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Norway’s historical and projected water balance in TWh

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Hydroelectric power production is closely linked to the water cycle, and variations in power production numbers reflect variations in weather. The expected climate changes will influence electricity supply through changes in annual and seasonal inflow of water to hydropower reservoirs. In Norway, more than 95 percent of the electricity production is from hydroelectric plants, and industry linked to hydropower has been an important part of the society for more than a century. Reliable information on historical and future available water resources is hence of crucial importance both for short and long-term planning and adaptation purposes in the hydropower sector. Traditionally, the Multi-area Power-market Simulator (EMPS) is used for modelling hydropower production in Norway. However, due to the models’ high level of details and computational demand, this model is only used for historical analyses and a limited number of climate projections. A method has been developed that transfers water fluxes (mm day-1) and states (mm) into energy units (GWh mm-1), based on hydrological modelling of a limited number of catchments representing reservoir inflow to more than 700 hydropower plants in Norway. The advantages of using the conversion factor method, compared to EMPS, are its simplicity and low computational requirements. The main disadvantages are that it does not take into account flood losses and the time lag between inflow and power production. The method is used operationally for weekly and seasonal energy forecasts, and has proven successful at the range of results obtained for reproducing historical hydropower production numbers. In hydropower energy units, mean annual precipitation for the period 1981-2010 is estimated at 154 TWh year-1. On average, 24 TWh year-1 is lost through evapotranspiration, meaning runoff equals 130 TWh year-1. There are large interannual variations, and runoff available for power production ranges from 91 to 165 TWh year-1. The snow pack on average peaks in the middle of April at 54 TWh, ranging from 33 to 84 TWh. Given its simplicity, the method of using conversion factors is a time and computational efficient way of producing projections of hydropower production potential from an ensemble of climate model simulations. Regional climate model (RCM) projections are obtained from Euro-Cordex, and precipitation and temperature are bias corrected to observation based datasets at 1 km2. Preliminary results, based on an ensemble consisting of 16 members (8 RCMs, RCP4.5 and RCP8.5) and transient hydrological simulations for the period 1981-2100, indicate an increase in hydroelectric power production of up to 10 percent by the end of the century, given the effect of climate change alone. The expected increase in temperature causes a negative trend for the energy potential stored in the annual maximum snow pack. At the end of the century (2071-2100), the maximum snow pack holds 43 TWh and 30 TWh for RCP4.5 and RCP8.5, respectively, compared to 54 TWh in 1981-2010. The substantial decrease in the peak snow pack is reflected in the seasonally more even inflow to reservoirs expected in the next decades.