Bathymetric characteristics in the Krueng Raba Lhok Nga and Krueng Leupung, Aceh Besar Regency, Indonesia

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Abstract. Depth information is a very important aspect for several studies of marine resource activities, both deep water and shallow water depths. Information on bathymetry is needed, especially in areas that have tourism potential such as waters in river basins that can be used as fishing areas, pond cultivation, and tourism areas. The purpose of this study was to determine the depth of the Krueng Raba and Krueng Leupung watersheds. This study used a conventional method by lowering lead weights to the bottom of the waters and then measuring them using a roll meter. Based on the results of the study, the bathymetry of the Krueng Raba watershed ranges from 0.95 m to 5.58 m, and Krueng Leupung ranges from 0.88 m to 4.10 m. The findings of variations in the watershed bathymetry are influenced by the morphology of the river and the surrounding land.

1 Introduction

Depth information is a very important aspect for several studies of marine resource activities, both in deep and shallow waters [1]. Bathymetric information is especially needed in areas that have tourism potential, such as waters in river basins that can be used for fishing, aquaculture, and tourism [2]. Bathymetry is the activity of obtaining depth data and topographic conditions of the seabed, as well as the location of potentially dangerous objects. Mapping bathymetry is a basic need in providing deep spatial information planning, activities, and decision-making related to marine information for fishing activities, hydrography, and navigation safety. In local applications, bathymetry plays an important role in tourism, aquaculture, and community welfare. In the tourism sector, bathymetry helps identify attractive locations for diving and snorkeling while ensuring the safety of tourist boat routes. In aquaculture, this data guides the selection of optimal fish and seaweed farming sites. Other benefits include supporting fishermen with information on fish-rich areas,

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helping mitigate the risk of disasters such as tsunamis, and providing the basis for sustainable coastal infrastructure development [3].

Not only using conventional methods, bathymetry measurements can also be carried out using other methods. One way is by using remote sensing methods. Remote sensing techniques are very good for compiling and changing data. Natural resources are therefore useful technology to support planning and management of reliable sources [4]. And there is also an acoustic method, namely by using a tool called an echosounder. They use acoustic principles to reflect sound waves into the air. Very useful in many fields, especially in fisheries and maritime affairs. In coastal area planning, water depth can be used as a reference [5].

Starting from planning, measuring, processing, and visualizing the waterbed, bathymetric survey is the process of depicting the waterbed. Bathymetry studies the measurement of the depth of bodies of water, such as oceans, seas, or other bodies of water, and bathymetry maps are maps that depict the depth of the sea and also analyze its morphology. Silting is the cause of ships running aground which often occur in harbor pools. Due to the input of sediment from the river mouth, the depth becomes lower than the minimum draft of the ship. Because loading and unloading is disrupted, the port pool needs to be cleaned by dredging [6, 7].

The depth of the waters is also caused by the tides in a body of water. Tides are the phenomenon of the rise and fall of sea water due to the influence of the gravitational force of the earth and the moon. Tidal data is used to determine the fixed depth of the sounding process. Tidal data recording was carried out using the Valeport Tidemaster Portable Water Recorder, which automatically records tide data using radar and also with Palem. Below are the results of 30 days of tidal measurements and also the results of tidal measurements during the survey [8]. Bathymetry not only serves to understand the depth of water but also has a wide range of practical applications that support sustainable development and risk mitigation. In disaster mitigation, bathymetry data is used to model tsunami movement and identify high-risk zones, enabling more effective evacuation planning. In the tourism sector, bathymetry mapping helps determine optimal locations for activities such as diving or snorkeling, contributing to the development of marine tourism. Additionally, in aquaculture development, bathymetry supports the selection of suitable aquaculture sites based on depth, currents, and bottom characteristics, which is important to ensure ecosystem sustainability and optimal yields.

Global studies show that utilization of bathymetry data has helped reduce disaster risks in coastal areas such as Japan, which has a tsunami early warning system based on bathymetry data. At the regional level, research in coastal areas of Indonesia, including Aceh, has shown the importance of bathymetry in supporting the development of the fisheries and tourism sectors. For example, bathymetry mapping in Sabang waters has been used to identify ideal locations for marine tourism while helping to manage sensitive marine ecosystems. This study confirms the importance of integrating bathymetry data in various aspects of coastal development and management.

Thus, this study aims to determine the depth of the Krueng Raba and Krueng Leupung watersheds and to analyze changes in depth, along with the factors that cause variations in depth. This research is important to understand the dynamics of river flow and its potential impact on the environment and community activities around the area.

2 Research methods

The research was conducted in the Krueng Raba and Krueng Leupung watersheds, Aceh Besar Regency, Aceh Province (Fig. 1). Krueng Raba is located in the Lhoknga sub-district. Meanwhile, Krueng Leupung is located in the Leupung sub-district.

Fig. 1. Research location map.

2.1 Location point determination

This research was carried out at 15 stations in each watershed, with a distance of 100 meters between each station. Not only based on distance, these stations can also be determined by the location or conditions of certain watersheds, such as the presence of bridges or rocks. DAS bathymetry data were taken in Krueng Raba in the Lhoknga sub-district (Fig. 2) and Krueng Leupung in the Leupung sub-district, Aceh Besar district, Aceh Province (Fig. 3).

Fig. 2. Krueng Raba (KR) watershed research location.

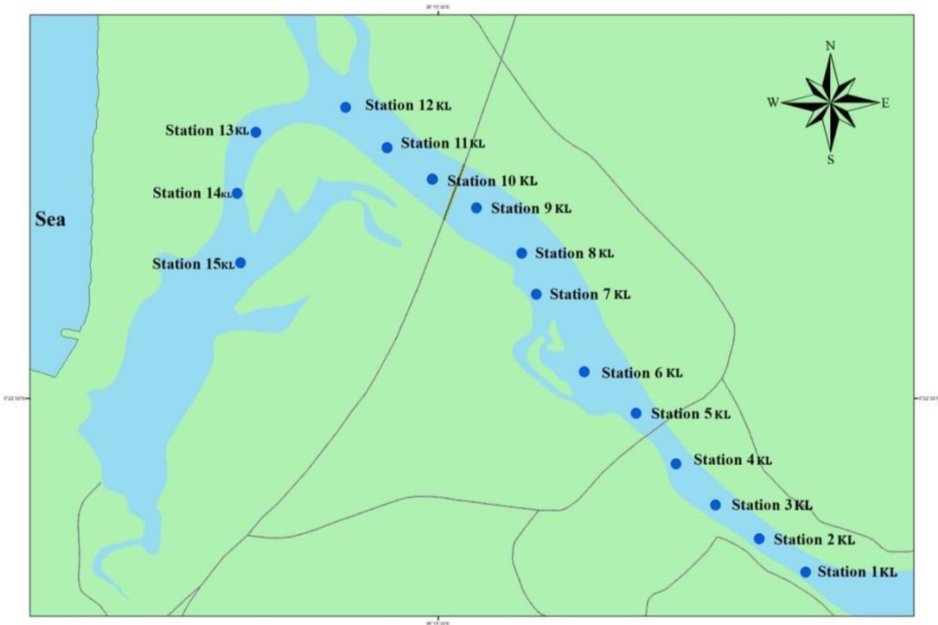

Fig. 3. Krueng Leupung (KL) watershed research location.

2.2 Water sampling and analysis

This research was carried out using conventional methods, using lead or weights that were lowered to the bottom of the waters according to predetermined stations. Then mark the lead rope or weight, then count it using a roll meter and record the results.

Furthermore, conventional methods can save research costs and can also provide fairly accurate depth information. For the ballast, we use lead that is suitable for the location we want to study; such as in rivers with calm currents, we can use lead that weighs only 5 kg, while in rivers or seas that have strong currents, we must use heavier ballast [9].

3 Results and discussions

Figures 4 and 5 show the bathymetry of the Krueng Raba and Krueng Leupung watersheds. Station 1 and 2 Krueng Raba (KR) are upstream of the river; this depth can change with factors such as weather changes, flooding, and global warming [10, 11]. In Fig. 4, at Stations 3, 4, 5, 6, 7, and Station 8 KR, there are bridges that have pillars; these bridge pillars can make the water deeper and shallower. Existence Bridge pillars in river flow cause changes in river flow patterns. Changes in flow patterns will result in local scouring around the pillars [12]. At Stations 9 to Station 15 KR, a significant shallowing pattern can be seen. This is caused by sedimentary material from the sea, which is carried during tides from the downstream direction of the river towards the upstream [13].

Furthermore, in Fig. 5, Station 1 Krueng Leupung (KL), the depth has the same factors as the Krueng Raba watershed. Stations 2, 3, 4, and 5 KL tend to have stable depth data; this is because at these stations there are no obstacles [14]. Meanwhile, at Stations 6,7, 8, and 9 KL are shallow because of the former bridge pillars, so the sediments are shallowly carried away by the current when the flood was behind the bridge. At Station 10 and Station 11 KL there is a bridge that has pillars [12, 15]. This can occur in the depth and shallowness of a body of water. The most striking difference in depth is at Stations 12 and Station 13 KL; this is due to Station 12 KL, where there is land that divides the river flow into two. With the land in the middle of this river, so the depth at Station 12 KL is shallow. Meanwhile, on Station 13 KL occurs deeper because the bottom waters are exposed to strong currents already brought downstream, and part of it becomes new land. Then the depth of Stations 14 and 15 KL also follows Station 13 KL [16].

Fig. 4. Bathymetry of the Krueng Raba watershed (meters).

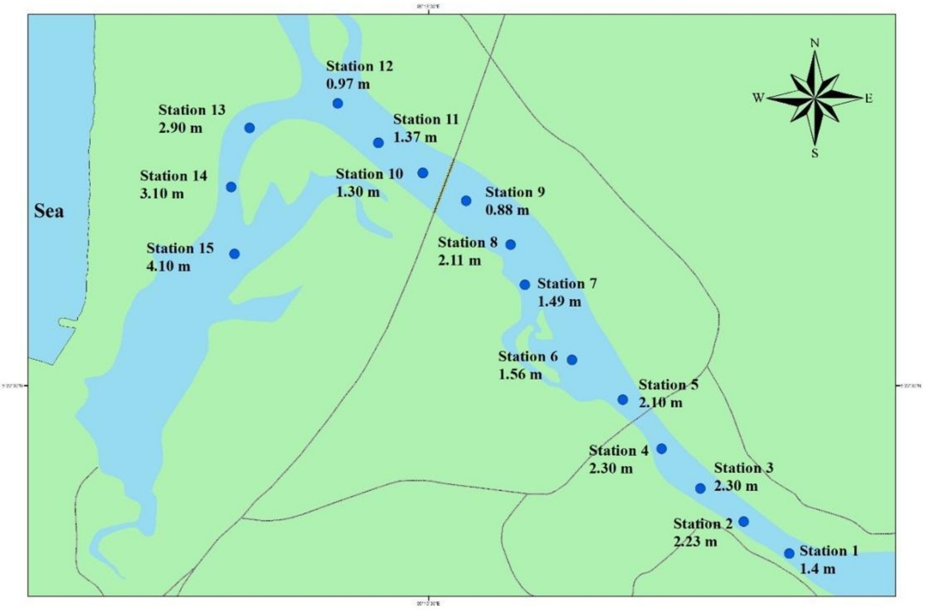

Fig. 5. Bathymetry of the Krueng Leupung watershed (meters).

In these two watersheds there has not been much research studied, so the depth data obtained in this study is very important for further research or for the surrounding community to protect each other so that things we don't want to happen just because of lack of information [17]. Because these two watersheds have the attraction of tourists visiting both from within the city and outside the city, as well from foreign countries. From these two watershed studies, several similarities and differences were obtained, where the depth value of the watershed is almost the same on average. This is because both watersheds have the same geography, such as in both watersheds having a bridge that can make the depth of the watershed change. The difference between these two watersheds is that the Krueng Leupung watershed has many rocky mountains, where, during floods, strong currents hit the rocks so that the Krueng Leupung watershed is more winding. Whereas in the Krueng Raba watershed, only some of the meanders are in the upper reaches of the river, and the estuary is gentler, and the flow is always calm. Not only is the nature different, the location of these two watersheds is also very different. Krueng Raba watershed is located close to residential areas and cities, so Krueng Raba watershed is visited by many tourists, and there are also several facilities and infrastructure provided by local residents. While the Krueng Leupung watershed is located far from the city, and also the lack of existing facilities and infrastructure, so Krueng Leupung watershed is still very beautiful [18]. In both watersheds, environmental factors such as tides and sediment transport play an important role in determining river dynamics and depth. Tides, which are influenced by the gravitational forces of the moon and the earth, can cause depth fluctuations, especially in the estuary. Meanwhile, sediment transport, both due to natural flow and human activities, contributes to changes in river morphology, such as siltation in some areas or the formation of new channels. Anthropogenic activities such as bridge construction, riverbed material extraction, and land use changes around the watershed can also affect flow patterns and river depth, which need to be considered in regional management.

Understanding the environmental and anthropogenic factors affecting these two watersheds, communities and policymakers can work together to manage tourism potential, protect river ecosystems, and prevent negative impacts such as flooding or extreme siltation. Knowledge of sediment transport can help with sediment management planning to maintain stable river depths, both for tourism activities and watershed ecosystem sustainability.

4 Conclusion

The bathymetric depth in the Krueng Raba watershed has been found to range from 0.95 m to 5.58 m, while in the Krueng Leupung watershed it ranges from 0.88 m to 4.10 m. Furthermore, the findings of variations in watershed bathymetry are influenced by the morphology of the river and surrounding land. The bathymetric data is of significant importance in the development of safe and attractive water tourism sites, as well as in the preservation of the surrounding river environment. Furthermore, bathymetric data is instrumental in the development of aquaculture, as it allows for the identification of areas with optimal depth and conditions conducive to the growth of cultured organisms. By employing a data-driven approach, the potential for tourism and aquaculture development in these two watersheds can be effectively harnessed while ensuring the long-term sustainability of the surrounding ecosystem.

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