Monitoring System for Sea Surface Temperature and Wind Speed in FADs Based on the Internet of Things

Andre Alfian Hidayat(1), Ping Astony Angmalisang(2), Robert Antonius Bara(3), Deiske Adeliene Sumilat(4), Alfret Luasunaung(5), Veibe Warouw(6)

[1]Student of Master of Aquatic Science Study Program, Faculty of Fisheries and Marine Science, University of Sam Ratulangi Manado
[2,3,4,5,6] Lecturer of the Master of Aquatic Science Study Program, University of Sam Ratulangi Manado
Bahu, Kec. Malalayang, Kota Manado, Sulawesi Utara, Indonesia

Email: [1]andre.alfian04@gmail.com

Available Online
http://www.jurnal.unublitar.ac.id/index.php/briliant

History of Article
Received on 29 March 2023
Accepted on 18 August 2023
Published on 19 August 2023
Pages. 740-747

Keywords
Wind speed; sea surface temperature; thingspeak

DOI
http://dx.doi.org/10.28926/briliant.v8i3.1298

Abstract: Sea Surface Temperature (SST) is the temperature of the water measured at sea level. SST is a crucial marine parameter that influences the weather and climate in Indonesia. The value of sea surface temperature will be very closely related to factors such as the depth of measurement from sea level, the intensity of sunlight received, season, weather, water depth, air circulation, and cloud cover. This study aims to design a prototype tool to measure wind speed and sea surface temperature parameters. The components used are the DS18B20 sensor, JL-FS2 sensor, Arduino Mega 2560, and the SIM900a GSM Module. The system is displayed in real-time via the Thingspeak website, accessed via a PC or smartphone. The DS18B20 sensor, as a sea surface temperature sensor, can measure these parameters by looking at the trend of changing day and night temperatures. The JL-FS2, as a wind speed sensor, has been able to measure wind speed parameters during field tests at FADs.

INTRODUCTION

Marine science relies heavily on developing sensors with new platforms, providing multidisciplinary data sets with advanced sampling strategies, and extending spatial plus temporal data to observe oceanographic and meteorological phenomena (Ruslinar & Waluyo, 2020).

Sea surface temperature is one of the parameters that characterize the mass of water in the oceans and is related to the state of the seawater layer beneath it so that it can be used in analyzing phenomena that occur in the oceans. Measurement of sea surface temperature is carried out through various methods. Direct measurements are carried out using the bucket method (WMO No. 8, 2014). Seawater samples were taken from a depth of one meter using a bucket. Measurements using a thermometer must be carried out immediately after the sample is obtained. The wind is a phenomenon of the movement of air masses from a place with high air pressure to an area with lower air pressure to achieve equilibrium. At sea level, the wind will push the surface water layer resulting in a void at the top, as a result water coming from below moves to replace the void above.

The water temperature parameter can be used to determine the upwelling phenomenon's early occurrence. Colder-temperature water has a greater specific gravity than hotter water. When the specific gravity of the water on the surface is greater than the water in the deeper layers of the water, the surface water will descend, pressing the inner water, and a vertical reverse flow will occur (Hidayat, 2021). Upwelling incident information can be identified using satellite imagery data which can be downloaded and processed using specific software. The limitations of fishermen in accessing and processing this data lead to a lack of information on upwelling events received by fishermen. For this reason, a system is needed to monitor upwelling event parameters such as surface wind speed and sea water temperature, which can be directly accessed via a web browser on a computer or smartphone. Fishermen can access this data through a link that will be provided to see the potential for catching fish in their FADs.

Previous research (Fathurachman, 2017), Prototype of Upwelling Detector in Freshwater Lakes with Dissolved Oxygen and Temperature Difference Methods. The study was conducted to design a prototype of an upwelling detector based on surface temperature and dissolved oxygen parameters. Machine-to-machine monitors dissolved oxygen levels and surface temperature in the water. Previous research (Hidayat, 2021), Upwelling Detection and Early Warning Systems. This research was conducted to build an upwelling detection and early warning system using a control system and two temperature sensor components. This system can provide information through Android-based applications and websites when there are signs of an upwelling phenomenon. Previous research (Hermawan, 2019), Design and Build of a Multi-Sensor-Based Upwelling Event Detection System Using a Microcontroller. This study designed an upwelling detection system using temperature, wind speed, and color sensors. This system can display this information in real-time through an interface.

The system is designed using DS18B20 temperature sensor and JL-FS2 wind sensor integrated with the Arduino Mega microcontroller as the central control system. The DS18B20 temperature sensor is a sensor that functions to convert heat quantities into voltage quantities. This sensor has waterproof capabilities and good precision. The JL-FS2 wind speed sensor is an analogue sensor with output voltage to measure wind speed. These sensors consist of three cup counters, where the more significant the wind speed, the faster the cup counter will rotate. Sensors, microcontrollers, and modems will be installed in fisherman's FADs to obtain real-time data in the field. The resulting data will be sent to the IoT cloud using an internet connection to monitor the data online and in real time.

METHOD

This study uses Research and Development (R&D). In the first stage, the problem is formulated to be studied. The second stage is conducting a literature study; the author reviews several journals or previous studies related to the research topic. The third stage is designing hardware and software; the author assembles all these components into a single unit that is connected (Hendri, et al., 2023).

Figure. 1 The Block Diagram

The block diagram is an illustration of the design of an upwelling incident detection system and communication device so that it can be seen how the whole system circuit works. Fig. 1 shows a block diagram of a general system consisting of input, process, and output.

This research was conducted in two stages: data collection with the prototype made and processing of ECMWF (European Centre for Medium Range Forecast) Era-Interim satellite imagery data. Data collection was carried out at the Manado Bay Fisherman FADs from 26 June 2022 at 04.00 UTC to 28 June 2022 at 04.00 UTC with coordinates 01.49865° N, 124.80167° E.

Data verification is done by comparison method. To verify the sensor measurement data, the instrument that can be used is a satellite or using modeling analysis if no in situ tool can compare the data. The parameters to be compared with the ECMWF satellite data are SST parameter data and surface wind speeds, averaged in one hour.

Measuring Sea Surface Temperature and Wind Speed

The temperature sensor is placed 1 meter below sea level. The wind speed sensor is placed 1 meter above the surface of FADs. The data collection location allows the modem to send data to the Thingspeak server. ThingSpeak is an internet service that provides services for IoT applications (Sorongan, et al., 2018). The IoT system collects data generated by each object connected to the internet to be processed and analyzed into helpful information so that later it can be used to control and monitor these objects (Cahyono, 2015). Figure 2 shows the condition of the equipment when installed on FADs.

Figure 2. Installation of sensors on FADs.

Data Processing of Sea Surface Temperature and Wind Speed ECMWF

Sea surface temperature and wind speed data were obtained from ECMWF. This data results from analyzing and interpolating meteorological data obtained from various world meteorological observation data centers and parameters (Zulfikar. et al., 2018). The data obtained is hourly for 24 hours which will then be processed using Ocean Data View software.

RESULTS AND DISCUSSION

Data verification is done by comparison method. The measurement results of the prototype will be compared with the results of satellite measurements. Table 1 shows the results of the comparisons that have been made.

Tabel 1. Comparison Between Prototype and Satellite

Date	Time	ECMWF SST (C)	PROTOTYPE SST (C)	ECMWF WS (m/s)	PROTOTYPE WS (m/s)
26/06/2022	04:00	29.94	29.23	1.52	2.7
26/06/2022	05:00	29.94	29.29	1.41	3.96
26/06/2022	06:00	29.94	29.32	1.71	4.25
26/06/2022	07:00	29.94	29.42	1.97	3.35
26/06/2022	08:00	29.94	29.48	1.67	2.36
26/06/2022	09:00	29.94	29.46	0.99	1.58
26/06/2022	10:00	29.94	29.43	0.98	1.41
26/06/2022	11:00	29.94	29.39	0.87	2.25
26/06/2022	12:00	29.94	29.39	1.02	2.38
26/06/2022	13:00	29.94	29.32	1.34	1.77
26/06/2022	14:00	29.94	29.38	1.04	2.28
26/06/2022	15:00	29.94	29.44	0.67	2.89
26/06/2022	16:00	29.94	29.29	0.64	2.63
26/06/2022	17:00	29.94	29.31	0.38	2.88
26/06/2022	18:00	29.94	29.29	0.56	2.39
26/06/2022	19:00	29.94	29.24	0.57	2.52
26/06/2022	20:00	29.94	29.1	0.53	3.13
26/06/2022	21:00	29.94	28.96	0.45	0.32
26/06/2022	22:00	29.83	28.88	0.55	1.31
26/06/2022	23:00	29.83	28.9	0.81	1.39
27/06/2022	00:00	29.83	28.93	1.27	1.04
27/06/2022	01:00	29.83	29.03	1.26	0.24
27/06/2022	02:00	29.83	29.1	1.46	1.04
27/06/2022	03:00	29.83	29.19	1.93	2.87
27/06/2022	04:00	29.83	29.35	1.71	3.46
27/06/2022	05:00	29.83	29.36	1.61	3.47
27/06/2022	06:00	29.83	29.19	1.02	4.01
27/06/2022	07:00	29.83	29.06	0.3	2.03

27/06/2022	08:00	29.83	29.3	0.57	1.92
27/06/2022	09:00	29.83	29.33	0.84	2.22
27/06/2022	10:00	29.83	29.24	1.21	3.22
27/06/2022	11:00	29.83	29.25	0.98	3.04
27/06/2022	12:00	29.83	29.22	1.08	2.25
27/06/2022	13:00	29.83	29.32	1.02	1.08
27/06/2022	14:00	29.83	29.36	0.84	1.56
27/06/2022	15:00	29.83	29.24	0.55	1.64
27/06/2022	16:00	29.83	29.17	0.39	2.65
27/06/2022	17:00	29.83	29.12	0.17	1.71
27/06/2022	18:00	29.83	29.1	0.31	2.19
27/06/2022	19:00	29.83	29.06	0.33	2.94
27/06/2022	20:00	29.83	29.1	0.6	2.44
27/06/2022	21:00	29.83	29.09	1.05	2.48
27/06/2022	22:00	29.76	28.92	0.89	1.91
27/06/2022	23:00	29.76	28.87	1.37	0.77
27/06/2022	00:00	29.76	28.95	1.5	1.23
28/06/2022	01:00	29.76	28.94	1.51	1.06
28/06/2022	02:00	29.76	29.09	1.26	1.95
28/06/2022	03:00	29.76	29.12	0.91	1.91
28/06/2022	04:00	29.76	29.24	0.44	2.94
AVERAGE		29.86	29.20	0.98	2.22
MAX		29.94	29.48	1.97	4.25
MIN		29.76	28.87	0.17	0.24
CORRELATION		0.61		0.14	
RMSE		0.68		1.57	

Sea Surface Temperature data that has been sent to the cloud will then be generated graphs to analyze and compare with ECMWF data on a time-series basis. Figure 3 shows a graph of sea surface temperature records from sensors and satellites.

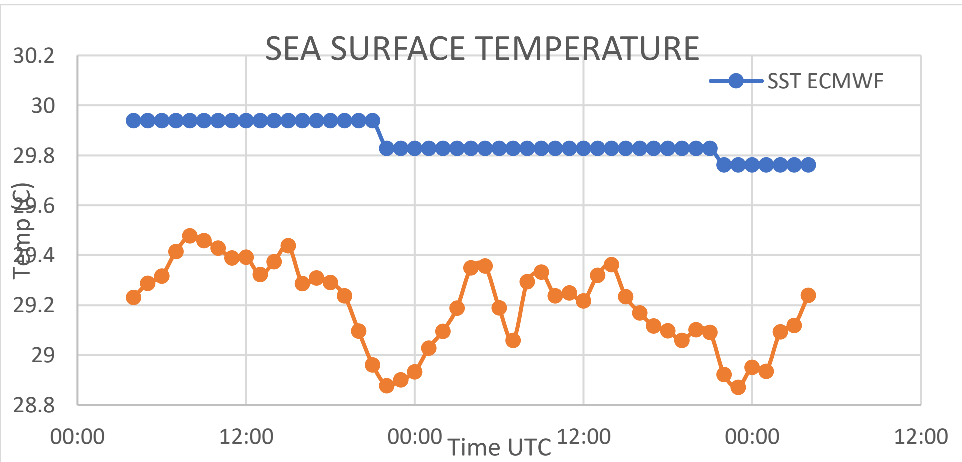

Figure 3. SST Chart

Figure 3 shows that measuring sea surface temperature using a sensor will form a pattern of rising temperatures during the day and falling at night. The sea surface temperature data from the satellite does not show this pattern and tends to be homogeneous. There is an average temperature difference of 0.66 C, where satellite sea surface temperature data is higher than measurements using sensors. Due to measurements using sensors that are more sensitive to temperature changes around FADs.

Table 1 shows that the correlation value for the SST parameter is 0.61, and the RMSE value is 0.68. This indicates a moderate correlation and low error variation for SST parameter measurements. The sea surface temperature sensor measurements obtained the maximum recorded average sea surface temperature value of 28.48 °C and the minimum average sea surface temperature value of 28.87 °C. The maximum sea surface temperature value from the satellite is 29.94 °C, and the minimum sea surface temperature value from the satellite is 29.76 °C.

Wind Speed data that has been sent to the cloud will then be generated graphs to analyze and compare with ECMWF data on a time-series basis. Figure 4 shows a graph of wind speed records from sensors and satellites.

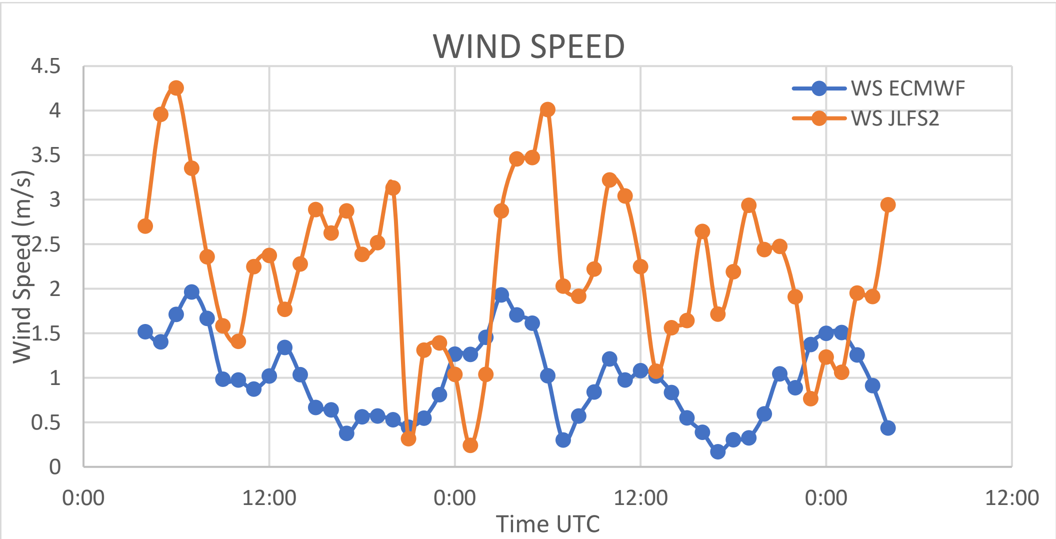

Figure. 4 Wind Speed Chart

Figure 4 shows the differences in data patterns from wind speed measurements using sensors and satellite data. The differences are caused by the installation of sensors on FADs which are 1 meter above the surface of FADs compared to the 10-meter wind speed data on the satellite. The structure of a sensor only has a height of 1 meter because it makes it easier to install, does not require a significant location to establish a support pole, and is safe from lightning strikes. Wind speed data on ECMWF has the lowest range at a height of 10 meters.

Table 1 shows that the correlation value for the wind speed parameter is 0.14, and the RMSE value is 1.57. This shows a weak correlation and a significant error variation for wind speed parameter measurements. The Jl-FS2 sensor measures the average wind speed at the location of 2.23 m/s, and the maximum recorded wind speed is 4.25 m/s. Wind speed data on the satellite has an average wind speed of 0.98 m/s and a top wind speed of 1.97 m/s.

After field testing, this research can monitor the parameters of sea surface temperature and wind speed directly at fisherman FADs. In the three previous studies, field tests were conducted not on the high seas but on lakes and did not compare sensor output with satellite data. In this study, the system could send data to the cloud server quite well, even though some data was lost because there was no GSM network at the location.

CONCLUSION

Based on the research results, it can be concluded that the prototype research has succeeded in measuring and transmitting temperature and wind speed data placed in FADs. The DS18B20 sensor, as a sea surface temperature sensor, has been able to measure these parameters by looking at the trend of changes in temperature during day and night conditions during field tests. However, there is no similar pattern in the satellite data. Correlation and RMSE values also show a strong correlation and low error variation between the SST sensor and ECMWF data. The JL-FS2 sensor, as a wind speed sensor, has been able to measure wind speed parameters during field trials, but it isn't easy to find relevant comparative data. The available comparative data is wind speed data of 10m ECMWF, which has a different height from the sensor attached to FADs. The correlation and RMSE values show a very weak correlation and a significant variation in error. The communication modem has been able to transmit data properly, although there are still blank data due to signal limitations at the location.

SUGGESTION

Field tests were carried out with a longer sampling time and simultaneously at several points to obtain a better variation of data. Added solar panels and regulators so the prototype could work more durable. Added ocean current direction and speed sensors to obtain different measurement parameter data.

REFERENCES

Cahyono, G. H. (2015). Internet of Thing, *Forum Teknologi, vol. 06* (3), 35-41. http://ejurnal.ppsdmmigas.esdm.go.id/sp/index.php/swarapatra/article/view/115/137

Fathurahman, C. (2017). Upwelling Detection Prototype in Freshwater Lakes with Dissolved Oxygen and Temperature Difference Methods. Telkom University. Bandung.

Hendri, et al. (2023). Tool for Monitoring Ammonia Levels and Controlling pH at IoT-Based Catfish Ponds. *BRILIANT: Jurnal Riset dan Konseptual, Vol. 8(1),* 272-280. DOI: http://dx.doi.org/10.28926/briliant.v8i1.1200

Hermawan, E. (2019). Design and Development of a Multisensor-Based Upwelling Event Detection System Using a Microcontroller. STMKG. Jakarta.

Hidayat, A. I. (2021). Upwelling Early Detection and Warning Systems. *Jurnal Ilmiah Ilmu Komputer, Vol. 7(1),* 55-61.

Ruslinar, M & Waluyo (2020). Sea Water Surface Wind Speed Measuring Tool Based On Microcontroller. *Jurnal Barakuda 45,* 2 (2), 80-88. https://doi.org/10.47685/barakuda45.v2i2.90

Sorongan, et al. (2018). ThingSpeak as a Tank Monitoring System Internet of Things-Based Gas Station. *JTERA - Jurnal Teknologi Rekayasa, Vol. 3 (2),* 219-224. DOI: 10.31544/jtera.v3.i2.2018.219-224

Zulfikar, et al. (2018). Spatial Variability of Sea Surface Temperature on Bintan Island Riau Archipelago Province in Four Different Seasons. *Dinamika Maritim, Vol 6 (2),* 12-15. https://ojs.umrah.ac.id/index.php/dinamikamaritim/article/view/316

World Meteorological Organization, 2014, Guide to Meteorological Instruments and Methods of Observations, WMO No.8, Jenewa, Swiss.