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Extreme flood estimation by the SCHADEX method in a snow-driven catchment: application to Atnasjø (Norway)

Emmanuel Paquet (1) and Deborah Lawrence (2)

(1) EDF-DTG, Grenoble, France (emmanuel.paquet@edf.fr), (2) NVE (Norwegian Water Directorate), Oslo, Norway (dela@nve.no)

The SCHADEX method for extreme flood estimation was developed by Paquet et al. (2006, 2013), and since 2008, it is the reference method used by Electricité de France (EDF) for dam spillway design. SCHADEX is a so-called "semi-continuous" stochastic simulation method in that flood events are simulated on an event basis and are superimposed on a continuous simulation of the catchment saturation hazard usingrainfall-runoff modelling. The MORDOR hydrological model (Garçon, 1999) has thus far been used for the rainfall-runoff modelling. MORDOR is a conceptual, lumped, reservoir model with daily areal rainfall and air temperature as the driving input data. The principal hydrological processes represented are evapotranspiration, direct and indirect runoff, ground water, snow accumulation and melt, and routing. The model has been intensively used at EDF for more than 15 years, in particular for inflow forecasts for French mountainous catchments.

SCHADEX has now also been applied to the Atnasjø catchment (463 km^2), a well-documented inland catchment in south-central Norway, dominated by snowmelt flooding during spring/early summer. To support this application, a weather pattern classification based on extreme rainfall was first established for Norway (Fleig, 2012). This classification scheme was then used to build a Multi-Exponential Weather Pattern distribution (MEWP), as introduced by Garavaglia et al. (2010) for extreme rainfall estimation. The MORDOR model was then calibrated relative to daily discharge data for Atnasjø. Finally, a SCHADEX simulation was run to build a daily discharge distribution with a sufficient number of simulations for assessing the extreme quantiles.

Detailed results are used to illustrate how SCHADEX handles the complex and interacting hydrological processes driving flood generation in this snow driven catchment. Seasonal and monthly distributions, as well as statistics for several thousand simulated events reaching a 1000 years return level value and assessment of snowmelt role in extreme floods are presented. This study illustrates the complexity of the extreme flood estimation in snow driven catchments, and the need for a good representation of snow accumulation and melting processes in simulations for design flood estimations. In particular, the SCHADEX method is able to represent a range of possible catchment conditions (representing both soil moisture and snowmelt) in which extreme flood events can occur.

This study is part of a collaboration between NVE and EDF, initiated within the FloodFreq COST Action (http://www.cost-floodfreq.eu/).

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