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SALINITY DISTRIBUTION PATTERN IN SPERMONDE WATERS USING REMOTE SENSING DATA (COPERNICUS MARINE SERVICE) IN 2022

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ABSTRACT

Salinity is the total concentration of ions found in water. Salinity is important for the survival of organisms. Almost all marine organisms can only live in areas that have small changes in salinity. The aim of this research is to determine the distribution pattern of salinity in Spermonde waters in 2022 and to find out a comparative picture of the salinity distribution pattern on Kapoposang Island, Samatellu Lompo Island, Kuninggareng Lompo Island and Lanyukang Island in Spermonde waters in 2022. This research was conducted from August to October 2023 in Hasanuddin University Makassar, Makassar City, South Sulawesi Province. Research was conducted at the Indraja Laboratory, Faculty of Marine and Fisheries Sciences. The data used was satellite image data, namely CMEMS satellite image. The pattern of salinity distribution in Spermonde Waters with an average value of 34.04 ppt is the highest salinity in August, and for the average value of salinity distribution of 32.52 ppt is in January. The comparison pattern of salinity distribution in 2022 on Kapoposang Island, Lanyukang Island, and Samatellu Lompo Island has the same average value, namely the lowest January and the highest August, except for Koninggarang Lompo Island the highest average value is in September and the lowest is in January.

Keywords: Salinity, Kapoposang Island, Lanyukang Island, Koninggareng Lompo Island, Samatellu Lompo Island

INTRODUCTION

Spermonde waters are waters that surround the Spermonde islands in which the shallows area are located to the southwest of South Sulawesi and are separated from the Sunda shallows located elsewhere in the Makassar Strait. This network of island waters covers the southern part of Takalar Regency, Makassar City, Pangkep Regency, and Barru Regency on the northern part of the West coast of South Sulawesi (Jalil *et al.*, 2020). This area, which is inhabited by 121 islands, has a fairly high level of coral diversity. There are 78 genera of coral with a total number of species of 262. Diving enthusiasts are already familiar with this area. A number of well-known diving spots are found in this area. The best diving spot in this area is Lau Kapopong Park. In this area, coral reefs are found with steep contours (drop off) or running vertically forming a wall that is rarely found in other places. Apart from being a paradise for divers, Spermonde is also the main economic source of the people in the area. Most of the fish supply is obtained from this area.

Salinity is a physical parameter that can affect water quality (Antisari *et al.,* 2020; Rosalina *et al.,* 2023a). Salinity is the total concentration of ions found in water (Nthunya *et al.,* 2018; Rosalina *et al.,* 2023b). Salinity describes the total solids in water after all the carbonates have been converted to oxides, all the bromides and iodides have been replaced by chlorides, and all the organic matter has been oxidized. Salinity is expressed in units of g/kg or promil (º/00). Salinity is crucial for the survival of organisms (Velasco *et al.,* 2018). Almost all marine organisms can only live in areas that have small changes in salinity. When salinity is small or low, organisms in the

sea will lose the ability to regulate the balance of ion concentrations in their bodies, whereas when salinity is large or high it can disrupt fish weight growth (non-optimal growth). The high and low salinity values are greatly influenced by the supply of fresh water to sea water, rainfall, seasons, topography, tides and evaporation (Yan *et al.,* 2015; Rosalina *et al.,* 2023c). Therefore, it is necessary to map the salinity distribution pattern in Spermonde waters using remote sensing data. It is hoped that mapping the distribution of salinity will provide an overview of the factors causing the rise and fall of salinity in these waters. Salinity is important for the survival of organisms, almost all marine organisms can only live in areas that have small salinity changes. When salinity is small or low, organisms in the sea will lose their ability to regulate the balance of ion concentrations in the body, while if large or high salinity can affect the growth of fish weight becomes non-optinal. The high and low salinity value is strongly influenced by the supply of fresh water to seawater, rainfall, season, topography, tides, and evaporation (Dedi Sumarto, 2013). According to (Nagendra *et al.,* 2013), the use of remote sensing is widely used in various things occurring on this earth. One of them is used as a method of monitoring biological resources (Kuenzer *et al.,* 2014).

Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring reflected and emitted radiation from a distance (usually from satellites or aircraft). Special cameras collect remote sensing images allowing observers to "sense" everything about the Earth. In this practice, the data used is Marine Copernicus data to determine the distribution of salinity.

MATERIALS AND METHOD

This research activity was carried out from August to October 2023 at Hasanuddin University Makassar, Makassar City, South Sulawesi Province. This research took place at the Indraja Laboratory, Faculty of Marine and Fisheries Sciences. The method to be used in this practice is the descriptive method, namely by describing an image of the results of data processing. The result of this method is in the form of a picture of the salinity distribution pattern, as well as the value of the salinity distribution. This method uses satellite imagery data, i.e. for salinity data using CMEMS satellite imagery data downloaded on https://marine.copernicus.eu/. The locations used for mapping studies on salinity distribution patterns were Spormande waters on Kapoposang island, Samatellu Lompo island, Koninggareng Lompo island, and Lanyukang island in 2022 (**Figure 1**).

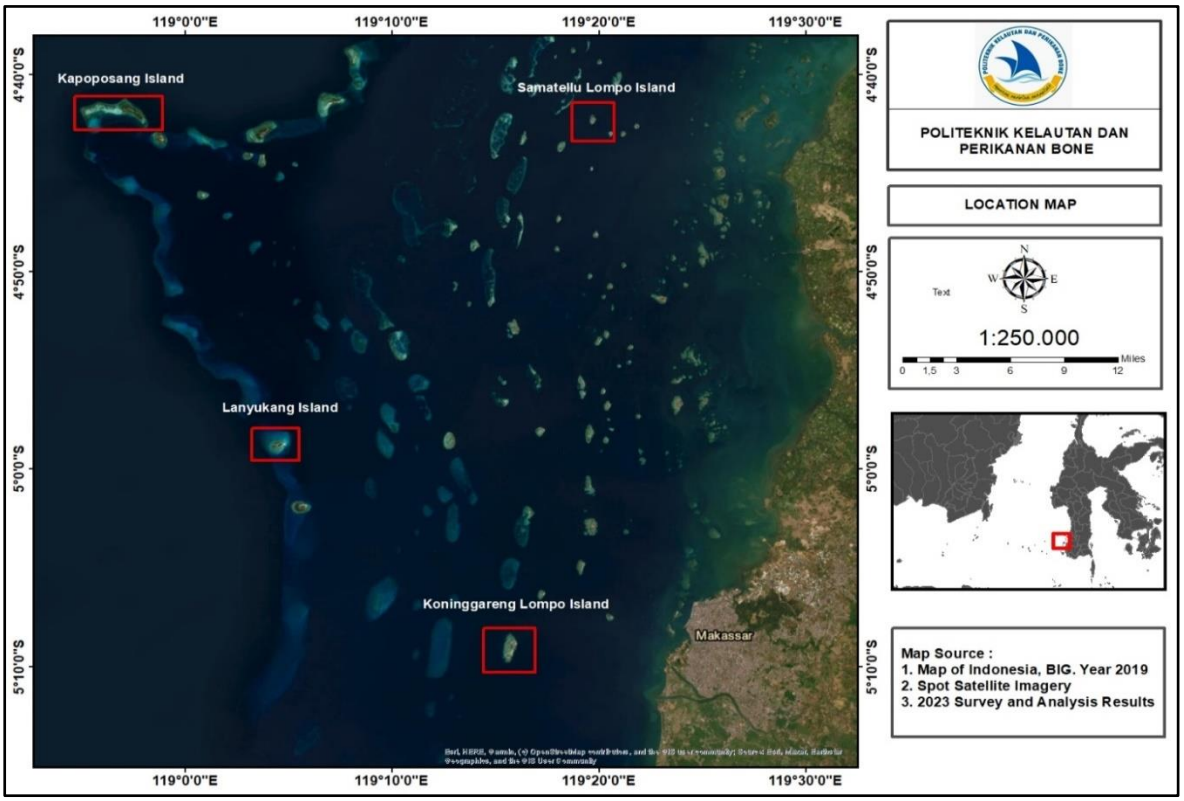

Figure 1. Research Map

The data analysis used was temporal analysis. Temporal analysis was carried out by creating salinity time series data over a period of one year, then the increase and decrease in this data was analyzed based on the highest and lowest values. The time series data created contained salinity data for a full year, namely January, February, March, April, May, June, July, August, September, October, November, December.

Analysis (time series) is a type of data collected according to time sequence in a certain time vulnerability. If time is viewed as discrete (the time modeled is continuous) the frequency of collection is always the same (equidistant). In discrete cases, frequency can be for example seconds, minutes, hours, days, weeks, months or years (Rosadi, 2006).

The tools and materials used in the implementation of field work practices consist of software / computers. The software used is as follows, it can be seen in **table 1**.

Table 1. Tools and materials

No.	*Software*	Uses
1.	Marine Copurnicus	Used to download salinity data to be used.
2.	SeaDAS	Used to process monthly salinity satellite imagery data.
3.	ArcMap	This application is used in data management for visualization, editing and to manage marine copurnicus satellite imagery data.
4.	Google Earth Pro	Used as a coordinate point retrieval or determination of the research location station point.
5.	Microsoft Excel 2007	This application is used as a processing of marine copurnicus salinity satellite data and making table graphs.
6.	Microsoft Word 2013	Used as a research report writing.

RESULT AND DISCUSSION

Salinity Distribution Area in Spermonde Waters

Data on the average distribution of salinity in 2022 in Spermonde waters showed quite large differences in each month. The difference in psu in January and February was 0.7 where the psu in January was 32.52 ppt and the psu in February was 32.59 ppt. Furthermore, the average salinity in March was 32.62 ppt. The difference in psu in April and May was 0.6 where the psu in April was 32.83 ppt and the psu in May was 32.99 ppt. The salinities in June, July and August respectively were of 33.34 ppt, 33.79 ppt and 34.04 ppt (as the highest psu). Furthermore, the salinities occurred in September, October, November and December respectively were at 33.99 ppt, 33.83 ppt, 33.64 ppt and 33.17 ppt (**Figure 2**).

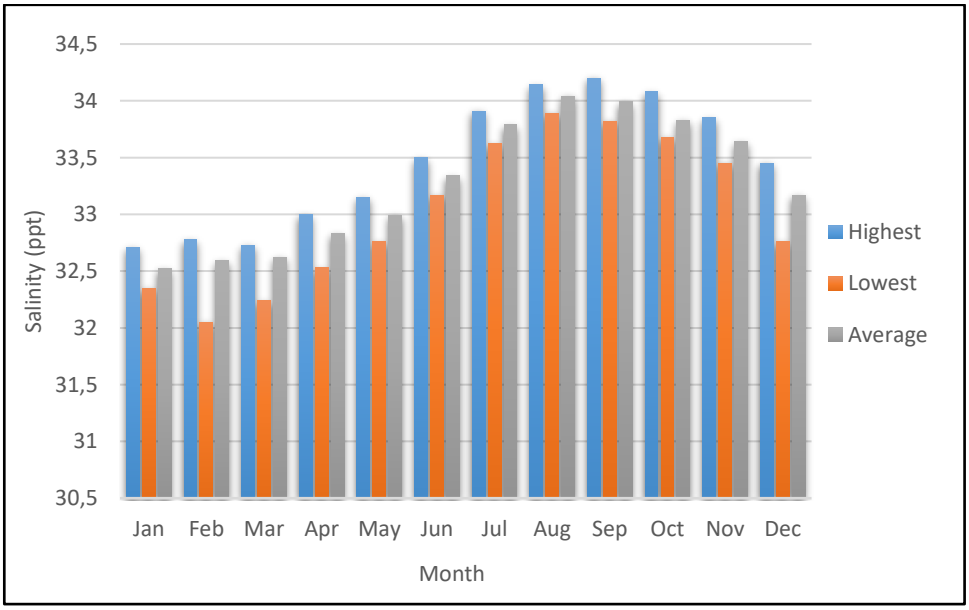

Figure 2. Average distribution of salinity in Spermonde Waters

The average distribution of salinity in Spermonde waters demonstrated that the average salinity values was in the range of 32.52 ppt to 34.04 ppt. Based on average salinity data, the highest salinity value in Spermonde waters was found in August, namely 34.04 ppt. This phenomenon occurred possibly because in these months the east monsoon began to take place where very little rainfall fell in these months. Therefore, the average spread in these months was relatively higher. This is in accordance with the statement of Pratama *et al.* (2016) stating that during the east season water masses with high salinity move from the east of the Makassar Strait and the Flores Sea. This phenomenon forces low salinity water to move back westward. This phenomenon is also in line with the findings of (Ikhwan *et al.,* 2019) saying that salinity in the waters of the Makassar Strait is influenced by the circulation of monsoon winds. During the east season, water masses from the Flores Sea would enter Makassar waters so that they could increase the salinity value in these waters. During the process of rising water during the east monsoon, salinity could reach a value of 34-34.05 ppt. The lowest average value was found in January, namely 32.52 ppt. The low distribution of salinity this month was influenced by changes in weather and wind. This is in accordance with the statement by Patty *et al.* (2020) stating that high and low salinity values in the sea are influenced by various factors such as water circulation patterns, evaporation, rainfall and river flow. This is reinforced by Tompkins *et al.* (2021) statement saying that differences in sea water salinity values can be caused by mixing due to sea waves or the movement of water masses caused by gusts of wind.

Salinity Distribution Pattern on Kapoposang Island, Lanyukang, Koninggareng Lompo, Samatellu Lompo

The distribution of salinity started from January to December, where each month had a different color distribution where purple represents high level of salinity, dark blue represents medium level of salinity and light blue represents low level of salinity. Differences in salinity color in each month can be caused by several things such as geographic structure, the influx of fresh water from rivers, rainfall, evaporation and circulation of water masses. Mapping of salinity distribution patterns on Lanyukang Island was carried out using ArcGIS 10.8 software. The results obtained can be seen in (**Figures 3**, **4**, **5**, and **6**).

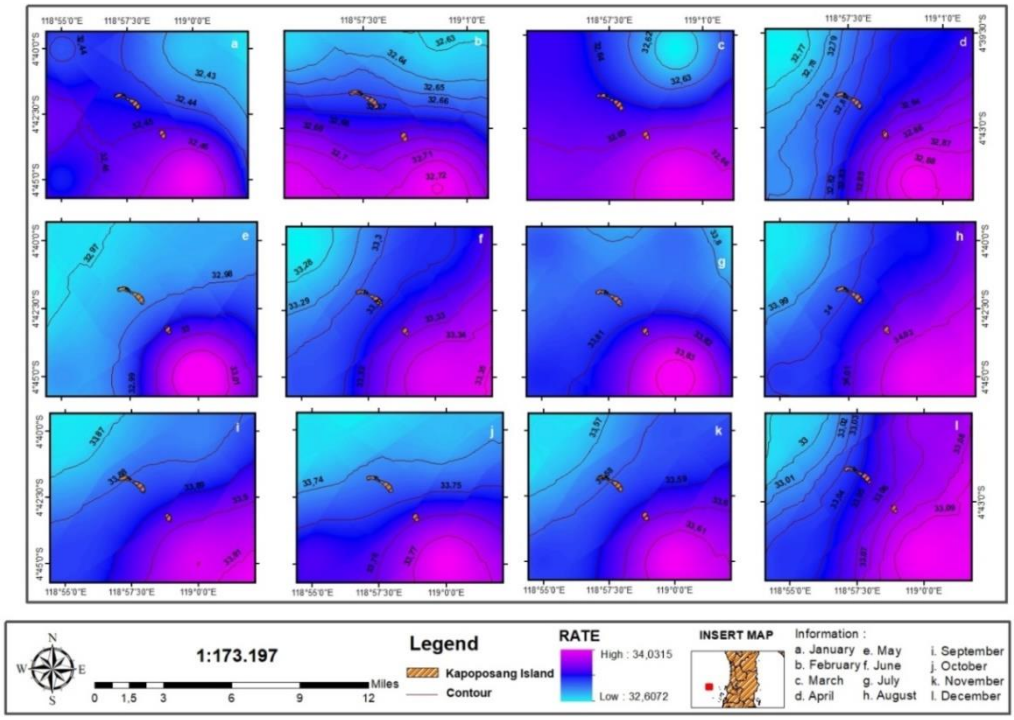

Figure 3. Salinity distribution pattern of Kapoposang Island in 2022

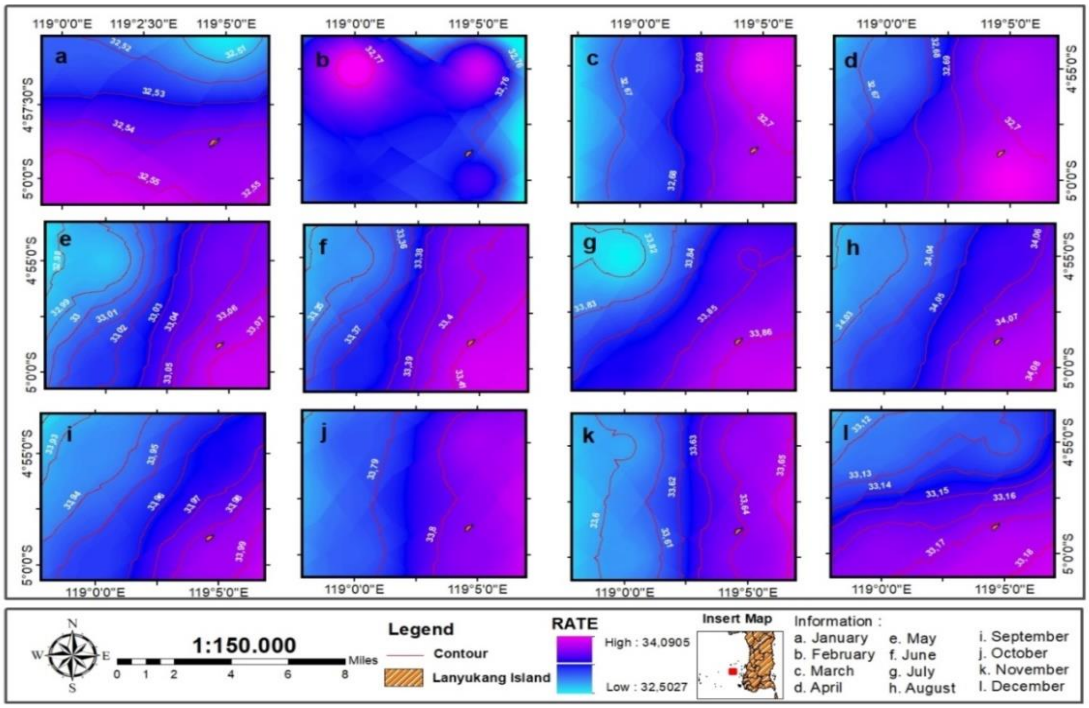

Figure 4. Salinity distribution pattern of Lanyukang Island in 2022

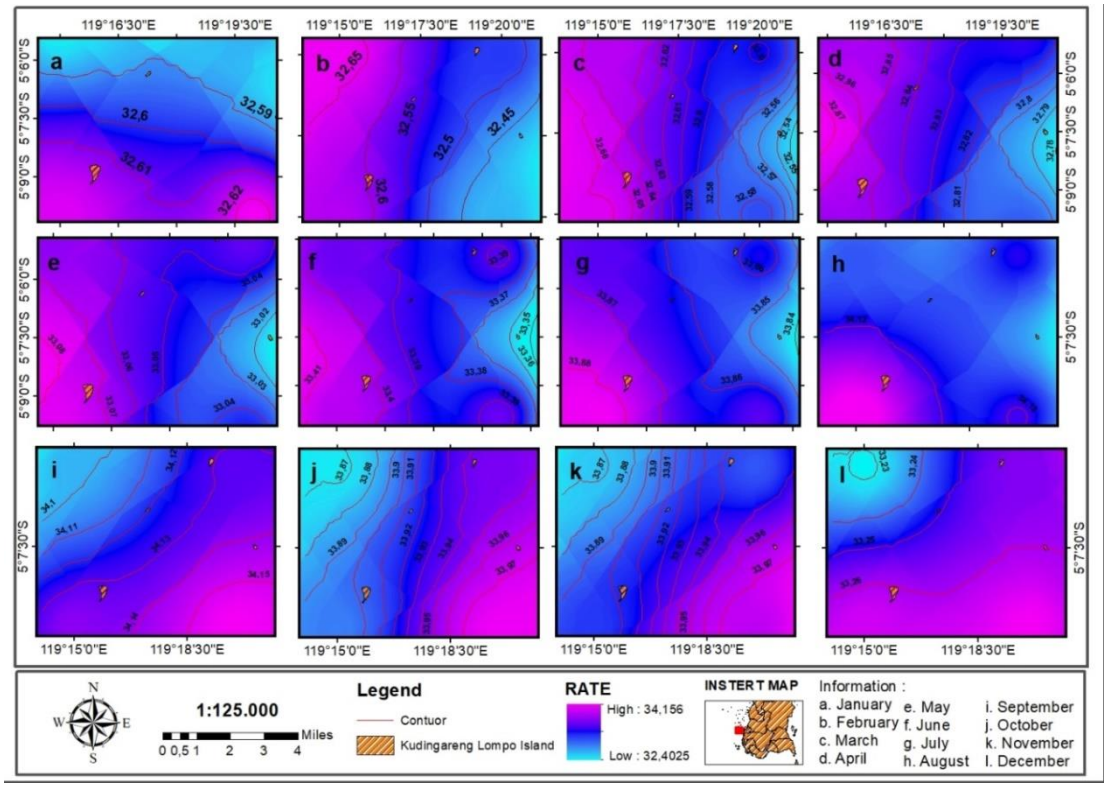

Figure 5. Salinity Distribution Pattern of Koningareng Lompo Island in 2022

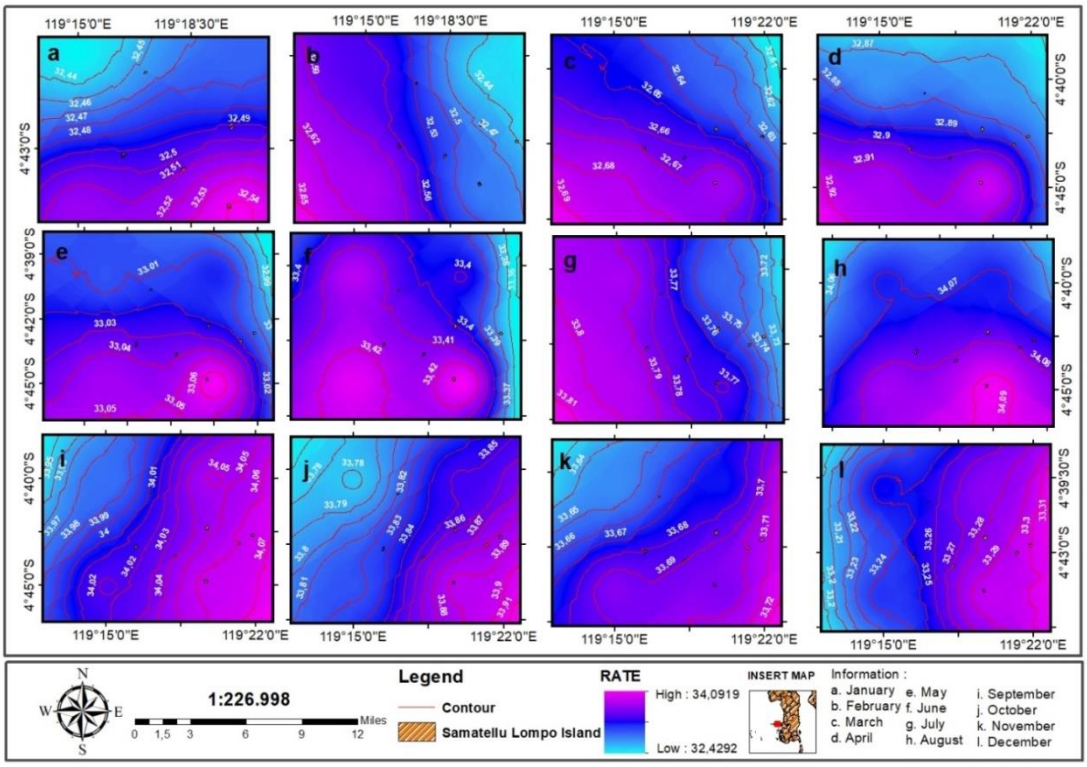

Figure 6. Salinity Distribution Pattern of Samatellu Lompo Island in 2022

Analysis of sea surface salinity data from January to December showed a dynamic trend of salinity fluctuations. Image data for each month illustrated different salinity, where in January, February, March and April the distribution of sea surface salinity was generally 32.42 ppt – 32.88 ppt. This condition is characterized by light blue gradations. Salinity data in May, June, July, September, October, November and December showed the distribution of sea surface salinity in the range of 33.02 ppt – 32.99 ppt. This condition is characterized by a dark blue gradation color. In August, the distribution of sea surface salinity was 34.03 ppt, marked by a purple gradient.

Average distribution of salinity on Kapoposang Island

The average monthly distribution of salinity in 2022 in Spermonde waters on Kapoposang Island showed quite large differences. In January, the average salinity distribution was 32.44 ppt. Furthermore, in February and March the difference in psu was 0.1, where salinity in February was 32.67 ppt and in March was 32.65 ppt. In April the salinity was 32.82 ppt and in May the salinity was 32.98 ppt. The increase in salinity occurred in June, namely 33.31 ppt, salinity in July was 33.81 ppt, and then salinity in August was 34.01 ppt (the highest salinity). Furthermore, a decrease in salinity occurred in September, October, November and December where the respective salinity values were 33.89 ppt, 33.75 ppt, 33.59 ppt and 33.05 ppt respectively (**Figure 7**).

The highest salinity distribution occurred in August with a total salinity distribution of 34.01 ppt. This happened because the east season took place in that month, where very little rainfall fell in that month so that evaporation of sea water occurred in an area with high salinity. This phenomenon is in accordance with the statement by Putra *&* Kunarso (2020) saying that during the east monsoon, an increase in salinity existed due to large evaporation. This is reinforced by the influx of high salinity water masses from the Pacific Ocean, Sulawesi Sea into the waters of the Makassar Strait.

The lowest average salinity occurred in January with a total salinity distribution of 32.44 ppt. This happened because the west monsoon winds occurred in that month which moved from the Asian continent to Australia passing through the Indian Ocean and carried a lot of water vapor. Based on the statement (Prayogo et al., 2021), this incident resulted in the rainy season. Rainwater entering this area would affect the salinity value of sea water.

This phenomenon is reinforced by the statement from Wardi et al. (2017) stating that the large amount of incoming river water causes changes in water salinity. The closer the study point is to the upstream of the river, the smaller the salinity value obtained will be, whereas the farther the study point is from the river upstream to the open sea, the greater the salinity value will be. According to Suhana (2018), the distribution of salinity in Indonesian waters is very fluctuating. This phenomenon depends on geographic structure, fresh water input from rivers, rainfall, evaporation and circulation of water masses, and changes in sea surface salinity in Indonesian waters.

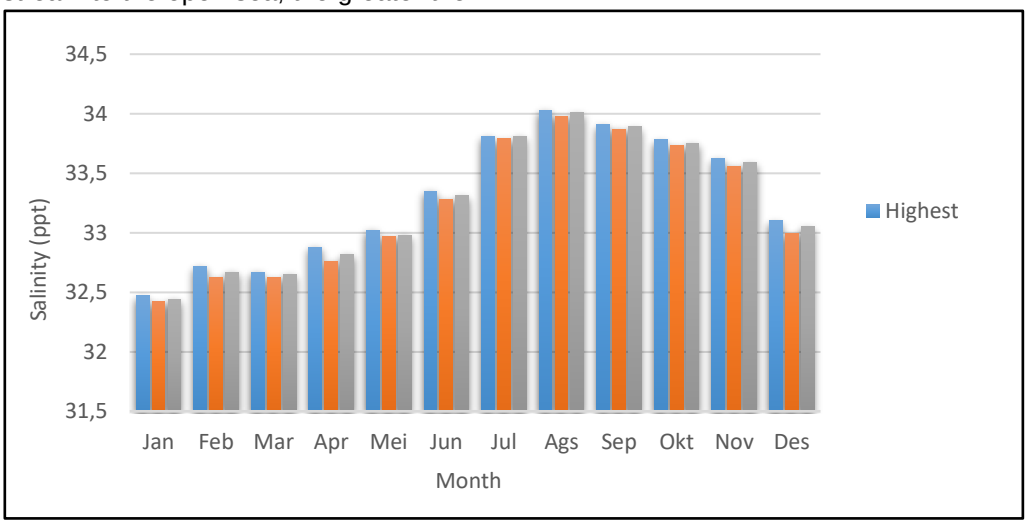

Figure 7. Average distribution of salinity on Kapoposang Island

Average distribution of salinity on Lanyukang Island

The average distribution of salinity in 2022 in Spermonde waters on Lanyukang Island showed quite large differences every month. In January, the average salinity distribution was 32.53 ppt. Furthermore, the difference in ppt in February and March was 0.7, where salinity in February was 32.76 ppt and in March was 32.69 ppt. A ppt difference of 0.1 occurred in April and May, where salinity in April was 32.93 ppt and salinity in May was 33.03 ppt. Furthermore, the increase in salinity occurred in June, July and August with values of 33.38 ppt, 33.84 ppt and 34.05 ppt, respectively. Furthermore, a decrease in salinity distribution occurred in September, October, November and December with changes in salinity values of 33.89 ppt, 33.8 ppt, 33.62 ppt and 33.15 ppt, respectively (**Figure 8**).

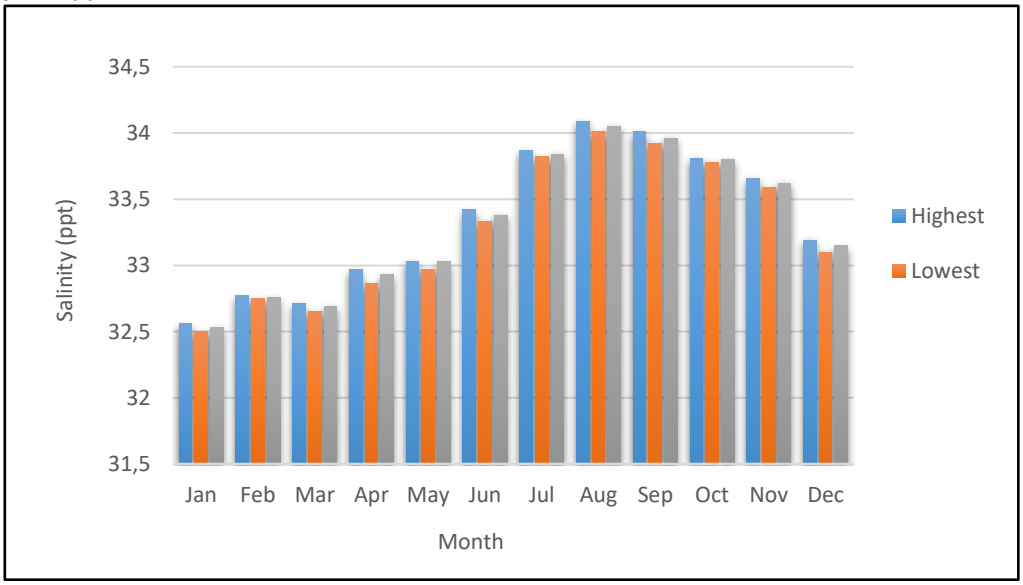

Figure 8. Average salinity distribution on Lanyukang Island

The highest average salinity distribution occurred in August with a total salinity distribution of 34.05 ppt. This happened because the east season existed in that month where sea water masses had a path to enter the Makassar Strait so that the distribution of salinity became high. This is in accordance with the statement of Panjaitan *et al.* (2021) saying that the water mass entered from the Pacific Ocean through the Mindanao current to the Makassar Strait. These water masses came from different places in the Pacific Ocean. The first water mass came from water with high salinity that occurred on the surface of subtropical waters in the Pacific Ocean, while the second water mass came from submerged north polar water and then spread to the equator.

The lowest average salinity occurred in January, namely 32.53 ppt. This happened because of the west season in that month. The same phenomenon fell on other islands where the salinity was the lowest in certain months. Several factors influencing this phenomenon are changes in weather, geographic structure, and others. According to Putra & Mutmainah (2017), salinity will vary vertically and horizontally depending on freshwater input, rainwater and evaporation. This incident was clarified by Kalangi *et al.* (2013) explaining that the horizontal distribution of salinity is influenced by water circulation patterns, evaporation and rainfall. The influence of river water makes variations in salinity in coastal waters greater than in open sea waters. The salinity range in coastal waters ranges from 0–33 which depends on the volume of river water flowing. Vertically, the salinity value of sea water will increase with the increasing of depth. The thing to take notice is that this change is not linear.

Average distribution of salinity on Koninggareng Lompo Island

The average distribution of salinity in Spermonde waters on Koningareng Lompo Island in 2022 demonstrated quite large differences every month. In January and February, the salinity change occurred by 0.5 ppt, where the salinity in January was 32.6 ppt and the salinity in February was 32.55 ppt. Meanwhile, in March the water salinity was 32.61 ppt, then the salinity continued to increase starting in May (by 33.05 ppt), then the salinity in June was 33.39 ppt, and the salinity in July was 33. 86 ppt. Furthermore, very high salinity distribution occurred in August and September, namely 34.12 ppt and 34.13 ppt. In October, November and December, water salinity decreased. The water salinity in October, November and December were 33.13 ppt, 33.73 ppt and 33.25 ppt respectively (**Figure 9**).

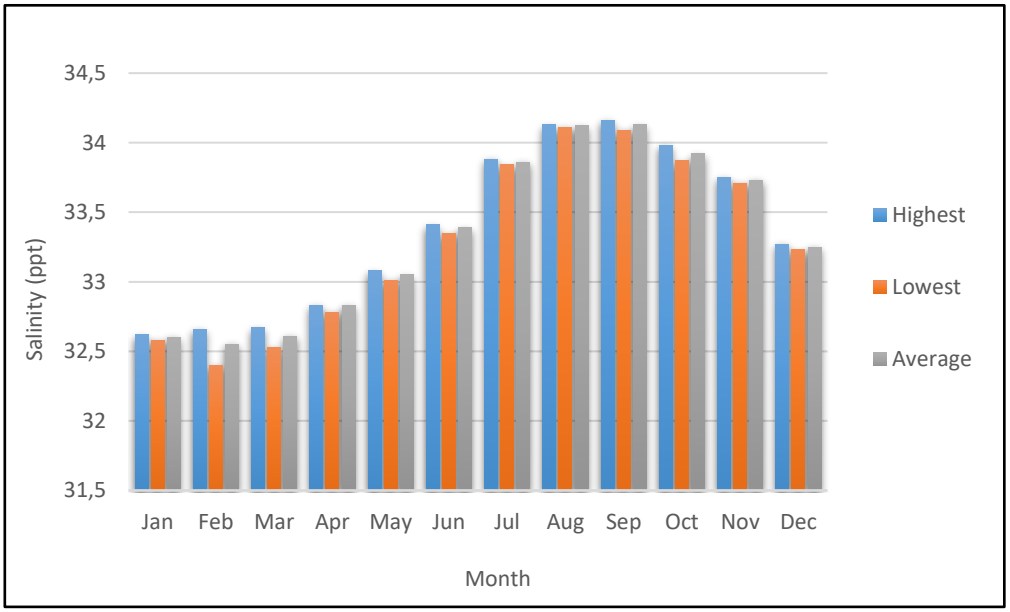

Figure 9. Average salinity distribution on Koningareng Lompo Island

Based on the average salinity distribution data for 2022, the highest salinity value occurred in September with a total salinity distribution of 34.13 ppt. This occurred because of the transition season II phenomenon in the month where the high salinity value was influenced by weather conditions and sea water masses in Sulawesi. According to (Triyulianti *et al.*, 2018), in September (Transition Season II) the Sulawesi sea had higher salinity (reaching

34.45 ppt) compared to the Maluku sea (34.05 ppt). Apart from that, during the second transition season, low rainfall and very good weather resulted in very effective solar radiation for heating water masses in the surface layer. This causes the average salinity value to increase and triggers upwelling. This is in accordance with the opinion of Wibisono *et al.* (2022) that the upwelling phenomenon in Spermonde waters is also strengthened by upwelling events in adjacent waters such as the Makassar Strait, the waters of Selayar Island south of Makassar city, and even the waters of Tolo Bay which is east of Central Sulawesi. Indications of upwelling in the waters of Selayar Island during the east season, which is in accordance with research by Utama et al. (2017), are lower water temperature (2 ^{0}C) and higher water salinity (0.5 ppt) compared to the previous season (transition 1).

The lowest average salinity occurred in February, namely 32.55 ppt. This happened because of the west monsoon phenomenon in the month. In the west season, rainfall was very high and a lot of fresh water entered the sea. This is in accordance with the opinion of Supiyati *et al.* (2017) saying that the distribution of salinity in the sea is greatly influenced by various factors such as water circulation patterns, evaporation, rainfall and river flows in the surrounding area. This causes the distribution of salinity to vary. Apart from that, the monsoon wind system also causes rainy and hot seasons which ultimately have an impact on annual variations in water salinity.

Average distribution of salinity on Samatellu Lompo Island

The average distribution of salinity in Spermonde waters on Samatellu Lompo Island in 2022 showed quite large changes every month. In January, the average distribution of water salinity was 32.48 ppt, then in February the average distribution of water salinity was 32.54 ppt and in March the distribution of water salinity was 32.65 ppt. In April the average distribution of water salinity was 32.89 ppt, while in May the distribution of water salinity was 33.02 ppt. Furthermore, in June, July and August there was an increase in water salinity with the average salinity distribution being 33.41 ppt, 33.77 ppt and 34.07 ppt, respectively. In September, October, November there were a decrease in the distribution of salinity where the water salinity values were respectively 34.02 ppt, 33.83 ppt, 33.68 ppt and 33.26 ppt. A clearer observation of the distribution of water salinity can be seen in **Figure 10**.

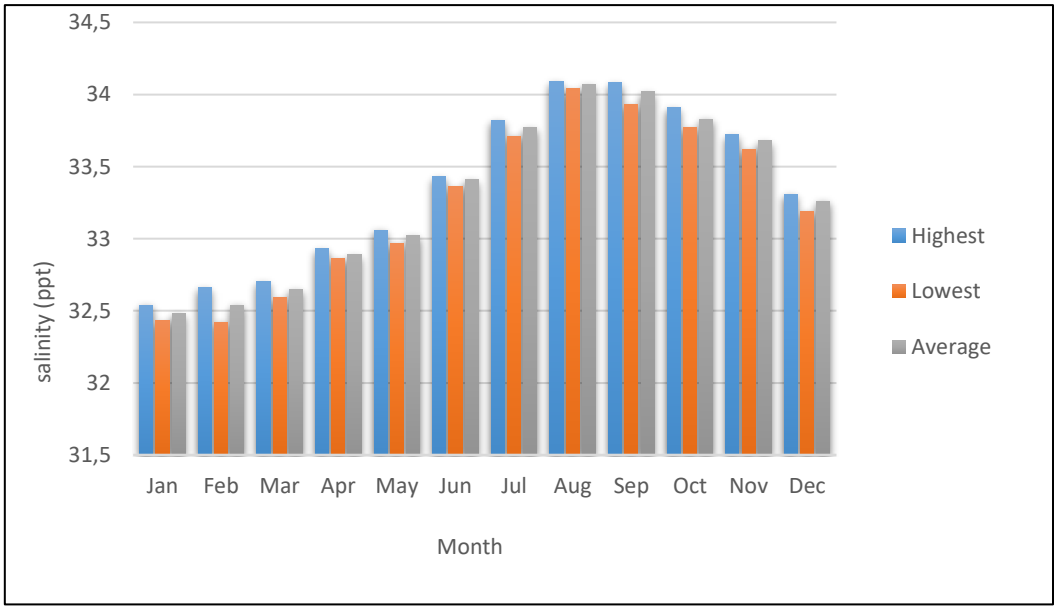

Figure 10. Average salinity distribution of Samatellu Lompo Island

The highest average salinity distribution in 2022 occurred in August with a total salinity distribution of 34.07 ppt. This happened because of the east monsoon phenomenon in the month. In the month, very little rainfall fell so that evaporation of sea water occurring in an area resulted in high water salinity. This is in accordance with the findings of Sidabutar *et al.* (2019) that this increase in salinity occurs because the influence of freshwater input from land decreases as depth increases. Fresh water entering the waters has a smaller water

mass, so the water mass will be above the water mass of waters with high salinity.

Apart from that, the lowest average salinity occurred in January with a total salinity distribution of 32.48 ppt. This happened because of the west monsoon phenomenon in the month, so that the greater/more rainfall in a sea area, the lower sea water salinity. According to (Najid *et al.*, 2012), during the west monsoon, water masses from the Natuna Sea enter the Java Sea from the west. During its journey, the rainy season experiences a lot of dilution by river flows from Sumatra, Kalimantan and Java. As a result, water salinity has decreased and pushed the high salinity water mass eastward towards the Flores Sea, so that the average salinity value in these waters becomes high.

Comparison of salinity distribution patterns on 4 islands

Salinity in January, February, March and April on 4 islands in Spermonde was generally >32 ppt. Furthermore, in May, June and July the increase in water salinity reached 33 ppt on 4 islands in Spermonde waters. August was the peak of the increase in salinity on 4 islands in Spermonde waters, namely >34 ppt. Furthermore, in September, October, November and December water salinity decreased by >33 ppt on 4 islands in Spermonde waters (**Figure 11**).

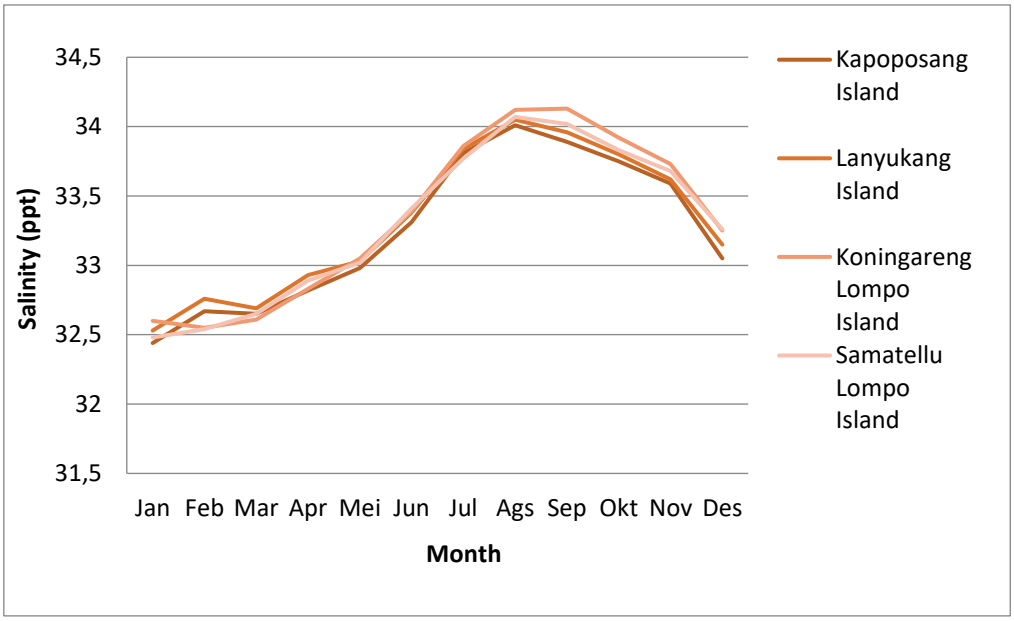

Figure 11. Average salinity distribution

These four islands had the same salinity value, where the distribution of salinity every August reaches 34 ppt, while the lowest average salinity value occurred in January, namely 32 ppt. Three of the islands had salinity distribution patterns not much different, except Koninggareng Lompo Island which had the highest salinity in September and the lowest salinity in February. Things that might differentiate this island from the other three islands in the context of salinity distribution were seabed topography, weather, wind, current structure and water depth in an area. Shallower areas might have greater salinity fluctuations compared to deeper ocean areas. This is supported by the statement by Juniarti *et al.* (2017) saying that salinity in the surface layer to a depth of 100 meters has the same variations according to the season. During the east season, high salinity water masses move from the east to the Makassar Strait and the Flores Sea which pushes low salinity water back to the west (Pratama *et al.*, 2016). Apart from that, the low salinity is thought to come from the input of freshwater masses, such as input from river estuaries, which greatly influences the process of seawater dilution and decreasing of salinity (Muhaemin *et al.*, 2022). Meanwhile, according to Patty (2013), factors influencing the decrease and increase in water salinity are weather and wind. Mixing due to sea waves or movement of water masses caused by wind can be the cause of differences in salinity values.

CONCLUSION AND SUGGESTION

The salinity distribution pattern in Spermonde Waters with an average value of 34.04 ppt was the highest salinity. This phenomenon occurred in August. The average value of salinity distribution of 32.52 ppt occurred in

January. The distribution of salinity in 2022 on Kapoposang Island, Lanyukang Island and Samatellu Lompo Island had the same average value, where the lowest salinity occurred in January and the highest salinity in August, except for Koninggarang Lompo Island. The highest average salinity value on this island occurred in September and the lowest salinity was in January.

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