THE 4th INTERNATIONAL SEMINAR ON SCIENCES AND TECHNOLOGY (4th-ISST) 2022

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Nomor : 005/ISST-4/X/2022 October 3rd, 2022
Subject : **Acceptance letter for oral presentation**

Dear **Ahmad Zaenudin,**
Geophysical Engineering, University of Lampung, Bandar Lampung, Lampung, Indonesia

Congratulations!

We are pleased to inform that your paper:

Title	:	Relocated Seismicity in Bakauheni, Lampung and It's Implication with Local Fault Activity
Authors	:	Ahmad Zaenudin, Syamsurijal Rasimeng, Erlan Sumanjaya, Fajriyanto, and Adhi Wibowo
ID	:	ISST-4_045

is accepted to be orally presented in the ISST-4 that will be held on 2-3 November 2022. The presented and reviewed papers will be published in Scopus and SINTA indexed publication.

For more information, please contact us at email: isst4.untad@gmail.com

Kindly regards,

The 4th-ISST 2022 Committee

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Relocated Seismicity in Bakauheni, Lampung and Its Implication with Local Fault Activity

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Abstract. In the last decade, Bakauheni, Lampung has been shocked by sequences of small magnitude earthquakes which is probably resulted by complex faulting around Bakauheni region. To determine the source of the earthquake, we present hypocenter relocation using data from the Agency for Meteorology, Climatology and Geophysics (BMKG) station network of Indonesia for the period 2009-2022. The relocations were performed using double-difference method to improving the result. The results obtained amounted to five events where the depth of hypocenter ranges from 2-195 km. Earthquake with a depth less than 60 km are caused by local fault activity and the depth of more than 60 km are probably caused by slab subduction activity between Eurasian plate and Indo-Australian plate. Based on our result of relocation shows that there is two event: on 23 March 2020 located at 5.828243^0S and 105.686012^0E with a depth around 17.3 km, which is indicated to Peterjajar Fault. Wheras on 12 February 2020 located at 5.873412^0S and 105.753402^0E with depth 2 km, which is indicated to Fault behind Bakauheni Harbour. Based on this result, we suggested that Peterjajar fault and other local fault activities sourrounding Bahauheni are active fault which is resulted shallow crust earthquake and then it is becomes dangerous earthquakes for harbour infrastructure.

INTRODUCTION

The Bakauheni, Southern Lampung and its surroundings are located on the southern tip of Sumatra Island. This area is the center of attention of scientists from various branches of science because this area will be part of the construction site of the Sunda Strait Bridge which connects the mainland of Java and Sumatra. In addition, in this area, a national mega project known as Bakauheni Harbor City (BHC) will be built. Seeing the high vitality in this area, it is necessary to consider the potential vulnerabilities in the area such as from the threat of earthquakes. The vulnerability of this area to earthquake hazards is determined by various conditions such as the history of destructive earthquakes that have occurred, seismotectonic (regional) conditions, local geological conditions, including geological structures and physical properties of the constituent rocks.

As it is known that the Bakauheni area is located at a radius of < 400 km from the source column of the oblique subduction earthquake between the Indo-Australian plate and the Eurasian plate, which is located < 200 km from the Mentawai active fault and 100 km from the Sumatran active fault [1]. The three main sources of active fault earthquakes have resulted in the formation of local active faults in the Bakauheni area such as the peterjajar fault [2], waybaka fault [3] and several other potential faults. The existence of this active fault is evidenced by a series of small earthquakes in the last decade. To identify the source of the earthquake, we present hypocenter relocation using data

from the Agency for Meteorology, Climatology and Geophysics (BMKG) station network of Indonesia for the period 2009-2022. The relocations were performed using double-difference method to improving the result.

MATERIAL AND METHODS

The data used in this study is a catalog of the arrival times of the P and S waves that occurred in the period 2009 to 2022. These seismic data were recorded by the BMKG station network around Lampung, South Sumatra, Bengkulu, Banten, and Jakarta. The data is limited to researchers who collaborate with BMKG Kotabumi, Lampung and obtained officially from the relevant BMKG. The data obtained will be used for the relocation of the earthquake hypocenter using the double difference method through the *hypoDD software*.

The accuracy of determining the location of the hypocenter is influenced by several factors, including the arrangement of the seismometer network, the P and S wave phases, the accuracy of the wave arrival time reading, and knowledge of the structure of seismic wave velocities in the earth's crust [4]. Corrections to the seismic wave velocity structure can be effectively minimized by using the relative earthquake location method [5]. In this study, the relative earthquake relocation method was carried out using the double-difference algorithm from Waldhauser and Ellsworth (2000) [6]. This algorithm is implemented in the hypoDD package which can be accessed freely via the website *https://www.ldeo.columbia.edu/~felixw/hypoDD.html*.

This double-difference algorithm utilizes the hypocenter as well as the wave propagation path of two adjacent earthquakes. Two earthquakes that are close together will produce similarities in the wave propagation path [7]. The difference in propagation time of two adjacent earthquake events recorded in one observation station can be a character that represents the spatial distance of the hypocenter of the two earthquakes. Calculation of the difference in propagation time, otherwise known as double-difference. The double difference method is good for areas that have dense seismicity and the distance between seismic events is much smaller than the distance from the event to the earthquake recording station (several km or less than 1 km). The data needed in this study are the hypocenter, the time of the earthquake, the coordinates of the seismic station, the arrival time of the seismic waves at each station, and the seismic wave velocity model. This method has been successful in relocating earthquakes in Sumatra using BMKG network data with some active tectonic interpretation such as [8-10]

RESULTS AND DISCUSSION

The P wave velocity model is derived from the interpolation of the Crust 1.0 velocity model [11]. The selection of this speed model is because information about the speed model in our research area has not been obtained. The S wave velocity model was obtained using the ratios from the Wadati Diagram (Fig 1).

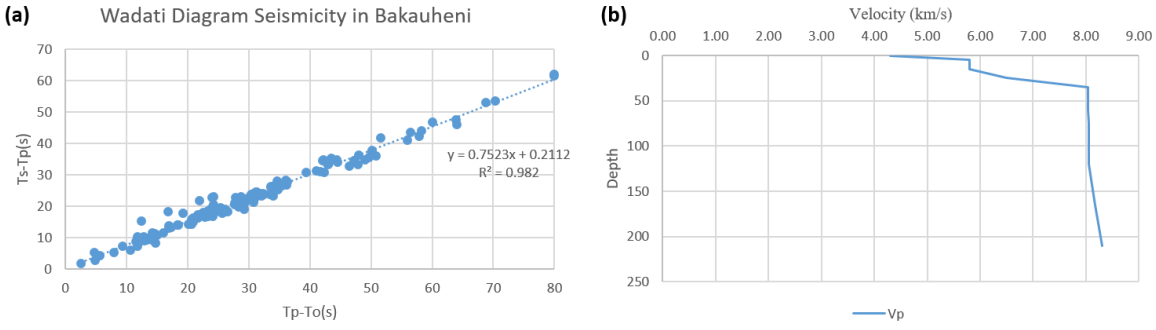

Figure 1. (a) Wadati Diagram (b) Crust 1.0 Velocity Model

The Wadati diagram shows the relationship between the arrival time of the P wave minus the origin time (T_p-T_o) with the arrival time of the S wave minus the arrival time of the P wave (Ts-Tp). The Wadati diagrams are good for

providing initial value estimates for the Vp/Vs ratio. The value of the Vp/Vs ratio obtained from the Wadati Diagram is 1.74 (Fig. 3). The results of the relocation can be said to be consistent if the difference in travel time between observations and calculations is close to zero. The histogram in Figure 4 shows the distribution of the difference between the observed and calculated travel times for the P and S phases of each pair of adjacent events (neighbors). It can be seen that after the relocation the amount of data with a difference in travel time approaching zero is increasing.

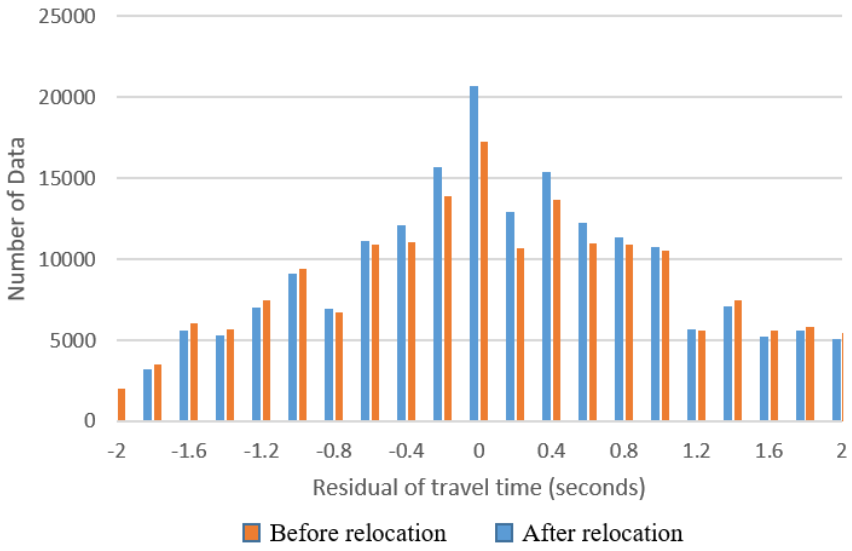

Figure 2. Histogram of the difference in travel time between observations and calculations of the P and S wave phases for each pair of earthquake events.

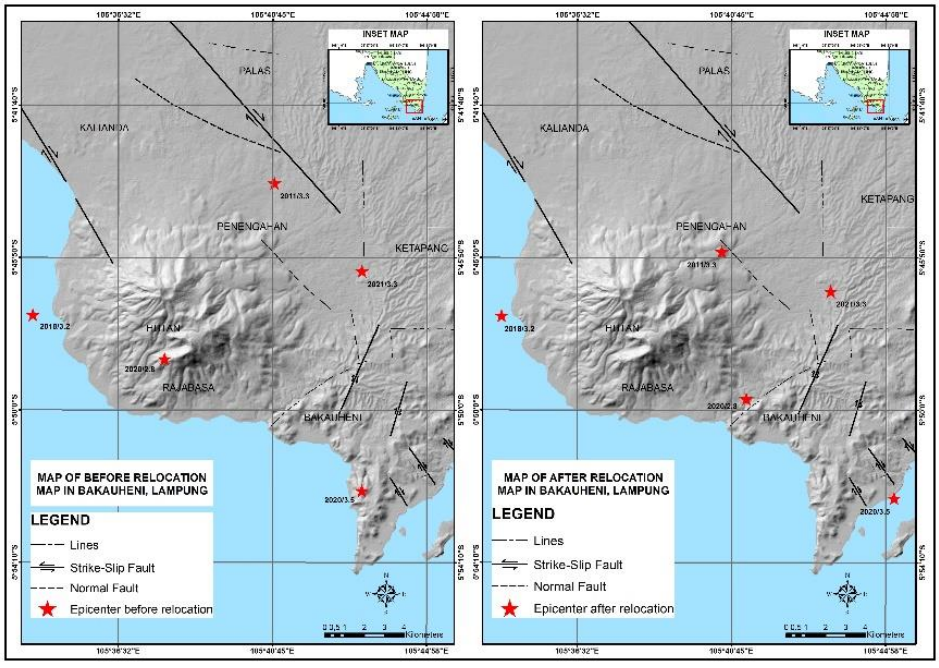

Figure 3. Distribution of epicenter before (left side) and after (right side) relocation in Bakauheni, Lampung.

We compare the relocated events with their initial locations where there were any five events in Fig. 3. Based on our result, we can see that there are two epicenters that are significantly changed. Before being relocated, the epicenter was located near the foot of Mount Rajabasa and after being relocated, the epicenter was close to the Peterjajar Fault or towards the east. The detail of two events, after relocated, are on 23 March 2020 located at 5.828243^{0}S and 105.686012^{0}E with a depth around 17.3 km, which is indicated to Peterjajar fault. Meanwhile, on 12 February 2020 located at 5.873412^{0}S and 105.753402^{0}E with the depth 2 km, which is indicated to local fault activity which is located behind Bakauheni Harbour. In addition, the direction of the hypocenter displacement vector can be observed in Fig. 4. The displacement is quite significant, it can be seen that there are two events which move eastward towards the peterjajar fault (in 2020 with magnitude 2.8) while the other moves eastward but approaches to the other local fault (in 2020 with magnitude 3.5). Based on this result, we suggested that Peterjajar fault and other local fault activities sourrounding Bahauheni are active faults which is resulted shallow crust earthquakes and then it is becomes dangerous earthquakes for harbour infrastructure.

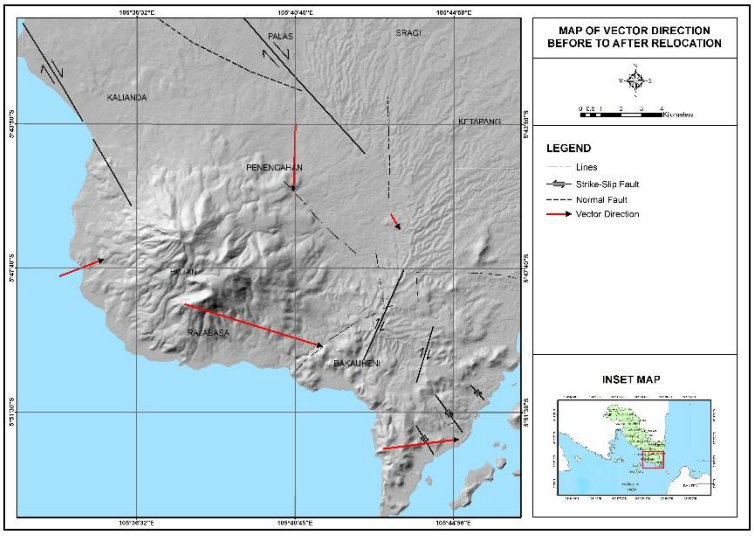

Figure 4. Displacement of vector position of the epicenter before and after relocation (arrows).

CONCLUSION

Based on our result of relocation shows that there is two event: on 23 March 2020 located at 5.828243^{0}S and 105.686012^{0}E with a depth around 17.3 km, which is indicated to Peterjajar Fault. Wheras on 12 February 2020 located at 5.873412^{0}S and 105.753402^{0}E with the depth 2 km, which is indicated to Fault behind Bakauheni Harbour. Based on this result, we suggested that Peterjajar fault and other local fault activities sourrounding Bahauheni are active fault which is resulted shallow crust earthquakes and then it is becomes dangerous earthquakes for harbour infrastructure.

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ISST-4 2022

THE 4TH INTERNATIONAL SEMINAR ON SCIENCE AND TECHNOLOGY (ISST-4 2022)

Innovative Research in Science and Technology for Sustainable Development

CERTIFICATE OF APPRECIATION

No. 6339/UN28.1.28/TU/2022

as Oral Presenter is awarded to

Erlan Sumanjaya

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Palu, 3 November 2022

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ISST-4 2022

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PAPER CERTIFICATE

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Prof. Ir. Darmawati Darwis, M.Si., Ph.D.
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