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Imam Rohani, Daeng Paroka, Muhammad Arsyad Thaha, et al.

Distributions of Water Temperature at the Bottom in Semi-Enclosed Saro Estuary, Takalar, Indonesia

Imam Rohani[1,a)], Daeng Paroka[2,b)], Muhammad Arsyad Thaha[1,c)], and Mukhsan Putra Hatta[1,d)]

[1]*Civil Engineering Department, Engineering Faculty, Hasanuddin University, Indonesia*
[2]*Naval Engineering Department, Engineering Faculty, Hasanuddin University, Indonesia*

[a)]Corresponding author: imamrhnmt@gmail.com
[b)]dparoka@eng.unhas.ac.id
[c)]athaha_99@yahoo.com
[d)]mukhsan.hatta@gmail.com

ABSTRACT. Narrowing in semi-closed estuaries caused water circulation, both freshwater flow from rivers and saltwater from the sea to be obstructed. In the back-barrier region, seawater to be isolated affects the distribution of water temperature in the estuary. The purpose of this study was to describe of water temperature at the bottom in semi-closed estuaries at the tide conditions. This research is field research, at the Saro River, Takalar, Indonesia. The results are at high tide, the bottom temperature of the estuary ranges from 28.3 °C - 29.2 °C, with the upstream pattern having a higher base temperature value. At low tide, the bottom temperature of the estuary is 29.2 °C - 30.6 °C, with the trend to go downstream to the mouth of the estuary is getting higher. The mouth of Saro river, which is classified as shallow, has a significantly high effect on the bottom temperature of the estuary. The back-barrier region causes seawater to be isolated from the main waterway in the estuary, causing high temperatures. Tides and the flow of water from the upstream of the river cannot flow seawater in the estuary (back-barrier region) to the sea, where the temperature difference between the estuary and beyond waters in the sea reaches 2 °C. An increasing water temperature can cause water quality problems and impact on aquatic ecology.

INTRODUCTION

Water temperature has a strong influence on the environment and the ecological sustainability of waters [1]. In semi-closed estuaries, the narrowing of the estuary due to sediment deposits causes water circulation, both freshwater flow from rivers and saltwater from the sea to be obstructed. The existence of a barrier across the estuary causes seawater to be trapped in the Back barrier region at low tide or water from river discharge, so it affects the distribution of water temperature in the estuary [2]. At high tide, seawater with a certain temperature will enter the river at a certain distance, and at low tide, the seawater that comes out of the river takes a longer time due to a narrowing in the estuary. Because the salt content in seawater is greater, seawater tends to move on the bottom of the water while freshwater is on the surface, so the study of the bottom temperature of the waters is important, as a reference for estuary ecological life.

Several previous studies related are: Salinity in semi-enclosed estuary [2], River water temperature [3], Temperature Variability in a Subtropical Estuary [4], Surface-water temperature [5,6], Water Temperature at Bottom in Bay Mouth [1], river water temperature under climate change [3,7], River Temperature Modelling [8,9]. That makes the author interested in conducting research on the distributions of water temperature at the bottom in semi-enclosed Estuary. The purpose of this study was to obtain the distribution of the bottom temperature of the estuary at high tide, towards high tide, low tide and towards low tide, to analyze the relationship between depth,

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distance and temperature, the effect of estuary narrowing on temperature distribution with the research location in the Saro river, Takalar, Indonesia.

STUDY AREA AND METHODS

Study Area

The study area in this study was carried out in the Semi-Enclosed Estuary in the Saro River, Takalar, South Sulawesi, Indonesia, with the existing conditions as shown in Fig. 1. Located at Latitude 119° 21'39.508"E and 5°20' 36.455"S. The width of the mouth of the mara is 40 m, the width of the estuary is 58m, the average river width is 50m. With varying depths from 0.2m to 1.9m. The study area is towards the sea 500m from the mouth of the estuary and the area towards the upstream which is reviewed is 2.2km, in order to obtain data on the exact location of the mixing of seawater and freshwater which affects temperature can be determined.

FIGURE 1. Semi-enclosed Saro Estuary

Methods

Field data collection was carried out from 4 July 2020 to 5 July 2020, the time for data collection was predetermined namely high tide, towards high tide, low tide and towards low tide from the tide chart. The measuring instrument used is CastAway CTD with data collection from the boat, as shown in Fig. 2.

FIGURE 2. Retrieval of temperature data using the CastAway CTD

The temperature data collection points were carried out at 9 points in the river estuary given the notation T1 to T9 as shown in Fig. 3. The temperature data collection coordinates are as follows: T1 119°22'4.631"E, 5°21'0.683"S; T2 119°22'6,473"E, 5°20'54,119"S; T3 119°22'4.154"E, 5°20'45.256" S; T4 119°21'57.623"E, 5°20'50.098"S; T5 119°21'48,684"E, 5°20'54,732"S; T6 119°21'50,635"E, 5° 20'48.081"S; T7 119°21'50.499"E, 5°20'42.192"S; T8 119°21'45,672"E, 5°20'39.067"S; T9 119° 21'40.072"E, 5°20'36,696"S.

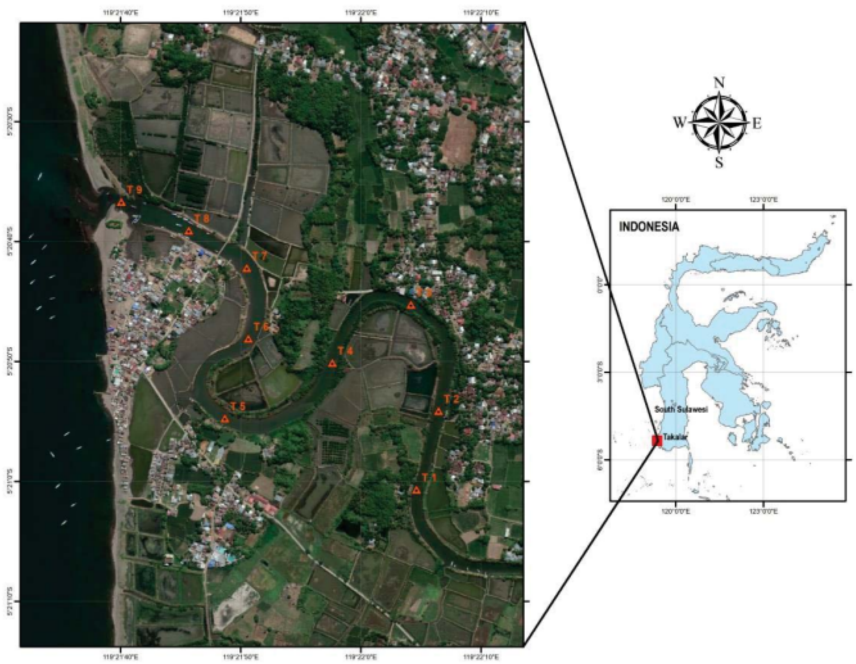

FIGURE 3. Temperature data collection point

RESULTS AND DISCUSSION

Temperature Distribution

Figure 4 shows the variation in depth from points T1 and T9 from the observed temperature data during high tide. The depth at the mouth of the Saro River varies with a depth range of 0.8m - 1.9m. At the mouth of the estuary T9, the area experiencing narrowing, the water depth is 1m. Meanwhile, the depth in the back-barrier region is T8 depth 1.6m, T7 depth 1.3m and T6 depth 1.8m.

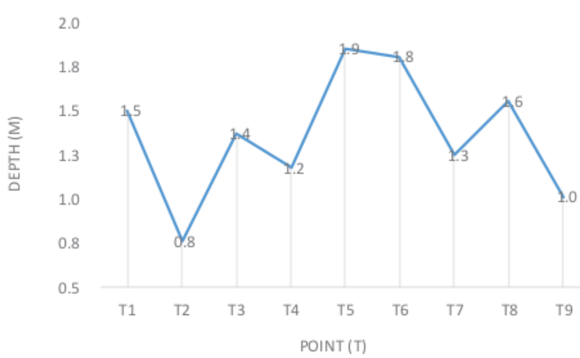

FIGURE 4. Depth of temperature point observation

Figures 5-6 show the horizontal distribution of the bottom temperature of the Saro Estuary at the tide, with red showing low temperature values and green showing high temperature values. At high tide, in Fig. 5, low temperature, which is influenced by temperature by seawater, spreads upstream to reach point T3, 1.63km from the mouth of the estuary. At low tide, in Fig. 6, the low temperature value (red color) which is influenced by river discharge, spreads to point T6, 0.67km from the mouth of the estuary. At low tide, at points 6, 7 and 8, it is very dominant in red, showing a high temperature value.

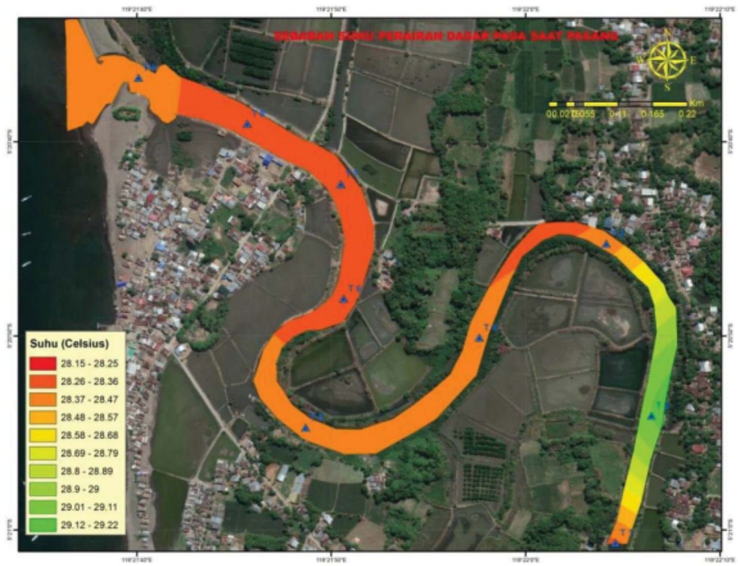

FIGURE 5. Temperature distributions at the bottom in high tide

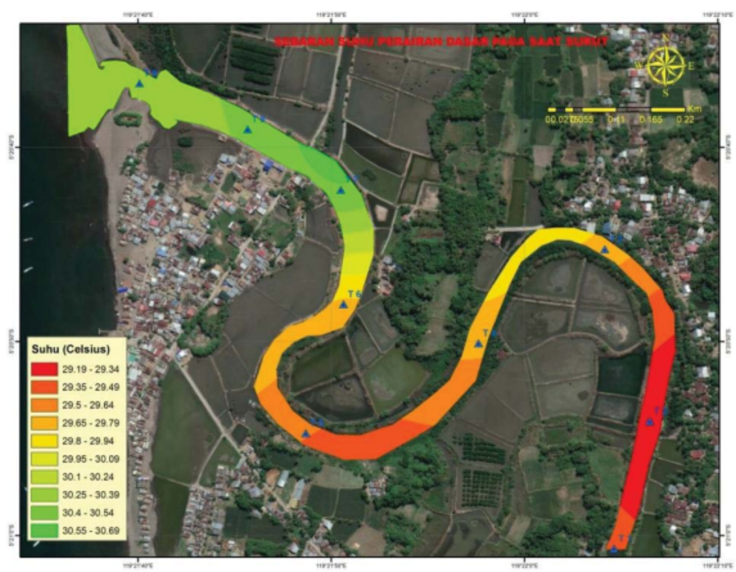

FIGURE 6. Temperature distributions at the bottom in low tide

At high tide, the bottom temperature of the estuary ranges from 28.3°C - 29.2°C, with the upstream pattern having a higher bottom temperature value. At low tide, the bottom temperature of the estuary is 29.2°C - 30.6°C, with the trend to go downstream to the mouth of the estuary is getting higher. The mouth of the Saro River, which is classified as shallow, has a significantly high effect on the bottom temperature of the estuary.

At high tide, the difference in water temperature between the outer waters and the waters inside the river is 0.1°C and at low tide it is 2°C, which is very contrast. The water depth at point T8, although it is quite deep, does not affect the bottom temperature of the estuary. Meanwhile, when viewed upstream, at T4 and T5, there is a significant difference in temperature to the water depth of 0.2°C between them both, with a difference of 0.7m depth. The increase in water temperature is caused by shortwave radiation from the sun and the sky and the heat of the seawater from long-wave radiation from the air that occurs all the time. In addition, heat temperature is also caused by air conduction and ocean currents [1]. This can be attributed indirectly to changes in river flow patterns and is directly related to an increase in the input of atmospheric energy into water [7]. Changes in the river flow regime (such as a shift in flow volume to a lower one), more turbid water, more artificial structures in canals causing inundation, removal of riparian vegetation, or changes in land use across a catchment, variations in p parameters as locally mediated responses related to channel and riparian conditions. In addition, changes in measurement time can also produce different temperature values [6]. Where the mouth of the Saro River is also used as a mooring and fishing boat shipping traffic, which can affect the distribution of the bottom temperature and some of the things above have the potential to decrease water quality and disrupt aquatic ecological habitat, as well as reduce water availability for human needs [1].

Influence Semi-Enclosed Estuary to Temperature

Narrowing at the mouth of the Saro estuary is due to the presence of a barrier that crosses the estuary and shallow channels due to sedimentation, so that seawater is isolated in the back-barrier region at high tide. The bottom water temperature in the back-barrier region of the Saro estuary occurs up to point T6 or 0.67km from the estuary to the upstream of the river. The bottom temperatures, at high tide (HT), low tide (LT), toward high tide (THT) and toward low tide (TLT) are shown in Table 1. The bottom temperature trends of the four tidal conditions are shown in Fig. 7.

From Table 1, the bottom temperature in the back-barrier region at the mouth of the Saro River is shown at T8 to T6. It shows at high tide values of 28.3°C - 28. 4°C, at the time at low tide 29.7°C - 30.6°C, at toward high tide 28.3°C - 29.7°C, and at toward low tide 29.4°C - 29.9°C. There is a significant difference in the upstream area of the river and the back-barrier region, the area upstream of the river has the highest base temperature value of 29.7°C and in the back-barrier region of 30.6°C, with the difference between high and low reaching 1.2°C. In Fig. 7, when the high tide and toward the low tide have a flat trend, the effect of tide flow from the sea and tide flow from the upstream river. Towards the high tide, the trend of the bottom temperature shows a higher upstream trend, and otherwise at a low tide.

TABLE 1. Temperature at the bottom in several conditions

Point	HT	LT	THT	TLT
T1	28.3	29.4	29.7	29.4
T2	29.2	29.2	30.1	29.7
T3	28.4	29.7	29.6	29.4
T4	28.4	29.7	29.5	29.7
T5	28.4	29.5	28.6	29.9
T6	28.3	29.7	29.7	29.4
T7	28.3	30.6	28.3	29.9
T8	28.3	30.4	28.4	29.6
T9	28.4		28.3	29.6

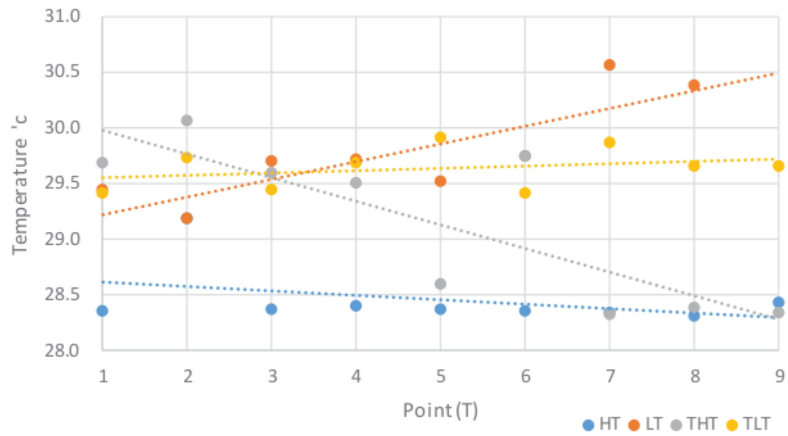

FIGURE 7. The trend of distribution water temperature at the bottom

Back-barrier region causes seawater to be isolated from the main waterway in the estuary, causing high temperatures. Tides and water flow from upstream rivers cannot flow seawater in the estuary (back-barrier region) to the sea, where the temperature difference between the estuary and beyond waters in the sea reaches 2°C. Although seawater tends to move on the bottom of the water while freshwater is on the surface, because its specific gravity is greater than freshwater [2]. Where increasing water temperature can cause water quality problems and impact aquatic ecology [10].

CONCLUSIONS

Based on the results of the discussion, some conclusions can be drawn, at the mouth of Saro estuary; at high tide, the bottom temperature of the estuary ranges from 28.3°C - 29.2°C, with the upstream pattern having a higher base temperature value. At low tide, the bottom temperature of the estuary is 29.2°C - 30.6°C, with the trend to go downstream to the mouth of the estuary is getting higher. The mouth of the Saro River, which is classified as shallow, has a significantly high effect on the bottom temperature of the estuary. Back-barrier region causes seawater to be isolated from the main waterway in the estuary, causing high temperatures. Tides and the flow of water from the upstream of the river cannot flow seawater in the estuary (back-barrier region) to the sea, where the temperature difference between the estuary and beyond waters in the sea reaches 2°C.

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