



Rainfall frequency analysis using a hourly rainfall model calibrated on weather patterns: application on Reunion Island

Yoann Aubert (1), Patrick Arnaud (2), Jean-alain Fine (1), and Philippe Cantet (2)

(1) HYDRIS-hydrologie, 5 Avenue du Grand Chene, 34270 Saint-Mathieu-de-Trévières, France, (2) Irstea, UR OHAX, 3275, route Cézanne, 13182 Aix-en-Provence Cedex 5, France

The National Research Institute of Science and Technology for Environment and Agriculture (Irstea) has developed an original method for regional rainfall frequency analysis applied on the whole French territory: the SHYREG¹ method. It is based on a stochastic hourly rainfall generator. The parameters of the rainfall generator were regionalized at the spatial resolution of 1 km² thus allowing for the implementation of the model for every 1 km². Frequency distributions were then derived from long simulated rainfall series for each pixel. Therefore statistical rainfall estimates of various durations (from 1h to 72h) and return periods (from 2 to 1000 years) are made available in a rainfall risk database (intensity-duration-frequency) for the entire French territory.

This article presents the application of the SHYREG method in Reunion Island. Reunion Island (with a 2500-km² surface area) is located in the south-west Indian Ocean. The climate is tropical and characterised by cyclonic rainfall. Tropical cyclones generate heavy rains: during the last one (Bejinsa) in January 2014, rainfall observed exceeded 1000 mm in Cilaos station. Likewise, world records of rainfall, lasting between 5 days (4301 mm in Commerson) and 15 days (6433 mm in Commerson), were observed in Reunion Island during the Hyacinthe Cyclone in January 1980².

In mainland France, the calibration of the hourly rainfall generator depends on two seasons (winter from December to May and summer from June to November). However, in order to account for different types of events during a same season, a specific calibration of the hourly rainfall model was necessary. Four types of rainfall event were defined by Météo-France: cyclones, storms, hard rain and rain. Météo-France rainfall data, evenly located over the Island (52 hourly rain gauge stations and 98 daily rain gauge stations), were used to calibrate the hourly rainfall generator. The SHYREG parameters were regionalized based on 17 physiographic maps of the Island (relief, ocean distance, etc.) with a 1-km² spatial resolution.

For return periods of up to 10 years, the SHYREG-estimated rainfall frequency values are consistent with estimates from the GPD law according to the Nash-Sutcliffe criteria. For extreme return periods, we validate SHYREG-based rainfall frequency estimates according to criteria of reliability and stability³ and compare with the GPD performance. The stability of the frequency analysis method is defined by its capacity to produce similar results when calibrated with different data samples, its reliability by its capacity to assign accurate probabilities of occurrence to observations. Results from applying both criteria have shown that the SHYREG method is highly stable and reliable compared to the GPD law.

¹ARNAUD, P., et al., 2008. Regionalization of an hourly rainfall generating model over metropolitan France for flood hazard estimation. *Hydrological Sciences Journal*, 53 (1), 34-47.

ORGANDE, D., et al., 2013. Régionalisation d'une méthode de prédétermination de crue sur l'ensemble du territoire français : la méthode SHYREG. *Revue des Sciences de l'Eau*, 26 (1), 65-78.

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²DEPARTEMENT DE LA RÉUNION-DIRECTION DÉPARTEMENTALE DE L'AGRICULTURE-SERVICE DE L'AMÉNAGEMENT HYDRAULIQUE 1980. *Esquisse hydrométéorologique des effets du cyclone HYACINTHE sur le département* [online]. Available from: http://www.eaureunion.fr/fileadmin/user_upload/Etudes/ETUDE_00595.PDF

³RENARD, B., et al., 2013. Data-based comparison of frequency analysis methods for extremes: a general framework. *Water Resources Research*, 49 (2), 1-19.