The Characteristics Influence of The Seismic Signal Noise Using Spectral Analysis

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Abstract. The observation of earthquake monitoring station had deployed in Indonesia. The data for this study were earthquake data recorded from BMKG Seismic Network. We use the 2016 Aceh earthquake, struck the Indonesia Island of Sumatra with Mw of 6.5 in Aceh province on December 7th 2016, at 05:03 WIB (22:03 UTC December 6th 2016) with duration 14 days from December 1st 2016, 00:00:00 UTC to December 14th 2016 00:00:00 UTC. Spectral analysis response to determine the level of background noise in the seismic station by using the Power Spectral Density and the Probability of Density function from the spectral result. The results of our background noise analysis are useful for characterizing the performance of existing BMKG Network Station, for detecting operational problem.

1. Introduction

Indonesia had installed the broadband seismic network. All data are telemetered in real-time to the Indonesia Tsunami Early Warning System (Ina-TEWS) Tsunami warning center in BMKG (Indonesia’s Agency for Meteorology, Climatology and Geophysics) at Jakarta. After the tsunami tragedy following the great Mw=9.3 Andaman earthquake of December 2004, BMKG as government was develop the seismic monitoring Ina TEWS with many institution and had donate form many countries such as Germany government, Japan, United State, China, UNESCO, UNDP, UNOCHA, ISDR. Ina TEWS consisted by hundreds of seismic stations (Figure 1).

The InaTEWS station repersent an important part of the global FDSN (Federation of Digital Seismograph Networks, http://www.fdsn.org) backbone network, and also initiated and supported national network.

The Ina-TEWS was development of the SeedLink protocol as part of SeisComP (Seismological Communication Processor) concept, permitting connection of digitizers and data loggers from all major manufactures and all major acquisition system, conversion of the native data format to SEED and uniform transmission, acquisition and archival of heterogeneous network data.
In last 8 years, Indonesia earthquakes have occurred average 5000 events per years. It means that Indonesia was an active earthquake area. In 2016 year, catalog earthquake is about 6000 event. (Figure 2).

The main function of a seismic network is to provide high-quality data for earthquake monitoring, source studies and earth structure research. Characteristics of seismic data needs to be researched and analyzed for parameter of tectonic earthquake [1] The utility of seismic data is greatly increased when noise levels are reduced.

A good quantification and understanding base on station seismic noise levels study [2-3]. Purpose of this research projects is determining response characteristic of the station in Indonesia. We use...
spectral analysis to describe response characteristic of these stations. We analyzed background noise level of sites using Power Spectral Density (PSD) and Probability Density Function (PDF).

2. Data and Methods

2.1 Data

We used broadband seismic signal recording from BMKG Network-IA, and the dataless SEED. In this case, we use the 2016 Aceh earthquake, struck the Indonesian island of Sumatra with a Mw of 6.5 in Aceh province on December 7th 2016, at 05:03 WIB (22:03 UTC December 6th 2016) with duration 14 days from December 1st 2016, 00:00:00 UTC to December 14th 2016 00:00:00 UTC. The shock was reported to be at a depth of 13 km, categorized as a strong, shallow earthquake. The epicenter was located near the village of Reuleut in Pidie Jaya Regency, 164 km (102 mil) southeast of the province's capital, Banda Aceh. It is about 104 people died in the quake, with at least 1,000 people injured. It was the deadliest earthquake in Aceh since the 2005 Nias – Simeulue earthquake and the deadliest in Sumatra since the 2010 Mentawai earthquake and tsunami. We use DSRI Station, EGSI Station, JMBI Station and GSI Station in Table 1 and the waveform from DSRI, EGSI, JMBI and GSI station can show in figure 3.

| No | Station | Lat | Long | Sensor |
|----|---------|-----|------|--------|
| 1. | SNSI    | 2.408 | 96.32 | STS 2  |
| 2. | JMBI    | -1.6764 | 103.576 | STS 2  |
| 3. | EGSI    | -5.3524 | 102.27 | STS 2  |
| 4. | GSI     | 1.3039 | 97.575 | STS2,Triaxial |

2.2 Methods

2.2.1 Power Spectral Density

The PSDs is the standard and basic method for quantifying seismic back-ground noise to calculate and performed for each component of the seismic noise. In generally the most common method to estimate the PSD for stationary random seismic data is called the "direct Fourier transform" or the other hand we called the “Cooley–Tukey method”[4]. In this case the method computes the PSD via a finite range FFT of the original data and is advantageous for its computational efficiency. The PSD results were compared to the high and low noise model of [2].

Finally, the seismometer instrument response is removed by dividing the PSD estimate by the instrument transfer function to acceleration, in the frequency domain. For direct comparison to the NLNM, the PSD estimate is converted into decibels (dB) with respect to acceleration (m/s²)/Hz.
3. Results and Analysis

The Power Spectral Density (PSDs) have been calculated for each broadband sensor seismic. The NHNM (New High Noise Models) is a spectrum of average high background noise power in the network. PSDs are computed from continuous, overlapping (50%) time series segments (BH channels: one-hour segments sampled at 40 sps or 20 sps; LH channels: three-hour segments sampled at 1 sps). All available data are included; there is no removal of earthquakes, system transients, or data glitches. The instrument transfer function is deconvolved from each time segment, yielding ground acceleration for direct comparison to the NLNM and NHNM [5][6].

DSRI station in figure 4 shows the amplitude ranging from -135 to -90 dB, with Power Density Function percentage is 0-3 %. The segment did not stick closely with NHNM or NLNM, but rather staying in the middle area between both models.
Figure 4. DSRI, EGSI, JMBI, GSI Broadband Network

EGSI station shows the amplitude ranging from -120 to -80 dB (Figure 5), with PDF percentage is 0-3 %. The segment did not stick closely with NHHM or NLNM, but rather staying in the middle area between both models. JMBI station in figure 6, shows the amplitude ranging from -120 to -85 dB, with PDF percentage is 0-3 %. The segment did not stick closely with NHHM or NLNM, but rather staying in the middle area between both models. GSI station shows the amplitude ranging from -120 to -80 dB, with PDF percentage is 0-3 %. The segment did not stick closely with NHHM or NLNM, but rather staying in the middle area between both models.

X axis in showing the Period (s) Powers for each 1/8 period interval were then accumulated in one dB power bins, and show the time series of the waveform. And Y axis in Red Box showing the Power Spectral Density Unit (Amplitude of ground acceleration). Based on the Fourier theorem any arbitrary transient function f(t) in the time domain can be represented by an equivalent function F(ω) in the frequency domain.

4. Conclusion
Finally, we have computed waveform that represents a more realistic noise floor for earthquake monitoring networks within the BMKG, Indonesia. The results of our background noise analysis are not only useful but also powerfully for characterizing the performance of existing BMKG Network Station, for detecting operational problem. Performing preliminary surveys is very important to
determine the level of seismic signal background noise using longer duration of passive seismic recording before placement and building of seismic station in Indonesia.

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