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Seismic noise generated by rainfall, snowmelt and floods on a Pyrenean mountain river.

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The seismic and strain data recorded in an underground geodynamical facility located in the central Pyrenees have allowed the identification of distinct signals related to discharge variations in the Aragon River, a typical Alpine-style river in the southern side of the Pyrenees. During the routine processing of the seismic data recorded in a seismic station located inside the Canfranc Underground Laboratory (LSC), we detected an unusual spectral signature, in a frequency band ranging 2 to 10 Hz, which does not correspond to the typical sources of seismic noise and which can also be recognized in the strain records. After checking against meteorological and hydrological data, we can relate those signals to variations in the discharge and/or the bedload carried by the Aragon River, located about 400 m. Three types of river-generated seismic events have been identified, related respectively to moderate rainfall episodes, snowmelt season and large flooding events associated to severe storms. Each of those types has distinctive characteristics which allow monitoring the hydrological features from the analysis of seismic data. The seismic signal associated to large flooding events could be used to develop near-real time alerts valid for Civil Protection authorities. The analysis of the seismic data also allows analyzing the differences in duration, daily periodicity and frequency content among the different snowmelt seasons, providing valuable data to the meteorological / climatologic community.

Significant deformation, as recorded by laser interferometers, is coeval with river-induced seismic noise. During heavy rain episodes extension is observed in both directions, probably due to a general pore pressure increase in the hosting rocks. For moderate rainfall events we observe extension along the direction of the main faults and compression along the orthogonal direction, probably reflecting that the water infiltration preferentially follows the fault gouges.

This contribution shows that it is feasible to extend the application of the so-called “fluvial seismology” to the study of the hydrological evolution of Alpine style streams, even if the discharges are relatively small. This is an example of interdisciplinary studies and may have a potential interest for the civil authorities in charge of the management of hydrological basins.