The 2006 Java Earthquakes revealed by the broadband seismograph network in Indonesia

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JISNET

• JISNET is a broadband seismograph network in Indonesia, and now maintained by NIED and Meteorological and Geophysical Agency of Indonesia (BMG).

• We have developed a data acquisition system by real-time basis of this network.

• Data from the seismographs are transmitted in real time to BMG Headquarter and NIED.

• This system has begun its operation in this spring.
Waveforms of the Java earthquakes obtained from JISNET

May 26, 2006

July 17, 2006
Method

• Focal mechanism
  – Assuming a point source and double-couple
  – Grid search with respect to strike, dip, and rake
  => Inversions are stabilized even using data from a small number of stations

• Source location
  – To find out source location, we carry out a spatial grid search.
  – For each virtual source, focal mechanism is estimated
  – The combination of source location and focal mechanism that yields the minimum residual is adopted as the solution.
Estimation of source-time function in the frequency domain

• In the time domain

\[ \mathbf{d} = \mathbf{G} \mathbf{m} \]

(Number of data) x (Number of parameters) = (Nt Ns) x (Nm Np)

\( \mathbf{d} \): Data vector
\( \mathbf{m} \): Parameter vector, for source-time function

• In the frequency domain

\[ \tilde{\mathbf{d}}(\omega_k) = \tilde{\mathbf{G}}(\omega_k) \tilde{\mathbf{m}}(\omega_k) \]

\( k = 1, \ldots, N_f \)

➢ Much faster!

Nt : data traces
Ns : samples for each trace
Nm: moment components
Np : elementary functions to describe temporal variation of STF
The earthquake occurred on May 26

- Three-component seismograms obtained from two closest stations (BJI and LEM) (EW component at BJI is not available)
- Waveforms are filtered between 50 and 100 s, and used for the inversion.
Estimated source location and focal mechanism

Depth=10km
Mw=6.4

(strike, dip, rake)
= (145, 85, 220),
(51, 50, 353)

+: virtual sources for the search of source location

The areas of severe damage after UNOSAT (2006)
Source-time function

$$M_0 = 4.63 \times 10^{18} \text{ Nm}$$

$$M_w = 6.4$$
Comparison between observed and recovered seismograms

BJI NS
\[
\begin{align*}
\text{max} &= 3.36 \times 10^{-1} \text{ mm} \\
\text{min} &= -4.85 \times 10^{-1} \text{ mm}
\end{align*}
\]

BJI UD
\[
\begin{align*}
\text{max} &= 2.39 \times 10^{-1} \text{ mm} \\
\text{min} &= -1.80 \times 10^{-1} \text{ mm}
\end{align*}
\]

LEM NS
\[
\begin{align*}
\text{max} &= 1.91 \times 10^{-1} \text{ mm} \\
\text{min} &= -1.55 \times 10^{-1} \text{ mm}
\end{align*}
\]

LEM UD
\[
\begin{align*}
\text{max} &= 2.43 \times 10^{-1} \text{ mm} \\
\text{min} &= -1.88 \times 10^{-1} \text{ mm}
\end{align*}
\]

LEM EW
\[
\begin{align*}
\text{max} &= 1.74 \times 10^{-1} \text{ mm} \\
\text{min} &= -1.13 \times 10^{-1} \text{ mm}
\end{align*}
\]

Residual = 0.07
Seismic intensity estimation (1)

• The source is located immediately below the areas of severe damage after UNOSAT (2006).

• We estimate the seismic intensity in these areas using empirical attenuation relations.
Seismic intensity estimation (2)

• First, we estimate horizontal Peak Ground Velocity (PGV) by the empirical attenuation proposed by Kanno et al. (2006).

• Next, we estimate the instrumental modified Mercalli intensity (I_{mm}) from the PGV values using the relation proposed by Wald et al. (1999).

• We estimated that strong ground motion with I_{mm} of about 7 occurred within 10 km of the earthquake fault.
Summary

• We have developed a broadband seismograph network in Indonesia (JISNET).
• Using data from JISNET stations, we estimated source locations and mechanisms of the 2006 Java earthquakes.
• For the event on May 26, we also estimated seismic intensity in the areas of severe damage using empirical relations.
  – Strong ground motion with $I_{mm}$ of about 7 is estimated in the areas of severe damage.
  – Such an estimation of seismic intensity may help early estimates of seismic damages.