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Seismicity rate and wave-velocity variations as consequences of rainfall: the case of the catastrophic storm of September 2002 in the Nîmes Fault region (Gard, France).

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The Provence region in the southeastern France is an intraplate low deforming region, cut by large sinistral strike-slip faults as the Nîmes Fault. The deformation rate of this fault was estimated at 0.1 mm/yr from geological and morphological observations. Nevertheless, some large earthquakes occurred in this area in historical times inducing well-documented partial destructions on the roman monument Pont-du-Gard. In 1946, an earthquake of intensity I_0 = VII occurred in the region south of the city of Nîmes. In order to investigate if this area is still seismically active, we installed a temporary seismological network of 13 stations between the cities of Nîmes and Avignon for a 1-year period experiment (July 2002 – June 2003). Over the observation period, we recorded and located a total amount of 80 earthquakes of magnitude Ml ranging between 1 and 2.8, and of 153 quarry blasts. The seismic event locations are interpreted in terms of regional tectonics concerning the geometry at depth of the Nîmes Fault and the possible seismic activity of the Roquemaure Fault. At the beginning of September 2002, a catastrophic rainfall event occurred in the same area of our network with cumulated precipitations at 600 mm in 28 hours, causing casualties and major inundations and damages. We then detected a clear and sudden increase of the local seismic activity as an immediate consequence of this exceptional meteorological phenomenon. We interpret this rainfall triggering of earthquakes as a response of the crust to an abrupt overloading due to this major rainwater contribution. The geological

context of this zone is characterize by the presence of sedimentary basins and an important karstic network in a calcareous environment allowing the retention of a third of the total rainwater volume during few weeks after the catastrophic event. In order to investigate the influence of the stored water, we inverted month by month the seismic velocities for only the first 1-km thick layer of the crust. Thus, we evidence a clear decrease of both $P-$ and $S-$velocities, and, then, an increase of the Vp/Vs ratio. The variations obtained are at 2%, 6% and 4.5% for $P-$, $S-$velocities and Vp/Vs ratio respectively. These variations are discussed in confront of previous studies and can be directly related to the known water volume.