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Extreme runoff simulation for a small catchment in the tropical Island of Tahiti, French Polynesia

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The inactive volcanic Island of Tahiti, located in the South Pacific Ocean, is exposed to extreme flood hazards. Its climate is tropical humid and precipitations can reach 10,000 mm/year. The rainfall distribution in Tahiti mostly depends on trade winds strongly modulated by topography. Due to these extreme rainfall events, the island is deeply dissected by erosion, with elongated and small catchments, inducing strong flash-floods.

Our study is focused on the small Titaaviri catchment (about 15 km^2) located in the South-West of the island and crossed by 2 hydroelectric dams. The precipitations are highly variable in the valley, from 3,000 mm/year in the outlet to 8,000 mm/year in the upper valley. Our goal is to establish an event based rainfall-runoff model for this catchment, from only a small data set, both in space and time.

As there is only one rain gauge in the middle of the valley, in operation since 2013, we first derived a whole island extreme flood model, studying the extreme rainfall events from 40 rain gauges spread out over the island and representing 20 years of data. Extreme daily events were analysed by using a Gumbel distribution function and a model of rainfall distribution, with topography inputs parameters (e.g. altitude, azimuth, slope…), was built.

This rainfall distribution model helped us to elaborate the rainfall-runoff model of the valley, which was first calibrated on 40 runoff events recorded by a water level gauge (pressure sensor) in the Titaaviri River. Secondly, extreme runoff with high return periods were simulated using extreme rainfall as input data. Every 50 years, these extreme precipitations can exceed 900 mm/day in the upper valley.