Classification of Seismic Signal by Evaluating Broadband Networks Station in Sumatera Fore-Arc

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Abstract. Classification of seismic signal waveform is an essential component to realize the characteristics of the signal. The processing of the waveform signal is broadly used for the analysis of the real-time seismic signal. The numerous wavelet filters are developed by spectral synthesis using machine learning python to realize the signal characteristics. Our research aims to generate the performance of seismic signal and processing the waveform from Broadband Network Station by using Wavelet-Based on Machine Learning. In this case, we use Continuous Wavelet Transform (CWT) on Morlet. CWT is also clearly to identify spectral amplitudes and frequency-energy from the component of signal seismic performed by Broadband Network in Indonesia. The characteristic of the digital broadband network in Indonesia is variance. Our project tries to classification and evaluate the Broadband Seismic Network which deployed in Sumatera Region, Indonesia by using Power Spectral Density Probability Density Function (PSDPDF).

1. Introduction
The broad variety of waveform in digital seismic signals and the high non-stationary nature of various of them is one of the main difficulties to mature automatic detection system for them. In a broad sense, Machine Learning (ML) is not only techniques that extract information directly from the waveform [1], [2] but also is a core component in any variance digital signal processing to improve the quality of signal [3], [4]. In this case, we use the wavelet transform as a method approach for analyzing signal. The present purport of this paper to analyse and classification of time-series and signals seismic which recorded of Broadband Seismic Network in Sumatera Region. The tested of the waveform by Continuous Wavelet Transform (CWT) in order to find out the best for our purport in seismic analysis. Sumatera Region is a field in western Indonesia that is a part of the Sunda Islands. Sumatera is islands to be seriously affected by the earthquake and tsunami. Broadband Seismic network had been deployed in Indonesia after the big earthquake in Aceh, Indonesia 2004. In Sumatera region, the seismic sensor had been deployed and operated to record all earthquake event and cover event not only in Indonesia but also in Asia. The recorded of waveform in digital seismic produced the variance row data. In this paper, we use the mseed as short periode (SP) in Tarutung event, Januari 2019. To analyse the waveform from the sensor, needed the preprocessing the row data and other think, to checked the performance of broadband seismic network.
2. Data and Methods

2.1 Data
The waveforms were employed in Sumatera Region, which recorded from the seismic network. We selected the broadband seismic sensor in Tarutung event in January 2019, which recorded from GEOFON and EIDA Data Archives.

![Waveform recorded based on Geofon Broadband Network in Sumatera.](image)

In fig.1 shown the recorded of the broadband seismic network from Tarutung event in January 2019. The waveform indicated recorded of earthquake.

The broadbands seismic network produced the raw waveform data with component Short Horizontal (North, East and Z component), and located in Sumatera Fore-Arc Region, the sensors are BKNI, GSI, MNAI and PMBI (Table 1).

| Network Code/Station Code | Station Description          | Longitude  | Latitude |
|---------------------------|------------------------------|------------|----------|
| GE/BKNI                   | Station Bangkinang, Sumatra  | 101.0396   | 0.3262   |
| GE/GSI                    | Station Gunungsitoli, Nias   | 97.5755    | 1.3039   |
| GE/MNAI                   | Station Manna, Sumatra       | 102.9557   | 4.3605   |
| GE/PMBI                   | Station Palembang, Sumatra   | 104.6993   | 2.9024   |

2.2 Method
In this paper, we use the power spectral density to indicate the performance of seismic network, by using the PSDPDF [5]–[7]. The PSDs is the standard and basic methods for quantifying seismic background noise to calculate and performance each component of the seismic noise [8].
The machine learning approach in this research, using the wavelet transform methods by using the morlet wavelet [9], [10]. The continuous wavelet transform is a method for examining the time-frequency detail of seismic data whose spectral with time.

\[
CWT_f^\psi(a,b) = \int_{-\infty}^{\infty} f(t) \psi_{ab}(t) dt
\]

where,

\[
\psi_{ab}(t) = \frac{1}{\sqrt{a}} \psi\left(\frac{t-b}{a}\right) \quad a, b \in \mathbb{R}; a \neq 0
\]

presence \(\psi\) the mother wavelet with two representative parameters, namely, dilation \((a)\) and translation \((b)\), which vary continuously. The regularly used mother wavelet for CWT is the Morlet function which acquires features with equal variation in the time and frequency [11]–[14].

3. Result and Discussions
The result of this paper show the power spectral for each seismic sensor can show in Fig. 2. BKNI station in Fig. 2 a shows the amplitude ranging from -160 to -100 dB, with Power Density Function percentage is 15-30 %. The segment did not stick closely with NHNM or NLNM, but rather staying in the middle area between both models.
GSI station in Fig. 2 b shows the amplitude ranging from -170 to -90 dB, with Power Density Function percentage is 15-30 %. MNAI station in Fig. 2 c shows the amplitude ranging from -150 to -100 dB, with Power Density Function percentage is 15-30 %. PMBI station in Fig. 2 d shows the amplitude ranging from -160 to -80 dB, with Power Density Function percentage is 15-30 %.

The spectral waveform in Fig. 3 had been processed by using CWT. In this result, the CWT analysis has a great perspective for seismic waveform, such as frequency and spread spectrum signals. Based on the waveform spectrum, in Fig. 3 a as the GSI sensor shown the information had been found in the instantaneous spectrum, and makes seismic signal most useful is that spectrum change over time as shown in previous study [4], [6], [8], [10], [11].

Figure 2. PSDPF of Broadband Newtwok Seismic; a. BKNI seismic network, b. GSI seismic network, c. MNAI seismic network, d. PMBI seismic network
Figure 3. Frequency time spectrograms based on CWT; a. BKNI seismic network, b. GSI seismic network, c. MNAI seismic network, d. PMBI seismic network.

The spectrum in Fig. 3 as the result of BKNI, GSI, MNAI, and PMBI, shown the characteristic spectral waveform indicated the time-frequency. The blue spots indicated higher energy. Based on the waveform spectrum, in Fig.3 shown the information had been found in the instantaneous spectrum and makes seismic signal most useful is that spectrum change over time.

4. Conclusions
The seismic waveform and four broadband networks have been investigated by using the machine learning approach using wavelet-based and using the power spectral density of the probability density function method. The result of the PSD PDF of each broadband seismic network indicated good performance. Based on the result of the PSD PDF, we can calculate the waveform to analyze the energy which indicated from the continuous wavelet transform methods. The CWT utilizing a complex Morlet analyzing shows the clearly and concurrently of amplitude, but also influential for processing frequency-energy with alternate signal seismic with a short period.

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