Present status and future scope of the GNSS buoy array project for synthetic disaster mitigation

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We have developed a GNSS buoy system for about 20 years. This presentation reviews the status of the development and discusses future scope and problems to be solved. Originally, the buoy was developed aiming at the tsunami early warning apparatus. Early experiments succeeded to observe a few centimeters height of tsunamis, and, thus, was adopted as a part of nationwide wave monitoring system called NOWPHAS (Nationwide Ocean Wave information network for Ports and HArbourS). The system used RTK-GPS, which uses relative positioning algorithm, so that the buoy was established less than 20km from the base station placed nearby the coast to secure the positioning accuracy within a few centimeters. The NOWPHAS buoys have been used as one of monitoring tools for the tsunami monitoring system operated by Japan Meteorological Agency. The system was able to detect the high tsunami of the 2011 Tohoku-oki tsunami before its arrival to the coast and was used for updating the tsunami alert. Yet, the lead time to the arrival was only a few minutes and consequently lots of people’ s lives were lost. This motivated us to upgrade the system, introducing a precise point positioning system so that we do not require any onshore base station and the buoy can be put much farther away from the coast. We also introduced a satellite communication for data acquisition instead of ground radio system that was used in the previous system. Currently, we are conducting the experiments of the system borrowing a fishery buoy of Kochi Prefecture off the Cape Ashizuri, south west Japan. Given that the system is evaluated as feasible, the area of application fields will get much wider. One of the most challenging application is to use the buoy for the GNSS-Acoustic system for continuous or much more frequent ocean bottom crustal movement measurements against the current GNSS-Acoustic system that uses vessel for the measurements. Such frequent or continuous measurements of ocean bottom crustal movements observations might discover new phenomena such as slow slip events nearby oceanic subduction zones. To make the system more cost effective, buoys can be used for other applications such as atmospheric and ionospheric researches including their applications to the geohazards monitoring. Moreover, ancillary sensors on, above and below the buoys can be used for ocean researches. If such buoys are established many places in the ocean, say, northwestern Pacific, such system will be a powerful infrastructure for synthetic geohazards monitoring. Yet, there are still many problems, both engineering and operational, to be solved in the future. First, reliable high-speed large-channel satellite communication is required and the dedicated satellite for this system may be imperative. For securing the positioning accuracy of a few centimeter, precise orbits and clocks broadcasted through the Michibiki satellite is also necessary. Other technical and engineering problems of sustainable buoy for long-term operation and autonomous operation of apparatus on and/or below buoys are to be clarified. Institutional and budgetary problems should be clarified as well. We really hope that this kind of GNSS buoy array in the ocean will be materialized in the future by solving these problems.

Keywords: GNSS buoy, buoy array, ocean bottom crustal movement observation

