Soil Dynamics and Earthquake Engineering 31 (2011) 119–126

Contents lists available at ScienceDirect

Soil Dynamics and Earthquake Engineering

journal homepage: www.elsevier.com/locate/soildyn

The operation and performance of Earthquake Early Warnings by the Japan Meteorological Agency

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ARTICLE INFO

Article history:
Received 31 October 2009
Received in revised form
14 June 2010
Accepted 20 June 2010

ABSTRACT

The Japan Meteorological Agency commenced an Earthquake Early Warning (EEW) provision service in August 2006 to advanced users and in October 2007 to the Japanese public. By the end of 2009, EEWs had been issued to advanced users for more than 2100 earthquakes and to the public for 11 earthquakes. Nearly 80% of seismic intensity predictions were accurate within ± 1 intensity unit on JMA's Seismic Intensity Scale. The Iwate-Miyagi Nairiku Earthquake in 2008 demonstrated the efficiency of EEWs in many places. However, there were other cases where the warnings were not issued in time for strong tremors. Further technical development is needed for both earthquake source parameter estimation and seismic intensity prediction. Public education in regard to the technical limitations and accuracy of EEWs as well as actions to take in response to such warnings are also indispensable.

1. Introduction

Knowing the timing and degree of strong ground motion caused by an earthquake before it may strike is valuable in order to prevent damage from such ground motion. In this regard, an earthquake early warning is one of the most powerful tools for allowing people to save their lives and to reduce damage to their properties when an earthquake occurs.

A number of earthquake-prone countries are engaged in ongoing efforts to develop earthquake early warning systems. In Mexico, for example, the Seismic Alert System (SAS) of Mexico City launched in 1991 [1].

In Japan, the Japan Meteorological Agency (JMA) commenced its nationwide Earthquake Early Warning (EEW) service for advanced users in August 2006, and for the public in October 2007. This was preceded by an experimental EEW provision beginning in February 2004, which demonstrated effectiveness of EEWs [2,3]. Japan is currently the only country in the world where EEWs are available throughout the whole nation.

JMA issued EEWs to advanced users for more than 2100 earthquakes, and to the public for 11 earthquakes by the end of 2009. This brief report describes the operation and performance of JMA's EEW services.

2. Provision of EEWs

2.1. Definition of EEWs and seismic intensity in Japan

The Meteorological Service Law defines JMA's entire mandate of services related to weather, climate, and oceanographic phenomena as well as earthquakes, tsunamis, and volcanic phenomena. In the law, a "Forecast" is defined as an announcement of expected future phenomena, based on observational data; a "Warning" is also defined as an announcement of anticipated future phenomena that may cause serious damage. These definitions of Forecasts and Warnings under the law also apply to EEWs which contain expectations of tremor, i.e., ground motion phenomena caused by fault rupture. A degree of ground motion caused by an earthquake is usually expressed with a seismic intensity value. In Japan, unlike in other countries, seismic intensity is instrumentally calculated on site from an accelerogram, taking into account the valuables of amplitude, frequency, and duration of a seismic wave. When estimation is performed at a seismic station, the resulting value, called instrumental seismic intensity, is transmitted to the JMA on a real-time basis. Then, a message detailing seismic intensity values (known as seismic intensity information) is composed for provision to the public through disaster management organizations and broadcast companies, who interrupt programming to transmit this information or superimpose it over program content. This allows seismic intensity to be confirmed in Japan simply turning on a TV or radio whenever ground motion is felt. Therefore, people living in Japan are very familiar with the seismic intensity scale as the earliest

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doi:10.1016/j.soildyn.2010.06.009