Natural Hazards and Higher Education in Indonesia

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ABSTRAK

Kepulauan Indonesia yang terletak di pertemuan potongan lempengan laut Eurasia, Australia, Pasifik, dan Filipina menyebabkan spektrum topografi yang luas, seringnya muncul gempa bumi, dan vulkanisme. Dengan mempertimbangkan wilayah Indonesia yang rawan bencana, pembangunan sebuah program mitigasi bencana alam yang sistematik dan berkelanjutan dipandang perlu. Kesuksesan program ini bergantung pada berbagai faktor seperti memadainya keahlian yang berhubungan dengan bencana alam. Sayangnya, sebagian besar keahlian di bidang ini masih terfokus di pusat penelitian dan universitas di pulau Jawa, dan bahkan di luar Indonesia. Keahlian yang terpisah-pisah ini tidak kondusif untuk mengembangkan sebuah program mitigasi yang kuat dan sehat sehingga harus ditangani secara sistematis. Makalah ini akan memetakan dan menilai distribusi ruang dan status pusat penelitian, laboratorium, dan program studi ilmu alam serta mitigasi bencana alam di seluruh Indonesia. Berdasarkan penilaian ini, makalah juga memberikan beberapa rekomendasi untuk menangani keterbatasan pemisahan keahlian ini.

Kata kunci: bencana alam, lempengan samudera, letusan gunung berapi, mitigasi bencana

The Indonesian archipelago located at the junction of the Eurasia, Australia, Pacific, and Philippine Sea plates, (see Figure 1) resulting in wide spectrum topography, frequent earthquakes, and volcanism [*Hamilton*, 1979]. In the west, the Australia plate subducts beneath the Eurasian plate along the Java trench while to the east, the continental part to the east, the continental part of the Australia plate collides with the Banda arc and the Pacific oceanic plate. Indonesian region is therefore prone to earthquakes, tsunamis and volcanic eruptions.

The high seismicity of Indonesian region is indicated in Figure 2 with many occurrences of earthquakes. In general, each year about 450 earthquakes with magnitude larger than 4.0 occur in Indonesian region. The earthquakes in sea may generate tsunamis on seashore. Figure 3 shows the earthquakes that have caused the relatively large tsunamis in Indonesian region.

Indonesia has also 129 active volcanoes and 271 eruption points as a consequence of interactions and collisions among those plates. The most actives volcanoes in Indonesia are shown in Figure 4. This Figure also shows that the most populated island in Indonesia (i.e. Java) has the most number of active volcanoes. According to (*Katili & Siswowidjojo*, 1994), around 10% of Indonesian people live in the area endangered by the volcanic eruptions, and about three million of them live in the danger zones.

Considering rugged topography and usually heavy rainfall, landslide is also one of prominent geohazards that continuously affect Indonesia. Land subsidence moreover also affect some large cities in Indonesia, such as Jakarta, Bandung and Semarang. There are several types of land subsidence that can be expected to occur in those cities, namely: subsidence due to groundwater abstraction, subsidence induced by the load of constructions (i.e. settlement of high compressibility soil), subsidence caused by natural consolidation of alluvium soil, and geotectonic subsidence.

Considering the aforementioned hazard-prone nature of Indonesian region, the systematic and sustainable (natural) hazard mitigation program is very important for Indonesia. The success of this hazard mitigation program will depend on several factors. One of them is the availability of sufficient expertise related to natural hazard phenomena in

Indonesia. Natural hazard experts from various knowledge disciplines, e.g. geology, geophysics, geodesy, geography, oceanography, meteorology, civil engineering and environmental engineering, are required with sufficient quantity and quality. Unfortunately, at the present times most of this expertise is concentrated mostly at the research institutions and universities in Java, and some even outside Indonesia. This spatial divide in natural hazard expertise of Indonesia is obviously not conducive for development of strong and healthy natural hazard mitigation program in Indonesia, and therefore should be systematically overcome.

In the following, the spatial distribution and status of research centers, laboratories and study programs related to earth sciences and natural hazard mitigation in various universities in Indonesia is assesed. Based on this assessment, several recommendations will be given to overcome the spatial divide in natural hazard expertise in Indonesia.

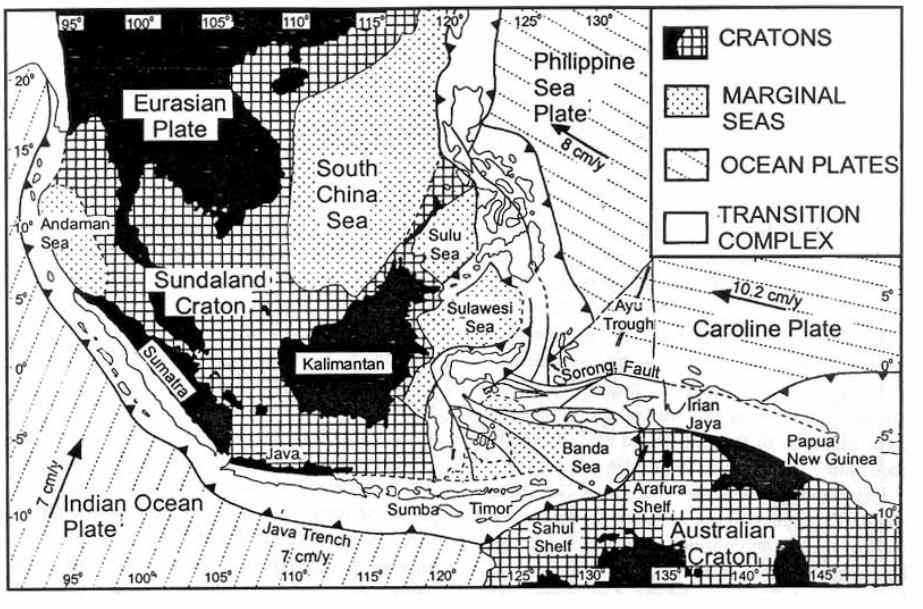

Figure 1: Tectonic settings of Indonesia; from Simandjuntak and Barber (1996)

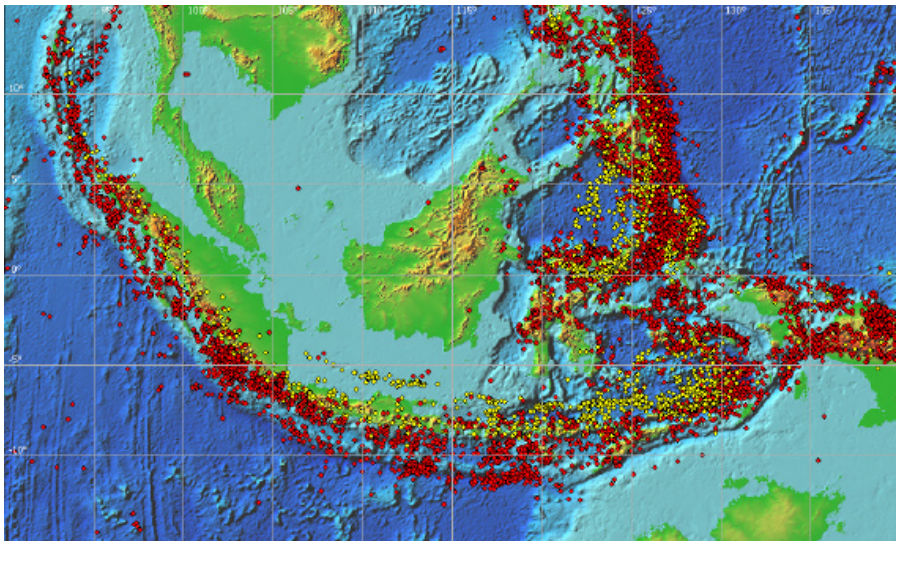

Figure 2: High seismicity of Indonesian region (*USGS*, 2006)

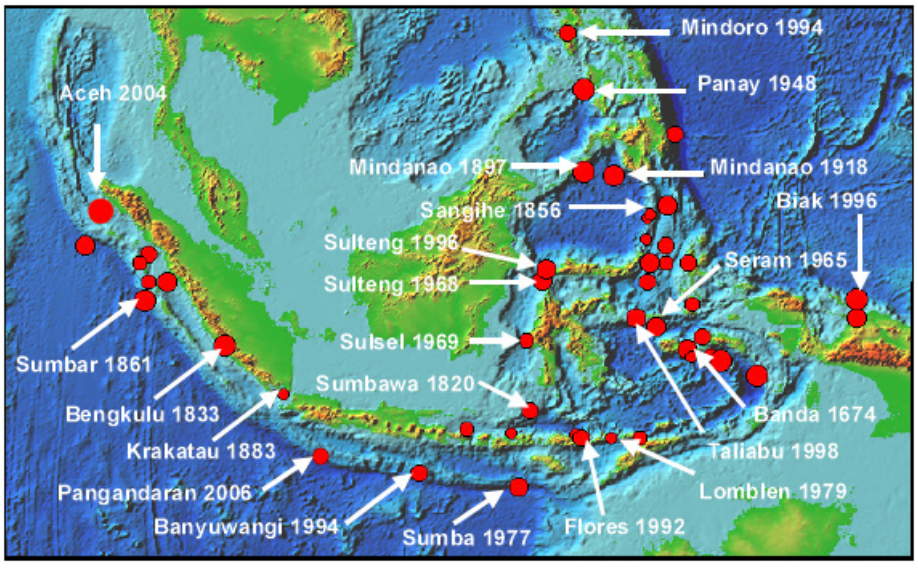

Figure 3: Large tsunamis in Indonesian region

Figure 4: Location of major active volcanoes of Indonesia (*USGS*, 2006)

Higher Education in Indonesia

Higher education in Indonesia was started in the end of the 19th century with the establishment of medical education for indigenous doctors in Jakarta. After the independence in 1945, the higher education system has been significantly expanded (see Table 1), particularly after the Education Act in 1961 was enacted. Currently there are 82 state (public) and almost 2900 private higher learning institutions with about 4 million of students.

Table 1: Growth of higher learning institutions in Indonesia [*Djanali*, 2005; *DIKTI*, 2008]

Year	Number of institutions, State (S) and private (P)	Number of students
1950	10	6,500
1970	450 (S+P)	237,000
1990	900 (S+P)	1,486,000
1995	52 (S) and 1228 (P)	2,339,000
2005	82 (S) and 2518 (P)	about 3 million
2008	82 (S) and ≈2900 (P)	about 4 million

The higher learning institutions in Indonesia are very diverse, with separate groups of institutions, namely [DIKTI, 2008] : (1) Universities, both private and state owned (public), which are recognized by the Ministry of Education and Culture; (2) Institutes and teacher training institutes (Institut Kegurun dan Ilmu Pendidikan or IKIPs) that rank as universities with full degree-granting status; (3) Islamic institutes, which have the same rank as universities but come under the Ministry of Religious Affairs; (4) Schools (Sekolah Tinggi), both public and private, which offer academic and vocational university-level education in one particular discipline; (5) Single-faculty academies which offer Diploma/ Certificate technician-level courses at public and private levels; and (6) Polytechnics, which are attached to universities and provide sub-degree junior technician training. In Indonesia, the Ministry of National Education, through the Directorate General of Higher Education, exercises authority over both state and private institutions.

Higher learning institutions in Indonesia usually offer three types of studies, namely as described in the following.

(1) Non-university level post-secondary studies (technical/vocational type), where in this case higher technical/vocational education is offered by Akademi, which are single-faculty academies which confer Diploma level qualifications (up to three years' study) and by Polytechnics, which also confer Diplomas. Diploma programs are considered to be professional rather than academic.

(2) University level studies, which consist of: (a) University level first stage: Sarjana (S1) is awarded after four years of full-time study at a recognized university, institute or school, and students must obtain 144 credits; (b) University level second stage: Magister (S2) is awarded after a further two years' study plus research, and some 36-50 credits beyond S1 are required to graduate, and (c) University level third stage: Doktor (S3) takes another three to four years beyond the Magister. The Doktor degree is the highest award conferred by Indonesian universities or institutes.

(3) Teacher education, which consist of: (a) Training of pre-primary and primary/basic school teachers: Primary school teachers are trained at IKIPs where they follow two-year courses leading to the award of a Diploma; and (b) Training of secondary school teachers: Junior secondary school teachers are trained at post-secondary level in two-year programs at IKIPs leading to the award of a Diploma. Both Diplomas (DII, DIII) and Degrees (SI, SII, and SIII) are conferred to IKIP graduates.

Natural Hazard Related Educational Entities

Higher learning institutions in Indonesia offer various study programs, ranging from natural and earth sciences, engineering, agriculture, forestry, social sciences, economy, education and medical sciences. Of about 2500 higher learning institutions in Indonesia, only about 55 universities and institutes that have earth sciences and hazard mitigation related study programs (i.e. geology, geophysics, geodesy/geomatics, geography, oceanography, meteorology, civil engineering, and environmental science/engineering), as shown in Table 2.

Disciplines of geology, geophysics, oceanography and meteorology are important for understanding the nature and characteristics of various natural hazards. Geodesy/geomatics and geography are important for monitoring, observing and mapping the hazards and hazard prone areas. Civil engineering and environmental science/ engineering will play important roles in hazard mitigation and also reconstruction and rehabilitation stages. It should be noted in Table 2, that the quality of the departments or study programs varies from university to university. In general, universities/ institutes in located in Java island have better quality than those located in Sumatra and other regions of Indonesia. In case of private universities/ institutes, only those with relatively good quality are shown in the Table. In fact more private universities have study program of civil engineering. However, due to its quality or its concentration that has no natural hazard attachment, they are not included in the list.

Spatial distribution of study programs related to earth sciences and hazard mitigation are shown in Figure 5, 6 and 7. From Figure 5 it can be realized that most study programs of Geology, Geophysics, Oceanography and Meteorology are located in Java. Several universities outside of Java have also oceanography program. However, no universities outside of Java which offer Meteorology program. In the case of Geodesy/Geomatics, all are located in Java as shown in Figure 6; while study program of Geography has a wider spatial coverage. It should be noted however that study program of Geography outside of Java is mostly educational in nature and aim to graduate geography teachers for high schools.

Figure 6 shows also that the most eastern parts of Indonesia (e.g. Papua and Maluku) do not have a single study program on Geodesy/ Geomatics and/or Geography.

In the case of study programs of Civil Engineering and Environmental Engineering/ Science, the spatial distribution are slightly better;

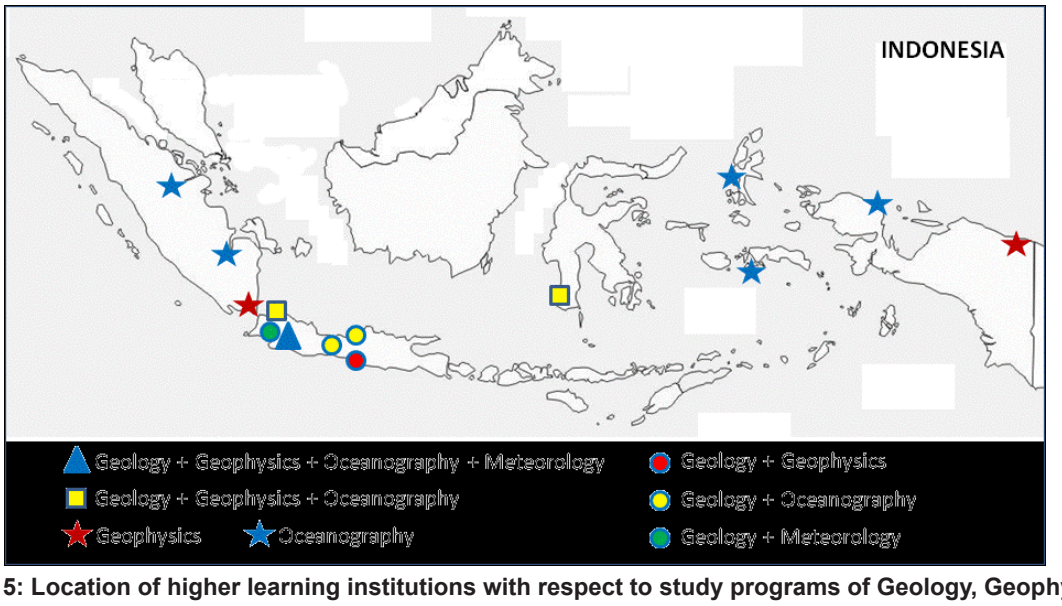

Figure 5: Location of higher learning institutions with respect to study programs of Geology, Geophysics, Oceanography and/or Meteorology

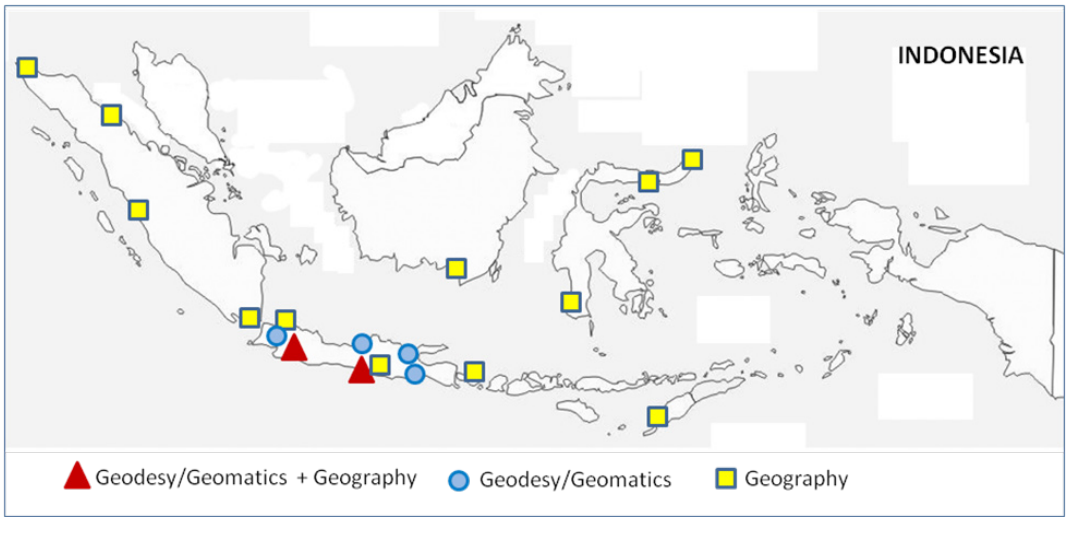

Figure 6: Location of higher learning institutions with respect to study programs of Geodesy/Geomatics and/or Geography

although Java still has the largest number of higher learning institutions in those programs.

In terms of research center or study center related to hazard mitigation and its related aspects, Table 3 and Figure 8 shows that most of them also located in Java. Eastern region of Indonesia has only one center, namely in Universitas Gorontalo.

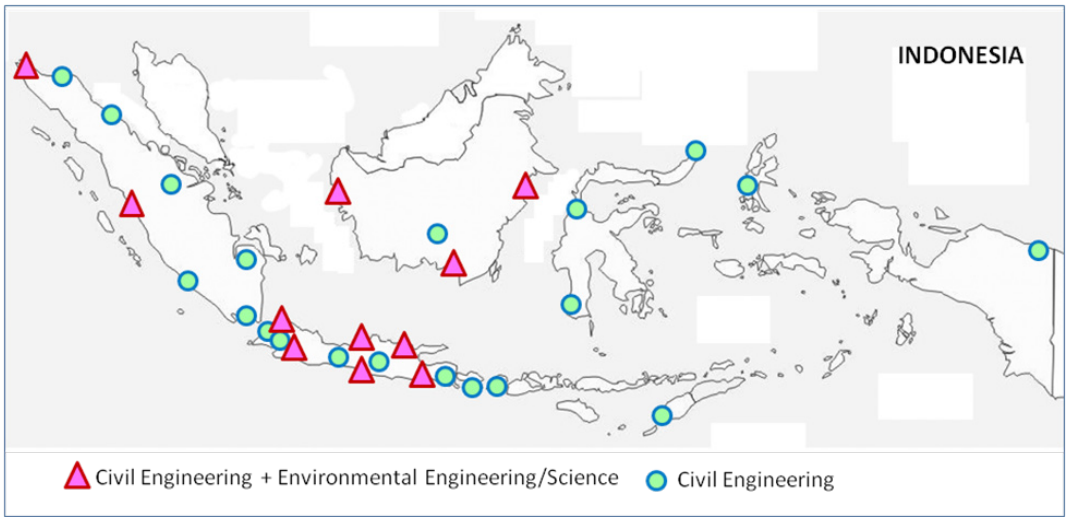

Figure 7: Location of higher learning institutions with respect to study programs of Civil Engineering and/or Environmental Science/Engineering

Table 2: Earth science and hazard mitigation related Department or Study Programmes in the State (S) and Private (P) Universities/Institues, at the university undergraduate (S1) program [*DIKTI*, 2008]

Island : JAVA & MADURA			Department / Study Programme							
No.	University / Institute	City	GL	GP	GD	GG	OC	ME	CE	EV
1	Institut Teknologi Bandung (S)	Bandung	√	√	√	x	√	√	√	√
2	Universitas Padjajaran (S)	Bandung	√	x	x	x	x	x	x	√
3	Universitas Pendidikan Indonesia (S)	Bandung	x	x	x	√	x	x	√	x
4	Universitas Gajah Mada (S)	Yogyakarta	√	√	√	√	x	x	√	√
5	Universitas Negeri Yogyakarta (S)	Yogyakarta	x	x	x	√	x	x	√	x
6	Universitas Indonesia (S)	Jakarta	x	√	x	√	√	x	√	√
7	Universitas Negeri Jakarta (S)	Jakarta	x	x	x	√	x	x	√	x
8	Universitas Sultan Ageng Tirtayasa (S)	Serang	x	x	x	x	x	x	√	x
9	Institut Teknologi Sepuluh November (S)	Surabaya	x	x	√	x	x	x	√	√
10	Universitas Negeri Surabaya (S)	Surabaya	x	x	x	√	x	x	√	x
11	Universitas Brawijaya (S)	Malang	x	x	x	x	x	x	√	x
12	Universitas Negeri Malang (S)	Malang	x	x	x	√	x	x	√	x
13	Institut Pertanian Bogor (S)	Bogor	x	x	x	x	√	√	x	x
14	Universitas Diponegoro (S)	Semarang	√	x	√	x	√	x	√	√
15	Universitas Negeri Semarang (S)	Semarang	x	x	x	√	x	x	√	x
16	Universitas Sebelas Maret (S)	Solo	x	x	x	√	x	x	√	x
17	Universitas Jendral Sudirman (S)	Purwokerto	√	x	x	x	√	x	√	x
18	Universitas Jember (S)	Jember	x	x	x	x	x	x	√	x
19	Universitas Trunojoyo (S)	Bangkalan	x	x	x	x	√	x	x	x
20	Universitas Trisakti (P)	Jakarta	√	x	x	x	x	x	√	x
21	Universitas Tarumanegara (P)	Jakarta	x	x	x	x	x	x	√	x
22	Universitas Pakuan (P)	Bogor	√	x	√	x	x	x	√	x

Island : JAVA & MADURA			Department / Study Programme							
No.	University / Institute	City	GL	GP	GD	GG	OC	ME	CE	EV
23	Universitas Katolik Parahyangan (P)	Bandung	x	x	x	x	x	x	√	x
24	Institut Teknologi Nasional (P)	Bandung	x	x	√	x	x	x	√	√
25	Universitas Islam Indonesia (P)	Yogyakarta	x	x	x	x	x	x	√	√
26	Universitas Pembangunan Nasional Veteran (P)	Yogyakarta	√	√	x	x	x	x	x	√
27	Institut Teknologi Nasional (P)	Malang	x	x	√	x	x	x	√	√
28	Universitas Muhamaddiyah	Malang	x	x	x	x	x	x	√	x

Island : SUMATRA			Department / Study Programme							
No.	University / Institute	City	GL	GP	GD	GG	OC	ME	CE	EV
1	Universitas Syaih Kuala (S)	Banda Aceh	x	x	x	√	x	x	√	√
2	Universitas Malikussaleh (S)	Lhokseumawe	x	x	x	x	x	x	√	x
3	Universitas Sumatra Utara (S)	Medan	x	x	x	x	x	x	√	x
4	Universitas Negeri Medan (S)	Medan	x	x	x	√	x	x	√	x
5	Universitas Andalas (S)	Padang	x	x	x	x	x	x	√	√
6	Universitas Negeri Padang (S)	Padang	x	x	x	√	x	x	√	x
7	Universitas Sriwijaya (S)	Palembang	x	x	x	x	√	x	√	x
8	Universitas Riau (S)	Pekanbaru	x	x	x	x	√	x	√	x
9	Universitas Bengkulu (S)	Bengkulu	x	x	x	x	x	x	√	x
10	Universitas Lampung (S)	Bandar Lampung	x	√	x	√	x	x	√	x

OTHER AREAS OF INDONESIA			Department / Study Programme							
No.	University / Institute	City	GL	GP	GD	GG	OC	ME	CE	EV
1	Universitas Tanjungpura (S)	Pontianak	x	x	x	x	x	x	√	√
2	Universitas Mulawarman (S)	Samarinda	x	x	x	x	x	x	√	√
3	Universitas Lambung Mangkurat (S)	Banjarmasin	x	x	x	√	√	x	√	√
4	Universitas Palangkaraya (S)	Palangkaraya	x	x	x	x	x	x	√	x
5	Universitas Udayana (S)	Denpasar	x	x	x	x	x	x	√	x
6	Universitas Pendidikan Ganesha (S)	Singaraja	x	x	x	√	x	x	x	x
7	Universitas Mataram (S)	Mataram	x	x	x	x	x	x	√	x
8	Universitas Nusa Cendana (S)	Kupang	x	x	x	√	x	x	√	x
9	Universitas Hasanuddin (S)	Makasar	√	√	x	x	√	x	√	x
10	Universitas Negeri Makasar (S)	Makasar	x	x	x	√	x	x	√	x
11	Universitas Negeri Manado (S)	Manado	x	x	x	√	x	x	√	x
12	Universitas Negeri Gorontalo (S)	Gorontalo	x	x	x	√	x	x	x	x
13	Universitas Tadulako (S)	Palu	x	x	x	x	x	x	√	x
14	Universitas Pattimura (S)	Ambon	x	x	x	x	√	x	x	x
15	Universitas Khairun (S)	Ternate	x	x	x	x	√	x	√	x
16	Universitas Cendrawasih (S)	Jayapura	x	√	x	x	x	x	√	x
17	Universitas Negeri Papua (S)	Manokwari	x	x	x	x	√	x	x	x

NOTE : GL = Geology; GP = Geophysics; GD = Geodesy/Geomatics; GG = Geography; OC = Oceanography; ME = Meteorology; CE = Civil Engineering; EV = Environmental Engineering or Science; √ = Yes; x = No

Table 3: Earth science and hazard mitigation related Reseach and Study Centers

No.	Research Center	University	City
1	Reseach Center of Tsunami and Hazard Mitigation	Universitas Syiah Kuala	Banda Aceh
2	Center for Disaster	Universitas Andalas	Padang
3	Center for Disaster	Institut Pertanian Bogor	Bogor

No.	Research Center	University	City
4	Center for Disaster Mitigation	Institut Teknologi Bandung	Bandung
5	Research center of Disaster and Refugee	Sekolah Tinggi Kesejahteraan Sosial	Bandung
6	Center for Disaster	Universitas Pendidikan Indonesia	Bandung
7	Center for Disaster Mitigation	Universitas Jendral Sudirman	Purwokerto
8	Center for Disaster	Universitas Gajah Mada	Yogyakarta
9	Center for Disaster Management	Universitas Pembangunan Nasional Veteran	Yogyakarta
10	Center for Natural Disaster	Universitas Negeri Sebelas Maret	Solo
11	Center for Geosphere and Disaster	Institut Teknologi Sepuluh November	Surabaya
12	Center for Disaster and Mitigation	Universias Tanjungpura	Pontianak
13	Center for Disaster Mitigation	Universitas Gorontalo	Gorontalo

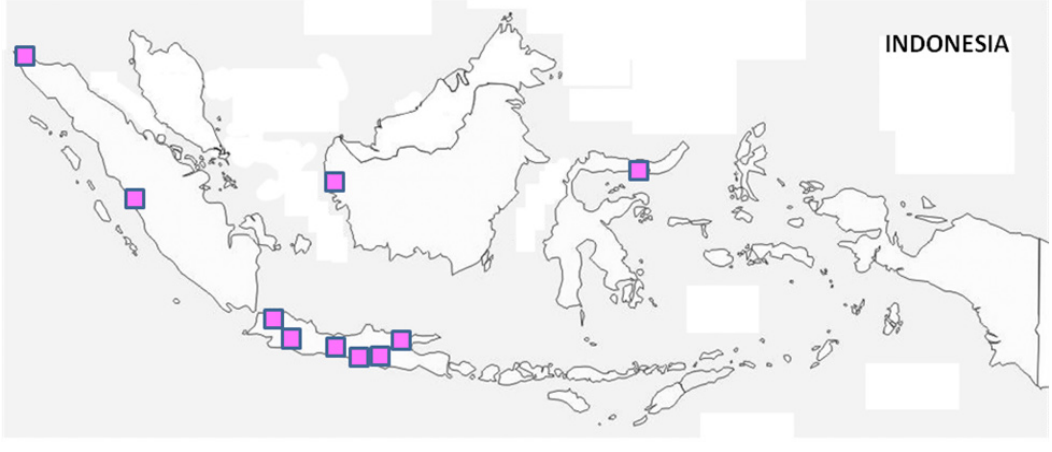

Figure 8: Location of research/study center related to earth science and hazard mitigation

Conclusions

Although Indonesia has about 2500 higher learning institutions, only about 55 institutions have study programs and 12 institutions have reserach and study centers related to earth sciences and hazard mitigation. Unfortunately, most of them are still located in Java.

Considering that most of Indonesian region are prone toward natural hazards, it will be preferable if the study programes and research/study centers related to earth sciences and hazard mitigation are located all over Indonesia with relatively good distribution. Otherwise, the spatial divide in earth science and natural hazard expertise of Indonesia will not be conducive for development and operation of strong and healthy natural hazard mitigation program in Indonesia.

Since natural hazards will always be occuring all over Indonesia, this spatial divide should be systematically overcome and should be started from now on. In building this (educational) capacity building in the area of earth sciences and natural hazard mitigation, the eastern region of Indonesia and Sumatra Island should have more priority. In this regard, the political will and government supports will be very important and necessary.

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