Seismically detected ground tilts induced by precipitation and fluvial processes: Examples from Taiwan

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Broadband seismometers not only record translational motions from earthquakes, but also rotational motions induced by ground deformations from environmental processes. The rotational motions can be generated by shear strains from ground tilts. Those signals show much higher amplitudes on the horizontal components than those on the vertical component in seismograms because the ground tilt causes the gravitational acceleration to be partitioned into the horizontal components. At several broadband seismic stations near rivers in Taiwan, we found ultra-long period seismic signals induced by ground tilts. After comparing many different environmental time series near these seismic stations, we interpreted those seismic signals as a result of loading from fluvial processes due to precipitation during typhoon and heavy rainfall events. The seismic velocity waveforms correlate with precipitation and with the time derivative of the water level in a nearby river. The seismically derived tilts induced by the river loads are in the same orders of magnitude as the tilts from a co-located tiltmeter. In addition, we modeled seismic waveforms using an empirical Green's function method, which gives good fits to both main event seismic waveforms and precipitation time history. This work demonstrates that continuous recordings from broadband seismometers may help determine local fluvial water load and could be useful for decadal rainfall change research.