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OBSERVATION OF SEISMIC INTENSITY AND STRONG GROUND MOTION BY JAPAN METEOROLOGICAL AGENCY AND LOCAL GOVERMENTS IN JAPAN

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ABSTRUCT: The seismic intensity-meters over 3400 have been deployed by Japan Meteorological Agency (JMA) and local governments of all over Japan. These intensity data are utilized for quick earthquake information through all broadcasting in Japan. Most of seismic intensity-meters have capability to record and preserve the strong ground motion (acceleration). The high-level accelerations that had never observed before the installation were recently observed due to very dense sites.

Key Words: seismic intensity, intensity-meter, strong motion seismograph

INTRODUCTION

After an occurrence of a felt earthquake, Japan Meteorological Agency (JMA) immediately issues seismic intensity information based on the data observed by seismic intensity-meters through broadcasting facilities in Japan. Now, there are about 3400 seismic intensity observation sites in Japan. JMA has about 600 sites and the other sites belong to local governments all over Japan. Most of these seismic intensity-meters have capability to record and preserve strong ground motion time history because accelerometers are used as a sensor of the seismic intensity meter. We introduce seismic intensity and strong ground motion observation systems of JMA and local governments.

OBSERVATION OF SEISMIC INTENSITY

The seismic intensity is convenient scale in order to evaluate the degree of the ground shaking and it is possible to estimate the degree of damage from seismic intensity. The seismic intensity has been measured by physical feelings and damages to man-made structures for long time in Japan. The method for measuring seismic intensity by the instrument was developed in order to measure the intensity objectively and to make immediately an emergency operation after an earthquake. Seismic intensity meters were deployed at meteorological observatories in 1991 and these seismic intensity meters were called JMA 91-type seismic intensity meter. The accelerometer was used for the purpose of measuring seismic intensity. However JMA 91-type seismic intensity meter didn't have the capability for recording and preserving strong motion data.

During the 1995 Hyogo-ken-Nanbu earthquake (M7.3) that caused severe damages, seismic intensity 7 by JMA seismic intensity scale was observed. Because the JMA 91-type intensity meter had not function to measure the intensity 7, the method of calculation for measuring seismic intensity was modified. The upgraded intensity meter is called JMA 95-type intensity-meter. Figure 1 shows a picture of the JMA 95-type seismic intensity meter.

We have another type of seismic intensity-meter. After the 1993 Hokkaido-Nanseki-oki earthquake (M7.3), JMA revised the seismological observation network. Two types of three components sensor are installed at each site; one is a force-balance accelerometer and the other is a short period seismometer. We obtain the ground displacement data by filtering and integrating the signal from the accelerometer in order to determine the magnitude, but these accelerometers are used as seismic intensity meter by data processing. The capability of these accelerometers is equal to the JMA 95-type. The total number of these type accelerometers and JMA 95-type seismic intensity- meters is about 600 all over Japan.

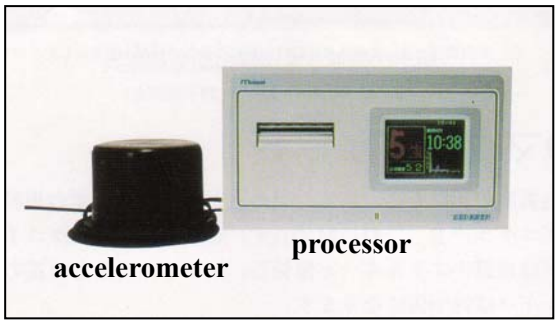

Figure 1. The picture of JMA 95-type seismic intensity meter. The left-hand side is an accelerometer and the right-hand side is an processor.

There are 47 prefectures in Japan. After the 1995 Hyogo-ken-Nanbu earthquake, the local governments all over Japan have started to deploy their own seismic intensity-meters and established the seismic intensity networks in order to control the immediate emergency operation after an earthquake. Seismic intensity data are transmitted to JMA through the local government's system and they are immediately announced as earthquake information by the TV and radio networks in Japan. The total number of seismic intensity observation sites of local governments amounts to about 2840. Figure 2 shows the current locations of the sites of JMA and local governments. The seismic intensity data from JMA sites are usually transmitted by landline but it is also possible to use the satellite link in order to avoid the loss of the intensity data even if the landline is damaged.

OBSERVATION OF STRONG GROUND MOTION

JMA had observed strong ground motion by mechanical seismographs without magnification from the 1950. The data measured by this instrument are proportional to ground displacement and the data were often clipped during strong motion. The JMA 87-type electromagnetic strong motion seismograph was developed and deployed at about 80 meteorological observatories. The observation by the JMA-87 type started from 1988. A force balance accelerometer was adopted as a sensor. The sampling rate, the resolution, and observation range are 50 Hz, 16 bits, and +/- 980 cm/s/s, respectively. This seismograph retrieved the strong ground motion records at Kushiro from the 1993 Kushiro-oki earthquake, at Suttsu from the 1993 Hokkaido Nansei-oki earthquake, and at Kobe from the 1995 Hyogo-Ken-Nanbu earthquake. Figure 3 shows the waveforms obtained at the Kobe marine observatory during the 1995 Hyogo-ken-Nanbu earthquake.

The observation by the JMA 87-type strong-motion seismographs was ended in March 1997 because of deployment of JMA 95-type seismic intensity-meters. The JMA 95-type seismic intensity-meter has the following specifications as a strong motion seismograph. The sampling rate, the resolution, and observation range are 100 Hz, 24 bits, and +/- 2048 cm/s/s. The frequency characteristics is flat from DC to 40 Hz. The JMA 95-type seismic intensity-meter has a capability to record preserve the strong motion data in a flash memory card. The JMA 87-type strong-motion seismographs were replaced by the JMA 95-type seismic intensity meter in March, 1997.

Most of municipalities' seismic intensity-meters also have the function of recording for the strong

motion data. However, because the seismic intensity networks of municipalities were established only for the purpose of seismic intensity observation, some of the networks don't have the function of recording to preserve the waveform data. Moreover, the data of main shock have ever overwritten by the data from many aftershocks. Therefore, the important data were lost during the earthquake of northern part of Miyagi prefecture on July 26,2003.

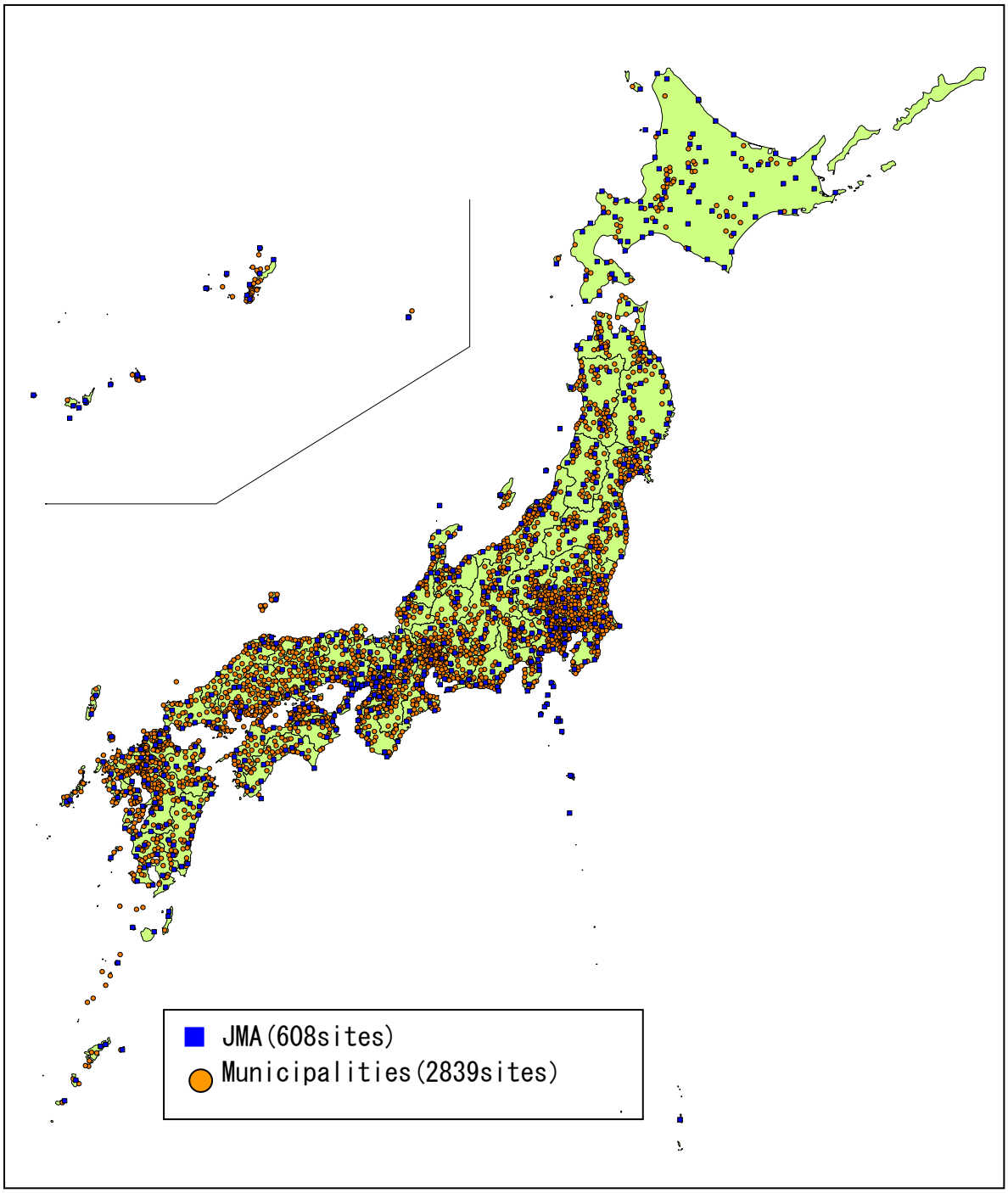

Figure 2. Location of seismic intensity observation sites (2004.1.1) Squares and circles show JMA and municipalities sites, respectively.

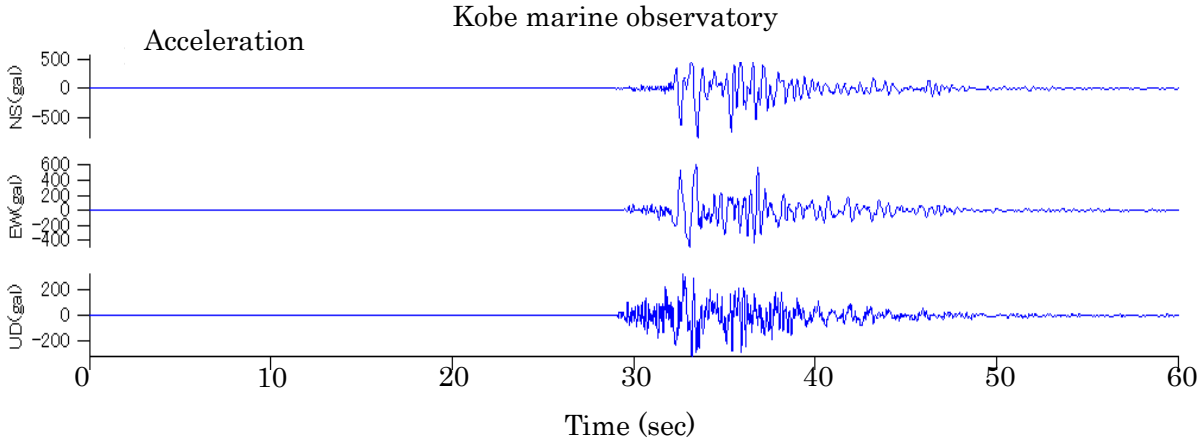

Figure 3. The 1997 Hyogo-ken-Nanbu earthquake's strong motions obtained by JMA 87-type electromagnetic strong motion seismograph.

On September 26, 2003, a large earthquake occurred at off Tokachi, near Hokkaido, Japan. The epicenter was offshore at Tokcahi and the magnitude was 8.0 by the JMA magnitude scale. The largest intensity was the 6 lower by the JMA intensity scale and the largest peak acceleration of 874 (cm/s/s) was recorded at Makubetsu town with the seismic intensity-meter installed by Hokkaido local government. The strong motion seismograms were obtained at 19 sites of Hokkaido local government.

JMA collects the strong motion data of the intensity meters observed higher intensity than 3 at the JMA sites. JMA also collects the strong motion data observed higher intensity than the degree of 5 lower at municipalities' sites when the largest intensity is observed over the degree of 5 upper. These data are provided to seismologists and earthquake engineers.

SUMMARY

There are about 3400 seismic intensity observation sites in Japan. These seismic intensity-meters are mainly used for the immediate emergency operation after an earthquake. But most of seismic intensity meters have capability to record and preserve strong ground motion. A highly dense distribution of the intensity observation sites may have opportunities to retrieve the strong ground motion from very near earthquake sources.

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