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Assessment of climate change impacts on floods in Finland

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Climate change impacts on floods in Finland by 2010–2039 and 2070–2099 were estimated to gain a general overview on national scale impacts. General assessments of changes of flood magnitudes are needed to incorporate climate change into planning and because of the EU flood directive. Hydrology in Finland is characterised by strong snow-dominated seasonality with snow accumulation in winter and snow melt in spring, but the temperature gradient from north to south is strong especially in winter. Coastal and southern Finland has a more maritime climate with mild winters. Lakes are an important part of Finnish watersheds especially in the lake region in central and eastern Finland.

Changes in floods were evaluated at 67 sites in different part of Finland with runoff-areas ranging from 86 to 61 000 km2. The hydrological simulations were performed with a HBV-type conceptual hydrological model Watershed Simulation and Forecasting System (WSFS) developed and operated in the Finnish Environment Institute (Vehviläinen et al. 2005). Altogether 20 climate scenarios from both global and regional climate models and with different emission scenarios were used with the delta change approach. The magnitudes of 100 year floods in the reference period 1971–2000 and in 2010–2039 and 2070–2099 were estimated with frequency analysis using the Gumbel distribution.

According to the results, the 100 year floods in Finland decreased on average 8–22 % in 2070–2099 compared to the reference period, but variation between different sites and regions was significant. In areas in northern and central Finland, where snowmelt-floods are the largest floods, the annual floods decreased or remained unchanged due to decreasing snow accumulation. On the other hand, increased precipitation resulted in increasing floods in large central lakes and their outflow rivers in central Finland. Changes in snow accumulation and melt and the importance of this process in flood generation explained much of the changes in floods. A significant shift took place in the seasonal distribution of runoff and flood with increasing autumn and winter floods and decreasing spring floods especially in southern and central Finland. Floods decreased on most sites with most scenarios, but increased in some of the most important flood hazard regions with high potential damages.

The results demonstrate that even within a relatively small area like Finland the impacts of climate change on floods can be vary substantially due to regional differences in climatic conditions and watershed properties. Important explanatory variables in the changes of floods were many present day hydrological and climatological characteristics such as timing of floods, importance of snowmelt-floods, snow water equivalent, winter temperature, latitude, lake percentage and watershed size. These variables can explain most of the average changes in different sites and their explanatory power improves when applied separately to different hydrological regions. The uncertainties included in flood and climate change studies are however still considerable and in many sites the range produced by the 20 climate scenarios was large.