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2010 Chilean Tsunami Observed on Japanese Coast by NOWPHAS GPS Buoys, Seabed Wave Gauges and Coastal Tide Gauges

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The 2010 Chilean Tsunami was observed on the Japanese coast by 11 GPS buoys of NOWPHAS (Nationwide Ocean Wave Information Network for Ports and Harbours); these buoys measured the water level by using real-time kinematic GPS technology at a water depth of 100 to 300 m. The highest tsunami crest was 0.1 to 0.3 m, and the predominant period was longer than 50 min. Owing to the coastal bathymetry, tsunami components longer than 30 min at the GPS buoy sites appeared amplified to nearby seabed wave gauge sites at water depths of 30 to 50 m, and the shorter components of 10 to 20 min appeared significantly amplified at the coastal tide gauge sites.

INTRODUCTION

Since 1970, Japan's Ports and Harbours Bureau, Ministry of Land, Infrastructure, Transport and Tourism and its associated organizations, including the Port and Airport Research Institute, have been conducting wave and tide observations around Japan as well as central data processing and data dissemination through the Nationwide Ocean Wave Information Network for Ports and Harbours (NOWPHAS) (Nagai et al., 2008). The data accumulated through NOWPHAS include not only high-wave events, but also the tsunami triggered by the 1983 Nihonkai-Chubu Earthquake, the 1993 Hokkaido-Nansei-oki Earthquake, the 1996 Irian Jaya Earthquake, the 2003 Tokachi-oki Earthquake, the 2004 Tokaido-oki Earthquake, the 2005 Miyagi-ken-oki Earthquake, the 2006 Kuril Islands Earthquake (Tanimoto et al., 1983; Takayama et al., 1994; Kobune et al., 1996; Nagai et al., 2004, 2005a and b, 2006a and b, 2007; Shimizu et al., 2007), the 2010 Central Chile Earthquake and the 2011 Earthquake off the Pacific Coast of Tohoku.

NOWPHAS started with seabed wave gauges and coastal tide gauges in 1970 and introduced new equipment—GPS buoys—in recent years after a research team successfully used an experimental stand-alone GPS buoy to acquire data on the tsunamis triggered by the 2001 Peru Earthquake, the 2003 Tokachi-oki Earthquake and the 2004 Tokaido-oki Earthquake (Kato et al., 2005; Nagai et al., 2005a and b, 2006a, 2007). As of February 2010, NOWPHAS operated 11 GPS buoys, 60 seabed wave gauges, 1 air-launched acoustic wave gauge and 74 coastal tide gauges. Fig. 1 shows that these GPS buoys are located at sites furthest from the coast. The vertical motion of the buoy due to waves and tides is measured every second by the real-time kinematic (RTK)-GPS instruments on the buoy and at the base station (Shimizu et al., 2006a, b). The GPS buoys were expected to measure deepwater waves continuously every day and to detect tsunamis earlier than coastal tide gages. In reality, it takes several minutes for the tsunami to travel from the GPS buoy site to the shore. Such a lead time will be helpful for evacuating coastal residents.

A massive earthquake in central Chile triggered a tsunami at 15:34 h, 27 February 2010, Japanese Standard Time (GMT+9 h). The tsunami traveled across the Pacific Ocean and reached the Japanese coast nearly 1 day after the earthquake. All of the NOWPHAS GPS buoys succeeded in acquiring the tsunami data. It was the first time worldwide that an operational network of GPS buoys observed a tsunami by the RTK-GPS instruments. Analysis of the tsunami record obtained by the GPS buoys, their seabed wave gauges nearby, and coastal tide gauges is necessary for gaining a deep understanding of tsunami behavior in coastal areas and for the development of an early tsunami detection and warning system.

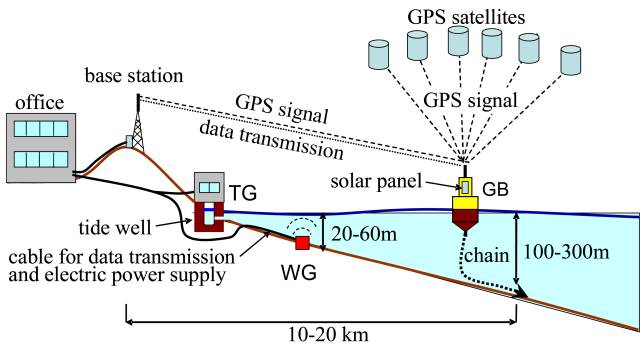

Fig. 1 NOWPHAS equipment for tsunami observation

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KEY WORDS: Tsunami, GPS buoy, seabed wave gauge, coastal tide gauge, predominant period.