Hydrological Projections under Uncertainties from Hydrological Models and Meteorological Inputs

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12 May 2017

11:30 a.m.

Conference Room, 3/F, Mong Man Wai Building

Global warming brings about considerable impacts on the hydrological cycle and water hazards. Projections of future possible hydrological conditions, such as streamflow and floods, are usually conducted based on hydrological models (HMs) driven by meteorological variables simulated from Global Climate Models (GCMs). Under the same future climate scenario, outputs of different GCMs can vary. Similarly, hydrological simulations from different HMs driven by the same GCM can be various. At the same time, downscaling techniques that solve the spatial resolution differences between GCMs and HMs further introduce uncertainties in hydrological projections. The first part of the study projects future changes in hydrological conditions across China, especially floods and water availability, based on 40 combinations of eight HMs driven by five GCMs, and evaluates uncertainties associated with HMs and GCMs. The results show that increasing floods but decreasing water availability is detected in south China under Representative Concentration Pathway 8.5 scenario, implying that this region may face greater threats from flood hazards but also endure less available water resources which may worsen the conflict between water demand and availability. The insignificant changes in precipitation combined with increased evapotranspiration may reduce water availability. In north China, both floods and water availability increase. Uncertainties from GCMs/HMs predominate the uncertainties in the wet/dry areas in eastern/northwestern China. Model agreements are higher in simulated floods than water availability because increasing precipitation extremes are more consistent among different GCM outputs compared to mean precipitation. The control experiments in the second part of the study show that the increase in inter-daily variability of precipitation and temperature, which is an important statistical feature of more extreme climate but usually ignored in statistical downscaling, can lead to considerable changes in long-term hydrological simulations.

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