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MORPHOLOGICAL ANALYSIS OF RIVER CHARACTERISTICS IN MUSI RAWAS UTARA REGENCY

ANALISIS MORFOLOGI KARAKTERISTIK SUNGAI DI KABUPATEN MUSI RAWAS UTARA

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ABSTRACT
Effective watershed management requires the efficient collection, storage, and use of runoff water, as well as the recharge of groundwater. This study will employ morphometric analysis to determine the characteristics of the rivers flowing through one of the districts of the Province of South Sumatera, Musi Rawas Utara (Muratara). Using DEM data and GIS software, this study conducted a quantitative-descriptive analysis to obtain quantitative information about the watershed. The acquired numbers are interpreted descriptively to provide a description of the watershed's characteristics and their implications for rivers in Muratara. The eighth-order rivers of Muratara Regency are classified as major rivers. A mean bifurcation ratio (Rb) of 3.98 indicates that geological features have no effect on the typical flat drainage pattern. On average, the drainage density of the watersheds was moderate, but a few locations had a very high drainage density range, indicating their erodibility. The basins of rivers with low circularity and elongation ratios (0.19 and 0.48, respectively) are elongated and have a steep slope. The morphometric research reveals that the Muratara rivers have abundant water resources and are also predicted to experience numerous water-related disasters. Using morphometric knowledge, however, the local government could develop mitigation and planning systems for river management. Future measures must include ensuring that adequate drainage systems are in place and that all construction adheres to the principles of proper land management.
Keywords: *Watershed, Morphology, River characteristics, Muratara*

ABSTRAK
Pengelolaan daerah aliran Sungai (DAS) yang efektif memerlukan pengumpulan, penyimpanan, dan penggunaan air limpasan yang efisien, serta pengisian ulang air tanah. Penelitian ini akan menggunakan analisis morfometrik untuk mengetahui karakteristik sungai yang mengalir melalui salah satu kabupaten di Provinsi Sumatera Selatan, Musi Rawas Utara (Muratara). Dengan menggunakan data DEM dan software GIS, penelitian ini menggunakan analisis deskriptif kuantitatif untuk memperoleh informasi kuantitatif mengenai DAS. Angka-angka yang diperoleh diinterpretasikan secara deskriptif untuk memberikan gambaran mengenai karakteristik DAS dan implikasinya terhadap sungai-sungai di Muratara. Sebagai sungai dengan ordo percabangan urutan kedelapan, sungai di Kabupaten Muratara tergolong sungai besar. Rata-rata Rasio bifurkasi (Rb) sebesar 3,98 menunjukkan bahwa fitur geologi tidak begitu berpengaruh pada pola aliran air pada umumnya. Rata-rata, kepadatan drainasei DAS tergolong sedang, namun beberapa lokasi memiliki kisaran kepadatan drainase yang sangat tinggi, yang menunjukkan tingkat erodibilitas sungai tersebut. Secara keseluruhan daerah aliran sungai Muratara memiliki rasio sirkularitas dan pemanjangan rendah (masing-masing 0,19 dan 0,48) berbentuk memanjang dan memiliki kemiringan yang curam. Hasil penelitian morfometrik menunjukkan bahwa sungai Muratara memiliki sumber daya air yang melimpah dan juga diperkirakan akan mengalami berbagai bencana terkait air. Namun dengan menggunakan pengetahuan morfometrik, pemerintah daerah dapat mengembangkan sistem mitigasi dan perencanaan pengelolaan sungai. Langkah-langkah di masa depan harus mencakup memastikan bahwa sistem drainase memadai dan semua konstruksi mematuhi prinsip-prinsip pengelolaan lahan yang baik.
Kata Kunci: *Daerah Aliran Sungai, Morfologi, Karakteristik Sungai, Muratara*

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1. INTRODUCTION

Most water resources in Indonesia are came from surface water sources such as rivers. According to USAID (2012), over 5,700 rivers in Indonesia are managed within 133 official river basin territories. Watersheds are classified as transboundary, inter-provincial, national strategic, inter-district, and sub-district. The most important basins are managed by the central government, including five transboundary basins shared with Papua New Guinea, Malaysia, and Timor - Leste. In addition, there are 27 inter-provincial basins and 37 national strategic basins. The Rawas River and the Rupit River both flow through the Musi Rawas Utara (Muratara) Regency in South Sumatera Province. Muratara is a part of the Rawas sub-watershed, one of the fourteen sub-watersheds that comprise the Musi Watershed. The Rawas sub-watershed is the fourth largest sub-watershed in the Musi watershed, covering 586,769.30 ha (10.97% of the Musi watershed area). This district's surface water sources are the Rawas River, the Rupit River, Raya Lake, and Merung Lake. In addition to being used for irrigation, the rivers in Muratara serve as a source of water, a mode of transportation, and a domestic function for households.

Muratara has recently completed its water provision planning document and is anticipated to use gravity flow water distribution to allocate water from the Rawas and Rupit rivers. As the name implies, gravity flow water distribution requires elevation as its principal technique. In a gravity distribution system, the water flows from an input point, which is at the highest elevation, to all other points of the system. Normally, this system is possible in areas where the source of water is natural water, such as a spring or river, which lie at a higher elevation, by building an intake vessel. Depending on the topography and the availability of land, the water treatment plant and reservoir are also constructed near the intake structure to ensure the quality and quantity of the water. Muratara's plan for using gravity to deliver water takes into account the estimated population, the amount of water required, the length of the pipe, the size of any booster systems, the capacity of any water treatment facilities, the location of any intakes, and the expenses. However, in the document, water quality tests or motives for why the exact location of the water intake was chosen are unclear.

In their practical guide to water provision according to public works (PU) has to meet such criteria as quality, quantity, and continuity (Asmadi & Kasjono, 2011). Quality means that the substances contained in the water must meet the standard demand permitted for consumption, while quantity means that the water resource has to have a sufficient amount of water to provide the community, and continuity suggest that the water must be continually obtainable regardless of the season. The use of elevation in gravity-flow water distribution depends on the stability of the surrounding areas, as their instability will affect the structure of the system (Haron et al., 2022). On account of finding the river structure used in Muratara's water provision planning, this study intends to explore Muratara's river characteristics as a way to provide more information regarding the river condition. River morphology is the study of how rivers shape the earth's surface and its dynamics (Horton, 1945). Recently, the disciplines of hydrology and geomorphology were merged by imposing a morphological approach to simultaneously account for physical characteristics and stream processes (Belletti et al., 2015).

Since Horton's introduction of drainage morphometry in 1932, it has become an essential tool for comprehending the subsurface structure, geomorphological formations, and hydrological characteristics of any basin (Morisawa, 1985). In addition, it plays a significant role in describing soil erosion, flood conditions, and geomorphological processes. It is widely considered to be the most accurate representation of subsurface geology, geomorphology, relief, slope, climate, and hydrological dynamics (Mahala, 2020). As a result, Horton's drainage morphometry has become an indispensable tool for geographers, hydrologists, and other specialists interested in understanding the spatial characteristics of a given terrain. The study will use GIS tools to examine the shape of rivers from three different perspectives: linear parameters, aerial parameters, and relief parameters, in order to explore Muratara's rivers as a source of water, particularly the river's natural setting, and to describe the river morphology results.

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2. DATA AND METHODS

2.1. Research Design

This study employs a quantitative descriptive research design in which the result is quantitatively derived from the ArcGIS application, inputted into the parameter formulas, and the value is described. Using the ArcGIS application, the data will be collected and entered into a variety of mathematical formulas to generate meaningful results that can then be evaluated. First, the location, size, altitude, and water quality of the study area will be gathered and entered into the ArcGIS application. The digital elevation model was downloaded from the official website of Indonesia's National Digital Elevation Model. The downloaded DEM data are then used with the hydrology toolset in the spatial analyst menu of the ArcGIS software to derive stream information and obtain numerical details that can be applied to the morphometry formula. The next step, following the collection of data, is to input the information into the morphometry equation. After obtaining the numerical values for the watershed, the study would describe the relevance of the morphometric results for the watershed's characteristics.

2.2. Data

To examine Muratara's river conditions as water supply resource, specifically the river's natural setting, and describe the numerical values derived from river morphology results using formulas from linear, aerial, and relief parameters, this study uses several data compiled in Table 1.

Table 1. Data Requirement

Data Used	Types of Data	Data Sources
Planning Document	Secondary	Bappeda, Public Works
Topographic data	Primary and Secondary	Public Works, DEMNAS
Land use data and map	Secondary	Public Works, Dept. of environment and land
Morphometric values results	Secondary	DEM processing results

2.3. Data Analysis

The morphometric analysis considers the channel network's linear, aerial, relief, and gradient aspects, as well as the basin's slope (Nag & Chakraborty, 2003). In this study, the parameters will be classified as linear, aerial, or relief because each parameters represents a unique arrangement of the river's characteristics.

The linear characteristics of a drainage network depict the behavior of a river and its tributaries from source to mouth, as well as the lithological and structural controls of the drainage basin. The linear aspect includes stream number, stream order, stream length, mean stream length, stream length ratio, and bifurcation ratio. In the meantime, aerial views of a drainage basin reflect the impact of the basin's lithology, geological structure, climatic conditions, and history of denudation. The aerial aspect includes parameters such as drainage density, stream frequency, elongation ratio, and circulatory ratio. The relief aspect of a basin is the variation in elevation, specifically the elevation of the structure. Further formulas are shown in Table 2.

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Table 2. Morphometric Formula

No.	Parameters	Formulas	Sources
Linear Aspects			
1	Stream Order	Hierarchical rank	Strahler and Chow (1964)
2	Stream Length Ratio (Rl)	$R_L = L_{sm}/L_{sm} - 1$ L_{sm} = Mean stream length of a given order, $L_{sm} - 1$ = Mean stream length of next lower order	Horton (1945)
3	Bifurcation Ratio (Rb)	$R_b = N\mu/N\mu + 1$ R_b = Bifurcation ratio $N\mu$ = No. of stream segments of a given order, $N\mu + 1$ = No. of stream segments of next higher order.	Schumn (1956)
4	The length of overland flow (Lg)	$L_g = 1/2D$ Where, D = Drainage density (km/km^2)	Horton (1945)
Areal Aspects			
5	Drainage Density (Dd)	$D_d = L\mu/A$ D_d = Drainage density (km/km^2) $L\mu$ = Total stream length of all orders, A = Area of the basin (km^2)	Horton (1932)
6	Drainage Texture (Dt)	$D_t = N\mu/P$ $N\mu$= No. of streams in a given order P = parameter (km)	Horton (1945)
7	Elongation Ratio (Re)	$Re = (2\left(\sqrt{\frac{A}{\pi}}\right))/Lb$ A = Area of the basin (km^2) L_b = (Maximum) Basin length (km)	Schumn (1956)
8	Circularity Ratio (Rc)	$R_c = 4\pi A/P^2$ A = Basin area (km^2) P = perimeter of the basin (km)	Miller (1953)
9	Form Factor (Rf)	$R_f = A/L^2{}_b$ A = Area of the basin L_b = (Maximum) basin length	Horton (1932)
Relief Aspects			
10	Relief Ratio (Rh)	$R_r = H/L_b$ H = basin relief (m) L_b = Basin length	Schumn (1956)
11	Ruggedness Number (Rn)	$Rn = H \times D_d$ H = Basin relief (m) D_d = Drainage density (km/km^2)	Strahler (1968)

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3. RESULT AND DISCUSSION

This study finds that the two upstream flows entered the less elevated areas of the regency via four subdistricts and converged in the middle of the town in the regency's lower elevations. Generally, streamflow over or through the landscape, influenced by geological and topographical structure, carves out its valley. Stream flow patterns influence drainage system efficiency and hydrographic characteristics, and flow patterns are crucial in determining soil and watershed surface conditions, especially erosion forces (Ningkeula, 2016). The topography of the study area defines the river pattern as dendritic and meandering. The dendritic pattern depicts a river branch that resembles a tree root, whereas the meander pattern depicts a sharp loop or bend in the path of the stream. Laterally and longitudinally meandering rivers migrate through the erosion process along concave riverbanks (Seminara, 2006). Concave areas at the two upstream branch junctions typically identify the confluence of two tributaries as a flood-prone area, especially during the rainy season. If it rains upstream, the river will encounter a queues of river water flow and overflow, flooding the surrounding area. The water then flows west through the administrative boundaries until it reaches the next river downstream.

There are numerous stream ordering techniques, such as Horton's (1945) and Strahler's (1952). In this study, stream order was determined using Strahler's methodology, which is a slightly modified version of Horton's method. First-order streams are the smallest (unbranched) rivers. When two first-order streams meet, a second-order stream is formed; when two second-order streams meet, a third-order stream is created, and so on. When two distinct levels of streams merge, the stream with the highest level always remains.

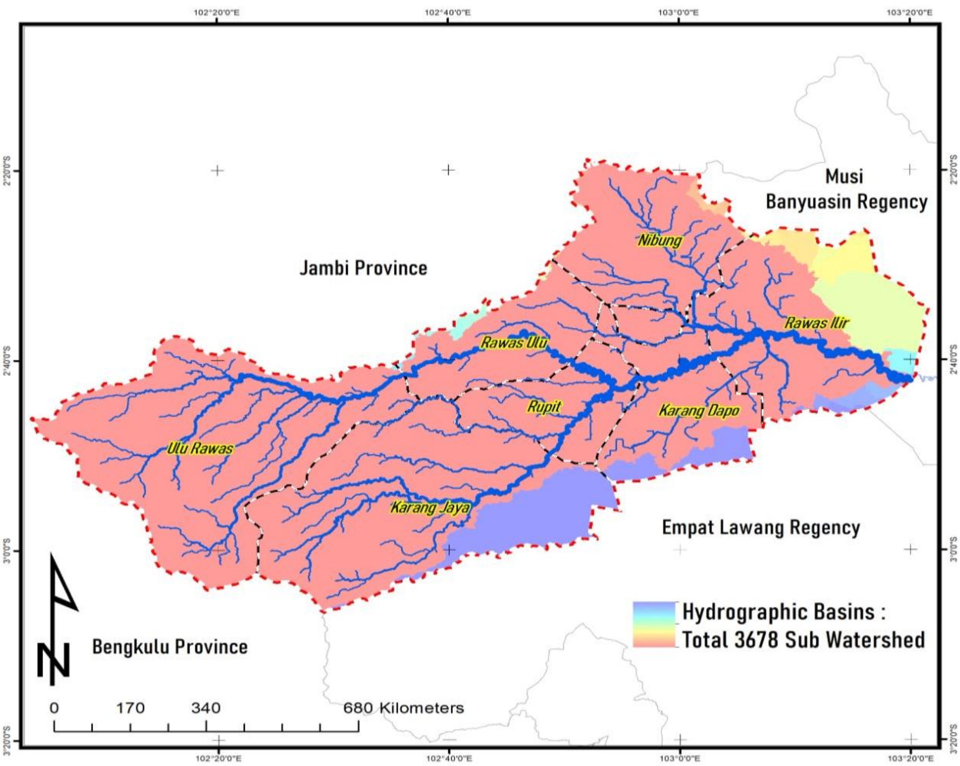

Figure 1. Muratara's Watershed Delineation

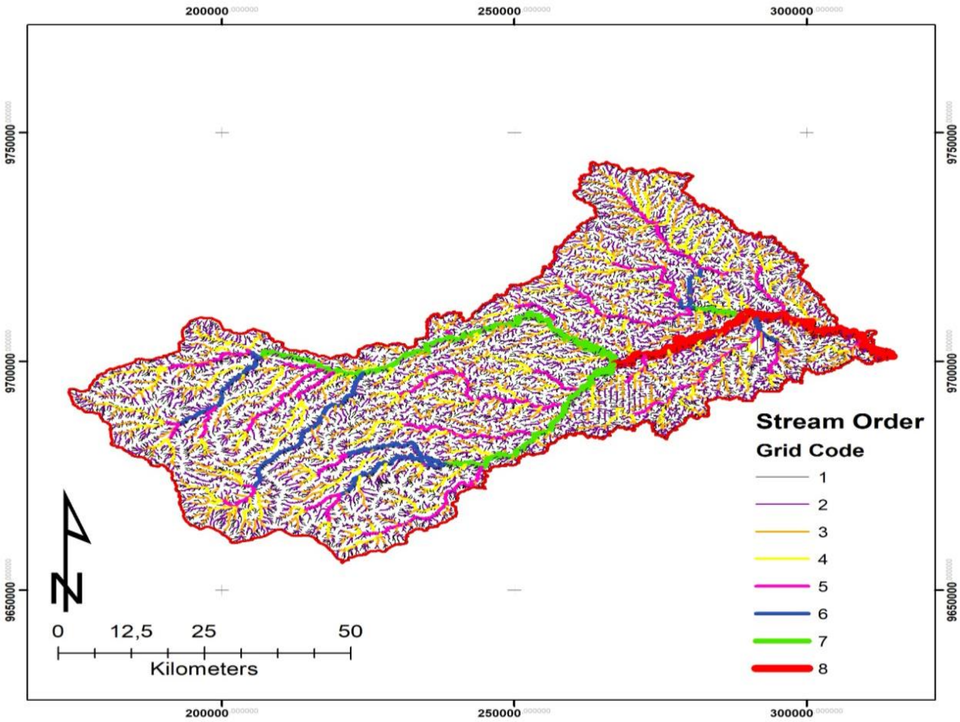

Figure 2. Stream Order

Stream order was the initial step in the morphometric analysis. Stream order is a positive whole number used in geomorphology and hydrology to define the number of branches in a river system (Bogale, 2021). The linear aspect of a drainage network illustrates the behaviors of a river and its tributaries, in addition to the lithological and structural constraints of the drainage basin. Stream number, stream order, stream length, mean stream length, stream length ratio, and bifurcation ratio are the linear properties that give geographers, geologists, hydrologists, and other professionals and scientists an idea of the magnitude and strength of a particular waterway within a stream network. Streams must be categorized in accordance with their stream order (size). The number of streams is proportional to the size of the watershed, the channel width, and the stream's flow. As the stream's order increases, so does the discharge, while the velocity and channel diameters increase to accommodate the rising flow from the lower orders.

3.1. Linear Aspect

Based on Table 3 of linear parameter calculation results, Muratara Regency has up to eight levels of stream order, with the lowest stream order having 13,766 tributaries. This indicates that the stream system in Muratara Regency is quite complex, and due to this complexity, a more detailed analysis is required to comprehend the topography and drainage basin of the region. Horton's law of stream length states that the total stream length contributes to the formation of a geometric series beginning with the mean segment length of the first order and increasing in length ratio at a constant rate. The stream characteristics of the watershed complied with this law (Bogale, 2021). Stream length is also one of the most promising indicators for understanding a basin's hydrological characteristics. A large number of relatively short streams are indicative of the basin's steep slope and finer texture. Typically, a longer stream length corresponds to a flatter catchment (Adhikari, 2020). In addition, the table depicts the correlation between stream order and total length. Changing stream orders suggest that water flows from a high altitude, diverse lithology, and a steep slope to a flatter land surface. The bifurcation ratio (Rb) is the ratio of stream segments of a given order to those of the next higher order (Schumm, 1956). The Muratara River bifurcation ratio ranges from 2.67 to 4.53, with a mean of 3.98, indicating that the river has a low bifurcation ratio or that geologic features have a relatively average impact on the basin.

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Table 3. Linear Aspect Value

Stream Order	Number of Stream	Total Stream Length	Mean stream length	Bifurcation Ratio	Mean of Bifurcation Ratio	Stream length Ratio (RL)
1	13766	6055.51	0.44	4.53	3.98	-
2	3042	2844.85	0.94	4.51		2.14
3	674	1403.84	2.08	4.46		2.21
4	151	771.83	5.11	4.44		2.46
5	34	423.71	12.46	4.25		2.44
6	8	148.42	18.55	2.67		1.49
7	3	176.67	58.89	3		3.18
8	1	92.16	92.16	-		1.57

3.2. Aerial Aspect

The aerial characteristics of a watershed reflect the influence of lithology, geological structure, climatic conditions, and the river's denudation history. A watershed's lithology, or structure, provides an important source of nutrients for the water that flows through it. The Muratara river basin area has a length of 5106 km^2 and an average drainage density of 2.33 km/km^2, according to the calculations. This calculation shows that the Muratara River Basin's watershed is spread out over a large area.

Table 4. Aerial Aspect Values

Parameter	Value
Basin Area	5106 Km^2
Drainage Density (Dd)	2.33 Km/Km^2
Form Factor Ratio (Rf)	0.43
Elongation Ratio (Re)	0.48
Circularity Ratio (Rc)	0.19
Constant of Channel Maintenance (C)	0.43
Length of Overland Flow (Lof)	0.22

The density of drainage areas determines the density of the stream channels. The drainage density is proportional to the soil permeability (Babu et al., 2016). Less permeable soil allows for less precipitation infiltration, causing it to concentrate in surface runoff. A network's drainage density is a measure of its texture that reveals the balance between the erosive strength of streamflow and the resistance of surface soils and rocks. A low drainage density indicates a high groundwater potential area, whereas a high drainage density indicates a low groundwater potential area. Moderate drainage density could explain the balance between the erosional intensity of overland flow and the resistance of surface soils and rocks. According to Strahler (1957), "high drainage density indicates a weak basin and impermeable subsurface materials with sparse vegetation and high relief, whereas low drainage density indicates a weak coarse drainage texture, high potential runoff, and a high potential basin area". Schumm (1956) defines the elongation ratio (Re) as the ratio of the diameter of a circle with the same area as the basin to the maximum basin length. The

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elongation ratio of the study area is 0.48, which indicates a moderately elongated but significant and steep ground slope. Due to the steep slope of the ground, the study area has a relatively high infiltration capacity and little runoff. The circularity ratio (Rc) is the relationship between the basin's area (A) and the circumference of a circle with the same radius as the basin (Miller, 1953). The determined value of the circulatory ratio in the study area is 0.19, indicating that the examined river basin is elongated, and water moves along the river rather than permeating the soil, making it less prone to flooding. The constant of channel maintenance (C) is measured in square units per square meter and is the inverse of drainage density (Horton, 1945). The examined river basin's low constant channel maintenance value (= 0.43) is indicative of low subsoil permeability, a steep slope, and high surface runoff (Horton, 1945). The basin of the study area has a Lof value of 0.22, indicating that drainage is in its early stages and that it has low values of the length of overland flow, indicating that rainwater will enter the stream relatively quickly and that less rainfall will contribute a significant volume of surface runoff to stream discharge, making the streams susceptible to flooding.

3.3. Relief Aspect

The catchment point is located at an elevation of 2382.50 meters above sea level. The catchment's topography ranges from 0.5 meters to 2,383 meters above sea level. This depicts the region's dramatic topography, with a shallow stream at its lowest point and towering mountains at its highest. As relief has a direct relationship with potential energy (Strahler 1968), denudation rate, amount of sediment that can be transported, and discharge rate of a watershed, the potential energy, denudation rate, amount of sediment transported, and discharge rate of watersheds with more significant relief are likely to be greater. The relief ratio is an indicator of steepness (Schumm 1956), the intensity of the erosion process, and the potential energy available to transport water and sediment downslope (Prabhakaran & Jawahar Raj, 2018). The low relief ratio of Muratara indicates a stable region with slow erosional processes, resulting in an extremely low surface discharge rate. The ruggedness number (Rn) was defined by Strahler (1958) as the product of basin relief and drainage density. Rn represents the difference in basin slope and relief. The basin area is susceptible to soil erosion and has a complex structure due to the basin's slope and drainage density, as indicated by the high value of Rn (5.55), which indicates that the soil is easily eroded. The high Rn values indicate that the terrain of Muratara is structurally complex, with a high relief and drainage density, and that the region is susceptible to erosion.

Table 5. Relief Aspect Values

Parameter	Value
Maximum Elevation of the basin	2383
Minimum Elevation of the basin	0.5
Basin Relief	2382.5
Relief Ratio (Rh)	14.22
Channel Gradient	
Ruggedness number (Rn)	5.55

3.4. Water Resources Potential and Water Intake Planning in Muratara Regency

The river morphology shows the recharge and discharge of the aquifers. It shows that in several locations where the river is wide, shallow channel and less steep area will have a greater potential for recharge of the aquifers through infiltration of surface water into the subsurface. On the other hand, locations where the rivers are narrow, has a deep channel and high elevation will have a lower potential for recharge as the water will flow quickly and not have much chance to infiltrate into the subsurface. Linear

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river morphology influences groundwater infiltration by influencing the flow rate and sediment carrying capacity of the river. The linear, aerial, and relief aspects of the river morphology can interact to indicate a high-water source potential due to increased water volume and velocity, more water available to be captured and distributed, and water cleanliness.

When choosing the water intake in Muratara Regency, it is essential to consider several factors. First, the water resource potential. Based on the river morphology parameters, the regency has a high potential of water resources due to its abundant water volume and velocity. A better quality of clean water is also available to be captured and distributed. Therefore, the water intake site should be located near the main stream of the river where the water is clean and has a high flow rate. Second, the accessibility of the water intake site. It should be located in an area that is easily accessible for maintenance and repair. This is crucial to ensure that the water distribution system can be maintained and repaired quickly in case of any problems. The water intake should also be located in an area that is easily accessible for the community, as it will be easier to access the water.

Third, the disaster risks area. Based on the river morphology parameters, this area has a high likelihood of flash floods, landslides, erosion, sedimentation and channel shifting. Therefore, the water intake site should be located in an area that is protected from these hazards. This to ensure that the water distribution system is not damaged or destroyed during a natural disaster. Fourth, the water demand. The intake site should be located in an area that can meet the water demand to ensure that the water distribution meet the needs of the population. Fifth, water quality. The water intake site should be located in an area that has a good quality of water to ensure that the water distribution system can provide clean and safe water which could also reduce planning and development costs.

3.5. Disaster Risk in Muratara Regency

Understanding the relationship between river morphology and disaster risk is essential for identifying vulnerable areas. Thus, a greater comprehension of planning and mitigation for potential hazards in the region is obtained. River morphology, which includes the shape and structure of a river and its surroundings, can have a number of significant effects on the surface water in Muratara. For instance, in regions where the rivers are wide and shallow, they will have a slower flow rate and a greater sediment carrying capacity than a river with a narrow and deep channel. This can lead to the deposition of sediment in the larger river, resulting in shape changes over time. In addition, Muratara Rivers have meandering channels, which result in a more stable flow and a lower erosion rate than a river with a straighter channel. While the shape of the river influences its ability to absorb water during floods, it also influences its stability to retain water during droughts. Muratara high elevation and steep slope cause water to move and flow on the surface rather than seep into the ground. The water flow contributes to natural erosive forces that cause soil and sediment to move downhill, resulting in increased soil degradation. Although additional research on the regency's soil is necessary to prove this, theoretically water does flow to lower areas.

Drainage morphometry, in addition to land cover and human activities, has a substantial impact on erosion. As an eight-order river with a complex river system, Muratara has several disadvantages, including flooding, erosion, impact on water quality, susceptibility to habitat destruction, and difficult management. The greater the number of tributaries a river has, the greater the likelihood of erosion. The greater the number of channels that water flows through, the greater the potential for erosion, especially in areas where the river is steeper or has a high velocity. This occurred in the rivers of the Muratara Regency. Additionally, tributaries may introduce pollutants into the main stream, making it difficult to maintain the water quality of the entire river system. Moreover, large water order can negatively affect the habitats of aquatic life. Reductions in sedimentation and modifications in river morphology can destroy habitats and reduce biodiversity. In addition, it is more difficult to maintain a large river due to its size and complexity. Planning an infrastructure would be more difficult unless multiple factors were considered. In addition, the long stream length and high bifurcation ratio can increase the likelihood of channel shifting and avulsion, which can alter the river's path and cause infrastructure damage.

3.6. Future Improvement Based on Morphometric Results

According to the river morphology results, the government could consider a number of improvements. First, given the high number of streams, stream length, high bifurcation ratio, and elevation, the local government of Muratara Regency should consider implementing flood and landslide mitigation measures. Second, based on the high drainage density, the high form factor ratio, the high elongation ratio, the high circularity ratio, the low constant of maintenance, the high basin relief, the high relief ratio, and the high ruggedness number, the government may consider implementing river channel stabilization measures such as planting vegetation along the riverbank and constructing check dams to reduce erosion and sedimentation. Thirdly, based on the high-water source potential, the government might also consider implementing water resource management policies such as regulating water use and distribution, protecting water quality, and implementing conservation measures to guarantee a sustainable water supply. Fourth, based on the probability of flash floods, landslides, erosion, sedimentation, and channel shifting, the government could consider constructing infrastructure that makes water intake infrastructure more accessible. Fifth, given the importance of water sources and disaster risks, the government needs to consider involving the community in water resource management decision-making and providing education on how to prepare for and reduce the risk of a water-related disaster.

4. CONCLUSION

Understanding the morphometrics of a river is essential for planners, particularly when interpreting its features for urban and regional development. Development of the future water intake site in Muratara for example can be accurately predicted and planned using the drainage area's characteristics including critical factors such as river location, water quality, and the potential for water loss. The detailed morphometric analysis of the Muratara River reveals a dendritic to sub-dendritic drainage pattern with a basin of the eighth order, revealing crucial information about the river's physical characteristics. The more first-order streams there are, the more homogeneous the lithology and the steeper the gradient of the slope. The river has significant potential as a water resource and as a source of aquifer recharge. Due to the density of the stream drainage, the low form factor ratio, the elongation, the high elevation, and the ruggedness of some river areas, they are susceptible to flooding, landslides, erosion, sedimentation, and channel shifting. In addition, multiple areas along the river have less permeable soils, sparse vegetation cover, and moderate to high relief. Due to the inability of river channels to rapidly disperse and distribute runoff, this combination of factors makes these areas especially susceptible to flooding, which can inform disaster risk reduction measures.

The bifurcation ratio suggests that the basin is relatively normal, with geomorphology governing the drainage network. Lower bifurcation ratios indicate that the stream has been accentuated and branched carefully. Circularity to elongation ratios indicate that the basin is elongated. These characteristics suggest that the basin's capacity to evenly distribute runoff throughout the region is limited, which could result in increased flooding. As evidenced by relief aspects, Muratara has numerous topographical features that contribute to the regency's diverse landform shapes. The low relief ratio of Muratara indicates a stable region with slow erosional processes, leading to an extremely low surface discharge rate. The high Rn value of the study area indicates that the soil is easily eroded, and that the basin area has a complex structure due to the slope and drainage density. When these factors are taken into account, it is determined that Muratara has low relief and a high erosion rate.

Understanding the morphometrics of a river is useful for planners and decision makers to reconsider river regulation and improvement, establishing a monitoring and enforcement system, providing training to optimize the use of morphometrics data, providing resources to relevant government agencies to use the potential and anticipate associated risks, and involving the community in decision-making.

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