019). The contamination of surface sediments, particularly within river systems, with harmful metallic elements has garnered significant public interest in recent decades (Laceby et al., 2017; Biddulph et al., 2017). The objective of this study is to identify the chemical composition in Bernam river catchment, Selangor Malaysia.

2.0 Study Area

Bernam River catchment is between N 03° 40' 45'' and E 101° 31' 20'' in north-eastern Selangor and the southern part of Perak, Malaysia (Figure 1). The research region's height above mean sea level is 41 metres, and its catchment area was 186 km^2. The catchment area's maximum length is 21 km, while its maximum width is 14 km. The remaining portion of this watershed is hilly, with the majority being steep mountain land reaching heights of 1830 metres. The hilly, undulating areas are primarily covered in rubber, whereas the mountainous areas are covered in rainforest. The granitic soil layer that covers much of the catchment is made up of clay and fine to coarse sand.

The cover often only descends a few metres, although in regions with severe weathering, deeper levels may be found. There is a tiny area in the south with a sandy loam soil layer that grades to clay loam. The alluvium in the valleys ranges in depth from 8 to 15 metres. Sediment strike is roughly northwest to southeast, with a dip that varies from 45° to 65° in the northeast and southwest. In addition, it provides water and irrigation for 20,000 hectares of rice paddies and supports local ecotourism. A significant quantity of rainfall fell in the Tanjong Malim Perak area near the Titiwangsa Range. In 2017, the research area received 2600 mm of annual rainfall. As of 2004, the Bernam catchment's land use was primarily composed of forest (47.7%), rubber (14.8%), oil palm (25.9%), schrub (7%), built-up area (3%) and water body (1.5%) (Shazwani et al, 2023).

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Station	Sampling station	Coordinate	River segments
ST 1	Inki River (Kalumpang)	3°37'37.3"U 101°34'54.8"T	Upstream
ST 2	Bernam River (Teratak Riverview)	3°41'47.9"U 101°32'46.7"T	Upstream
ST 3	Inki River (Bahtera)	3°40'26.6"U 101°31'41.4"T	Upstream
ST 4	Bernam River (Tanjung Malim)	3°40'41.2"U 101°31'14.5"T	Upstream
ST 5	Selisik River	3°44'19.4"U 101°26'45.1"T	Middle-stream
ST 6	Dara River	3°45'59.1"U 101°29'46.2"T	Middle-stream
ST 7	Bil River	3°49'28.0"U 101°29'12.5"T	Middle-stream
ST 8	Slim River	3°55'47.0"U 101°30'29.5"T	Middle-stream
ST 9	Trolak River	3°52'48.6"U 101°23'05.0"T	Middle-stream
ST 10	Bernam River (Kuala Slim)	3°48'15.0"U 101°21'43.2"T	Downstream
ST 11	Bernam River (Changkat Menteri)	3°42'48.3"U 101°13'32.3"T	Downstream

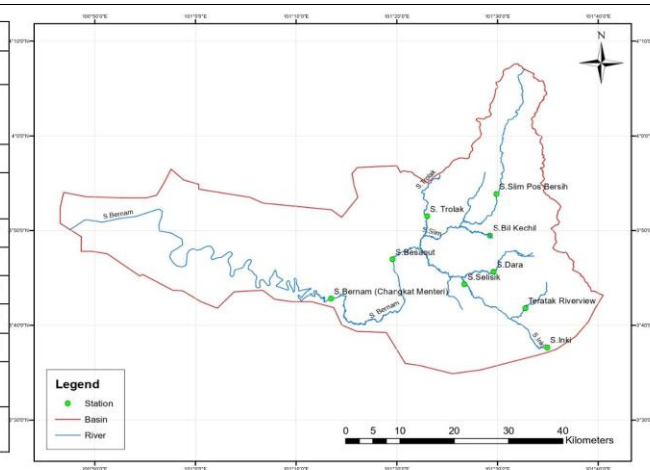

Figure 1: Study area of Bernam Catchment

3.0 Materials and Methodology

3.1 Sample collection/ Field sampling

Source material sampling involve the collection surface soil samples from eroding areas that represent each of the cultivated sites, slope lands and terraces (For subcatchment A, B, C etc). For each source samples, estimate 10 sub samples will be collected from 0 to 5cm depths along transects in a 5×5m grid and combine in the field to form a single composite samples. For solid sample analyses by inductively coupled plasma-optical emission spectroscopy (ICP-OES) to identify the atomic composition of a particular sample.

4.0 Results & Discussion

Table 1 shows content of chemical component in the study area. The dominant composition of chemical in sediment come from downstream site at ST9, which Iron 9041 mg/kg, Aluminium 8606 mg/kg, potassium 819.5 mg/kg and Magnesium 680.3 mg/kg. The highest contributions from iron samples, indicating the potential significance of localised inputs from outcrops in channel banks or topsoil near this sampling location. ST9 and ST10 and 11 high concentrations were closely related to increase intensity of residential and urbanization, agriculture, oil palm plantation, water flowing through peat in drainage basin.

The average composition of solid materials transported by rivers differs greatly from the chemical composition computed for varying ratios of suspended and bed loads (Motha et al., 2003). Sand-clayey sedimentary rocks exhibit a relative enrichment in sodium, magnesium, and potassium that is likely secondary in origin. The higher metal concentration variation can be attributed to natural process as water dilutes contaminants which can be transport and delivered through the river flow (Jiang et al., 2021).

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Table1. Comparison of the average content of component in sediment in Bernam catchment

Variable	Minimum (mg/kg)	Maximum (mg/kg)	Mean	Std. deviation
Iron	1405.2	9041.1	3773.7	2224.1
Aluminium	1763.2	8606.0	3540.7	2077.4
Copper	0.4	42.7	6.7	13.6
Total organic carbon	0.0	296.2	120.2	102.3
Zinc	2.1	20.9	8.8	5.5
Potassium	185.5	819.5	433.5	183.7
Calcium	44.0	183.2	95.4	50.1
Magnesium	89.2	680.3	339.9	195.8
Sodium as Na	114.3	311.5	197.7	64.3
Chromium	0.8	4.9	2.2	1.2
Cobalt	0.0	0.0	0.0	0.0
Nickel	0.3	1.5	0.8	0.4
Arsenic	0.9	3.7	2.0	1.0
Cadmium	0.0	0.0	0.0	0.0

4.2 Cluster Analysis

Figure 2 shows there are three cluster of group classification in this catchment. Cluster 1 for dominant chemical composition such as Iron, Aluminium, Zinc, Potassium, Calcium, Magnesium, Chromium, Nikel and Arsenic. Cluster 2 dominant by Copper, TOC, Cobalt, Cadmium and Cluster 3 Sodium. Based on cluster analysis, dominant sediment sources were identified by group, and those in close proximity to each sediment sampling location were found to be of greatest importance. Stations and composition of chemicals data were grouped using cluster analysis. Finding a technique that generated a logical pattern of association and showed consistency between findings for loc ation and chemical composition associations was the aim of the study. Creating a similarity data matrix from the raw data and grouping the resemblance coefficients in the matrix are the two steps that most cluster analysis algorithms entail. There are several ways to generate the input resemblance (similarity or dissimilarity) matrix. Despite this uncertainty, dominant sediment sources were identified, and those in close proximity to each sediment sampling location were found to be of greatest importance.

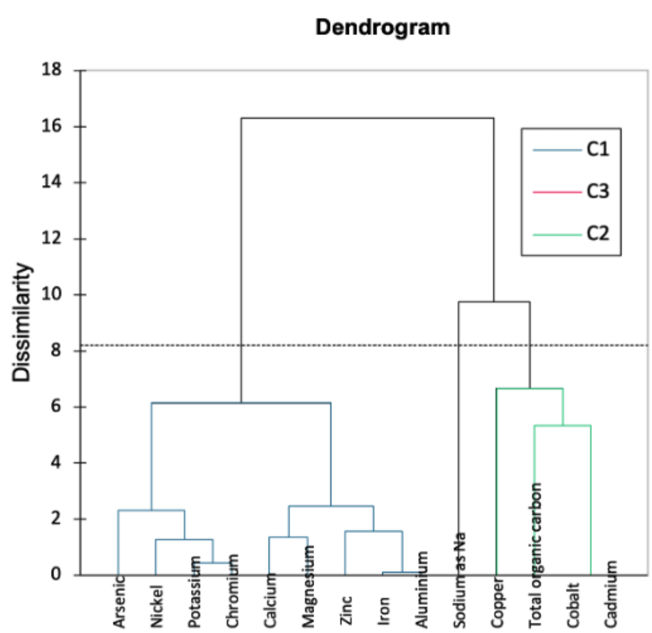

Figure 2: Three cluster for chemical compositions in the study area

5.0 Conclusions

A better understanding of erosion and suspended sediment transport within a basin will be obtained through sediment source tracing research. It will be easier to design and put into action suitable control measures to protect water once the main sources of sediments in the basin are identified. The existence of specific chemical components affects the water quality of rivers, lakes, and wetlands, which may have an impact on aquatic life health, human activity, and the environment. Since these water bodies must be preserved, it's critical to monitor their chemical composition and take preventative measures to maintain their health.

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Conflicts of Interest: The authors declare no conflict of interest.

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