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MAPPING OF SEA SURFACE TEMPERATURES ON THE COAST PROBOLINGGO WITH SATELLITE IMAGE DATA

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ABSTRACT
Indonesia has the advantage of abundant marine resources. One of them is on the coast of Probolinggo , where the average community there utilizes marine natural resources for livelihoods. Monitoring ocean conditions such as sea surface temperature (SST) is used to facilitate and streamline the utilization of marine resources, namely by using remote sensing technology from Aqua MODIS satellite images which can later be used as a database in the field of Civil Engineering in the planning and construction of water buildings such as ports and docks. In this study, it can be used for SPL mapping using field data (in situ) and data from Aqua MODIS satellite imagery with the help of the SeaDAS application. The data used from Aqua MODIS satellite imagery is data from 2019-2023, with wavelengths of 412 nm, 531 nm and 667 nm. The results of the analysis and discussion of satellite image data concluded that the best data is the 2023 image data. For SPL with a wavelength of 531 nm, the logarithmic equation with the SPL = 3.7797ln(x) + 51.436 algorithm model, R^2 value = 0.1201 and correlation value R = 0.4567300 which has a moderate positive correlation.
Keywords: *Sea Surface Temperature (SST), Remote Sensing, Aqua MODIS.*

INTRODUCTION

Probolinggo is one of the cities in East Java Province. Located about 100 km southeast of Surabaya, Probolinggo City is bordered by the Madura Strait to the north, and Probolinggo Regency to the east, south, and west (Suyarso et al., 2023). Probolinggo is the fourth largest city in East Java after Surabaya, Malang, and Kediri. The area of Probolinggo City is recorded at 56,667 Km (Sobari, 2023). Administratively, the Probolinggo government is divided into 24 sub-districts in Probolinggo Regency and 5 sub-districts in Probolinggo City (Buchori et al., 2017). According to the population of the district and the population of this city in 2021 amounted to 242,246 inhabitants (Moore, 2021). This city is located in the Horseshoe region, East Java and is the main route of the North coast that connects Java Island with Bali Island (Lunt, 2019). The area of Probolinggo City is located at an altitude of 0 to less than 50 meters above sea level (Susilo & Isdarmadi, 2017). Geographically, Probolinggo City is located at 7°43’41" to 7°49’04" South Latitude and 113°10’ to 113°15’ East Longitude (Sriningsih & Otok, 2023).

Probolinggo City is one of the cities dominated by the sea coast, so that in each district there are areas that have the potential to be used as natural resources by people on the coast of Probolinggo, so that the majority of people there mostly work as fishermen and have a business cultivating various types of fish from marine processing.

Indonesia's vast sea waters have oceanographic parameters that affect changes dynamically (Fauzi et al., 2021). Sea Surface Temperature (SPL) is one of the parameters in determining the quality of waters that affects life in the sea (Ali Shah et al., 2014). Sea Surface Temperature is used as material for meteorological studies, fish feeding speed, fish distribution, growth metabolism and fish abundance

(Vivekanandan, 2013). Sea Surface Temperature is also one of the factors used to determine the quality of waters (Ding & Elmore, 2015). In general, the term SPL (Sea Surface Temperature) is often used in the marine and fisheries fields (Selao et al., 2019). The SPL determination of this satellite uses infrared radiation. At this time to get information about SPL can be seen using remote sensing satellite imagery (Syahdan et al., n.d.). This research aims to utilize remote sensing technology using Aqua MODIS satellite images to map sea surface temperatures (Chaudhary et al., 2023).

The results of sea surface temperature mapping are then used as one of the parameters for monitoring water quality and in the field of Civil Engineering is used as a database in providing information related to safety, environmental, and other regulations and standards that must be complied with in the process of planning, building, and maintaining infrastructure. Provide information related to the latest technologies that can be used in the planning process, such as stronger and more durable construction materials and more efficient building technologies (Hafez et al., 2023). And can provide advice related to project management, including budget arrangements, timing, and risk management in the infrastructure development process (Osei-Kyei et al., 2023). So, overall, it can provide support for Civil engineers in the process of planning, building, and maintaining infrastructure more effectively and efficiently (Hao et al., 2023).

RESEARCH METHODS

By mastering research methods, not only can solve various research problems, but also can develop the scientific field involved. The research method used in this final project is a descriptive quantitative research method, namely by finding information about existing symptoms, clearly defining goals to be achieved, planning how to approach it, collecting data as material for making reports.

RESULTS AND DISCUSSION

Point Data Coordinate Temperature Sea Level (SST)

Point data collection coordinate temperature surface sea (SPL) is carried out in a way directly on location research on March 20, 2023 using GPS *(Global Positioning System)* tool to show points coordinates and digital/ infrared thermometer as tools measuring temperature . This research data was taken as many as 20 points coordinates on the coast beach Probolinggo with the following data :

Table 1. Point Coordinate Data Retrieval

No	Coordinate Geographical		SST (°C)
	Latitude	Longitude	
1	-7º 41' 55.53" S	113º 21' 54.14" E	31.2
2	-7º 41' 55.76" S	113º 21' 13.25" E	34.9
3	-7º 41' 55.98" S	113º 20' 32.35" E	32.7
4	-7º 41' 56.20" S	113º 19' 51.49" E	31.4
5	-7º 41' 56.43" S	113º 19' 10.60" E	30.5
6	-7º 41' 56.65" S	113º 18' 29.71" E	31.5
7	-7º 41' 56.86" S	113º 17' 48.80" E	31.2
8	-7º 41' 57.08" S	113º 17' 7.91" E	31.4
9	-7º 41' 57.32" S	113º 16' 27.05" E	30.9
10	-7º 41' 57.52" S	113º 15' 46.15" E	31.2

No	Coordinate Geographical		SST (°C)
	Latitude	Longitude	
11	-7º 41' 16.53" S	113º 16' 26.83" E	31.2
12	-7º 41' 16.31" S	113º 17' 7.69" E	29.7
13	-7º 41' 16.09" S	113º 17' 48.59" E	30.3
14	-7º 41' 15.88" S	113º 18' 29.48" E	30.6
15	-7º 41' 15.66" S	113º 19' 10.38" E	31.2
16	-7º 41' 15.43" S	113º 19' 51.24" E	32.4
17	-7º 41' 15.21" S	113º 20' 32.14" E	30.3
18	-7º 41' 14.99" S	113º 21' 13.03" E	32.1
19	-7º 41' 14.76" S	113º 21' 53.93" E	33
20	-7º 41' 14.54" S	113º 22' 34.81" E	31.2

Source : *Survey Result Data*

Aqua MODIS Satellite Image Data Processing

Aqua MODIS satellite data processing is calculated use modeling mathematical model algorithm . Where to get mark reflectance , must have long waves to be processed use Microsoft Excel application . Selected wavelength namely 412 nm (color blue), 531 nm (colour green) and 667 (colour red). This research uses image data satellites taken at different times namely in March 2019, 2020, 2021, 2022 and 2023. Reflectance values from image The satellite for March 2023 is shown in the following table

Table 2. Reflectance Value from Aqua Modis Satellite Imagery for March 2023

Reflectance Value Data March 2023			
Point	Rrs_412	Rrs_531	Rrs_667
1	0.00816	0.00503	0.00052
2	0.00798	0.00577	0.00105
3	0.00788	0.00507	0.00079
4	0.00754	0.00463	0.00068
5	0.00725	0.00424	0.00500
6	0.00763	0.00391	0.00033
7	0.00769	0.00427	0.00038
8	0.00831	0.00557	0.00081
9	0.00825	0.00551	0.00081
10	0.00794	0.00520	0.00688
11	0.00812	0.00505	0.00054
12	0.00804	0.00497	0.00060
13	0.00818	0.00521	0.00050
14	0.00769	0.00460	0.00048
15	0.00795	0.00473	0.00044

Reflectance Value Data March 2023			
Point	Rrs_412	Rrs_531	Rrs_667
16	0.00795	0.00417	0.00031
17	0.00767	0.00404	0.00036
18	0.00767	0.00404	0.00036
19	0.00738	0.00456	0.00628
20	0.00779	0.00498	0.00066

Source : *Aqua MODIS Satellite Image Extraction Results*

After get mark long reflectance _ 412 nm wave (color blue), 531 nm (colour green) and 667 (colour red), data processing reflectance results image satellite use Microsoft Excel application is created with scatter graphs to obtain mark degrees determination (R^2) is largest with value reflectance as x- axis parameter and temperature surface in situ sea (SST) as the y- axis . Used 4 equations namely linear, exponential, logarithmic and power so obtained mark degrees determination (R^2) as follows :

Table 3. Recapitulation of SPL Data Processing Results for March 2023

No	**Bands**	**Type**	**Algorithm Models**	**Degrees**
	Satellite Imagery	Equality		Determination
1	Rrs_412	Linear	$y = 156.2x + 30.092$	$R^2 = 0.0015$
2	Rrs_412	Exponential	$y = 30.188e^{4.6006x}$	$R^2 = 0.0013$
3	Rrs_412	Logarithmic	$y = 1.4158\ln(x) + 38.18$	$R^2 = 0.002$
4	Rrs_412	Power	$y = 22.588x^{-0.068}$	$R^2 = 0.0049$
5	**Rrs_531**	**Linear**	**$y = 853.66x + 27.129$**	**$R^2 = 0.1412$**
6	Rrs_531	Exponential	$y = 27.564e^{25.89x}$	$R^2 = 0.1356$
7	Rrs_531	Logarithmic	$y = 3.7797\ln(x) + 51.436$	$R^2 = 0.1201$
8	Rrs_531	Power	$y = 57.567x^{0.1145}$	$R^2 = 0.115$
9	Rrs_667	Linear	$y = -47.293x + 31.389$	$R^2 = 0.0058$
10	Rrs_667	Exponential	$y = 31.367e^{-1.46x}$	$R^2 = 0.0058$
11	Rrs_667	Logarithmic	$y = 0.054\ln(x) + 31.713$	$R^2 = 0.0016$
12	Rrs_667	Power	$y = 31.661x^{0.0016}$	$R^2 = 0.0014$

Source : *Data Processing Through Microsoft Excel application*

From the results of the description above it can be concluded that who has degrees determination (R^2) of three image bands The satellite above the largest is a linear equation in the image band satellite Rrs_531 with the algorithm model obtained namely $y = 853.66x + 27.129$ with a value of $R^2 = 0.1412$. Then correlation test was carried out between in situ SPL data and image SPL data to find comparisons mark correlation biggest so that it can be used as the best algorithm model for further calculations . Comparison mark correlation shown in the table as follows :

Table 4. Comparison of Correlation Values with Temperature Insitu

	SPL Insitu	*Linear*	*Exponential*	*Logarithmic*	*Power*
SPL Insitu	1				
Linear	0.074995	1			
Exponential	0.073816	0.999999	1		
Logarithmic	**0.095588**	0.999658	0.999617	1	
Power	0.094483	0.999694	0.999655	0.999999	1

Source : *Data Processing Through Microsoft Excel application*

From table mark correlation biggest that is **0.095588** , can be concluded that the best algorithm model in March 2023 is in the image band satellite **Rrs_531** equality **logarithmic with** algorithm models **y = 3.7797ln(x) + 51.436** and value **R^2 = 0.1201**

Algorithm Model Calculation for Temperature Sea Level (SST)

The best algorithm model will be used for calculating temperature data surface sea (SPL) in Microsoft Excel, x- axis as the reflectance result obtained from previous image data processing and the y-axis as temperature data surface sea (SST) from image satellite . Results of temperature data processing surface sea (SPL) imagery The satellites shown in the table are as follows :

Table 5. Temperature Value Data Processing Results Sea Surface (SST) with Algorithmic Models

No	SPL Insitu	Temperature Sea Level (SST)				
		2019	**2020**	**2021**	**2022**	**2023**
1	31.2	31.62465	31.96934	31.70214	32.66170	31.43256
2	34.9	31.69470	32.06695	32.13968	31.85169	31.95002
3	32.7	31.65942	32.11978	32.23162	31.59757	31.46250
4	31.4	31.53720	31.88737	31.94583	31.15551	31.11936
5	30.5	31.32166	31.41030	31.47310	30.97143	30.78321
6	31.5	30.88722	30.96166	31.09770	30.98592	30.47859
7	31.2	30.91234	30.89692	30.45993	30.86589	30.81165
8	31.4	31.03189	30.47252	30.85355	31.16059	31.81664
9	30.9	31.82659	30.56553	30.97859	31.34820	31.77980
10	31.2	32.08107	31.67092	30.97096	31.34820	31.56110
11	31.2	31.76859	30.59042	30.40971	31.56438	31.45055
12	29.7	31.08782	31.00220	31.30119	31.29731	31.39024
13	30.3	30.85649	31.05261	31.47310	30.98592	31.56400
14	30.6	30.79804	31.34342	31.09770	30.98592	31.09644
15	31.2	30.81585	31.85394	31.72704	31.11798	31,19853
16	32.4	31.40133	32.06537	32.13097	31.49227	30.72566
17	30.3	31.60559	32.11978	32.42744	31.89434	30.60788
18	32.1	31.50389	32.28073	32.62773	32.21973	30.60788
19	33	31.36512	32.06063	32.64156	32.59952	31.06012
20	31.2	31.63164	31.99681	32.05731	32.56987	31.39784

Source : *Data Processing Through Microsoft Excel application*

Example of calculation on data number 1 for 2023:

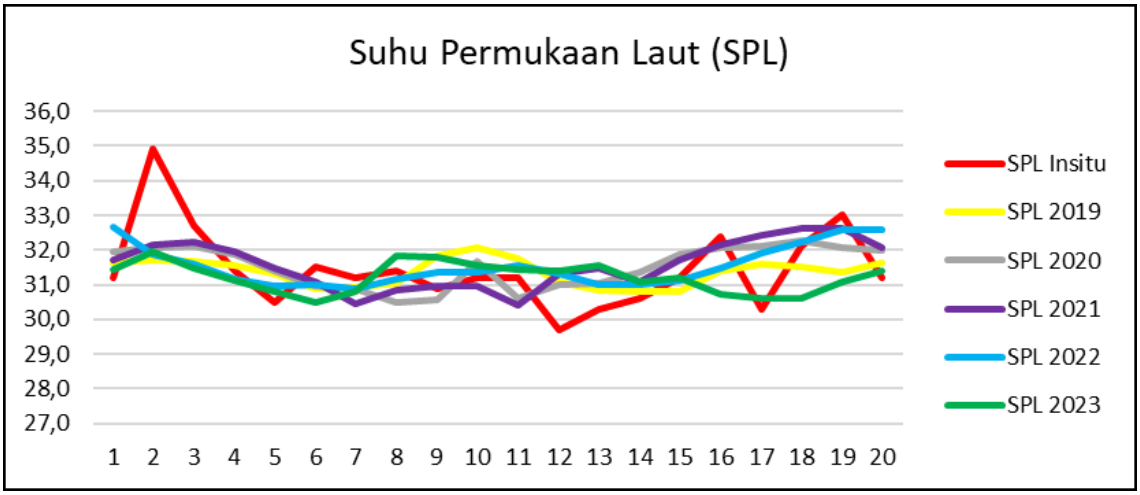
Description :

y = 3.7797ln(x) + 51.436 — y = Temperature data surface sea (SPL)

y = 3.7797 x ln (Reflectance Value) + 51.436 — x = Reflectance Value

y = 31.43256 °C

Line graph of table of value data processing results temperature surface sea (SPL) with a mathematical model can be shown in the following picture :



Source : *Microsoft Excel Chart*

Figure 1. Line graph of temperature data processing results Sea Level (SST)

After find out the results of data processing table , then done image data validation satellite using mark correlation biggest between in situ SPL data and image SPL shown in the table as follows :

Table 6. Correlation between Insitu SPL Data and Citra SPL

	Temperature Insitu	***2019***	***2020***	***2021***	***2022***	***2023***
Temperature Insitu	1					
2019	0.2976988	1				
2020	**0.4567300**	0.3205582	1			
2021	0.4427755	0.2177463	0.882421	1		
2022	0.3726072	0.5147188	0.596228	0.624377	1	
2023	0.1817939	0.3009905	-0.267109	-0.243553	0.0641142	1

Source : *Data Processing Through Microsoft Excel application*

Data processing from table is the result of image data validation satellite using _ mark correlation between in situ SPL data and image SPL data , from table can be viewed that mark correlation The largest is data from SPL 2020 with a value of 0.4567300 which can be concluded that correlation between in situ SPL data and image SPL data own correlation moderate positive (table correlation).

Meta Temperature Sea Level (SST)

From the results of calculations and analysis use application SeaDAS and Microsoft Excel, showing that the data is retrieved direct (in situ) and calculated data from image Aqua MODIS satellite is missing difference and have done correlation that gets quite good results . Next, it's done mapping for temperature surface sea (SPL) by means entering the results of the logarithmic equation in March 2023 with the algorithm model y = 3.7797ln(x) + 51.436 and the value of R^2 = 0.1201 on the length Rrs_531 nm wave to Math Band in the app SeaDAS so that obtained map SPL thematic for March 2019-2023 shown in the picture following .

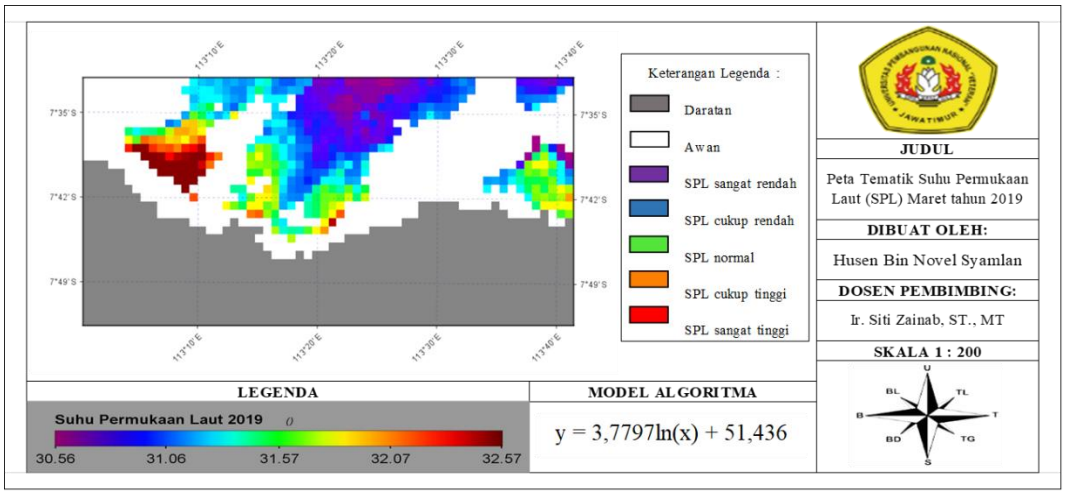


Figure 2 . SPL Thematic Map on the Bentar Coast of Probolinggo in March 2019

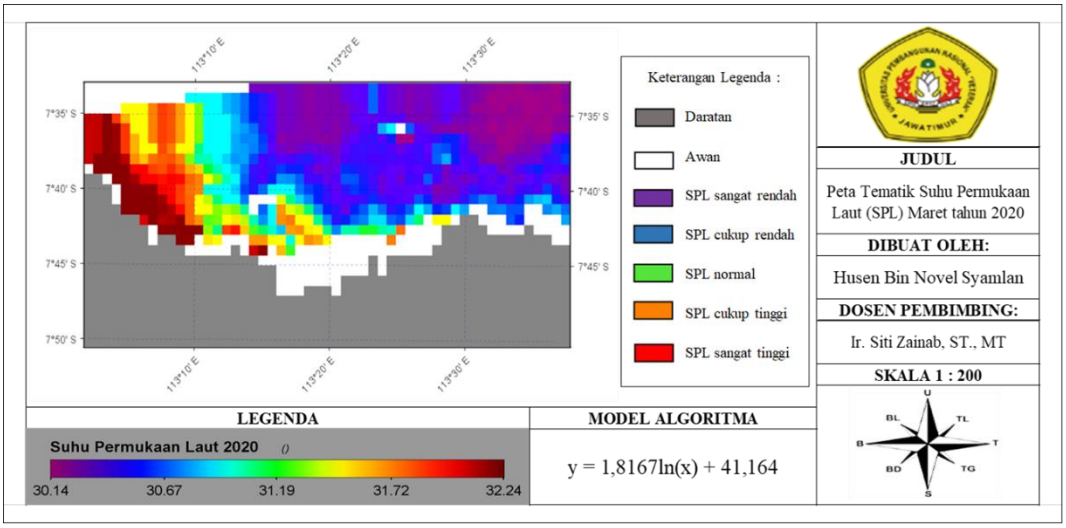


Figure 3. Thematic map of SPL on the coast of Bentar Beach, Probolinggo, March 2020

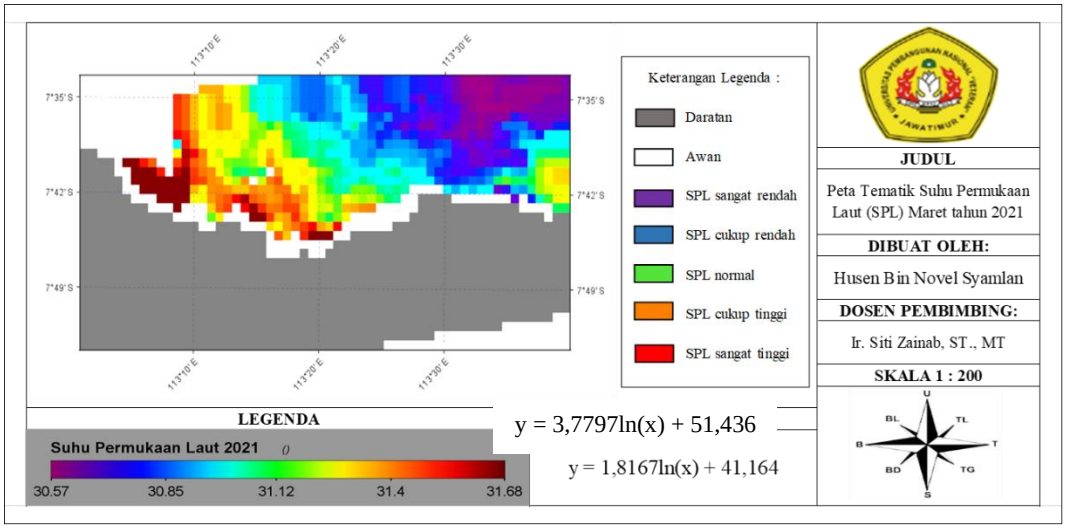


Figure 4. Thematic map of SPL on the coast of Bentar Beach, Probolinggo, March 2021

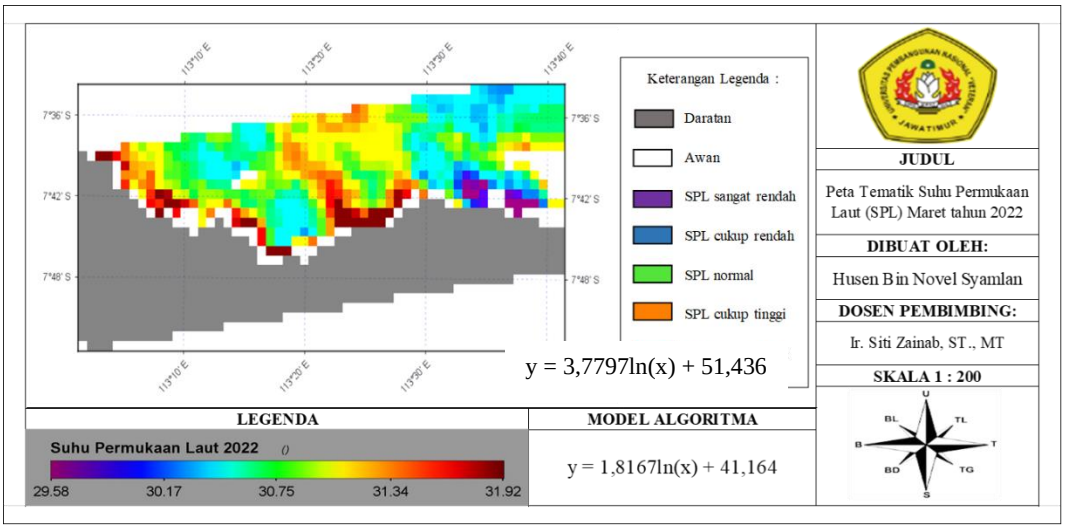


Figure 5 . Thematic map of SPL on the coast of Bentar Beach, Probolinggo, March 2022

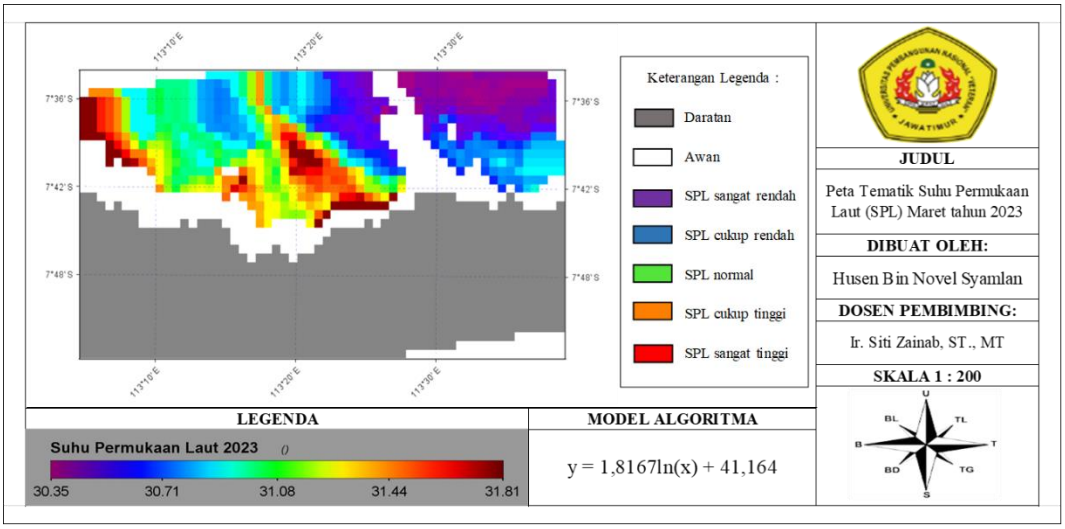


Figure 6 . _ Thematic map of SPL on the coast of Bentar Beach, Probolinggo, March 2023

CONCLUSION

Data from calculations and analysis of coastal image data Bentar Probolinggo beach in March 2023, the SPL value is around between 31.09°C – 31.79°C indicates that the SST is on the coast Bentar Probolinggo beach is normal. The best algorithm model for SPL is length Rrs_531 nm wave logarithmic equation with algorithm model SPL = 3.7797ln(x) + 51.436 and R^2 = 0.1201 and mark correlation 0.4567300 which has interpretation connection moderate positive . On the map Thematic SST for March 2023 shows a Legend value between 30.35°C-31.81°C. Thematic map temperature surface sea (SST) on the coast Bentar Probolinggo beach in March 2019-2023 is shown in figure 2-6.

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