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Distribution pattern of water salinity analysis in Jeneberang river estuary using ArcGIS

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Abstract. Interaction between freshwater and saltwater is a natural phenomenon in river estuaries, with no exception for Jeneberang estuary. This interaction will affect the distribution of salinity. Due to the difference in the density of saltwater and freshwater, blending will occur in between the two types of fluids. In another perspective, the existence of a driving factor such as the tidal routines affects the level of salinity. The purpose of this research was to describe the distribution of salinity at Jeneberang River Estuary both on high and low tide conditions. The results show that the salinity in Jeneberang River estuary in high tide conditions is distributed to distance as far as 2.63 km from the mouth of the estuary, while at low tide conditions the distances reach 2.12 km to the upstream. The salinity would decrease in line with the increase of the distance towards the headwaters of the river. The Salinity would also decrease in the same trends with increasing distance towards the surface of the river. While the value of salinity between the high tide and low tide is not too significant at depth of 0.8H. This is caused by the difference in the depth of the River at each point of sampling and a low stream at low tide conditions, so that the salt sediment washed from the sea at high tide did not return at low tide. Based on water classification, the kind of water in the Jeneberang River estuary could be categorized as freshwater to brackish. Keywords: Jeneberang River, Salinity, Distribution Patten, River Estuary

1. Introduction

Salinity is a common phenomenon in rivers that generally deal directly with the sea through estuaries. Water circulation in the estuary area is strongly influenced by the flow of fresh water sourced from the river body and saltwater from the sea. The process of seawater entering estuary is known as seawater intrusion. Seawater intrusion distance is very dependent on tides where the higher the tidal height, the further the seawater intrusion or vice versa. At high tide, seawater will intrude on the river at a considerable distance. Seawater intrusion in rivers can cause rivers to have high salinity. The effect of salinity in the waters can cause a decrease in oxygen concentrations, including those found on river bodies that have been influenced by estuary waters.

This interaction between freshwater and seawater occurs in the Jeneberang River estuary. This interaction will affect the distribution of salinity. Because of the difference in mass density between



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saltwater and freshwater, there will be mixing between the two. Besides, there are driving factors such as tides that affect salinity values. Tidal currents affect the shift in salinity along the estuary, which moves upstream during high tide and downstream at low tide. Several research works have been conducted in the field of salinity distribution in the estuary [1-9]. Some aspects have also been conducted in Jeneberang river, regarding the hydrodynamic modeling of its estuary [10-11], the distribution and behavior of dissolved and particulate of chemical [12] and velocity distribution [13-14]. The objectives of this research are to examine the level of water salinity in Jeneberang River estuary, to describe its distribution of high tide and low tide conditions and to analyze the relationship between the depth and salinity of the area.

2. Material and methods

A sampling of Jeneberang River water refers to SNI 6989.57: 2008 [15] in subsections 7 and 8. The sampling points of river water are determined by the size of the river discharge. The sampling points are shown in Figure 1. Research on high tide conditions was carried out on 01 February 2018 at 17.38 - 20.14 GMT+8, while the research on low tide conditions was carried out on 02 February 2018 at 08.45 - 10.49 GMT+8. This research was carried out at the estuary of the Jeneberang River in South Sulawesi. Total samples were 144 samples, 72 samples for respective tidal conditions. The tools and materials used in this study are: Refractometer, Van Dorn Water Sampler, Boat, GPS (Global Position System), sample bottles, funnels, buoys, measuring tapes, cool boxes, writing instruments, and cameras. The salinity distribution pattern was depicted by ArcGIS™ 10.2 program.

The determination of the position of the observation point is conducted using GPS (Global Position System). In this study, GPS is used as a navigation tool in the direction of the path in the river to the point of the research location and from the point of sampling one to another sampling point. Salinity sampling is carried out in the middle part of the river and estuary with 2-time conditions, high tide, and low tide. Water salinity is measured in the laboratory using an ATAGO type refractometer. The refractometer is also known as refractive index gauges in liquids to measure the concentration of salt compounds. The principle of this tool is to utilize the light refraction index to determine the level of water salinity. The salinity unit in the refractometer is part per thousand (o/oo).

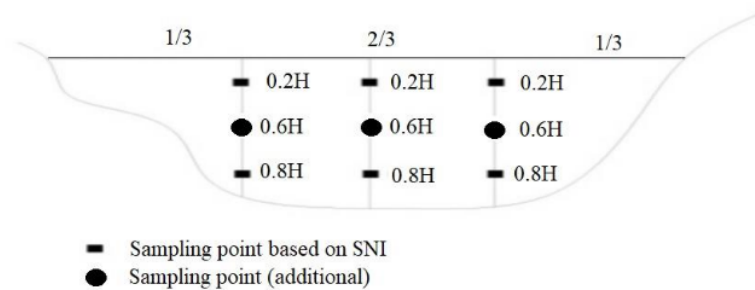
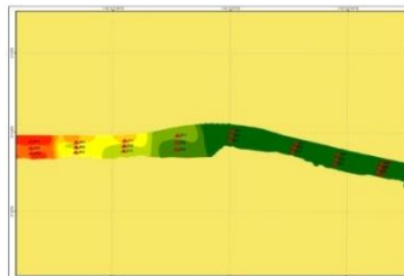


Figure 1. Salinity sampling location scheme.

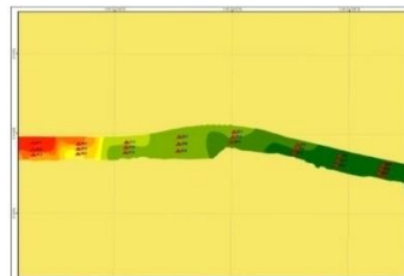
3. Results and discussion

3.1. Salinity distribution pattern

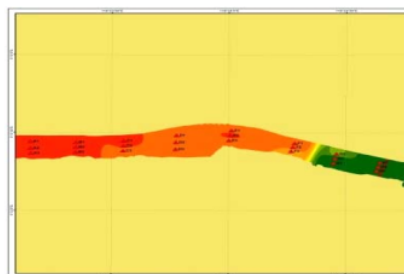
Figure 2 depicts the distribution pattern of salinity for 0.2H depth in high tide conditions, while Fig. 3 and Fig. 4 represents the distribution pattern of salinity for 0.6H depth and 0.8H, respectively, for the same tidal conditions.



10 **Figure 2.** Distribution pattern of salinity for 0.2H depth in high tide.



4 **Figure 3.** Distribution pattern of salinity for 0.6H depth in high tide.



4 **Figure 4.** Distribution pattern of salinity for 0.8H depth in high tide.

Figures 5, 6, 7 are the illustrations of the distribution pattern of salinity for 0.2H, 0.6 and 0.8, respectively, for low tide conditions of the river estuary.

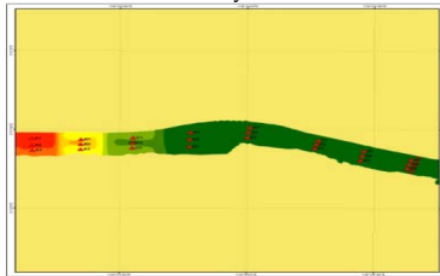


Figure 5. Distribution pattern of salinity for 0.2H depth in low tide.

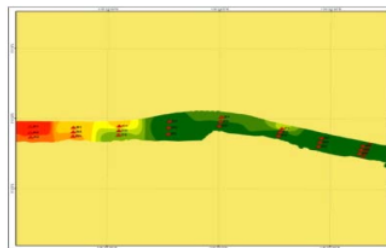


Figure 6. distribution pattern of salinity for 0.6H depth in low tide.

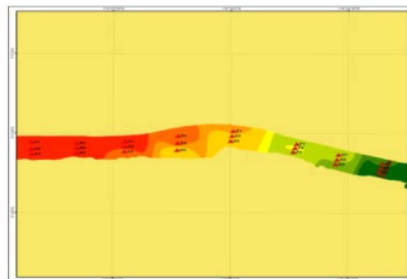


Figure 7. Distribution pattern of salinity for 0.8H depth in low tide
Influences of tidal conditions to salinity

The following figures show the influence of the tidal effect on the salinity of water in the estuary. For 0.2H depth, the dispersion of salinity is shown in Fig. 8

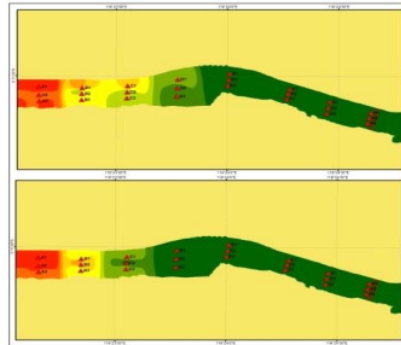


Figure 8. Dispersion of salinity for 0.2H depth in the two tide conditions, an upper picture is for high tide and the lower one is for low tide.

Based on the pictures, salt water from the sea spreads further upstream in high tide conditions when compared to the one to low tide conditions. According to Dahuri [16], when the tide rises further into the upper reaches of the river, it shifts the isohaline upstream and results in water to have maximum salinity. Figure 9 shows the dispersion of salinity for 0.6H depth in the two tide conditions, an upper picture is for high tide and the lower one is for low tide.

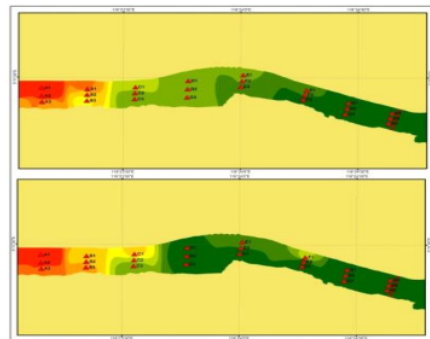


Figure 9. Dispersion of salinity for 0.6H depth in the two tide conditions, an upper picture is for high tide and the lower one is for low tide.

Based on the picture, there is an insignificant difference between the value of river salinity in high tide and low tide conditions. This means that there are other factors other than tidal conditions that affect the salinity value at the 0.6H depth sampling location. According to Triatmodjo [17], the factors that influence the salinity of estuary areas in addition to tides are different current strengths which cause flow velocity to vary resulting in the differences in flow circulation patterns. The dispersion of salinity for 0.8H depth in the two tide conditions is depicted in Fig. 10, where the upper picture is for high tide and the lower one is for low tide.

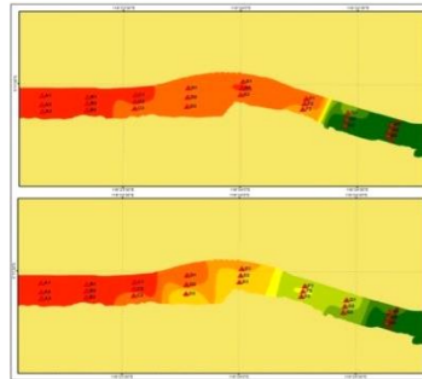


Figure 10. dispersion of salinity for 0.8H depth in the two tide conditions, an upper picture is for high tide and the lower one is for low tide.

Figure 10 shows an insignificant difference between the value of river salinity in high tide and low tide conditions. This means that there are other factors besides tides that affect the salinity value at the 0.8H depth sampling location. Small current strength at low tide sampling conditions causes salt deposits at 0.8H depth carried from the sea at high tide, not coming out at low tide. This is influenced by the difference in river depth at each point that allows the presence of salt deposits during high tide.

In addition to tides, the salinity value is also influenced by the season. Estuary salinity tends to be lower in the upstream direction. However, during the dry season when river water flows are reduced, seawater can intrude further upstream so that the salinity of the estuary increases. Conversely in the rainy season, freshwater flows from the river to the sea in greater amounts so that the salinity of the water in the estuary decreases.

3.2. Influences of depth to salinity

Distribution patterns of salinity in Jeneberang River on high tide conditions based on the depth of sampling points are shown in the following Figures 11 and 12.

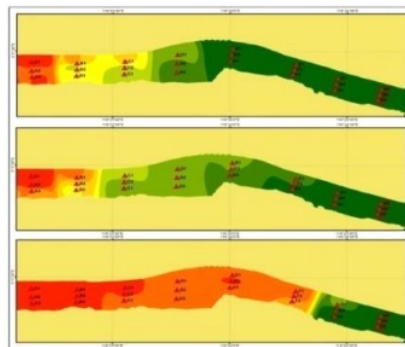


Figure 11. Dispersion of salinity for high tide conditions

Figure 11 shows that the furthest salinity distribution is at a 0.8H depth sampling location. This can be seen from the red and orange markers which show the highest salinity values scattered up to the point F sampling location 2.63 km distance from the mouth of the estuary, while the distribution of the nearest salinity is found at a location of 0.2H depth. This can be seen from the dark green markers that show the lowest salinity value spread from the point of sampling point E which is 2.12 km from the mouth of the estuary, meaning that at that distance there is no longer the influence of saltwater from the sea at 0.2H river depth or part of the river surface. Meanwhile, the pattern of spreading the Jeneberang River salinity in low tide conditions based on the depth of water sampling can be seen in the picture below.

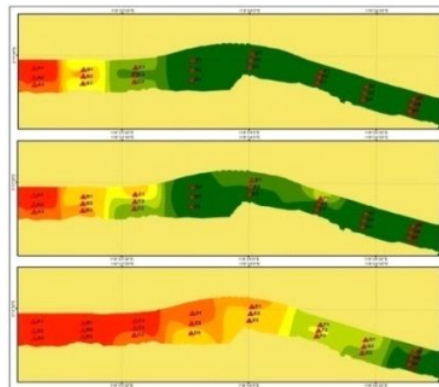


Figure 12. Dispersion of salinity for low tide conditions.

Based on the picture, the farthest salinity distribution is also found at the 0.8H depth sampling location. This can be seen from the red and orange markers that show the highest salinity values scattered to reach the point E sampling location is 2.12 km from the mouth of the estuary.

Figure 11 and Figure 12 show that the salinity value of both tidal and low tide conditions, at a sampling point of 0.8H depth, is very high compared to the salinity value at the sampling point of 0.2H depth and 0.6H depth. This is due to the intrusion of seawater into the river water. The intrusion of seawater will lead to an increase in salt in water, thus affecting the quality of river water. The deeper the sampling point, the intrusion of seawater which has a greater specific gravity will easily move upstream through the river bed. In this event, freshwater flows above seawater, between saltwater and freshwater occur on a salt wedge where the bottom layer salinity is the same as the salinity of seawater, while the upper layer is freshwater.

The water salinity value of the Jeneberang River estuary area from this study ranged from 0 ‰ - 20 ‰ or filled the three classifications of salinity which are oligohaline, mesohaline and lower level of polyhalite. These result in great disparities of salinity of Jeneberang estuary. Most of the tested water samples were classified as fresh to brackish water based on water classification. The difference in salinity can result in the occurrence of the freshwater plume and mass movement in the estuary. The difference in salinity of seawater with river water interfacing in the estuary can cause a mix of the different types of fluids into brackish water. The meeting zone between salt water and fresh water is called the interface. Saltwater has a higher mineral content than freshwater, giving it higher density and greater water pressure and resulting in the movement of salt waters towards freshwater. Because the salt content of seawater is

greater, seawater tends to move in the bottom of the water while freshwater is on the surface. This situation results in the water circulation in the estuary.

4. Conclusions

Based on the results of the discussion, some conclusions can be drawn. The water salinity value of the Jeneberang River estuary area ranged from 0o/oo - 20o/oo. Most of the water samples were categorized as fresh to brackish water. Based on the pattern of salinity dispersion using ArcGis 10.2 it can be seen that on high tide condition sea water can enter the river until the distance is 2.63 km from the mouth of the estuary, while in the condition of low tide the river enters the river up to a distance of 2.12 km from the mouth of the estuary.

Besides, changes in salinity values that were not significant between tidal conditions and receding conditions at a depth of 0.8H were caused by differences in river depth at each sampling point and small river currents at low tide conditions so that salt deposits carried from the sea at high tide will come out at low tide. The relationship between depth and salinity value of the Jeneberang River estuary area is directly proportional. This is because seawater is easy to intrude upstream through the river bed. The intrusion of seawater on the river bed is caused by differences in mass density between saltwater and freshwater.

References

- [1] Bacopoulos P, Kubatko E J, Hagen S C, Cox A T and Mulamba T 2017 *Modeling and data assessment of longitudinal salinity in a low-gradient estuarine river*. Environmental Fluid Mechanics **17(2)**, 323-353 <https://doi.org/10.1007/s10652-016-9486-8>
- [2] Sheng J, Tang L, Ji X, and Liu L, 2010 *An Examination of Seasonal Mean Circulation and Salinity Distributions in the Pearl River Estuary of China Using a Nested-Grid Coastal Ocean Circulation Model*. J.Estuarine and Coastal Modeling 108-127 [https://doi.org/10.1061/41121\(388\)7](https://doi.org/10.1061/41121(388)7)
- [3] Jumarang M I, Muliadi, Ningsih N I, Hadi S and Martha D 2011 *Pola Sirkulasi Arus Dan Salinitas Perairan Estuari Sungai Kapuas Kalimantan Barat* J. POSITRON **1(1)** 36-42 <https://doi.org/10.26418/positron.v1i1.1569>
- [4] Liu B, Liao Y, Yan S and Yan H 2017 *Dynamic characteristics of saltwater intrusion in the Pearl River Estuary China* Nat Hazards **89(3)**, 1097-1117 <https://doi.org/10.1007/s11069-017-3010-4>
- [5] Zhu J, Wu H, Li L and Qiu C 2018 *Saltwater Intrusion in the Changjiang Estuary* J. Coastal Environment, Disaster, and Infrastructure-A Case Study of China's Coastline 49-73 <https://doi.org/10.5772/intechopen.80903>
- [6] Syukri M, 2010 *Horizontal Distribution of Salinity and Temperature on Merbok Estuary* J. Indonesian Journal of Marine Sciences **14(2)** 93-97 <https://doi.org/10.14710/ik.ijms.14.2.93-97>
- [7] Jang D, Hwang J H and Park Y G 2012 *A study on salt wedge and River Plume in the Seom-Jin River and estuary* J. KSCE J Civ. Eng. **16(4)** 676-688 <https://doi.org/10.1007/s12205-012-1521-9>
- [8] Bergquist D C, Hale J A, Baker P and Baker S M 2006 *Development of ecosystem indicators for the Suwannee River Estuary: Oyster reef habitat quality along a salinity gradient* J. Estuaries and Coasts: J ERF **29(3)** 353-360 <https://doi.org/10.1007/BF02784985>
- [9] Yoon B I and Woo S 2015. *The along-channel salinity distribution and its response to river discharge in tidally-dominated Han River Estuary* J. Procedia Engineering **116**, 763-770 <https://doi.org/10.1016/j.proeng.2015.08.362>
- [10] Arafat Y, Pallu M S, Maricar F and Lopa R T 2016 *Hydrodynamics and Morphological Changes Numerical Model of the Jeneberang Estuary*. J.International Journal of Innovative Research in Advanced Engineering (IJIRAE) **3(8)** 21-29 <http://dx.doi.org/10.17632/dyfwkty5yb.1>

- [11] Arafat Y, Pallu M S, Maricar F and Lopa R T 2015. *Morphology evolution of lower Jeneberang River* J. International Journal of Earth Sciences and Engineering **8(5)** 2011-2016
- [12] Najamuddin P T, Sanusi H S and Nurjaya I W 2016 *Distribution And Behavior Of Dissolved And Particulate Pb And Zn in Jeneberang Estuary* J. Journal of Tropical Marine Science and Technology **8(1)** 11-28 <http://dx.doi.org/10.29244/jitkt.v8i1.12494>
- [13] Bakri B, Akbar M, Pallu M S, Lopa R T, Ihsan M and Arai Y 2018 *Study of flow velocity distribution on free intake structure and its influence on intake capacity* J. Journal of Engineering and Applied Sciences **13(17)** 7260-7265 <http://doi.org/10.3923/jeasci.2018>
- [14] Bakri B, Akbar M, Pallu M S, Lopa R T, Ihsan M and Arai Y 2017 *Flow velocity distribution analysis on free intake structure and its influence on intake capacity*. J. The 4th International Conference on Engineering and Technology Development (ICETD 2017) 46-52
- [15] Badan Standardisasi Nasional 2008. *Standard Nasional Indonesia (SNI) 6989.57:2008* Jakarta: Dewan Standardisasi Nasional
- [16] Dahuri R 2003 *Keanekaragaman Hayati Laut, Aset Pembangunan Berkelanjutan Indonesia* Jakarta: Gramedia Pustaka Utama
- [17] Triatmodjo B 1999 *Teknik Pantai*. Yogyakarta: Beta Offset

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