ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

REAL-TIME INFORMATION SYSTEM OF RAW WATER SALT LEVELS PDAM TIRTA KHATULISTIWA PONTIANAK BASED ON LORA GATEWAY TECHNOLOGY

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ABSTRACT

Quality clean water is essential for humans to meet their daily needs. In Pontianak City, one way to obtain clean water is by subscribing to the Perusahaan Daerah Air Minum (PDAM). PDAM obtains raw water in large volumes during the rainy and dry seasons from the Kapuas River. Water taken from rivers without going through treatment is commonly referred to as raw water. Previously raw water was still in poor condition, such as cloudy, high salt content, and smelled. It raises concerns in maintaining water quality which will later be distributed to customers after going through the sterilization process by the PDAM. The quality of raw water from the Pontianak Kapuas River is very vulnerable to saltwater intrusion from the high seas, especially in the dry season. Based on information from the media which contained an expert statement from the University of Tanjungpura Pontianak, seawater intrusion into the Kapuas River could reach 2000 ppm (salt content in water), which means it is the same as saltwater and goes as far as 50 km. Information about seawater intrusion into the Kapuas River that is conveyed occurs periodically or only when it occurs during the dry season. A breakthrough (innovation) is needed so that information about the water quality of the Kapuas River can be carried out continuously and in real-time and can be accessed by related parties and monitored remotely. In addition, variations in early detection of water quality in the Kapuas River can be an alternative in finding alternative locations for raw water sources for PDAMs. They become the right solution in distributing clean water to customers. The results of this study are an information system on the condition of raw water in the Kapuas River, which PDAM Tirta Khatuliswa Pontianak can monitor in real-time. This technology utilizes LoRa as data communication between nodes to the gateway. The monitoring process is carried out using a website that is connected by a microcontroller through the IoT process.

Keywords: *Raw Water Salt Level, Monitoring System, LoRa Gateway, Internet of Things, PDAM Tirta Khatulistiwa*

1. INTRODUCTION

Water is one of the basic needs and is very useful for human life. Water is needed for drinking, cooking, bathing, washing, cleaning equipment, watering plants, and other purposes. If there is a water shortage, there will be drought which has further consequences, and various disasters can occur.

The Kapuas River is a river in West Kalimantan. This river is the longest river on the island of Kalimantan and, at the same time, the longest river in Indonesia, with a length of 1,143 km. This river flows from Kapuas Hulu Regency to Pontianak City, which crosses 6 other regencies, namely Sintang, Melawi, Sekadau, Sanggau, Landak, Kubu Raya and Mempawah Regencies [1].

Some people in West Kalimantan are very dependent on the existence of the Kapuas River as a source of clean water, transportation support facilities, sources of income, and people's livelihoods. In Pontianak City, the Kapuas River is used by residential communities and almost the entire Pontianak City community with various interests. They start from residential activities, shipping, trade, industry, and tourism that color life in the region.

In the Kapuas River, West Kalimantan, Seawater intrusion reaches about 50 kilometers from the river mouth [2]. The head of the Research Center for Biodiversity and Wetland Communities at Tanjungpura University, Gusti Zakaria Anshari, said the extent of the intrusion indicates damage to the water catchment area. Damage to watersheds during the rainy season causes the Kapuas River to push seawater in the opposite direction [3].

Seawater intrusion on the Kapuas River that occurred in a relatively long time resulted in the raw water being processed into clean water to produce brackish and even salty water. The brackish and even salty clean water is distributed to the people of Pontianak. Delays in obtaining water quality information can delay water supply management strategies. As customers/users of brackish or salty clean water, the people of Pontianak are disturbed by household activities, such as cooking, washing, and bathing. This situation disrupts production services, and production can stop [4]. This condition should not happen and must be anticipated.

With these problems, an application of long-distance wireless technology is expected to display water quality parameter information in real-time, especially the water quality of the Kapuas River in West Kalimantan. PDAM and customers need to have an information system that can provide information about the dissolved salt content in the water of the Kapuas River. This study aims to design an early detection system for salt levels and the range of intrusion that enters the Kapuas River. Mapping the intrusion area and measuring salt content entirely using the Internet of Things (IoT) system by utilizing Long Range (LoRa) technology as a two-way data communication tool from the sensor location to the monitoring location [5].

2. LITERATURE REVIEW

Research on the need for clean water has been carried out using several monitoring methods and processes. Research conducted by Kirti and Werner [4] regarding the modeling for determining PDAM as a company trusted to manage clean water for the community in Indonesia. Case studies regarding consumer views on PDAM services and the performance itself are essential matters that impact social responsibility that companies must do for their consumers. The results of the case study show that service has a significant effect on customer satisfaction but has no significant effect on customer loyalty [6].

Given the importance of raw water quality as the primary source used by PDAMs, all efforts to monitor and maintain raw water quality have been carried out. Currently, technology has developed in monitoring raw water, which is carried out by almost all companies engaged in clean water treatment. Such as the monitoring system carried out by Liu Yong et al. to determine the salinity and alkalinity of the soil in the Tideland river by utilizing the communication of each node with a 4G module and each node working as a local data store and long-distance transmission [7].

In this study, it is not clear that there is information about the sensor working system at each node. David E. and Steven M. [8] also carried out rain intensity and wind measurements in coastal river areas to determine the level of salt content at the river and seacoast boundaries. The research revealed that measurements were made using a salinity sensor with remote sensing as a sensor control and found that the intensity of rain and wind speed towards the river affect the level of salt content in the water. The use of salinity sensors in mangrove forests was also carried out and obtained satisfactory results.

Research focuses on designing a salinity sensor that is lower in cost but can still be controlled remotely. Water quality monitoring was also carried out in river mouths and ice edges of the Atlantic Ocean by Wenqing T et al. [9], focusing on the effect of raw water on melting ice and areas frequented by ships daily. It was found that the salinity on the water's surface was favorable for the level of salinity, and measurements of the water from the Atlantic Ocean leading to the river had a negative result of salinity.

The application of technology in monitoring water flow [10] in rivers has been carried out using various methods in the field of information technology. Research conducted by VA Savel, Paitoon Rakluea et al [11], on the use of IoT for monitoring water and waste quality. Monitoring of water quality obtained consists of pH, turbidity, and temperature. The data is obtained and sent with LoRa technology by utilizing solar panel power that can last 36 hours as an energy supplier to the system. The results showed that the monitoring system error was less than 5%.

Lalit Kumar B and Sukriti Gautam et al [12] used LoRa as a remote sensing solution to determine the quality of water pollution. The data monitored in this study were pH, temperature, dissolved oxygen, and electrical conductivity. The designed device has been tested by obtaining good performance results by dividing four types of water quality as samples of polluted water.

The use of communication methods using wireless sensors and LoRa is currently the main choice in sending data between devices via the cloud [13]. The LoRa communication system is considered superior to other communication systems with the advantages of an independent network through wireless channels [14]. The use of LoRa has very little power in its operation. LoRa current data transmission range is quite far, so it can accommodate monitoring of water quality in rivers and away from the internet network.

3. SYSTEM AND IMPLEMENTATION

3.1 Salinity

Currently, various methods have been developed to determine water salinity. The most practical method currently in use is through electrical conductivity [15]. A real relationship has been made between conductivity C and salinity S as a function of temperature T and pressure p [16]. Salinity determined in this way is called 'practical salinity'. The possibility of measurement error can be eliminated by considering the relative conductivity R, the conductivity of seawater C(S, T) relative to the conductivity C(35,15) of a standard salt solution at 15oC containing 32.4356 g KCl in a mass of 1kg [17].

This conductivity sensor measures the ability of a solution to conduct an electric current between two electrodes. In solution, current flows with ion transport which increases the concentration of ions in the solution, resulting in higher conductivity values [18]. Conductance is defined as the reciprocal of resistance. While resistance is measured in ohms, conductance is measured using the SI unit, the siemens (formerly known as the mho). Since the siemens are very large, water samples are usually measured in microsiemens, or S [19].

Conductivity C can be obtain using equation below :

$$C = G.C_k \quad (1)$$

Where G is the conductance and c_k is the element constant (cell), the element constant, which is a pair of probes, is obtained using the equation :

$$C_k = \frac{d}{A} \quad (2)$$

Where d is the distance between the two electrodes, and A is the surface area of the electrode. A potential difference is applied to the two probe electrodes in the Salinity Sensor [20]. The resulting current is proportional to the conductivity of the solution, and then the current is converted into a voltage. The illustration can be shown in Figure 1.

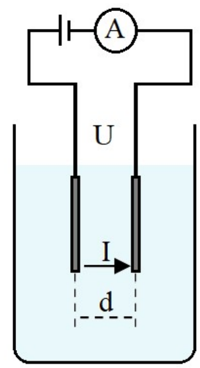

Figure 1: Electrical Conductivity Measurement Principle.

Where:

- D is the distance between the elements (electrodes).
- S is the surface area of the element.
- U is the voltage source.
- I is the current flow in the liquid.
- K is the constant value of the element being measured.

Then the conductivity is:

$$C = \frac{d}{S} . \frac{I}{R} = K . \frac{I}{U} \quad (3)$$

Experiments conducted by Y. Yin [21] for the measurement of water salinity using an optical sensor called MCR (microfiber coil resonator) resulted in a simple, compact, and high-sensitivity principle. Fadhilah Irwan and Afdal [22] determine the relationship between electrical conductivity and Total Dissolved Solids (TDS) and temperature in three types of water: seawater, rivers, and lakes. Samples of seawater were taken at Padang Beach, river water in the Batang Arau River, and lake water in Lake Above Alahan Panjang. Water samples were

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taken at each location at six different points with a distance of 500 m between points. The best relationship between TDS and electrical conductivity in river water and lake water is a second-order polynomial model with a correlation coefficient of 0.9506 for river water and 0.9896 for lake water.

3.2 Communication System Architecture

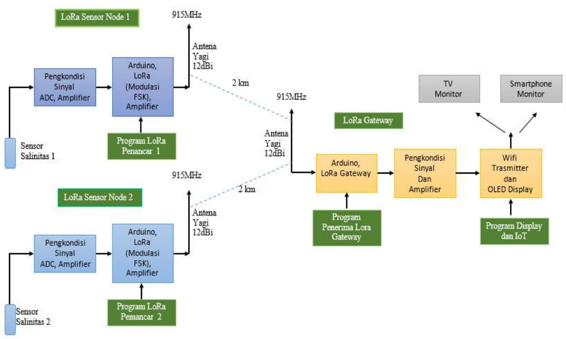

Figure 2: Data Communication Architecture.

Currently, various methods have been developed to determine water salinity. The most practical method currently in use is through electrical conductivity [15], [23]. A real relationship has been made between, Figure 2 is an overview of the data communication architecture used as a whole. The architectural design consists of designing hardware and software to support system performance [24]. The hardware components used consist of a Salinity Sensor, LoRa as a data transmitter, Yagi Antenna as a data transmitter to cover long distances, Arduino Uno as a microcontroller, Smartphone, and Television as monitoring data.

Data transmission in this study was carried out in one direction using a multi-node LoRa communication system. Each sensor installed has been combined with LoRa to send the data obtained to the LoRa Gateway as a signal received from the transmitter [25]. In terms of the sender and receiver on LoRa, each is provided with an additional device in the form of a yagi antenna to assist the communication process so that the data obtained is of good quality and reduces data loss. The gateway as the receiver then transmits the data to the microcontroller to process the sensor readings on the smartphone or television [26]. Communication using LoRa from the river area to the gateway location using the yagi antenna is shown in Figure 3.

(a)

(b) (c)

Figure 3: LoRa Installation Locations in Open Areas; a) Transmitter and Receiver LoRa Installation Plan; b) Recipient LoRa; c) Sender LoRa.

The use of the software is found in the microcontroller's programming process and the smartphone's interface. Configuration is also carried out on LoRa, a data sender from sensors to the system gateway [27]. The designed system can allow receiving of data from more than one sensor simultaneously [25]. The LoRa gateway has controlled this whole process.

3.3 LoRa

LoRa (Long Range) is a low-power, non-cellular long-range wireless technology. LoRa is based on CSS (chirp spread spectrum) modulation, which has low power characteristics like FSK (frequency shift keying) modulation but can be used for long-distance communication [28], [29]. Using the LoRa module, several parameters are set to get the best performance in long-distance communication. The parameters are SF (spreading factor), BW (bandwidth), and the last is CR (coding rate) [26]. The minimum components in the use of the Lora module include a Microcontroller as an electronic circuit controller and at the same time as program storage, LoRa module, a battery as a power

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supply, an antenna as a signal transmitter and receiver [30] as shown in Figure 4.

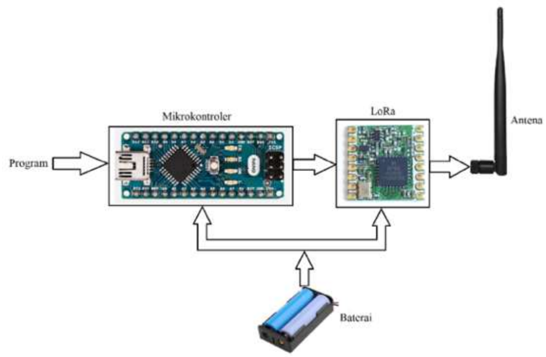

Figure 4: Minimum Components of LoRa Transmitter.

3.3.1. LoRa sensor node

LoRa Sensor Node refers to the device used to transmit sensor data. The word Node means it can be more than the sensors connected to this device. Only one sensor will be used in this practicum, namely the TDS/EC/Salinity sensor.

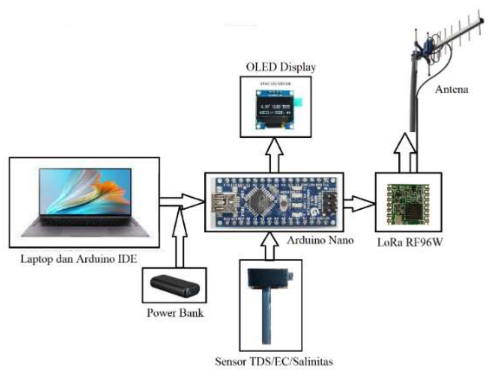

Figure 5: LoRa Sensor Node Scheme.

Figure 5 is a schematic of the use of LoRa sensor nodes on the Kapuas River. Arduino nano is used as a microcontroller that reads and processes data from the salinity sensor. The processed data will then be sent to LoRa RFM96W, which functions to modulate digital data from the sensor with a carrier frequency of 868 MHz to be transmitted into the air via a Yagi antenna. The Yagi antenna uses an SMA connector with an impedance of 50 Ohms with a gain of 12 dBi.

3.3.2. LoRa gateway

The term LoRa Gateway refers to the device used to receive the signal coming from the transmitter. The word Gateway means this device can receive signals from more than 1 Node. Gateway also means a bridge to forward data from the node to the display or to be forwarded to the internet network (cloud) [31].

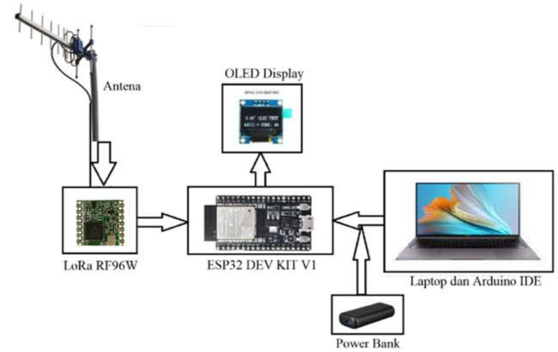

Figure 6: Lora Gateway Scheme.

LoRa gateway schematic is shown in Figure 6, this section is the process of receiving data that the LoRa sensor node has transmitted. The Yagi antenna has the function of receiving LoRa signals with a frequency of 868 Mhz from the air with the help of LoRa RFM96W. LoRa on the gateway functions to demodulate the signal then sent to the ESP32 DEV KIT V1 microcontroller. ESP32 is used as a data processor, which can then be displayed on the OLED display and forward sensor reading data to the internet network to be displayed on other interface devices.

3. RESULT AND DISCUSSION

4.1 Salinity sensor characteristics

Sensor calibration is a stage of activity to determine the correctness of the traditional value of the measuring instrument (sensor) by comparing the results of the sensor measuring instrument with the measuring material. This stage is carried out to process sample data from the river obtained with optimal results. The sensor used is calibrated against saltwater to obtain TDS, ADC, and analog voltage values, so that the mass of dissolved salt can be compared with the results of the sensors used. The process of sensor calibration is shown in Figure 7.

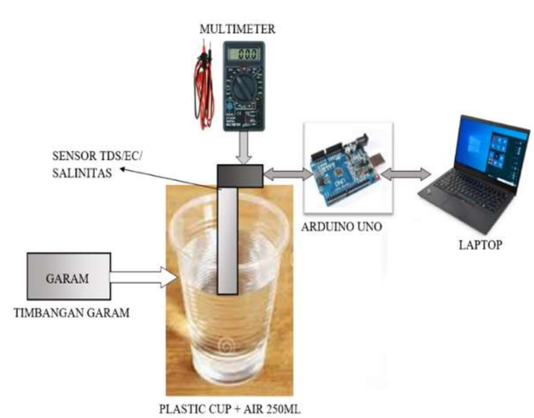

Figure 7: Salt Level Test in Water.

Table 1: Salt Solution Measurement Data.

No	Salt Mass (gr)	Water Volume (ml)	Salinity (gr/ml)	TDS (ppm)	ADC	Analog (V)
1	0,1	300	0.000333	88	56	0.22
2	0,2	300	0.000667	456	223	1.03
3	0,3	300	0.001000	1238	358	1.60
4	0,4	300	0.001333	1421	407	1.83
5	0,5	300	0.001667	1639	460	2.22
6	0,6	300	0.002000	2120	505	2.34
7	0,7	300	0.002333	2134	540	2.55
8	0,8	300	0.002667	2208	571	2.68
9	0,9	300	0.003000	2388	580	2.71
10	1,0	300	0.003333	2808	602	2.98
11	1,1	300	0.003667	2997	618	3.03
12	1,2	300	0.004000	3134	635	3.09
13	1,3	300	0.004333	3149	640	3.16
14	1,4	300	0.004667	3234	656	3.28
15	1,5	300	0.005000	3405	660	3.33
16	1,6	300	0.005333	3506	671	3.33
17	1,7	300	0.005667	3760	673	3.34
18	1,8	300	0.006000	3890	679	3.37
19	1,9	300	0.006333	4050	684	3.39
20	2,0	300	0.006667	4150	686	3.41
21	2,1	300	0.007000	4259	686	3.45
22	2,2	300	0.007333	4320	689	3.41
23	2,3	300	0.007667	4339	689	3.43
24	2,4	300	0.008000	4442	698	3.49
25	2,5	300	0.008333	4505	702	3.52
26	2,6	300	0.008667	4590	715	3.59
27	2,7	300	0.009000	4675	722	3.67
28	2,8	300	0.009333	4680	734	3.72
29	2,9	300	0.009667	4792	745	3.78
30	3,0	300	0.010000	4802	750	3.89

Table 1 shows the test data carried out 30 times, starting from 0.1 grams to 3.0 grams, with an increase of 0.1 grams for each test dissolved in water. The sensor then reads the dissolved salt in the water to obtain a minimum TDS value of 88 ppm, a maximum of 4802 ppm, a minimum ADC value of 56 and a maximum of 750, a minimum analog voltage value of 0.22V, and a maximum of 3.89 V. This is done to determine the sensitivity of the sensor on the dissolved salt readings.

4.1.1. TDS response graph

Using the regression data processing feature in Microsoft Excel, we get a graph of the relationship between the TDS value and the amount of dissolved salt in the water. Mathematical equations were

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obtained using logarithmic regression with correlation coefficient $R^2 = 0.9722$, which showed a strong relationship between changes in salinity and TDS values.

$$y_{TDS} = 1547{,}1 \ln(x_{garam}) + 2951{,}5 \text{(ppm)} \quad (4)$$

Where y_{TDS} is TDS (ppm) value, x_{garam} is the salt mass (gr)

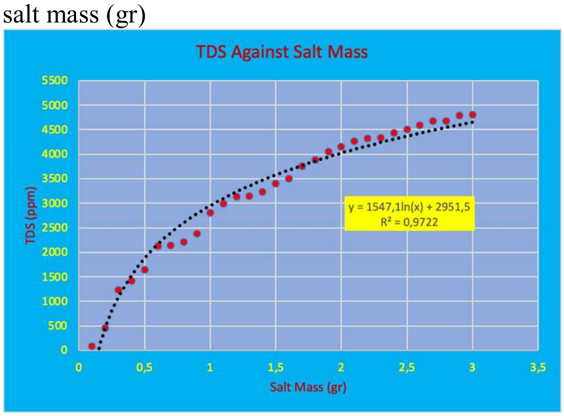

Figure 8: Logarithmic Correlation Between TDS (ppm) To Change Amount of Salt (gr).

The graph in Figure 8, shows that the less dissolved salt content in the water, the smaller the TDS value. The value is 88 ppm for 0.1 gr salt mass in this test. With an increase in the mass of salt dissolved in water, the TDS value will increase logarithmically (naturally) with a maximum value of 5200 ppm with a mass of 3 grams of salt dissolved in water. By modifying the data, the correlation between TDS value and salinity is obtained as follows:

Table 2: Correlation of TDS value and salinity

No	Salt Mass (gr)	Water Volume (ml)	TDS (ppm)	Salinity (gr/ml)	Salinity (ppm)
1	0,1	300	88	0.000333	333
2	0,2	300	456	0.000667	667
3	0,3	300	1238	0.001000	1000
4	0,4	300	1421	0.001333	1333
5	0,5	300	1639	0.001667	1667
6	0,6	300	2120	0.002000	2000
7	0,7	300	2134	0.002333	2333
8	0,8	300	2208	0.002667	2667
9	0,9	300	2388	0.003000	3000
10	1,0	300	2808	0.003333	3333
11	1,1	300	2997	0.003667	3667
12	1,2	300	3134	0.004000	4000
13	1,3	300	3149	0.004333	4333
14	1,4	300	3234	0.004667	4667
15	1,5	300	3405	0.005000	5000
16	1,6	300	3506	0.005333	5333
17	1,7	300	3760	0.005667	5667
18	1,8	300	3890	0.006000	6000
19	1,9	300	4050	0.006333	6333
20	2,0	300	4150	0.006667	6667
21	2,1	300	4259	0.007000	7000
22	2,2	300	4320	0.007333	7333
23	2,3	300	4339	0.007667	7667
24	2,4	300	4442	0.008000	8000
25	2,5	300	4505	0.008333	8333
26	2,6	300	4590	0.008667	8667
27	2,7	300	4675	0.009000	9000
28	2,8	300	4680	0.009333	9333
29	2,9	300	4792	0.009667	9667
30	3,0	300	4802	0.010000	10000

The following is a graph of the relationship between TDS and Salinity. The change in TDS is logarithmically different from the change in Salinity, exponentially. The graph of the data obtained is shown in Figure 9.

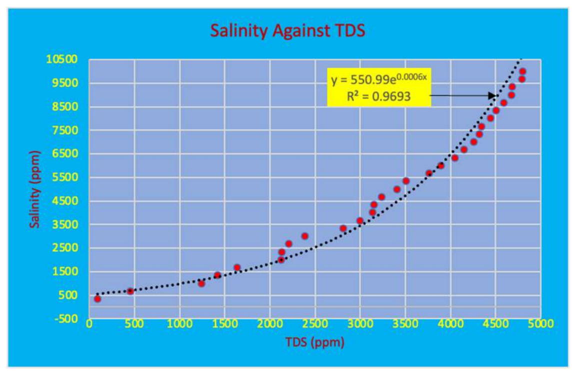

Figure 9: Correlation of salinity (ppm) to TDS (pm).

The mathematical equation was obtained using exponential regression with a correlation coefficient of $R^2 = 0{,}9693$, which shows a strong relationship between the TDS value and the Salinity value.

$$y_{Salt} = 550{,}99 e^{0{,}0006\ TDS} \text{ (ppm)} \quad (5)$$

Where y_{Salt} is the salinity value in ppm dan x_{TDS} is TDS (ppm).

4.1.2. ADC value graph

Figure 10, show obtained the correlation between the mass value of the salt in the ADC value, the correlation coefficient $R^2 = 0{,}9693$.

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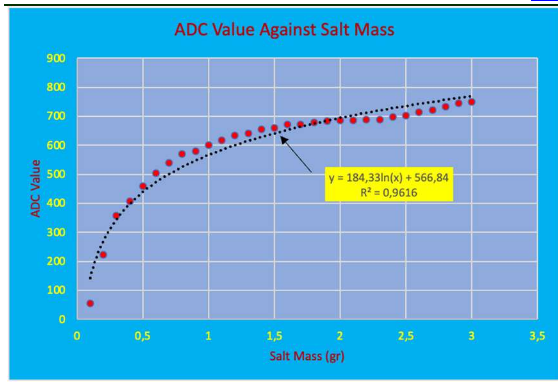

Figure 10: Correlation of ADC Value to Changes in The Amount of Dissolved Salt.

The ADC value obtained from the sensor changes logarithmically. The greater the salt content, the greater the ADC value (maximum 1024), but the ADC value experiences saturation starting from a salt mass of 3 g with an ADC value of 750. Using natural logarithmic regression, the mathematical equation of the relationship between the values is The ADC for the mass of dissolved salt in water is:

$$y_{ADC} = 184{,}33\ln(x_{garam}) + 566{,}84 \quad \text{(ppm)} \qquad (6)$$

Where y_{ADC} adalah ADC value, x_{garam} is the salt mass (gr), correlation coefficient $R^2 = 0{,}9616$.

4.1.3. Analog voltage value graph

From Figure 11, obtained the correlation between the value of the mass of salt in the analog voltage value, the correlation coefficient $R^2 = 0{,}9616$

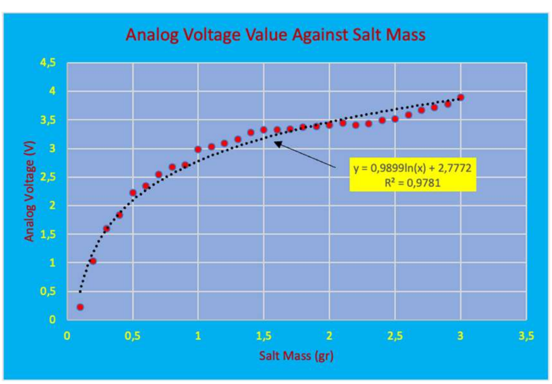

Fig. 11. Correlation of Analog Voltage (V) Against Changes in Salt Mass (gr).

The mathematical equation for the relationship between the analog voltage value and the mass of dissolved salt in water is:

$$y_{analog} = 0{,}9899\ln(x_{garam}) + 2{,}7772 \quad \text{(ppm)} \qquad (7)$$

Where y_{ADC} is analog voltage value (V), x_{garam} is salt mass (gr), correlation coefficient $R^2 = 0{,}9781$.

4.1.4. River water sample test

Water samples were obtained from the Kapuas River directly at three points, namely:

1. Location A : Latitue 0°1'32.72" S dan Longtitude 109° 20' 41.66" E.
2. Location B : Latitue 0°1'32.24" S dan Longtitude 109° 20' 42.61" E.
3. Location C : Latitue 0°1'31.65" S dan Longtitude 109° 20' 43.80" E.

Location A is 30m away, location B is 60m away, and location C is 100m from the left bank of the Kapuas River. The sampling location points are shown in Figure 12.

Figure 12: Location of Kapuas River Water Sampling.

At each location, six bottles of water samples were taken with the identities of Location A: A0, A1,..., A5, Location B: B0, B1, ..., B5, and Location C: C0, C1, ..., C5. At Location A, A0 means the sample is taken on the water surface, A1 means 1 meter below the water surface to A5, which means 5m below the water surface. In the same way, water samples were taken at Location B and Location C, as shown in the schematic Figure 13 The sampling procedure is:

- Prepare a container bottle (6 bottles).
- Write bottle ID.
- Prepare the diver's safety rope.
- Prepare the bottle holder.

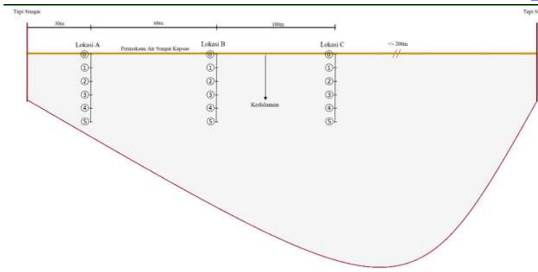

Figure 13: Water Sampling Scheme.

After the above preparation is done, the sample is taken from the surface (0m) to a depth of 6 meters with 1m steps. The collection and storage of water samples as described above are carried out thoroughly, but the measurement results will be calibrated to minimize deviations. The Figure 14, shows how to test a sample of Kapuas river water in a bottle with a volume of 560 ml.

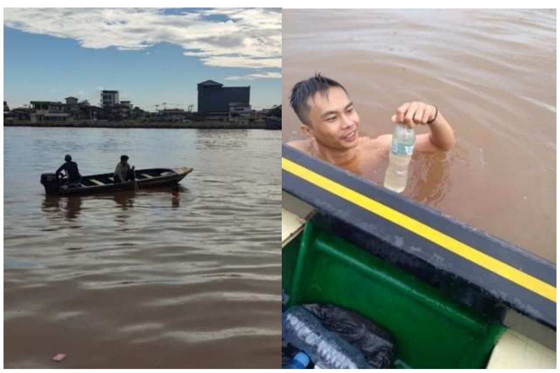

Figure 14: Kapuas River Water Sampling Process.

Figure 15: The Process of Measuring Salt Levels in Kapuas River Water Samples.

The Figure 15, show testing the Kapuas River water sample was carried out using a Salinity sensor which was included in the application program that was created. The complete results are shown in Table 3, Table 4, and Table 5.

Table 3: Water Sample Testing Data at Location A.

No.	Kode Sampel	Vol Total (ml)	TDS (ppm)	Garam (gr)	Salinitas (ppm)
1	A0	560	308,07	0.00032342	323.42
2	A1	560	307,51	0.000323230	323.30
3	A2	560	300.56	0.00032185	321.85
4	A3	560	297.82	0.0003213	321.28
5	A4	560	296.56	0.00032102	321.02
6	A5	560	295.77	0.00032085	320.85

Table 4: Water Sample Testing Data at Location B..

No.	Kode Sampel	Vol total (ml)	TDS (ppm)	Garam (gr)	Salinitas (ppm)
1	B0	560	308,13	0.00032343	323.43
2	B1	560	308,91	0.00032359	323.59
3	B2	560	302.90	0.00032234	322.34
4	B3	560	300.22	0.00032178	321.78
5	B4	560	298.56	0.00032143	321.43
6	B5	560	296.88	0.00032108	321.08

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 5: Water Sample Testing Data at Location C.

No.	Kode Sampel	Vol Total (ml)	TDS (ppm)	Garam (gr)	Salinitas (ppm)
1	C0	560	312,23	0.00032429	324.29
2	C1	560	310,62	0.00032395	323.95
3	C2	560	304.77	0.00032273	322.73
4	C3	560	298.34	0.00032139	321.39
5	C4	560	297.45	0.00032120	321.20
6	C5	560	295.08	0.00032071	320.71

By graphical visualization, the three sample measurement data above are shown as follows:

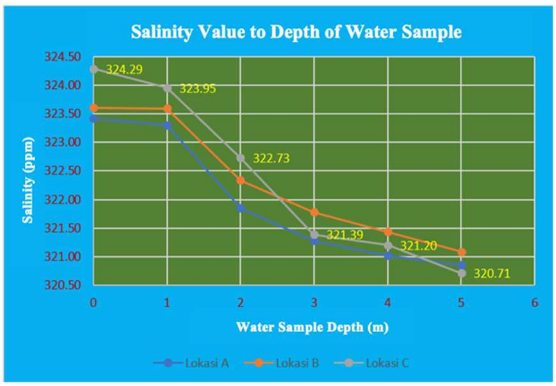

Figure 16: Graph of The Relationship of Salinity to Depth of Water Samples.

The Figure 16, shows that the deeper the water sample, the lower the salinity value. The highest Salinity value is 324.29 ppm, and the lowest is 320.71 ppm, both at Location C. From Tables 5.3, 5.4, and 5.5, the average Salinity values at Locations A, B, and C are 321.95 ppm, 322.31 ppm, and 322.38 ppm, respectively. The average value of Salinity illustrates that there is a tiny difference between the three locations. If viewed from the category of water quality based on the value of Salinity, then the three average values of Salinity are included in the category of freshwater.

4.2 Benefits of Monitoring

The designed monitoring system has succeeded in monitoring raw water quality in the Kapuas River, Pontianak. The monitoring process is carried out using various sensors that support collecting raw water quality data. Each sensor value obtained has been sent to the cloud to be processed and displayed on the system interface. The use of LoRa in this study aims to transmit raw water quality data from rivers to receiving devices at the Telecommunications Laboratory of Tanjungpura University. The data that has been obtained will then be sent to the cloud for processing and displaying actual data.

The use of this IoT-based monitoring method has been widely supported by other researchers who also use this technology for raw water monitoring. It has been stated in the literature review section that the use of monitoring tools can result in optimal data transmission with a high success rate. The technology used has also reduced the cost of checking raw water quality if it is done traditionally. The system designed has helped PDAM Tirta Khatulistiwa as a provider of clean water for the city of Pontianak in processing raw water into clean water.

5. CONCLUSION

The design of a salt level information system in the Kapuas river has helped PDAM Tirta Khatuliswa Pontianak know raw water conditions in real-time. The salinity sensor can measure the salt content in the water up to 10000 ppm. In comparison, the average salinity of the Kapuas River water from the three sample locations measured 321.95 ppm, 322.31 ppm, and 322.38. The total average salinity of the Kapuas River water at the time it is 322.21 ppm. From the water classification range based on the Salinity value, the average water condition of the Kapuas River is in a new state.

ACKNOWLEDGEMENT

The researcher would like to thank Tanjungpura University for funding this research and PDAM Tirta Khatuliswa Pontianak as a research partner. Furthermore, the entire research team who have assisted in carrying out this research achieve very satisfactory results.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

REFERENCES:

[1] Pemerintah Kota Pontianak, "Geografis | Pemerintah Kota Pontianak." Accessed: Mar. 12, 2022. [Online]. Available: https://pontianakkota.go.id/tentang/geografis

[2] Kompas, "Intrusi Air Laut di Sungai Kapuas hingga 50 Kilometer." 2012. Accessed: Feb. 12, 2022. [Online]. Available: https://regional.kompas.com/read/2011/07/05/0323062/intrusi-air-laut-sejauh-50-kilometer

[3] H. Herawati, Suripin, and Suharyanto, "Impact of climate change on streamflow in the tropical Lowland of Kapuas River, West Borneo, Indonesia," *Procedia Engineering*, vol. 125, pp. 185–192, 2015, doi: 10.1016/j.proeng.2015.11.027.

[4] K. Peniwati and W. Brenner, "Multi-decisions rating model: Establishing rescue policies for Regional Drinking Water Companies (PDAMs) in Indonesia," *European Journal of Operational Research*, vol. 186, no. 3, pp. 1127–1136, 2008, doi: 10.1016/j.ejor.2007.02.018.

[5] J. Petäjäjärvi, K. Mikhaylov, M. Pettissalo, J. Janhunen, and J. Iinatti, "Performance of a low-power wide-area network based on lora technology: Doppler robustness, scalability, and coverage," *International Journal of Distributed Sensor Networks*, vol. 13, no. 3, 2017, doi: 10.1177/1550147717699412.

[6] N. Afifah and A. Asnan, "The Impact of Corporate Social Responsibility, Service Experience and Intercultural Competence on Customer Company Identification, Customer Satisfaction and Customer Loyalty (Case Study: PDAM Tirta Khatulistiwa Pontianak West Kalimantan)," *Procedia - Social and Behavioral Sciences*, vol. 211, no. September, pp. 277–284, 2015, doi: 10.1016/j.sbspro.2015.11.035.

[7] Y. Liu, Y. S. Wang, S. P. Xu, W. W. Hu, and Y. J. Wu, "Design and Implementation of Online Monitoring System for Soil Salinity and Alkalinity in Yangtze River Delta Tideland," *2021 IEEE International Conference on Artificial Intelligence and Industrial Design, AIID 2021*, no. Aiid, pp. 521–526, 2021, doi: 10.1109/AIID51893.2021.9456521.

[8] L. Parra, S. Sendra, J. Lloret, and J. J. P. C. Rodrigues, "Low cost wireless sensor network for salinity monitoring in mangrove forests," *Proceedings of IEEE Sensors*, vol. 2014-December, no. December, pp. 126–129, 2014, doi: 10.1109/ICSENS.2014.6984949.

[9] W. Tang, S. Yueh, D. Yang, A. Fore, and A. Hayashi, "Investigating the utility and limitation of SMAP sea surface salinity in monitoring the arctic freshwater system," *International Geoscience and Remote Sensing Symposium (IGARSS)*, vol. 2018-July, pp. 5647–5650, 2018, doi: 10.1109/IGARSS.2018.8519602.

[10] M. K. ben Islam, M. A. H. Newton, J. Rahman, J. Trevathan, and A. Sattar, "Long range multi-step water quality forecasting using iterative ensembling," *Engineering Applications of Artificial Intelligence*, vol. 114, p. 105166, Sep. 2022, doi: 10.1016/j.engappai.2022.105166.

[11] V. Savel, P. Rakluea, T. Jangjing, B. Kumkhet, C. Mahatthanajatuphat, and W. Thaiwirot, "IoT Based Water Quality Monitoring System Using Solar Powered and LoRaWAN," 2022. doi: 10.1109/iEECON53204.2022.9741679.

[12] L. K. Baghel, S. Gautam, V. K. Malav, and S. Kumar, "TEMPSENSE: LoRa Enabled Integrated Sensing and Localization Solution for Water Quality Monitoring," *IEEE Transactions on Instrumentation and Measurement*, vol. 71, 2022, doi: 10.1109/TIM.2022.3175059.

[13] K. P. Kamble, "LoRa Communication based Wireless Sensor Monitoring system," in *International Conference on Sustainable Computing and Data Communication Systems, ICSCDS 2022 - Proceedings*, 2022, pp. 1127–1131. doi: 10.1109/ICSCDS53736.2022.9760796.

[14] W. A. Jabbar, T. Subramaniam, A. E. Ong, M. I. Shu'Ib, W. Wu, and M. A. de Oliveira, "LoRaWAN-Based IoT System Implementation for Long-Range Outdoor Air Quality Monitoring," *Internet of Things (Netherlands)*, vol. 19, Aug. 2022, doi: 10.1016/j.iot.2022.100540.

[15] B. J. Kefford, "Is salinity the only water quality parameter affected when saline water is disposed in rivers?," *International Journal of Salt Lake Research*, vol. 7, no. 4, pp. 285–300, 1998, doi: 10.1007/bf02442141.

[16] Y. Zhao, Q. lu Wu, and Y. nan Zhang, "Simultaneous measurement of salinity, temperature and pressure in seawater using optical fiber SPR sensor," *Measurement: Journal of the International Measurement Confederation*, vol. 148, 2019, doi: 10.1016/j.measurement.2019.07.020.

[17] F. Yang, R. Hlushko, D. Wu, S. A. Sukhishvili, H. Du, and F. Tian, "Ocean Salinity Sensing Using Long-Period Fiber Gratings Functionalized with Layer-by-Layer Hydrogels," *ACS Omega*, vol. 4, no. 1, pp. 2134–2141, 2019, doi: 10.1021/acsomega.8b02823.

[18] S. Akter, K. Ahmed, S. A. El-Naggar, S. A. Taya, T. K. Nguyen, and V. Dhasarathan, "Highly Sensitive Refractive Index Sensor for Temperature and Salinity Measurement of Seawater," *Optik (Stuttg)*, vol. 216, no. March, p. 164901, 2020, doi: 10.1016/j.ijleo.2020.164901.

[19] C. T. Chiang and C. W. Chang, "Design of a Calibrated Salinity Sensor Transducer for Monitoring Salinity of Ocean Environment and Aquaculture," *IEEE Sensors Journal*, vol. 15, no. 9, pp. 5151–5157, 2015, doi: 10.1109/JSEN.2015.2435742.

[20] V. A. Wardhany, H. Yuliandoko, Subono, M. U. Harun Ar, and I. G. P. Astawa, "Fuzzy Logic Based Control System Temperature, pH and Water Salinity on Vanammei Shrimp Ponds," *2018 International Electronics Symposium on Engineering Technology and Applications, IES-ETA 2018 - Proceedings*, pp. 145–149, 2019, doi: 10.1109/ELECSYM.2018.8615464.

[21] Y. Yin, S. Li, J. Ren, G. Farrell, E. Lewis, and P. Wang, "High-sensitivity salinity sensor based on optical microfiber coil resonator," *Optics Express*, vol. 26, no. 26, p. 34633, 2018, doi: 10.1364/oe.26.034633.

[22] F. Irwan and A. Afdal, "Analisis Hubungan Konduktivitas Listrik Dengan Total Dissolved Solid (TDS) dan Temperatur Pada Beberapa Jenis Air," *Jurnal Fisika Unand*, vol. 5, no. 1, pp. 85–93, 2016.

[23] F. Imansyah, L. Sandy, A. Putra, and E. Kusumawardhani, "Measurement and Analysis of Radiation Levels from Base Transceiver Station in Sambas."

[24] S. Opipah, H. Qodim, D. Miharja, Sarbini, E. A. Z. Hamidi, and T. Juhana, "Prototype design of smart home system base on LoRa," *Proceedings - 2020 6th International Conference on Wireless and Telematics, ICWT 2020*, 2020, doi: 10.1109/ICWT50448.2020.9243643.

[25] R. Z. Thamrin, O. N. Samijayani, S. Rahmatia, D. Adrianto, and I. K. A. Enriko, "Implementation of LoRa End-Device in Sensor Network System for Indoor Application," *2020 IEEE International Conference on Communication, Networks and Satellite, Comnetsat 2020 - Proceedings*, pp. 208–212, 2020, doi: 10.1109/Comnetsat50391.2020.9329003.

[26] D. Eridani, E. D. Widianto, R. D. O. Augustinus, and A. A. Faizal, "Monitoring System in Lora Network Architecture using Smart Gateway in Simple LoRa Protocol," *2019 2nd International Seminar on Research of Information Technology and Intelligent Systems, ISRITI 2019*, pp. 200–204, 2019, doi: 10.1109/ISRITI48646.2019.9034612.

[27] A. Zourmand, A. L. Kun Hing, C. Wai Hung, and M. Abdulrehman, "Internet of Things (IoT) using LoRa technology," *2019 IEEE International Conference on Automatic Control and Intelligent Systems, I2CACIS 2019 - Proceedings*, no. June, pp. 324–330, 2019, doi: 10.1109/I2CACIS.2019.8825008.

[28] C. Bouras, A. Gkamas, and S. A. K. Salgado, "Energy efficient mechanism for LoRa networks," *Internet of Things (Netherlands)*, vol. 13, p. 100360, 2021, doi: 10.1016/j.iot.2021.100360.

[29] R. S. Sinha, Y. Wei, and S. H. Hwang, "A survey on LPWA technology: LoRa and NB-IoT," *ICT Express*, vol. 3, no. 1, pp. 14–21, 2017, doi: 10.1016/j.icte.2017.03.004.

[30] E. K. Sari, A. Wirara, R. Harwahyu, and R. F. Sari, "Lora characteristics analysis for IoT application using NS3 simulator," *IEEE Region 10 Humanitarian Technology Conference, R10-HTC*, vol. 2019-November, pp. 205–210, 2019, doi: 10.1109/R10-HTC47129.2019.9042485.

[31] K. Niles, J. Ray, K. Niles, A. Maxwell, and A. Netchaev, "Monitoring for Analytes through LoRa and LoRaWAN Technology," *Procedia Computer Science*, vol. 185, no. June, pp. 152–159, 2021, doi: 10.1016/j.procs.2021.05.041.