SPATIAL DISTRIBUTION OF THE EARTHQUAKE EPISENTRUM BASED ON GEOGRAPHIC INFORMATION SYSTEM (GIS) ON AMBON ISLAND

Mohammad Amin Lasaiba[1], Hajirun Arfa[2]
[1,2]Geography Education Study Program Department of Social Sciences
Faculty of Teacher Training and Education, Pattimura University Ambon
Email corresponding: amin.lasaiba@fkip.unpatti.ac.id

Submitted:	Accepted:	Published:
30-5-2022	2-6-2022	25-7-2022

Abstrak

Gempa bumi merupakan goncangan pada permukaan bumi yang dihasilkan dari gelombang seismik akibat pelepasan energi secara tiba-tiba dari dalam bumi. Seiring dengan penemuhan kebutuhan informasi mengenai bencana gempa bumi yang ada di Pulau Ambon untuk meningkatkan kinerja dalam mengatasi dan mengurangi resiko atau dampak yang terjadi akibat bencana itu sendiri. Maka pada penelitian ini memberikan sebuah informasi mengenai Sebaran Spasial Hiposentrum Gempa Bumi berbasis Sistem Informasi Geografis di Pulau Ambon dengan menggunakan metode penelitian kualitatif dan kuantitatif.]Gempa Ambon 26 September 2019 yang konsetrasi lokasinya berada di antara pulau Ambon dan Haruku memanjang ke utara di sebelah barat daya Kairatu, Pulau Seram. Lokasi pusat gempa merupakan wilayah yang aktif secara tektonik. Wilayah Pulau Seram dan sekitarnya berada dekat dengan patahan (faulth) Seram yang dapat membangkitkan gempa besar dengan tipe penyesaran naik (thrust). Gempa bumi dengan magnitudo berskala 3,0 SR sampai 4,0 SR sangat sering terjadi di Pulau Ambon, sedangkan gempa yang berskala 5,0 SR ke atas jarang terjadi dan hampir semua gempa tersebut masuk dalam kategori gempa dangkal (< 70 km) yaitu dengan kedalaman rata-rata 10 Km.
***Kata Kunci** : Gempa Bumi, Sistem Informasi Geografis, dan Spasial.*

Abstract

Earthquakes are shocks on the earth's surface that are generated by seismic waves due to the sudden release of energy from deep within the earth. Along with meeting the need for information about the earthquake disaster in Ambon Island to improve performance in overcoming and reducing the risks or impacts that occur due to the disaster itself. So this study provides information about the Spatial Hypocenter Distribution of Earthquakes based on Geographic Information Systems on Ambon Island using qualitative and quantitative research methods. The Ambon Earthquake of September 26, 2019, whose location is concentrated between the islands of Ambon and Haruku, extends north to the southwest of Kairatu, Seram Island. The location of the epicenter is a tectonic active area. The area of Seram Island and its surroundings is close to the Seram fault which can generate a large earthquake with a thrust type of fault. Earthquakes with a magnitude of 3.0 SR to 4.0 SR are very common on Ambon Island, while earthquakes of 5.0 SR and above are rare and almost all of these earthquakes fall into the category of shallow earthquakes (< 70 km), namely with an average depth of 10 Km.
***Keywords**: Earthquake, Geographic Information System, and Spatial*

INTRODUCTION

In recent years, natural disasters continue to occur throughout the world and are global phenomena that are a major concern in all countries in the world (Wand et al., 2015). According to *the* World Risk Index, six out of ten countries in the world with the highest consequences from disasters are Asia and the Pacific (Hiwasaki et al., 2014). areas with various tectonic activities (Ring of Fire) (Atmojo, 2020).

In addition, it is geographically located at the confluence of the world's tectonic plates (Prihatiningsih et al., 2017). Geologically it is located on three tectonic plates, namely Indo Australia, Eurasia, and the Pacific (Latupeirisa & Pujianto, 2020). The meeting between two tectonic plates whose positions overlap each other (https://tekno.tempo.com). With the convergence of plates causing the Risk Index, six out of ten countries in the world with the highest consequences from disasters are Asia and the Pacific (Hiwasaki et al., 2014). Approximately 75% of the world's population lives in areas affected by disasters and at least once a year by earthquakes, tropical cyclones, or intermediate droughts (Hualou, 2014). In the

first decade of the 21st century, more than 200 million people were affected by disasters and more than 70,000 people died every year due to natural disasters which represent 90% and 65% of all regions of the world, respectively (Hiwasaki et al., 2014). This phenomenon causes damage that continues to increase beyond expectations (Wand et al., 2015). Of the various kinds of potential disasters that exist, there is only one potential disaster that has a very large potential, namely an earthquake (Atmojo, 2020).

Earthquakes are a form of a natural disaster whose events are unpredictable and unpredictable (Jung & Han, 2022). During an earthquake, ground movements occur randomly, both horizontally and vertically, in all directions radiating from the epicenter. (Dixit, 2013). Some countries that are frequently affected by earthquakes are Japan, New Zealand, Indonesia, and several other countries that have experienced natural disasters (Prihatiningsih et al., 2017). According to the United States Geological Survey (USGS), about 80% of earthquakes that occur in the world, are spread along the Pacific Ring of Fire and have a long fracture zone stretching from Chile, Japan to Southeast Asia (https://www.kompasiana.com). This earthquake activity is influenced by the orogenic zone of the Pacific Circum (Rosselló et al., 2020).

Earthquakes are natural disasters that almost always cause casualties (Hadiman & Djamaludin., 2022). In addition, it causes a wide range of damage (Wand et al., 2015), causing considerable economic losses (Onuma et al., 2017). This also causes significant damage in various areas, especially in urban areas with dense populations and buildings (Kwon & Park, 2019), and results in the destruction of land area and the destruction of various buildings and infrastructure, (Hadiman & Djamaludin., 2022).

Indonesia is one of the countries that are very prone to earthquake disasters because of its position in an area with various tectonic activities for the formation of front and back basins, magmatic trajectories, patterns of geological structures, and sources of earthquakes in the form of collision areas and active faults (https: //geology.esdm.go.id). According to the 2010 Asia Pacific Disaster Report, Indonesia is at the highest position where disasters occur frequently (McClean, 2010). In addition, almost all regions in Indonesia have the potential for natural disasters to occur both on a small and large scale (https://geologi.esdm.go.id).

Based on records from the Geological Agency in Indonesia, in 2021, earthquake activity has occurred approximately 26 destructive and relatively high events in 20 years. This earthquake occurred for the first time in Morowali, Central Sulawesi Province, and the last time in Southwest Maluku. The number of victims who died as a result of this earthquake recorded as many as 119 people and 6,803 who suffered injuries. The earthquake occurred throughout Indonesia with the potential for damage in Eastern Indonesia, including the Maluku region (https://geologi.esdm. go. id).

Maluku province is geologically located in a complex tectonic zone, which is flanked by the Eurasian, Pacific, and Philippine plates, and in the northern part of Seram Island is the border of the subdivision zone of the Indo-Australian plate. This area is also affected by the subduction of the Banda Arc in the north, the movement of the Seram Sea in the south, the subduction of the Maluku Sea plate, and the Sula Sorong fault in the south. From this condition, it was reported that from January 2000 to February 2016, there had been more than 160 earthquake events recorded by the earthquake recording station (Yusuf & Santosa, 2016). In 2021 there were destructive earthquakes that occurred in Taluti Bay, Central Maluku Regency, and similarly at the Port of Tehoru Village, Central Maluku Regency with a flow depth of about 1 meter. This occurrence is caused by active faults, some originating from the subduction zone. (https://geologi.esdm.go.id).

Ambon Island is one of the islands in the Maluku Province with an intensive earthquake. According to BMKG data, the earthquake on Ambon Island was an earthquake with a strike-slip fault in the crustal earthquake (Sianipar et al., 2019). The impact of this earthquake has caused damage to various other built areas. Based on the Regional Disaster Management Agency (BPBD) in 2020, the total number of damaged houses reached 85 heavily damaged, 135 moderately damaged, and 221 lightly damaged. Meanwhile, damage to public and social facilities was 87 units (https://www.tribunnews.com).

RESEARCH METHODS

This type of research is a descriptive analysis by collecting various secondary data needed, both in the form of spatial data and non-spatial data, and then analyzing map overlaps (overlay) according to the objectives to be achieved and presented in tabular form. Furthermore, the primary data needed is the

existing land use data obtained from the results of an aground check of the existing earthquake epicenter. A descriptive method is a method of describing or showing a picture of the object being observed based on data or samples obtained without providing analysis and concluding as it is generally applicable (Sugiyono, 2013).

The research location is the Ambon Island area the determination of the sample in this study is based on the sampling area, namely the epicenter point of the Earthquake spread over Ambon Island. The materials in this research activity include the map of Ambon Island with a scale of 1:250,000; a Geological Map obtained from the Center for Geological Development Research 1983 1:250,000 scale; earthquake epicenter data for the last 3 months from BMKG.GPS (Global Positioning System Garmin etrex 10 Arc GIS 10.6

collection techniques in this study are (1) Observation. This technique is by conducting direct observations of the research location to monitor the impact of the earthquake at several coordinate points of the earthquake. and (2) Documentary. Documentary techniques are used to obtain data from related agencies as well as pictures or documentation in the field. In addition, the seismic data for the Ambon island region is within the range of September 26 – November 26, 2019, with a magnitude, of > 3 Richter scales (the earthquake was felt) sourced from the Meteorology, Climatology and Geophysics Agency (BMKG).

The analytical methods were studied qualitatively and quantitatively. data were analyzed by deduction-induction, while quantitative data were analyzed using frequency tables, both obtained from the results of Geographic Information System (GIS) data processing

RESULTS AND DISCUSSION

The data used in this study are map data of research locations, geological maps,data on the distribution of the Epsentrum of Earthquakes, and data retrieval from the field in the form of coordinate points. The map of the research location was obtained from DUKCAPIL Maluku in December 2019, geological map data was obtained from the Regional Geological Map of the Research Center for geological development with a scale of 1:250,000 in 1983, and data on the distribution of the Earthquake Epicenter was obtained through Website the Meteorology, Climatology and Geophysics Agency (BMKG) Online Data (data online.bmkg.go.id).

1. Data Input Process

Input is an activity of entering earthquake coordinate data which can then be analyzed spatially. Before the earthquake coordinate data is input in the ArcGIS application, classification or division is carried out based on the Magnitude/Lichter Scale (SR), namely Magnitude 3.0 – 3.9 SR, Magnitude 4.0 – 4.9 SR, and Magnitude > 5.0 SR. The menu used to input Earthquake coordinate data uses the catalog as shown in Figure 1.

In the data Table 1 shows data on the point of occurrence of the Earthquake that occurred on Ambon Island in the time range from September 26 - November 26 2019 with a magnitude > 3.0 SR totaling as many as 140 earthquake occurrence points, consisting of 120 earthquake occurrence points with a magnitude of 3.0 - 3.9 SR, 18 earthquake occurrence points with a magnitude of 4.0 - 4.9 SR and 2 points of earthquake occurrence with a magnitude > 5.0 SR.

.

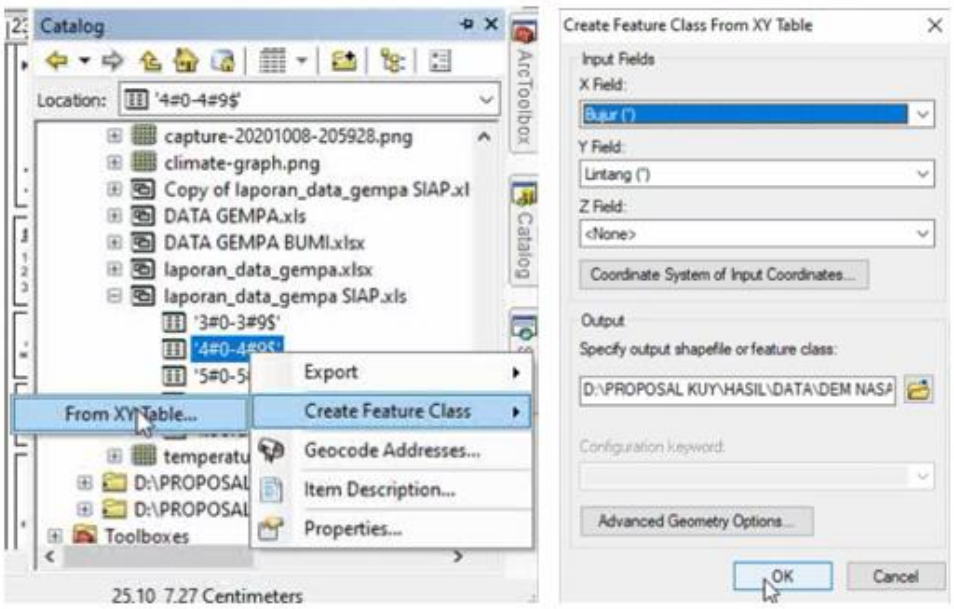

Figure 1. Menu Input Earthquake coordinate data

Table 1. Data Table for Earthquake Magnitude 3.0 – 3.9 SR on Ambon Island

No	Date (GMT)	Latitude (^{0})	Longitude (^{0})	Depth (Km)	Magnitude (SR)
1	2019-09-26 21:32:41	-3,53	128,35208	10	3,48
2	2019-09-26 20:19:41	-3,58	128,38425	10	3,44
3	2019-09-26 18:46:34	-3,65	128,37227	10	3,24
4	2019-09-26 14:44:04	-3,51	128,35895	10	3,05
5	2019-09-26 14:32:05	-3,62	128,36761	10	3,51
6	2019-09-26 11:42:46	-3,49	128,37801	10	3,6
7	2019-09-26 10:25:00	-3,56	128,34944	10	3,61
8	2019-09-26 09:15:34	-3,56	128,27122	15	3,62
9	2019-09-26 05:28:41	-3,61	128,326	10	3,98
10	2019-09-26 04:35:11	-3,49	128,34148	10	3,54
11	2019-09-26 04:16:14	-3,52	128,3732	10	3,35
12	2019-09-26 04:11:52	-3,58	128,34792	10	3,14
13	2019-09-26 03:27:10	-3,55	128,37375	10	3,51
14	2019-09-26 03:17:36	-3,54	128,3689	10	3,57
15	2019-09-26 02:20:11	-3,61	128,37939	10	3,81
16	2019-09-26 01:32:23	-3,61	128,34804	10	3,92
17	2019-09-26 01:31:35	-3,6	128,33076	10	3,69
18	2019-09-26 01:27:39	-3,48	128,34229	10	3,63
19	2019-09-26 01:20:25	-3,53	128,3709	10	3,39
20	2019-09-26 01:18:27	-3,56	128,32767	10	3,79
21	2019-09-26 01:15:56	-3,59	128,34918	10	3,31
22	2019-09-26 01:13:08	-3,62	128,34843	10	3,93
23	2019-09-26 01:11:19	-3,61	128,35968	10	3,76
24	2019-09-26 01:04:18	-3,5	128,36696	10	3,64
25	2019-09-26 01:02:36	-3,57	128,3726	15,9	3,82
26	2019-09-26 01:02:06	-3,59	128,31528	10	3,59
27	2019-09-26 01:01:00	-3,64	128,36768	10	3,75
28	2019-09-26 00:56:43	-3,49	128,37773	10	3,23
29	2019-09-26 00:52:19	-3,47	128,37972	10	3,72
30	2019-09-26 00:48:53	-3,58	128,32986	10	3,72
31	2019-09-26 00:28:46	-3,53	128,35085	10	3,96
32	2019-09-26 00:11:33	-3,6	128,36972	10	3,96
33	2019-09-26 00:04:44	-3,58	128,33914	10	3,97
34	2019-09-26 00:00:08	-3,49	128,29402	10	3,92
35	2019-09-27 20:32:32	-3,67	128,37845	10	3,38
36	2019-09-27 18:37:19	-3,65	128,33406	10	3,81
37	2019-09-27 18:17:31	-3,59	128,34097	13,2	3,71
38	2019-09-27 14:44:50	-3,55	128,28397	24	3,35
39	2019-09-27 14:29:59	-3,5	128,07811	10	3,4
40	2019-09-27 07:34:47	-3,56	128,3372	10	3
41	2019-09-27 06:30:06	-3,59	128,35713	10	3,04

No	Date (GMT)	Latitude (^{0})	Longitude (^{0})	Depth (Km)	Magnitude (SR)
42	2019-09-27 02:13:07	-3,67	128,37833	10	3,47
43	2019-09-28 19:35:10	-3,56	128,38406	10	3,49
44	2019-09-28 18:01:20	-3,6	128,34526	10	3,54
45	2019-09-28 01:48:33	-3,6	128,36794	10	3,79
46	2019-09-29 18:58:26	-3,62	128,3419	10	3,71
47	2019-09-29 09:03:41	-3,6	128,38147	10	3,02
48	2019-09-29 02:41:39	-3,65	128,34436	16	3,02
49	2019-09-29 02:14:12	-3,6	128,35562	11,1	3,25
50	2019-09-30 18:04:09	-3,46	128,36125	10	3,12
51	2019-09-30 06:25:55	-3,59	128,34827	10	3,02
52	2019-09-30 00:43:05	-3,62	128,37895	10	3,41
53	2019-10-01 19:11:26	-3,61	128,36919	10	3,09
54	2019-10-01 15:18:11	-3,45	128,33144	10	3,4
55	2019-10-01 05:48:41	-3,63	128,36607	10	3,16
56	2019-10-02 17:45:50	-3,61	128,33875	10	3,09
57	2019-10-02 11:58:15	-3,6	128,36	10	3,53
58	2019-10-02 10:23:03	-3,58	128,34712	10	3,09
59	2019-10-02 02:34:25	-3,57	128,37259	10	3,1
60	2019-10-03 22:18:48	-3,6	128,36377	10	3,68
61	2019-10-03 09:53:35	-3,62	128,3848	10	3,46

Continued Table 1. Data for Earthquake Magnitude 3.0 – 3.9 SR on Ambon Island

No	Date (GMT)	Latitude (^{0})	Longitude (^{0})	Depth (Km)	Magnitude (SR)
62	2019-10-04 08:49:38	-3,55	128,30901	10	3,22
63	2019-10-05 19:23:03	-3,57	128,36479	10	3,58
64	2019-10-06 19:15:44	-3,58	128,27435	10	3,42
65	2019-10-06 15:50:57	-3,68	128,1888	10	3,26
66	2019-10-07 06:50:37	-3,6	128,36105	10	3,1
67	2019-10-08 22:50:34	-3,53	128,36037	10	3,3
68	2019-10-09 21:47:51	-3,69	128,18385	10	3,45
69	2019-10-09 10:54:28	-3,62	128,37207	10	3,4
70	2019-10-09 01:29:06	-3,66	128,38017	10	3,79
71	2019-10-10 06:02:38	-3,61	128,25754	10	3,4
72	2019-10-10 05:27:18	-3,57	128,2413	10	3,87
73	2019-10-10 05:26:46	-3,54	128,15665	10	3,46
74	2019-10-10 05:00:58	-3,56	128,25981	10	3,14
75	2019-10-10 04:58:27	-3,58	128,25356	10	3,23
76	2019-10-10 04:53:11	-3,56	128,26802	10	3,23
77	2019-10-10 04:50:34	-3,58	128,25635	10	3,7
78	2019-10-10 04:49:38	-3,58	128,27907	10	3,55
79	2019-10-11 15:36:41	-3,63	128,25539	10	3,7
80	2019-10-11 00:32:50	-3,61	128,26262	10	3,46
81	2019-10-12 21:35:55	-3,45	128,34442	10	3,95
82	2019-10-12 08:55:20	-3,6	128,37421	10,8	3,07
83	2019-10-13 18:45:47	-3,58	128,32722	10	3,73
84	2019-10-14 21:07:21	-3,59	128,31941	10	3,31
85	2019-10-14 19:17:19	-3,62	128,36832	10	3,18
86	2019-10-14 17:06:06	-3,59	128,35323	10	3,13
87	2019-10-14 14:48:45	-3,6	128,2458	11,4	3,09
88	2019-10-15 20:57:17	-3,6	128,27139	10	3,41
89	2019-10-17 08:24:30	-3,6	128,34637	10	3,23
90	2019-10-19 06:02:37	-3,56	128,28349	10,7	3,05
91	2019-10-19 05:32:59	-3,46	128,37802	10	3,51
92	2019-10-22 19:50:03	-3,57	128,22653	10	3,15
93	2019-10-22 06:45:24	-3,59	128,24004	10	3,28
94	2019-10-23 20:40:54	-3,59	128,36726	10	3,41
95	2019-10-23 02:56:48	-3,56	128,2309	10	3,1
96	2019-10-24 20:41:39	-3,5	128,1947	31,8	3,13
97	2019-10-26 19:02:57	-3,61	128,36925	10	3,56
98	2019-10-27 07:23:28	-3,56	128,37138	10	3,1
99	2019-11-04 20:17:40	-3,6	128,36519	10	3,29
100	2019-11-09 15:39:45	-3,62	128,35339	10	3,66
101	2019-11-12 19:55:55	-3,61	128,29895	10	3,03
102	2019-11-12 14:36:12	-3,55	128,28845	10	3,37
103	2019-11-12 11:01:43	-3,6	128,28972	10	3,44
104	2019-11-12 10:52:12	-3,58	128,28976	10	3
105	2019-11-12 10:18:46	-3,57	128,27484	10	3,29
106	2019-11-13 17:18:37	-3,57	128,26389	10	3,34

107	2019-11-13 11:33:09	-3,56	128,22987	12,7	3,21
108	2019-11-13 07:56:08	-3,53	128,18323	10	3,2
No	Date (GMT)	**Latitude (^{0})**	Longitude (^{0})	Depth **(Km)**	**Magnitude (SR)**
109	2019-11-13 05:11:53	-3,66	128,36487	12,5	3,15
110	2019-11-13 01:35:40	-3,55	128,22845	10	3,2
111	2019-11-14 23:56:52	-3,55	128,28838	10	3,01
112	2019-11-14 09:59:19	-3,64	128,37813	10	3,64
113	2019-11-14 09:26:25	-3,6	128,36734	10	3,19
114	2019-11-15 22:42:40	-3,57	128,32368	10	3,24
115	2019-11-15 22:35:14	-3,63	128,313	10	3,96
116	2019-11-15 22:30:10	-3,58	128,2533	10	3,66
117	2019-11-15 06:28:54	-3,55	128,27745	10	3,18
118	2019-11-17 06:27:46	-3,57	128,3441	10	3,02
119	2019-11-19 11:17:21	-3,55	128,28593	10	3,03
120	2019-11-20 21:43:27	-3,65	128,32397	10	3,58

Table 2. Data for Earthquake Magnitude 4.0 – 4.9 SR on Ambon Island

No	Date (GMT)	Latitude (^{0})	Longitude (^{0})	Depth (Km)	Magnitude (SR)
1	2019-09-26 19:02:18	-3.49	128.29979	10	4.04
2	2019-09-26 15:58:23	-3.49	128.35152	10	4.33
3	2019-09-26 15:50:24	-3.63	128.33754	10	4.11
4	2019-09-26 11:33:15	-3, 55	128.30267	10	4.25
5	2019-09-26 08:59:45	-3.55	128.35625	10	4.03
6	2019-09-26 00:23:29	-3.56	128.36382	10	4 ,23
7	2019-09-26 00:03:55	-3.61	128.32358	10	4.33
8	2019-09-27 20:40:57	-3.59	128.37903	10	4.41
9	2019-09 -27 0:40:56	-3.6	128,38013	10	4.12
10	2019-09-27 17:26:26	-3.59	128,26628	10	4.09
11	2019-09-27 11:28:27	-3.58	128.32622	10	4.13
12	2019-09-27 09:09:25	-3.66	128.25269	10	4.03
13	2019-10-10 07:59:06	-3.53	128 ,16847	10	4.06
14	2019-10-10 04:42:26	-3.62	128.17583	10	4.65
15	2019-10-18 19:44:25	-3.61	128.25333	10	4.18
16	2019-10-18 11:36:23	-3.6	128.35277	10	4.14
17	2019-11-14 09:15:21	-3.63	128.375	10	4.62
18	2019-11-15 21: 2:01	-3,54	128,30685	10	4.8

Table 3. Data for Earthquake Magnitude > 5.0 SR on Ambon Island

No	Date (GMT)	Latitude (^{0})	Longitude (^{0})	Deep man (Km)	Magnitude (SR)
1	2019-10-10 04.39.44	-3.57	128.2606	10	5.17
2	2019-11-12 10.10.41	-3.56	128.35155	10	5.1

2. Earthquake Epicenter Classification

The classification process is carried out to identify and classify the depth level of each Earthquake Epicenter with a depth classification of 10.0 – 11.9 Km with 132 points of the earthquake epicenter, 12.0 – 13.9 Km with 3 points of the earthquake epicenter, 14.0 – 16.9 Km with 3 points of earthquake epicenter and a depth of > 17 Km as many as 2 epicenter points of the earthquake. The menu used to classify Earthquake depth points is using the *symbology* *tab* screen *properties* as shown in Figure 2. A map of the Spatial Distribution of the Earthquake Epicenter on Ambon Island can be seen in Figure 3.

When seen in Figure 3 the earthquakes that occurred on Ambon Island during the period 26 September – to 26 November 2019 were included in the shallow earthquake category (< 70 Km). Earthquakes that occurred on Ambon Island were dominated by earthquakes with a magnitude of 3.0 – 3.9 SR, while earthquakes

with a scale of > 5.0 SR were very rare. On Ambon Island, based on the earthquake distribution map above during the period from September 26 to November 26, 2020, the area that experienced the most earthquakes occurred in the Salahutu District. In Figure 3, it can be seen that Ambon Island was dominated by earthquakes with a depth of 10.0 – 11.9 Km which is indicated by the red symbol, while the green circle is an earthquake point with a depth of > 17 Km

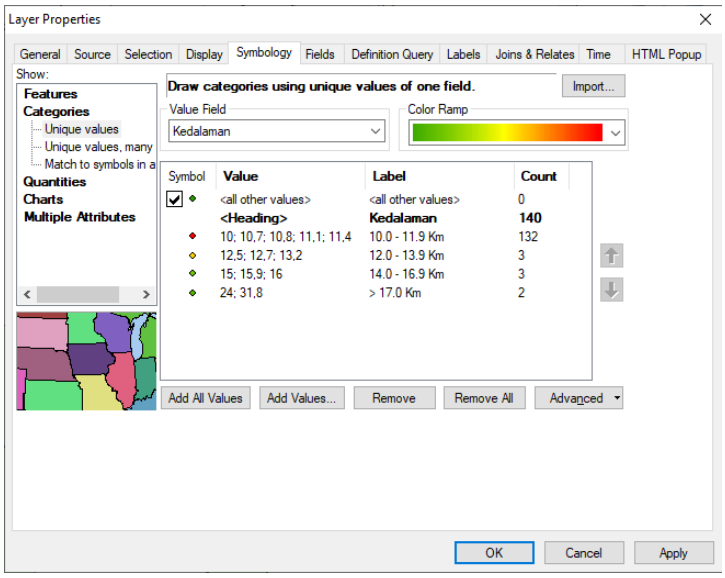

Figure 2. Menu Tab Symbology

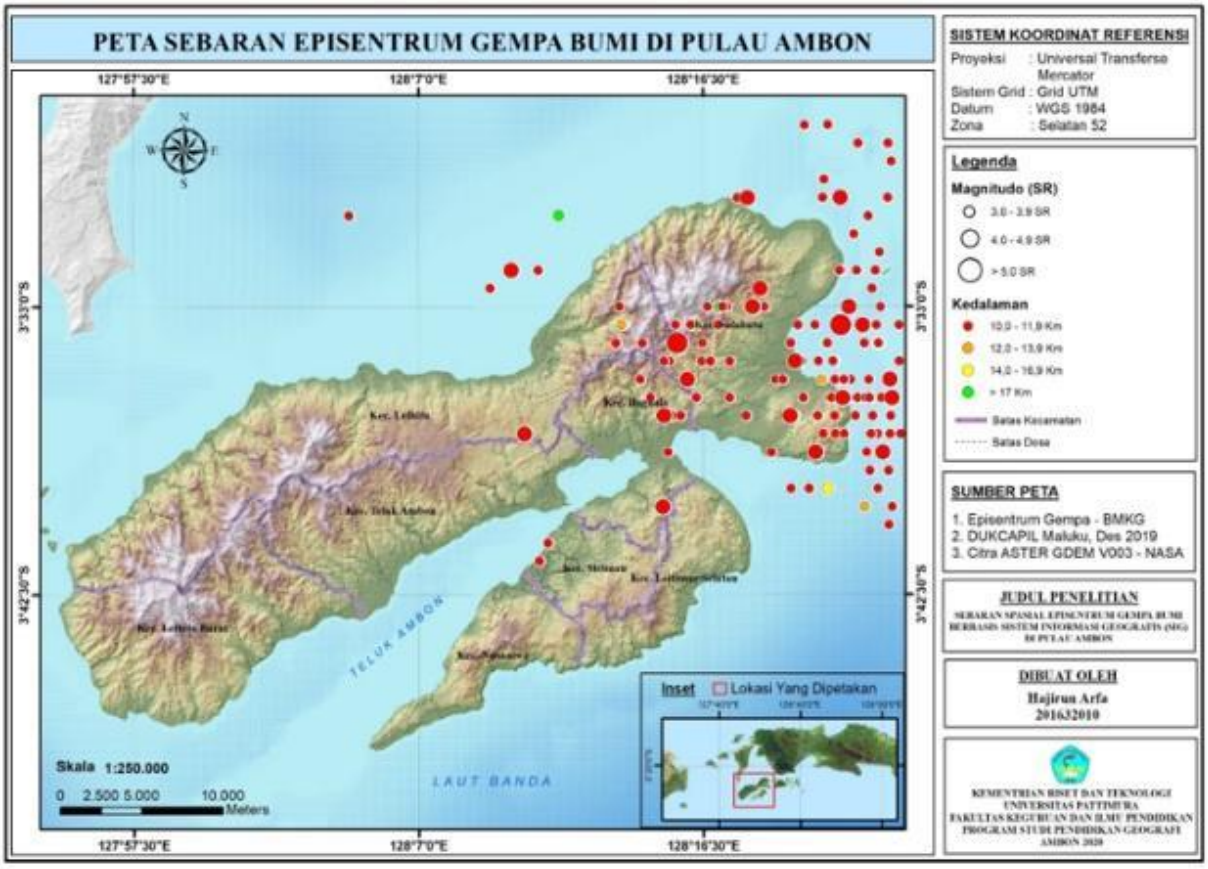

Figure 3. Map of Earthquake Epicenter Distribution on Ambon Island

Thus the earthquake that occurred on Ambon Island was a Shallow Earthquake with a depth of < 60 Km. Ambon Island can be said to be an area with a high level of risk of an earthquake (BNPB 2017).

From the results of mapping the distribution of the earthquake epicenter on Ambon Island in Figure 4, it can be observed that the distribution of the Earthquake Epicenter dominates the area between Ambon and Haruku islands extending north to the southwest of Kairatu, Seram Island following the pattern of aftershocks trending south-north.

The location of the epicenter is a tectonic active area. The area of Seram Island and its surroundings is close to the Seram fault *which* can generate a large earthquake with a thrust type of fault.

Here are some pictures of the location of the sampling point or GCP *(Ground Control Point)* in the research area as a result of the Earthquake for the period 26 September – to 26 November 2019:

No	Location	Damage Due to Earthquake	Date of Incident (GMT)	Depth (Km)	Magnitude (SR)
1	Liang Village, Kec. Salahutu X 425903.39 Y 9608472.03		2019-09-26 2019-10-10	10 10	6,8 5,17
4	Passo Village, Kec. Baguala X 417301.20 Y 9599822.98		2019-09-26 2019-10-10	10 10	6,8 5.17
5	Wai Village, Kec. Salahuu X 424665,17 Y 9604887.91		2019-09-26	10	6.8

Figure 4. Location of the Earthquake

The impact of the earthquake on September 26, 2019, followed by hundreds of aftershocks was felt not only on Ambon Island but also in the surrounding area Ambon Island is like in several areas in West Seram Regency, and several areas in Central Maluku Regency which are located not far from Ambon Island such as Haruku Island and Saparua Island. For the Ambon Island area, the area that was significantly affected by the earthquake from September 26 to November 26 is Salahutu sub-district, Central Maluku district.

Based on the results of a survey conducted by an earthquake that caused damage to people's houses, the average earthquake that occurred on 26/09/2019 with a magnitude of 6.8 on the Richter Scale and 10/10/2019 with a strength of 5.17 on the Richter Scale, in buildings where Living with an open brick structure is more severely damaged than buildings with a closed brick structure or reinforced with rigid diaphragms. Buildings with hairline cracks have a lower level of damage than residential buildings with open cracks.

Apart from damage to buildings as a result of the earthquake, there were several other impacts that occurred such as *landslides*, soil cracks, and mudflow or soil liquefaction that occurred in several areas in Salahutu District, Maluku Tengah Regency.

CONCLUSION

The earthquake that occurred on Ambon Island on September 26, 2019, whose location concentration was between the islands of Ambon and Haruku extended north to the southwest of Kairatu, Seram Island. The location of the epicenter is a tectonic active area. The area of Seram Island and its surroundings is close to the Seram fault *which* can generate a large earthquake with a thrust type of fault.

Based on the map of the distribution of the epicenter of the earthquake on Ambon Island from September 26 to November 26, 2019, illustrates that, the earthquake with a magnitude > 3.0 SR with a total of 140 epicenter points, mostly in Salahutu District, Central Maluku Regency and some in Lehitu District. and Ambon City. Earthquakes with a magnitude of 3.0 SR to 4.0 SR occur very often on Ambon Island, while earthquakes with a scale of 5.0 SR and above are rare and the earthquake that occurs on Ambon Island is included in the category of shallow earthquakes (< 60 km).

ACKNOWLEDGMENT

We thank the Geography Education Study Program, Faculty of Teacher Training and Education, Pattimura University, Ambon, which has funded this research. We also thank all those who have helped in collecting research data.

REFERENCE LIST

Atmojo, ME (2020). Disaster Mitigation Early Education. *Journal of Abdimas BSI: Journal of Community Service*, *3*(2), 118–126. https://doi.org/10.31294/jabdimas.v3i2.6475

Hadiman, R., Analysis, SD-ED, & 2022, undefined. (2022). Impact of Earthquake on Human Capital Formation. *Journal.Unnes.Ac.Id*, *1*. https://journal.unnes.ac.id/sju/index.php/edaj/article/view/46415

Hiwasaki, L., Luna, E., Syamsidik, & Shaw, R. (2014). Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. *International Journal of Disaster Risk Reduction*, *10*, 15–27. https://doi.org/10.1016/j.ijdrr.2014.07.007

Hualou, L. (2014). *Disaster Prevention and Management : A Geographical Perspective From the Ed tor's Desk Disaster Prevention and Management : A Geo raphical Perspective*. *January 2011*, 6–9.

McClean. D. (2010). *IFRC-WDR2010-full*.

Jung, H., & Han, S. (2022). *Development and Validation of Earthquake Fire Response Simulation Protocol for Korean College Students in Health Programs*.

Kwon, HR, & Park, SH (2019). Psychological Factors as Predictors of Posttraumatic Stress and Depressive Symptoms Among Survivors of the Gyeongbuk Area Earthquake. *Korean Journal of Clinical Psychology*, *38*(2), 127–144. https://doi.org/10.15842/kjcp.2019.38.2.001

Latupeirisa, VPS, & Pujianto. (2020). Level of earthquake disaster preparedness and its integrity in natural science learning: A literature review. *Journal of Physics: Conference Series*, *1440*(1). https://doi.org/10.1088/1742-6596/1440/1/012093

Dexit. (2013). *5.0 Earthquake Resistant Design of Structures*. *May*, 1–23. https://doi.org/10.13140/RG.2.1.4787.

1767

Onuma, H., Shin, KJ, & Managi, S. (2017). Reduction of future disaster damages by learning from disaster experiences. *Natural Hazards*, *87*(3), 1435–1452. https://doi.org/10.1007/s11069-017-2825-3

Prihatiningsih, TS, Widyandana, Hapsari, ED, Helmiyati, S., & Ananda, AJN (2017). A lesson learned: Implementation of interprofessional education in disaster management at the Faculty of Medicine, Gadjah Mada University, Indonesia. *Journal of Interprofessional Education and Practice*, *9*, 121–125. https://doi.org/10.1016/j.xjep.2017.10.001

Rosselló, J., Becken, S., & Santana-Gallego, M. (2020). The effects of natural disasters on international tourism: A global analysis. *Tourism Management*, *79*(January). https://doi.org/10.1016/j.tourman.2020.104080

Sianipar, D., Halauwet, Y., Daryono, & Karnawati3, D. (2019). *Study of the Source of the Ambon Earthquake 26 September 2019 Mw 6.5*. *September*, 1–20.

Sugiyono, D. (2013). *Educational research methods approach quantitative, qualitative and R&D*.

Wand, MZ, Ayuba, IGU, & Asika, BG (2015). Needs for Disaster Risks Reduction Education in Nigeria. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, *9*(1), 43–47. https://doi.org/10.9790/2402-09134347

Yusuf, RB, & Santosa, BJ (2016). Distribution of South Maluku Hypocenter Using Double Difference Method. *ITS Journal of Science and Arts*, *5*(2), 2337–3520.

https://geologi.esdm.go.id/id/media-center/arsip-berita/gempa-bumi-merusak-di-indonesia-tahun-2021

https://tekno.tempo.co/read/1552054/3 - big-earthquake-that-ever-happened-in-indonesi

https://www.kompasiana.com/altip/5bb1d028ab12ae5c63656647/importance-penerapan-

https://www.tribunnews.com/national/2021/01/02/bnpb-more-than-42000-rumah-warga-damage-due-disaster-nature-sepanjang-2020?page=2#:~:text=Badan%20Administration%20Disaster%20Regions%20%28BPBD%29%20Kabupaten%20Sukabumi%20A,citizens%20damaged%20as a result of%20disaster%20natural%20along%20year%202020