Local Tsunami Warnings and the role of high-rate GNSS in Earthquake Early Warning

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Local tsunami warning requires rapid assessment and communication of the tsunami hazard for communities immediately adjacent to large earthquake. Here, the warning times are typically of minutes to tens of minutes. Local warning remains a challenging problem with very few systems worldwide capable of issuing such alerts. Here, we demonstrate a flexible strategy for local tsunami warning that relies on regional geodetic and seismic stations. Through retrospective analysis of four recent tsunamigenic events in Japan and Chile, we show that rapid earthquake source information, provided by methodologies developed for earthquake early warning, can be used to generate timely estimates of maximum expected tsunami amplitude with enough accuracy for tsunami warning. We validate the technique by comparing to detailed models of earthquake source and tsunami propagation as well as field surveys of tsunami inundation. Our approach does not require deployment of new geodetic and seismic instrumentation in many subduction zones, and could be implemented rapidly by national monitoring and warning agencies. We illustrate the potential impact of our method with a detailed comparison to the actual timeline of events during the recent 2015 Mw8.3 Illapel, Chile earthquake and tsunami that prompted the evacuation of 1 million people.

For tsunami warning and for rapid assessment of large events high-rate GNSS observations are a fundamental tool. We will discuss the Geodetic Alarm System (G-larmS) tool. A software system developed in collaboration between the Berkeley Seismological Laboratory (BSL) and New Mexico Tech (NMT) for real-time Earthquake Early Warning (EEW). It currently uses high rate (1Hz), low latency (< ~5 seconds), accurate positioning (cm level) time series data from a regional GPS network and P-wave event triggers from the ShakeAlert EEW system. G-larmS has been in continuous operation at the BSL since 2014 using event triggers from the California Integrated Seismic Network (CISN) ShakeAlert system and real-time position time series. We evaluate the performance of G-larmS for EEW by analyzing the results using a set of well defined test cases to investigate the following: (1) using multiple fault regimes and concurrent processing with the ultimate goal of achieving model generation (slip and magnitude computations) within each 1 second GPS epoch on very large magnitude earthquakes (up to M 9.0) and (2) the use of Precise Point Positioning (PPP) real-time data streams of various operators, accuracies, latencies and formats along with baseline data streams. We will also discuss the recent expansion and performance of the G-larmS algorithm along the U.S. West Coast on a regional network basis for Northern California, Southern California and Cascadia.

We will further highlight ongoing collaboration between the National Seismological Center (CSN) in Chile and the Berkeley Seismological Laboratory. This strategic partnership’s goal is to share data and warning algorithms between the two institutions with the end goal of enabling CSN to issue and disseminate early warning alerts to the country at large.

