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# The RHYTMME system: an operational real-time warning and mapping system for flash floods, debris flows, landslide and rock falls in Southeastern France.

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Almost all municipalities of Southeastern France are concerned by natural hazards triggered by heavy rainfalls such as floods, debris flows, landslides and rock falls. Although some tools exist to forecast and monitor heavy rains and floods in France, their spatial resolution sometimes does not meet the needs of local risk managers who have to monitor events at a small spatial scale. In order to improve the risk management in the mountainous and Mediterranean areas of Southeastern France, Irstea and Météo-France have led the RHYTMME project. The goal of this project is to improve the ability to forecast and localize high-risk rainfall-induced hazards in the Provence-Alpes-Côte d'Azur administrative area. This goal is currently under achievement thanks to the implementation of a real-time warning and mapping system for rainfall induced natural hazards, fed by radar data and whose outputs are made available via the Internet to operators in charge of risk management (local and regional authorities, emergency and rescue services, road and rail networks managers, ...).

This system provides maps which display in real-time:
- the radar estimations of rainfall for different rain durations and at the spatial resolution of 1 $km^2$ (Westrelin et al., 2013),
- the estimation of the scarcity of these rainfall estimations, also at the spatial resolution of 1 $km^2$, thanks to a comparison with threshold values provided by a regionalized stochastic hourly point rainfall generator (Arnaud et al., 2007),
- an anticipation of the rivers discharges, computed at the outlet of 1700 watersheds of Southeastern France thanks to the AIGA warning system which combines a rainfall runoff model and an estimation of the scarcity of the discharges thanks to a comparison with threshold values (Javelle et al., 2014).

Maps of susceptibility to debris flow, landslide and rock falls can also be displayed in the RHYTMME warning system along with the real time maps of rainfall hazard (Batista, 2013a, 2013b; Bertrand, 2014). It enables to identify, during intense events, the reaches the more likely to generate and/or to spread debris flow and the areas the more likely to generate landslide and/or rock falls.

The RHYTMME warning and mapping system is now fully operational. It is currently being provided to local authorities (City councils, River boards, . . . ) as well as State authorities in charge of risk managements in the Provence-Alpes-Côte d'Azur administrative area. Training sessions are organized in order to help these end-users to handle the system.

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