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Using a stochastic hydrological model to study the sensitivity of flood frequency to climate change (France)

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The great interest in climate change during the past 20 years has led to a quasi unanimous conclusion for scientists: the Earth's climate is changing (IPCC 2013). It is important to know if this global change could lead to an increase in extreme events in order to prevent hydrological risks. In this work, the analysis of the climate change impact on flood was studied by a chain formed by projections (provided by climate models under SRES scenarios) and a stochastic hydrological model.

The National Research Institute of Science and Technology for Environment and Agriculture (Irstea) has developed an original method for flood frequency analysis applied on the whole French territory: the SHYREG method (Arnaud et al., 2008). It generates sequentially a lot of rainfall events at an hourly time step for which a rainfall-runoff transformation is performed. The stochastic rainfall generator has three parameters which are estimated by average, not by extreme, values of daily climatic characteristics. Few parameters enable to run the rainfall-runoff model. These parameters have been regionalized on the whole French territory in order to estimate rainfall/flood quantiles at the spatial resolution of 1 km^2. The rainfall model shows a good skill in reproducing extreme rainfall frequency (Carreau et al., 2013) and has been already used in a climate change context to detect trends in extreme rainfall (Cantet et al., 2011).

(Boé at al., 2006) propose climate projections on France at a 8km horizontal spatial resolution with daily rainfall available for two periods: reference period (1981-2000) and the end of the 21th century (2081-2100) under three SRES scenarios (B1, A1B, A2). The parameters of the rainfall model can be easily estimated for the different periods and scenarios and so, the sensitivity of flood frequency to the climate change can be studied under some hypothesis.

First, the performance of the climatic model to reproduce extreme rainfall has been tested throughout the SHYREG method. Then projections were used to estimate flood frequency in a possible future. In the first case, the rainfall-runoff relation is assumed to be stationary –ie- only rainfall parameters change between two periods. This configuration allows focusing only on the impact of a possible rainfall change on the flood frequency. Then different scenarios concerning the parametrisation of the rainfall-runoff model are proposed to underline the consequences of changes in the rainfall-runoff transformation on the flood frequency estimation in the future.

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