Assessment of probabilistic areal reduction factors of precipitations for the entire French territory with gridded rainfall data

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Assessment of probabilistic areal reduction factors of precipitations for the entire French territory with gridded rainfall data.

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The starting point of our study was the availability of maps of rainfall quantiles available for the entire French mainland territory at the spatial resolution of 1 km^2. These maps display the rainfall amounts estimated for different rainfall durations (from 15 minutes to 72 hours) and different return periods (from 2 years up to 1 000 years). They are provided by a regionalized stochastic hourly point rainfall generator, the SHYREG method which was previously developed by Irstea (Arnaud et al., 2007; Cantet and Arnaud, 2014). Being calibrated independently on numerous raingauges data (with an average density across the country of 1 raingauge per 200 km^2), this method suffers from a limitation common to point-process rainfall generators: it can only reproduce point rainfall patterns and has no capacity to generate rainfall fields. It can't hence provide areal rainfall quantiles, the estimation of the latter being however needed for the construction of design rainfall or for the diagnostic of observed events.

One means of bridging this gap between our local rainfall quantiles and areal rainfall quantiles is given by the concept of probabilistic areal reduction factors of rainfall (ARF) as defined by Omolayo (1993). This concept enables to estimate areal rainfall of a particular frequency within a certain amount of time from point rainfalls of the same frequency and duration. Assessing such ARF for the whole French territory is of particular interest since it should allow us to compute areal rainfall quantiles, and eventually watershed rainfall quantiles, by using the already available grids of statistical point rainfall of the SHYREG method.

Our purpose was then to assess these ARF thanks to long time-series of spatial rainfall data. We have used two sets of rainfall fields: i) hourly rainfall fields from a 10-year reference database of Quantitative Precipitation Estimation (QPE) over France (Tabary et al., 2012), ii) daily rainfall fields resulting from a 53-year high-resolution atmospheric reanalysis over France with the SAFRAN-gauge-based analysis system (Vidal et al., 2010). We have then built samples of maximal rainfalls for each cell location (the "point" rainfalls) and for different areas centered on each cell location (the areal rainfalls) of these gridded data. To compute rainfall quantiles, we have fitted a Gumbel law, with the L-moment method, on each of these samples.

Our daily and hourly ARF have then shown four main trends: i) a sensitivity to the return period, with ARF values decreasing when the return period increases; ii) a sensitivity to the rainfall duration, with ARF values decreasing when the rainfall duration decreases; iii) a sensitivity to the season, with ARF values smaller for the summer period than for the winter period; iv) a sensitivity to the geographical location, with low ARF values in the French Mediterranean area and ARF values close to 1 for the climatic zones of Northern and Western France (oceanic to semi-continental climate).

The results of this data-intensive study led for the first time on the whole French territory are in agreement with studies led abroad (e.g. Allen and DeGaetano 2005, Overeem et al. 2010) and confirm and widen the results of previous studies that were carried out in France on smaller areas and with fewer rainfall durations (e.g. Ramos et al., 2006, Neppel et al., 2003).

References

Allen R. J. and DeGaetano A. T. (2005). Areal reduction factors for two eastern United States regions with high rain-gauge density. Journal of Hydrologic Engineering 10(4): 327-335.
Arnaud P., Fine J.-A. and Lavabre J. (2007). An hourly rainfall generation model applicable to all types of climate. Atmospheric Research 85(2): 230-242.

Cantet, P. and Arnaud, P. (2014). Extreme rainfall analysis by a stochastic model: impact of the copula choice on the sub-daily rainfall generation, Stochastic Environmental Research and Risk Assessment, Springer Berlin Heidelberg, 28(6), 1479-1492.
Neppel L., Bouvier C. and Lavabre J. (2003). Areal reduction factor probabilities for rainfall in Languedoc Roussillon. IAHS-AISH Publication (278): 276-283.
Omolayo, A. S. (1993). On the transposition of areal reduction factors for rainfall frequency estimation. Journal of Hydrology 145 (1-2): 191-205.
Overeem A., Buishand T. A., Holleman I. and Uijlenhoet R. (2010). Extreme value modeling of areal rainfall from weather radar. Water Resources Research 46(9): 10 p.
Ramos M.-H., Leblois E., Creutin J.-D. (2006). From point to areal rainfall: Linking the different approaches for the frequency characterisation of rainfalls in urban areas. Water Science and Technology. 54(6-7): 33-40.
Tabary P., Dupuy P., L'Henaff G., Gueguen C., Moulin L., Laurantin O., Merlier C., Soubeyroux J. M. (2012). A 10-year (1997–2006) reanalysis of Quantitative Precipitation Estimation over France: methodology and first results. IAHS-AISH Publication (351) : 255-260.
Vidal J.-P., Martin E., Franchistéguy L., Baillon M. and Soubeyroux J.-M. (2010). A 50-year high-resolution atmospheric reanalysis over France with the Safran system. International Journal of Climatology 30(11): 1627-1644.