Sand Shale Ratio as Holocene Sea Level Change Indicator on The Gresik Plain, East Java

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Abstract: ***Sea Level Change Phenomenon is interest to be researched. Since Geological Quantitative approach needs to be required to solve the facing problem. Sand Shale Ratio as Holocene Sea Level Change Indicator on The Gresik Plain, East Java as the topic of the thesis research, wish could be implemented in the future. Analytical data were obtained by : the shallow wells drilled on the surrounding area. Statistical probabilistic approach has been utilized to verify, whether there is a difference between fluviatile sediments product and marine environment on the adjacent research area. The interpretation result of the Super Impose Map, Isopach Map, and Sand Shale Ratio, was indicated that probably, there are two kind of different genetic associated with the process of sedimentation occurring in the North and The South Blocks of the research area. Lilliefors method has been tasted on the Sidayu Block resulting as a normal distribution where $L_0 = 0,2658$, $L(\alpha=0,05) = 0,271$. However, on the Bungah Block resulting opposite, where $L_0 = 0,824$, $L(\alpha=0,05) = 0,190$. The result of Mann Withney Test which given Zcalc > Ztab (6,5288 > 1,96). indicated that there is a difference in the process of sedimentation between in Sidayu and Bungah Blocks. And also both population are tend to be different, as well as in the North and South Blocks. Geologically, it could be interpreted that the population data on Sidayu Block has been controlled by the external factor during the sedimentation process. Probably, due to the involvement of tectonic activity.***

Keywords : Sand shale ratio, holocene, sea level changes, Gresik

1. Introduction

The Gresik plain is located in the eastern part of Java, East Java Province, Indonesia (Fig. 1)

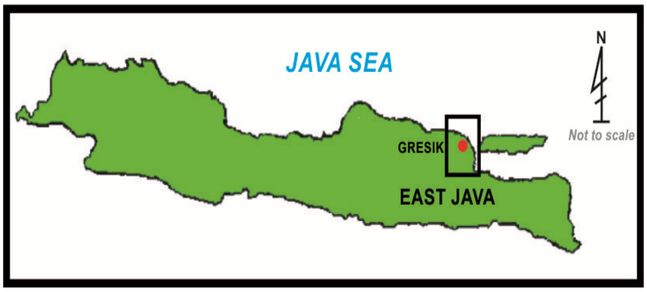

Figure 1: Index Location of Research Area

Physiographically, the research study is part of alluvium plain of northern Java [1]. In the southern part the area was boundary by Rembang-Madura Ridge. The Folding, faulting, uplifting, and erosion occurred in the Rembang – Madura Ridge since the Late Pliocene to Early Pleistocene [2]. In the Late Pleistocene age, a partly subsidence was occurred following by deposition of Pamengkasan Formation. on the transition environmental conditions between terrestrial and littoral. It is suspected that the uplifting in this area re-occurring Holocene [2]. Holocene sea level change could be recognized by a several of rock information recorded in the sequence of sedimentation. Based on the literature from the previous researcher, stated that sea level has been changed on the Gresik Plain in the Holocene age [3,4]. Sea level changes during the period of Holocene is reflected in the composition of lithological and faunal distribution [5]. The mechanism of the deposition process, especially on Fluvial facies is a good source of information for review. These events can be correlated to the mechanism of sea-level fluctuations follow a linear timescale of clastics facies [6,7, 8,9,10].

This aim study was emphasized the aspect on the sea level change utilized the sand shale ratio method which were obtained by drilled shallow wells.

- What is the difference between the Northern Block (Sidayu) and the Southern Block (Bungah) while the sedimentation being processed on Holocene age?
- How far the sea level change representing the sand shale ratio on the Gresik Plain, East Java?

The advantage of this research are:

- To reconstruct sea level change by approaching through the sand shale ratio method as a database.
- To give the geological knowledge as a characterized by the sea level change and how it could be implemented to reconstruct the sea level change on the Holocene age.
- To understand the Geodynamic of Holocene related to control the development process of sea level change behavior is a cycle event occurred and currently still being happened until today. Therefore, it is important to require the geodynamic knowledge as used for a database on the case of nature disaster and environment.

2. Methodology

The design of the research utilizes this method which generate a development of the theory by verification and validation of the empirical propositions such as deductive hypothesis. Several stages of the research will be conducted to obtain an accurate and integrated result among the research variables [11] Initially it should be designated in advance . (Fig. 2)

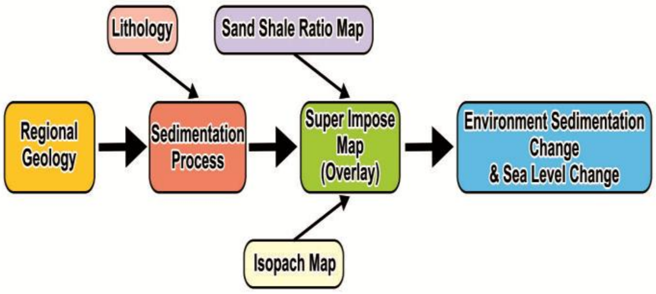

Figure 2: Fishbone Concept Research of Holocene Sea Level Change

The 40 of core from shallow wells have been taken by drilling along the Bengawan Solo River at site. To test the normality of the well data utilizes the Lilliefors and " U Mann Whitney " were used for comparative test [12,13]

3. Result & Discussion

The data have been analyzed and described using the fourty core samples of shallow wells and plotted them on to the Maps (Fig. 3).

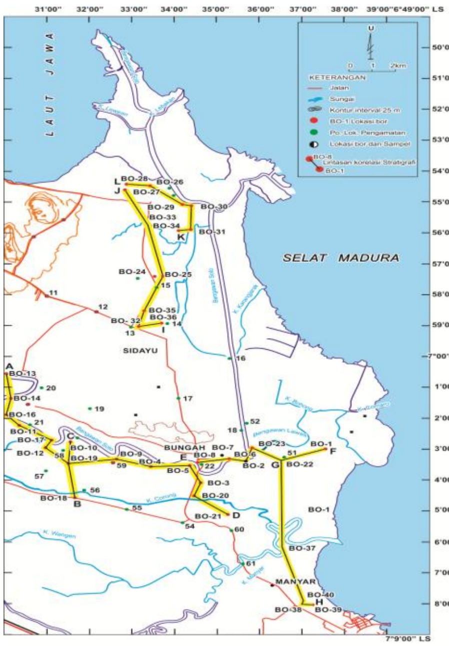

Figure 3: Location map of drilling wells, Gresik Plain, East Java

3.1 Shallow Drilling Wells

Total of fourty sample of cores have been described to calculate the total thickness of the sand of each well. Those were used to produce the Isopach Map. (Fig. 4) the result of total sand thickness can be seen on the table 1. Data of total sand thickness.

Table 1: Total Sand Thickness

Well	BO-1	BO-2	BO-3	BO-4	BO-5	BO-6	BO-7	BO-8
Thickness	3,85	4,00	0,80	0,90	5,00	4,90	0,30	2,80
Well	BO-9	BO-10	BO-11	BO-12	BO-13	BO-14	BO-15	BO-16
Thickness	3,60	8,90	3,65	1,90	4,20	-	2,35	4,40
Well	BO-17	BO-18	BO-19	BO-20	BO-21	BO-22	BO-23	BO-24
Thickness	3,55	4,30	3,90	8,70	2,20	6,90	7,20	-
Well	BO-25	BO-26	BO-27	BO-28	BO-29	BO-30	BO-31	BO-32
Thickness	0,80	2,80	2,70	-	0,80	1,20	9,10	0,70
Well	BO-33	BO-34	BO-35	BO-36	BO-37	BO-38	BO-39	BO-40
Thickness	0,20	-	-	1,00	2,30	0,40	1,60	4,90

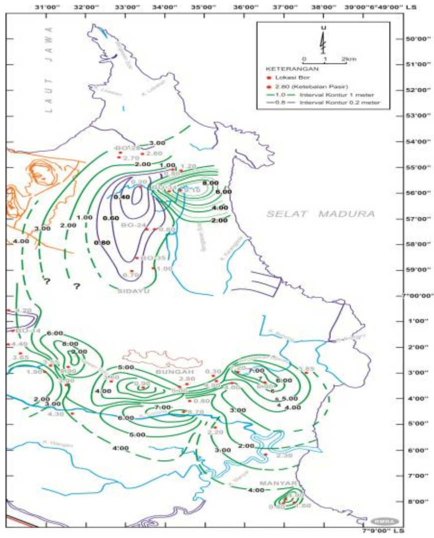

Figure 4: Isopach Map

3.2 Sand Shale Ratio

Sand Shale Ratio Map was generated based on the ratio of sand thickness versus shale of each wells. The result has been listed in table 2 Sand Shale Ratio Data. (Fig. 5)

Table 2: Sand Shale Ratio Data

Well	BO-1	BO-2	BO-3	BO-4	BO-5	BO-6	BO-7	BO-8
Ratio	0,56	1,00	1,36	0,13	1,43	1,04	0,33	0,63
Well	BO-9	BO-10	BO-11	BO-12	BO-13	BO-14	BO-15	BO-16
Ratio	0,67	8,21	2,14	0,33	0,82	-	3,13	0,83
Well	BO-17	BO-18	BO-19	BO-20	BO-21	BO-22	BO-23	BO-24
Ratio	0,76	0,76	0,59	1,67	0,17	1,96	12,00	-
Well	BO-25	BO-26	BO-27	BO-28	BO-29	BO-30	BO-31	BO-32
Ratio	0,50	0,93	3,86	-	0,44	0,72	2,50	0,13
Well	BO-33	BO-34	BO-35	BO-36	BO-37	BO-38	BO-39	BO-40
Ratio	0,17	-	-	0,62	1,33	0,0	1,00	6,1

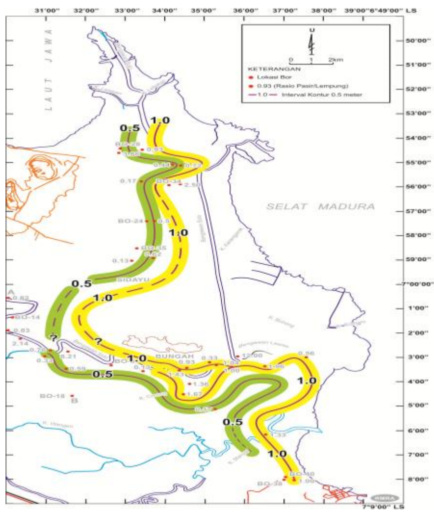

Figure 5: SSR Map on the Gresik Plain, East Java.

3.3 Superimpose Map

Superimpose Map was derived by combining the Isopach and SSR Maps consecutively (see Fig 6). The Super Impose Map shows that there are 2 Blocks can be separated, which are the Sidayu Block of the Northern part and the Bungah Block of the Southern part. Where indicated by the difference of environment sedimentation during the occurrence.

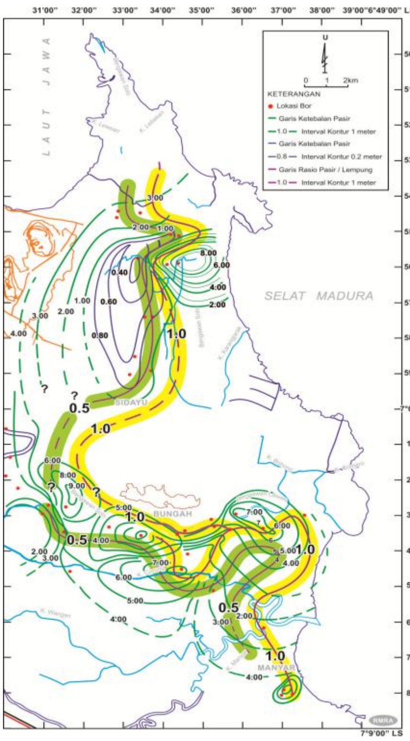

Figure 6: Superimpose Map of isopach map with sand sahe ratio map

3.4 Statistical Test

Based on statistical test of Lilliefors method to see the data distribution on two populations of Sidayu Block (North) and Bungah Block (South) it shows that there is different data population on both sides. (See table 3 and 4).

Table 3: Distribution Test on North Block (Sidayu)

No	x_i	xi-x	$(xi-x)^2$	zi	F(zi)	S(zi)	|F(zi)-S(zi)|
1	0.13	-2.06	4.23	-0.56	0.2877	0.1000	0.1877
2	0.17	-2.02	4.07	-0.55	0.2912	0.2000	0.0912
3	0.44	-1.75	3.05	-0.48	0.3156	0.3000	0.0156
4	0.50	-1.69	2.85	-0.46	0.3228	0.4000	0.0772
5	0.62	-1.57	2.46	-0.43	0.3336	0.5000	0.1664
6	0.72	-1.47	2.15	-0.40	0.3446	0.6000	0.2554
7	0.93	-1.25	1.57	-0.34	0.3669	0.7000	0.3331
8	2.50	0.31	0.09	0.08	0.5319	0.8000	0.2681
9	3.86	1.67	2.80	0.46	0.6772	0.9000	0.2228
10	12.00	9.81	96.30	2.69	0.9964	1.0000	0.0036

Average 2.19 Lo 0.3331
SD 3.64 L (a=0.05) 0.2580

Table 4: Distribution Test on North Block (Sidayu) - Anomaly Data Excluded

No	x_i	xi-x	$(xi-x)^2$	zi	F(zi)	S(zi)	|F(zi)-S(zi)|
1	0.13	-0.57	0.32	-0.79	0.2148	0.1111	0.1037
2	0.17	-0.53	0.28	-0.73	0.2327	0.2222	0.0105
3	0.27	-0.43	0.18	-0.59	0.2776	0.3333	0.0557
4	0.44	-0.26	0.07	-0.36	0.3594	0.4444	0.0850
5	0.50	-0.20	0.04	-0.27	0.3936	0.5556	0.1620
6	0.62	-0.08	0.01	-0.11	0.4562	0.6667	0.2105
7	0.72	0.02	0.00	0.03	0.5120	0.7778	0.2658
8	0.93	0.24	0.06	0.33	0.6293	0.8889	0.2596
9	2.50	1.80	3.23	2.49	0.9936	1.0000	0.0064

Blok Sidayu : L_0 0.2658
L (α=0.05) 0.271

L_0 < L at alpha 5%, therefore, the distribution of data is normal referring to the data distribution of Sand Shale Ratio which shows anomaly, therefore, to conduct comparison test of both Blocks (Sidayu and Bungah), the Mann Whitney U Test was used (See table 5)

Table 5: Mann - Whitney U Test

DATA		RANK	
SOUTH	NORTH	SOUTH	NORTH
0.56	12	6	10
1	0.5	13	4
1.36	0.93	16	7
0.13	3.86	2	9
1 .43	0.44	17	3
1.04	0.72	14	6
0.33	2.5	4.5	8
0.93	0.13	12	1
0.67	0.17	7	2
8.21	0.62	21	5
0.33		4.5	
0.82	2.187	10	5.5
3.13		20	
0.83		11	
0.76		8.5	
0.76		8.5	
1.67		18	
0.17		3	
1.96		19	
1.33		15	
0		1	
1.305714		11	

The result of calculation shows.
Where : Zcalculated : 6.5288
Ztable : 1.96

H_0 : there is no difference between the process in Sidayu (North) and Bungah (South) Blocks.

H_1 : There is a difference on the process between Sidayu (North) and Bungah (South) Blocks.

Due to Zcalculated is greater the Ztable
6.5288 > 1.96
Therefore, H_0 has been rejected
H_1 accepted

Geologically, it could be interpreted that Sidayu Block Bunga Block different depositional environment which has been influenced by the different process during the sedimentation. Sidayu Block more marine influence sedimentation than in Bungah Block

4. Conclusions

- Based on the data obtain from the Sidayu Block (North) and the Bungah (South) and the comparative test can be concluded that there is obviously different sand shale ratio in the Sidayu Block (North) and the Bungah Block (South).
- Probably, due to the different environment sedimentation process of the Sidayu Block (North) and the Bungah Block (South) on the Gresik plain, East Java, Indonesia.

5. Recommendation

According to the research which has been conducted, it is recommended:

- To elaborate the structural geology which controls the process of sedimentation on the Northern Block (Sidayu) and the Southern Block (Bungah).
- It is required to run the carbon isotope measurements for dating on the next well activity.

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