Time Series Analysis of Sea Surface Temperature With Aqua MODIS from 2011 to 2016. Case Studi: North Coast of Gresik and Madura

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Abstract—**Sea surface temperature (SST) is a measurement parameter for the condition of coastal and marine water quality, where the value of SST is a measure of fertility of ecosystems in the waters concerning the lives of flora and fauna. To measure the SST can be done by several methods, simple by using a alcohol thermometer dipped into the sea and water bodies to obtain the existing value of the SPL. To measure a wider area in order to obtain a global picture of course is not effective to measure in situ, we need a technology and methods that can replace the monitoring of the global SST, for the purposes of the use of remote sensing technologies by using algorithms that have been widely used. As the material in this study used satellite imagery Aqua Modis 250 meters during January from 2011 to 2016 that can instantly detect the SST value at some predetermined coordinates and as a case study area have Gresik coast towards the northern part of the island of Madura. The results obtained from this study is that the range value of standard deviation and variation of the average value of SST per year, which the SST is in the range of 27°C to 32°C, and from linear regression obtained an average value of R squared of 0.748 for a period of 6 years the process of aquisition of satellite imagery. The coastal area around the north Pangkah Gresik has the highest temperature is 31°C while the waters to the north of Madura has an average temperature of 28°C.**

Keywords— **sea surface temperature, Aqua Modis, marine water quality, linear regression, time series analysis.**

Abstrak— ***Suhu Permukaan Laut (SPL) adalah suatu parameter pengukuran terhadap kondisi pantai dan mutu air laut, di mana nilai SST adalah ukuran kesuburan ekosistem dalam perairan yang terkait dengan kehidupan flora dan fauna. Untuk mengukur SST dapat dilakukan dengan beberapa metode, salah satunya dengan menggunakan thermometer alkohol yang dicelupkan kedalam air laut dan badan air untuk memperoleh nilai SPL yang ada saat itu. Untuk mengukur area yang lebih luas dalam memperoleh sebuah gambaran secara global tentang kondisi pantai tidaklah efektif apabila mengukur secara langsung di situs/lokasi, dibutuhkan teknologi dan metode yang dapat menggantikan pemantauan SPL secara global, untuk tujuan tersebut digunakan teknologi penginderaan jarak jauh dengan menggunakan algoritma yang dapat digunakan secara luas. Sebagai bahan penelitian digunakan citra satelit Aqua Modis 250 meter yang diambil pada bulan Januari tahun 2011 sampai tahun 2016 yang dapat mendeteksi nilai SPL pada beberapa koordinat yang telah ditentukan sebelumnya dan sebagai area studi kasus, digunakan pantai Gresik kearah bagian selatan pulau Madura. Hasil yang diperoleh dari studi ini adalah jangkauan nilai deviasi standart dan variasi nilai rata-rata SPL per tahun, yang mana SPL berada dalam interval 27-32℃, dan dari regresi linier diperoleh sebuah nilai rata-rata R kuadrat 0.748 untuk periode selama 6 tahun proses akuisisi citra satelit. Area pantai di bagian utara Pangkah, Gresik memiliki temperature tertinggi yaitu 31℃ sedangkan sebelah utara Madura memiliki temperatur rata-rata 28℃***

Kata Kunci—**suhu permukaan laut , citra aqua modis, kualitas perairan pantai, regresi linier, analisa time series.**

I. INTRODUCTION

The surface temperature of the sea is one of the most important parameters for the planning of global ecosystems that occur on the surface of the sea, especially for shallow waters. When the sea surface temperature changes then the microbial life in marine waters will also be affected. Changes in temperature of 1 - 2 ° C will affect the reproduction of fish in these waters. Likewise, from the hydrological factors will change from the rainfall. The purpose of this study is to map and search the movement of sea surface temperatures along the series of times. And in this study is expected to find an exact picture of sea surface temperatures in the coastal area.

Sea surface temperature plays an important role in determining the characteristics of the ecological environment, especially in the coastal waters. Significant change of sea surface temperature of the biota in coastal areas will be affected too [1]. Has been much research done on the parameters of sea surface temperature, both of which involve a variety of weather satellites[2] as well as the use of sensors. The variation of the sensor which is used among other things that have been done to study the NPP-VIIRS [3], with Landsat and AVHRR [4], as well as the Modis [5]. Landsat utilize existing thermal bands, besides there that take advantage of this measurement with radio waves [6]. In addition it has many remote sensing algorithms developed in an effort to get the exact model in the evaluation of image data with field data [7], amongothers, by the use of infrared [8], also operating with the use of non-linear models [9].

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II. METHOD

This study took place in the northern coast of Gresik and partly the northern coast of Madura primarily to coordinate 6^o 49’ 04” south latitude and 112 12’ 45” east longitude to 6^o 49’ 39” south latitude and 112^o 53’ 16” east longitude.

SEADass 7.4.2 are use to do the data processing of satellite images, along with Excell to calculation of time series analysis.

Modis satellite data :

1. A2011331055000.L2_LAC_SST.nc
2. A2012332060000.L2_LAC_SST.nc
3. A2013332061500.L2_LAC_SST.nc
4. A2014330055500.L2_LAC_SST.nc
5. A2015331061000.L2_LAC_SST.nc
6. A2016331060000.L2_LAC_SST.nc

A. Area of interest

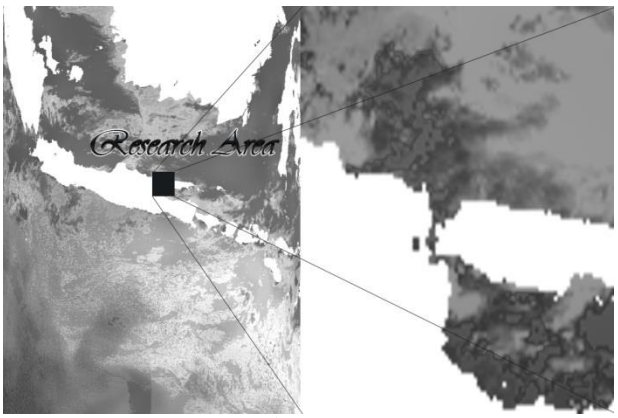

Figure 1. Area of Interest with black point

Technical collection of field data is done with using thermometer alcohol dipped directly on the surface of the sea at some point observations recorded with the help of GPS navigation equipment

The data which already collected then calculate with the linear regression formula y = Ax + B, where A and B are coefficients of linear regression, y is the field data of in situ for temperature and x is the value of the temperature of the satellite imagery in a variety of the year existing.

III. RESULTS AND DISCUSSION

The result show in Figure 2 to Figure 7 that represent images satellite with algorithm of Sea surface temperature from January 2011 until January 2016

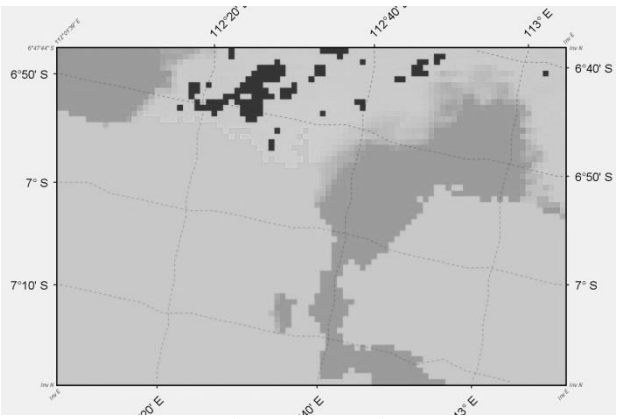

Figure 2. Sea surface temperature from January 2011

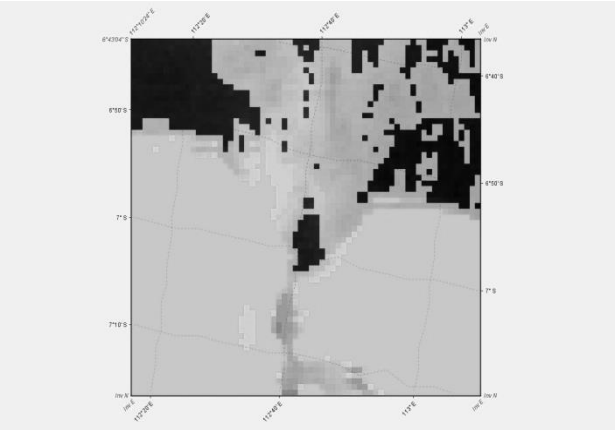

Figure 3.Sea surface temperature from January 2012

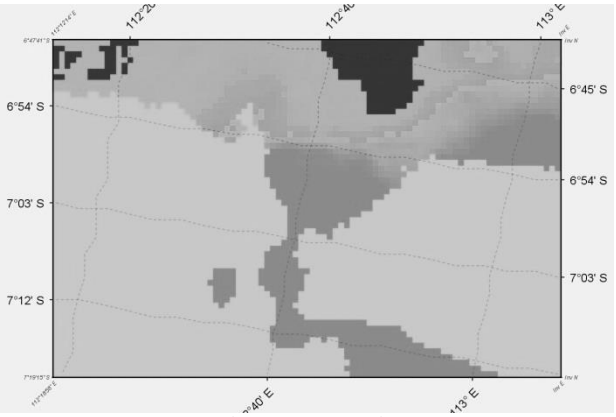

Figure 4. Sea surface temperature from January 2013

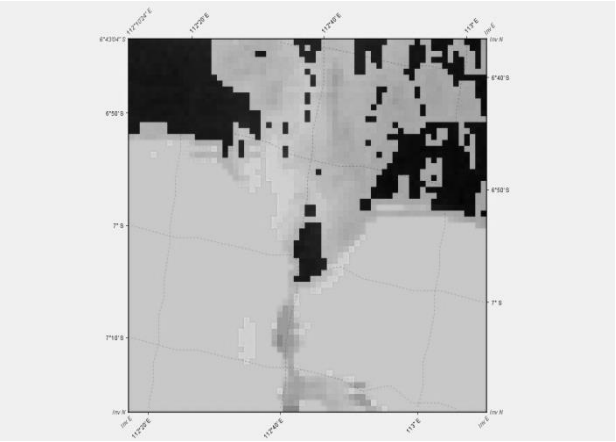

Figure 5. Sea surface temperature from January 2014

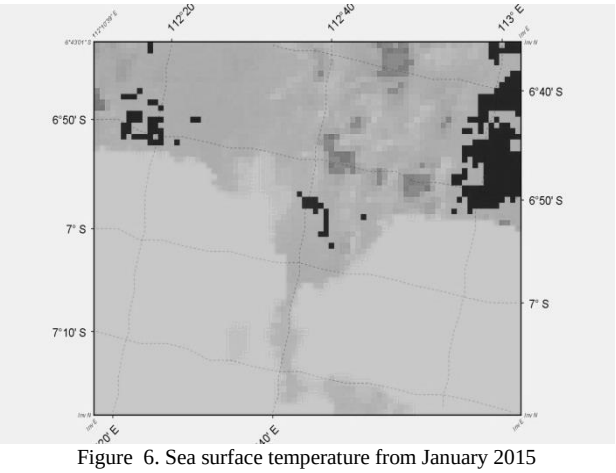

Figure 6. Sea surface temperature from January 2015

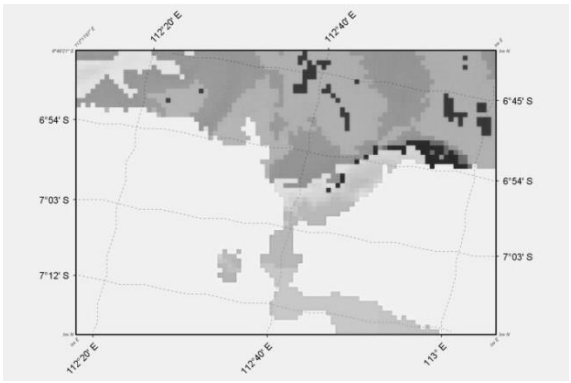

Figure 7. Sea surface temperature from January 2016

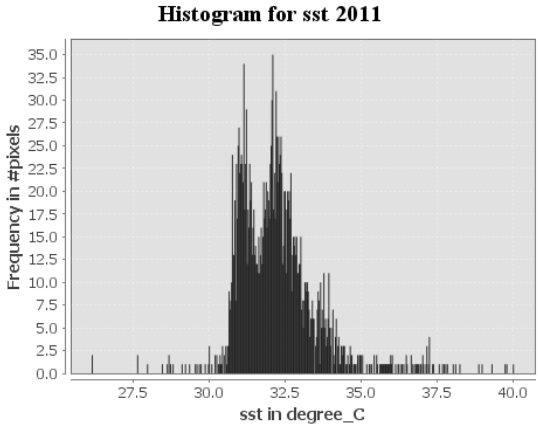

Figure 8. Histogram for Sea surface temperature at Januari 2011

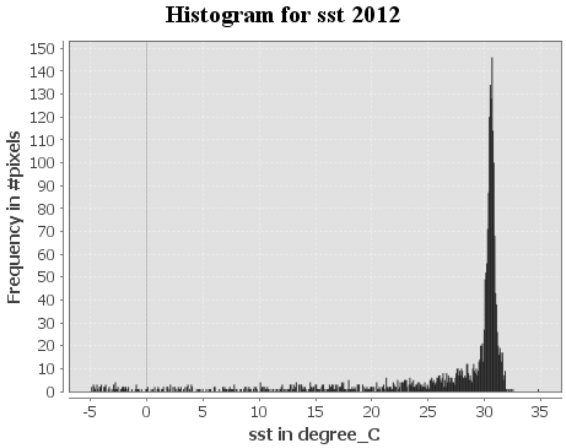

Figure 9. Histogram for sea surface temperature at Januari 2012

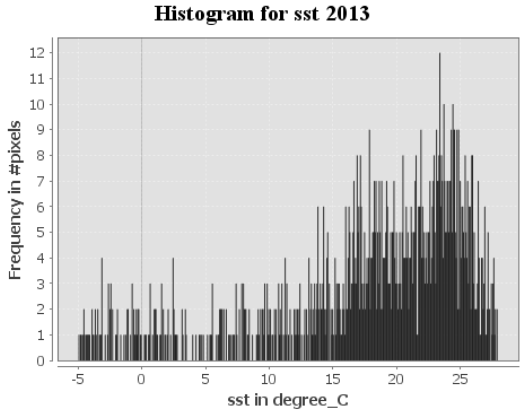

Figure 10. Histogram for sea surface temperature at Januari 2013

Data were obtained from 2011 to 2016 are not all available on any observation stations, especially at some point on the north coast of the island of Madura, it's can be seen in Table 1 that in 2012, 2013, 2014 and 2015 have some missing data. It can be predicted that the Modis satellite image at the time of the data recording process can not recognize the surface temperature of these waters..

To view the data histogram at SST channels on the Modis satellite image has shown in Figure 8 to Figure 13.For the histogram in 2011 (Figure 8) shows that the temperature are accumulated at 32,1^{o}C whereas in 2012 the average of temperature centered on 31,3^{o}C (Figure 9). Histogram for the year of 2013 (Figure 10) shows that the value just become anomaly where the peak value of the sea water temperature is almost evenly distributed to each value of x is given, the different results shown by histogram sea surface temperatures in 2014 (Figure 11), 2015 (Figure 12) and 2016 (Figure 13) where the value of the average of sea surface temperatures experienced centering respectively on 31,9^{o}C, 29,8^{0}C and on 32,3^{o}C.

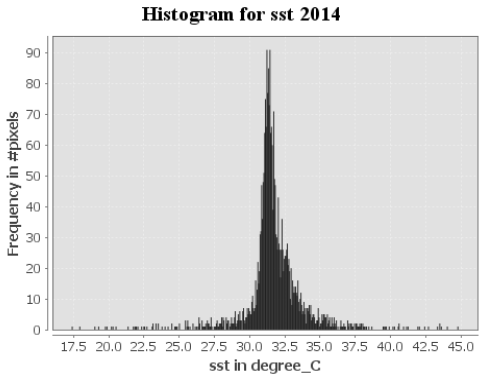

Figure 11. Histogram for sea surface temperature at Januari 2014

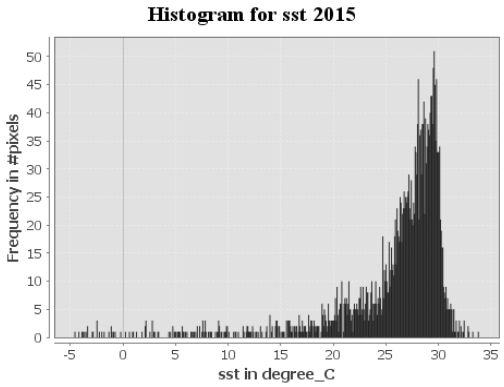

Figure 12. Histogram for sea surface temperature at January 2015

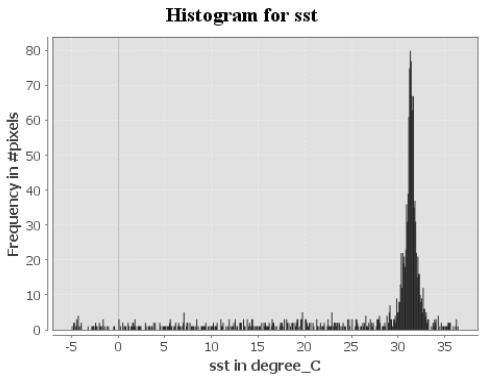

Figure 13. Histogram for sea surface temperature at Januari 2016

TABLE 1.
CORRELATION FOR SEA SURFACE TEMPERATURE FROM 2011 TO 2016

	sst2011	sst2012	sst2013	sst2014	sst2015	sst2016
sst2011	1					
sst2012	0,267	1				
sst2013	-0,019	-0,050	1			
sst2014	0,653	0,532	-0,242	1		
sst2015	0,625	0,701	0,195	0,762	1	
sst2016	-0,334	-0,181	-0,400	-0,259	-0,512	1

The Table 1 has shown that the correlation among the series of sea surface temperature have the different value, whereis the SST on 2015 has the strongest correlation with the year of 2014 and then 2012 and 2011. Many of them have the negative correlation.

IV. CONCLUSION

From the results that have been done, it can be said that the sea surface temperature has different variations from year to year, it is influenced by the geographic location and content of inorganic and organic materials that make up the body of water.

The highest sea surface temperature 31^{o}C in the region of the tip of Pangkah Gresik while the lowest temperatures are on the north coast of Madura with an average of 28^{o}C.

TABLE 2.
COMPARISON OF SEA SURFACE TEMPERATURE FROM 2011 TO 2016

Sta	sst 2011	sst 2012	sst 2013	sst 2014	sst 2015	sst 2016	Longitude	Latitude
1	32,29	28,41	28,09	32,29	30,01	31,35	112.495	-6.898
2	33,91	25,96	31,34	34,69	31,36	29,06	112.514	-6.904
3	37,25	21,68	29,51	35,14	31,53	27,81	112.540	-6.900
4	35,71	26,55	31,39	36,68	31,93	29,22	112.538	-6.882
5	35,43	22,15	29,72	34,51	30,57	30,59	112.530	-6.855
6	36,76	25,52	26,85	33,12	29,65	30,85	112.550	-6.844
7	35,82	29,74	23,49	36,53	32,23	28,78	112.561	-6.851
8	36,49	28,27	19,66	37,65	31,64	29,13	112.573	-6.868
9	35,52	27,01	20,40	37,45	31,26	32,03	112.585	-6.885
10	35,01	24,05	12,91	35,03	28,73	33,22	112.596	-6.901
11	36,03	25,24	30,35	35,63	30,65	32,88	112.616	-6.908
12	33,77	23,49	28,45	32,73	26,84	30,84	112.616	-6.927
13	32,32	16,50	23,21	32,03	25,67	31,56	112.617	-6.936
14	32,06	NaN	NaN	31,69	24,01	29,07	112.620	-6.954
15	32,19	NaN	NaN	31,79	22,61	26,84	112.648	-6.959
16	32,35	NaN	NaN	31,21	21,86	29,52	112.642	-6.978
17	32,41	NaN	NaN	31,41	16,95	29,07	112.661	-6.985
18	36,32	NaN	NaN	32,64	30,45	28,88	112.671	-7.012
19	34,73	NaN	NaN	31,05	28,75	26,73	112.673	-7.029
20	34,07	NaN	NaN	32,89	NaN	28,25	112.700	-7.025
21	36,88	NaN	NaN	36,49	NaN	26,62	112.711	-7.032
22	37,17	NaN	NaN	31,17	NaN	27,95	112.729	-7.030
23	33,58	NaN	16,73	32,09	NaN	26,37	112.735	-7.010
24	34,98	NaN	22,41	31,74	24,01	24,61	112.730	-6.992

Sta : station where the data was taken
Sst : sea surface temperature
NaN : no data available

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