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Machine learning on waveform spectral analysis of nuclear explosion from broadband seismic station in Indonesia

Mutammimul Ula[1], Eva Darnila[2], Parulian Siagian[3], Lestina Siagian[4], Peristiwanto[5], Marzuki Sinambela[6,7]

[1]Information Systems Management Department, Malikussaleh University, Lhoksumawe, Indonesia
[2]Department of Informatics Engineering, Malikussaleh University, Lhoksumawe
[3]Mechanical Engineering Department, Universitas HKBP University, Jl.Sutomo 4A, Medan, Indonesia
[4]Electrical Engineering Department, Universitas HKBP Nommensen, Medan
[5]Department of Informatics Engineering, STMIK Budidarma, Medan, Indonesia
[6]Department of Physics FMIPA, Universitas Sumatera Utara, Medan 20155, Indonesia
[7]Indonesia Meteorology, Climatology and Geophysics Agency, Medan, Indonesia

E-mail : moelula@gmail.com, sinambela.m@gmail.com

Abstract: Machine learning of seismic waveform is core component to realize the characteristics of signal. The nuclear explosion is Wavelet signal processing is broadly used for analysis of real time seismic signal. The numerous wavelet filters are developed by spectral synthesis using machine learning python to realize the signal characteristics. Our paper aims to solve and evaluating the frequencies-energy characteristic of nuclear explosion. The wavelet method by Continuous Wavelet Transform (CWT) is clearly to identify of amplitudes and frequency-energy from component of nuclear test performed by the North Korea that occurred on September 03, 2017. Finally, by machine learning python with Morlet wavelet allows good time resolution for identified and performed of Broadband Seismic from Comprehensive Nuclear-Test Ban Treaty Organization (CTBTO) in Indonesia.

1. Introduction

Signal of nuclear test was differentiated from base natural source of either earthquakes. We analyzing broadband seismic waveforms from a network of tele-seismic station of Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) which deployed in Indonesia. Nuclear explosions have long a seriously issue for some reasons, its need to identification the nuclear test by looking the characteristics of the waveform which recorded of broadband seismic. When nuclear explosion is tested, its impact and risk upon the environment is spread out within minute fatalities that may last for a space time. In this study, we have introduced the wavelet transform of nuclear explosion which recorded from tele-seismic station of CTBTO in Indonesia by using machine learning python on Morlet wavelet and performance of CTBTO station's in Indonesia.

CTBTO station in Indonesia, had been deployed, there are 6 stations which installed. In this case, we analyze each station to look the performance and characteristics of nuclear explosion on North Korea that occurred on September 03, 2017. To identify the nuclear

explosion on September 03, 2017 we use the tele-seismic station from CTBTO's station in Indonesia by analyze the waveform and performance the CTBTO's station for one week. In this paper aims to solve and analyze the characteristic of waveform of nuclear explosion by using machine learning python on Morlet and using the power spectral density.Analyze seismic noise for broadband seismic station had been doneby using power spectral density[1], the other researchertry to identify the performance of seismic station[2].Machine learning in this case to perform a Morlet wavelet transform by analysis of nuclear explosion from CTBTO's broadband seismic data recorded on September 03, 2017 with Magnitude 6.3 and Depth 1.0 Km. By using machine learning python (Mlpy) on wavelet transform allows good time resolution for low frequencies of nuclear explosion characteristic.

2. Data and Methods

2.1. Data

The CTBTO's broadband seismic data were employed from BMKG-IA real time seismic monitoring network at the Indonesia Tsunami Early Warning System (Ina-TEWS). We use the nuclear test on September 03, 2017 from North Korea, which recorded of 6 CTBTO's broadband stations in and around Indonesia. The location of each CTBTO's broadband stations is show in figure 1 and table 1. We take the CTBTO's broadband station seismic by using the available data for one weeks by using Power Spectral Density and the nuclear test explosion on September 03, 2017. We used Python by providing routines for the handling of seismic data. It provides read/write support for the most relevant waveform data formats in use at data center and observatories, its support the standard metadata exchange format of Dataless SEED (MSEED), and it comes with clients to interact with the most important data center at BMKG Network in figure 1.

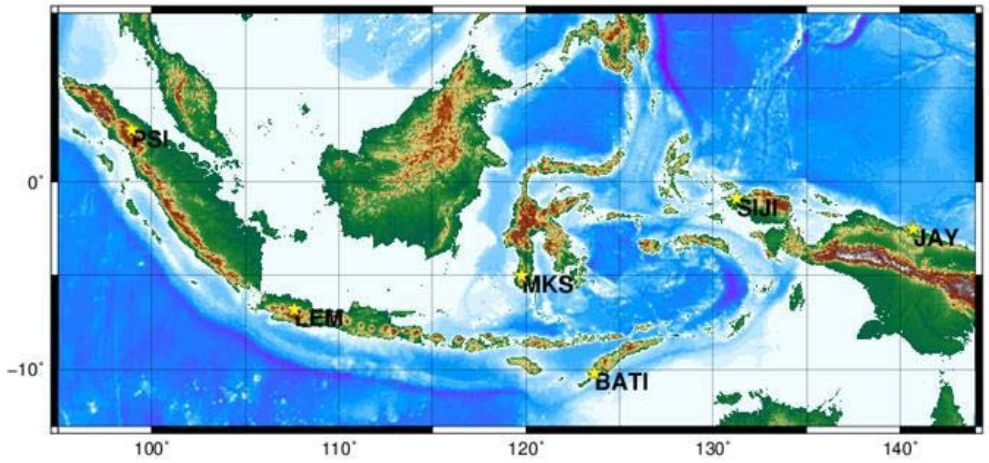

Figure 1. Distribution of CTBTO's broadband network seismic in BMKG-IA

2.2. Methods

The wavelet analysis discussed in this paper employed application of the continuous wavelet transform (CWT) using the Morlet wavelet [3][4][5] and power spectral density [6]. This appeared effective and operative at identifying features in seismic data.

3. Results and Analysis

3.1. Power Spectral Density

In this study, we analyze the CTBTO's broadband for one week. We analyze PSI, LEM, MKS, BATI and SIJI Station.

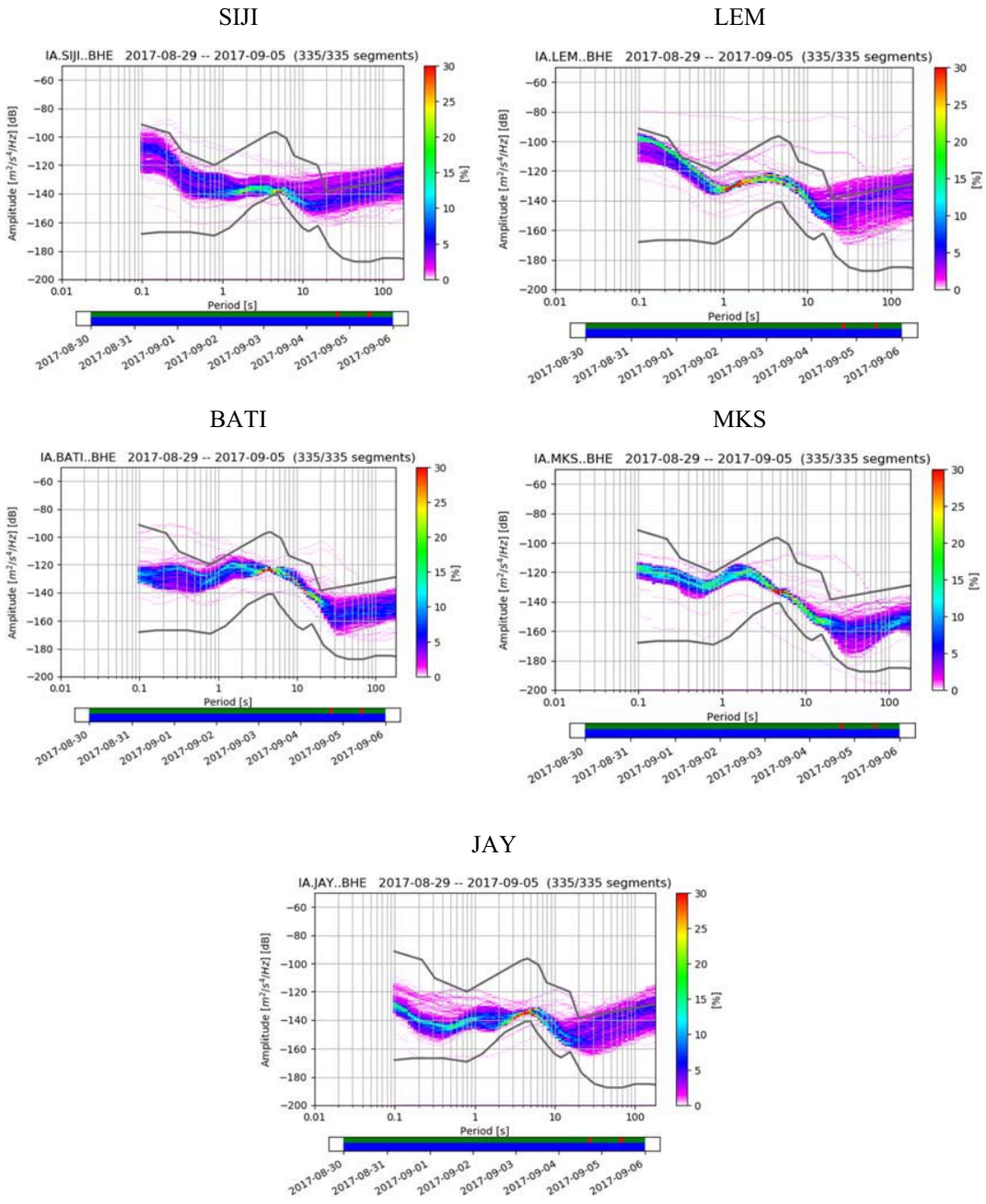

Figure 2. Power spectral density for CTBTO's station, PSI, LEM, SIJI, MKS, BATI and JAY station

The power spectral density of SIJI, LEM and BATI between -160 dB until -90 db. For MKS and JAY the power spectral density between -110 dB until -170 dB. There are small gaps for each CTBTO's Station which indicated in red at period on September 05-06, 2017. PSI station on Parapat, North Sumatra did not record the nuclear explosion, its mean that there is no data to analysis this event. Its mean that condition of sensor is good. The condition support the period of the waveform [7][8] is available to analysis by continuous wavelet transform. By using machine learning python (mlpy) we got the result of the continuous wavelet transform, bluish color represented low energy and yellowish colors represent high energy.

3.2. Machine learning Python on Morlet Wavelet

In this phase, we analyze all CTBTO's broadband station to show the frequency-energy and looking the characteristic of nuclear test waveform. From six CTBTO's sensor we got only BATIstation clearly recorded the nuclear explosion waveform.

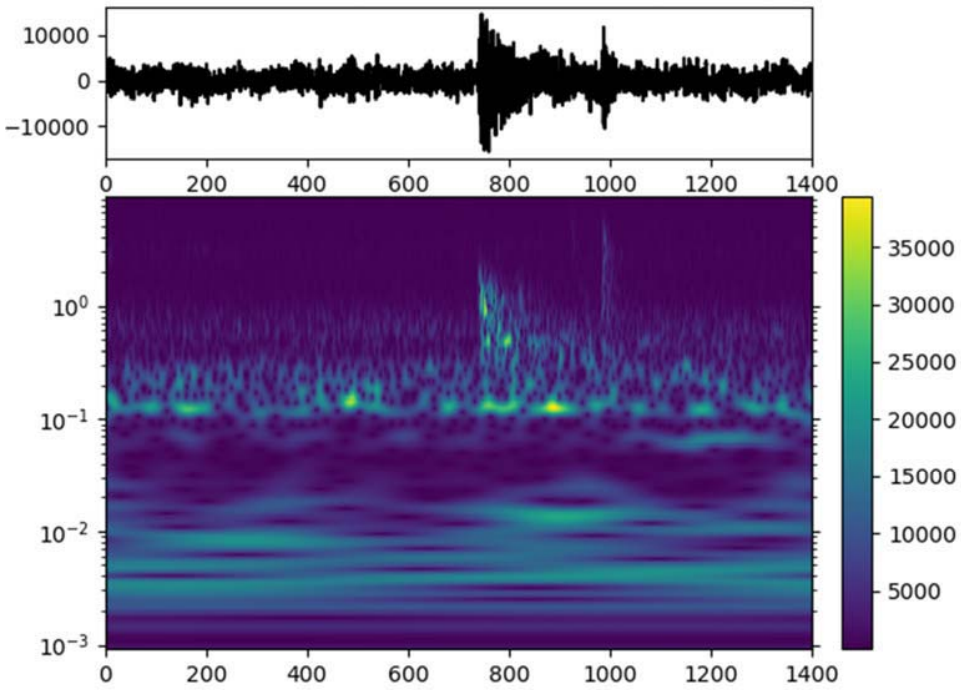

Figure 3. BATI waveform by mlpy package in python using Morlet

By using machine learning python on morlet wavelet, the waveform indicate the S-component is not clearly on BATI sensor and its clearly for P-component, the frequency 10^{0} Hz in figure 3.

Table 1. Frequency-Energy

Broadband	Description (Period= Time series)	Frequency (Hz)
BATI (AS045)	Small Gaps	10^{-0}
JAY (AS041)	Small Gaps	Not Clearly
MKS/KAPI (AS044)	Small Gaps	Not Clearly
LEM (AS040)	Small Gaps	Not Clearly
PSI (AS043)	No Data	Not Clearly
SIJI (AS042)	Small Gaps	Not Clearly

The characteristics of nuclear explosion, if we compare to normally tectonic earthquakes were different, in generally the kind of nuclear explosion has a unique parameter from P-Component is clearly for waveform, and S-Component is not clearly, the other is from depth parameter is shallow below 2 Km. In table 1 the frequency-energy are not clear for each waveform, only BATI is clear. In view of this research finding that the North Korea nuclear test site at Mount Mantap has collapsed, it is important to monitory the waveform of seismic not only using the tele-seismic station but also using the local station.

4. Conclusion

Using CTBTO's broadband analysis of waveforms obtained from tele-seismic CTBTO's station in Indonesia were identified as a nuclear bomb to its characteristics of wavelet transform in P-component was clearly of BATI waveform. By using machine learning python on Morlet wavelet, there is none of the station records the S-component, indicating only of the P-component. Wavelet analysis by machine learning presents a useful way of observing the arraying spectral (time-frequency) components of a seismic sensor broadband. The wavelet method by CWT is possible to clearly and simultaneously of amplitudes and frequency-energy from nuclear explosion component.

5. Acknowledgements

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6. Reference

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