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# The water demand from China's coal-fired power plants under shared social-economic pathways (SSPs): a unit-level study

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The coal-fired power is the largest water-demand industry in most countries. In China, it accounts for 7.8% of the total water consumption in 2016. Therefore, it's significant to estimate the future water withdrawal from coal-fired power industry and its geographical distribution for addressing water shortage problem. Previous studies mainly focus on the historical water scarcity or regional water stress in future, few study research the high-resolution water stress in future with climate model projection. In this study, we analyze the geographical characteristic of the installed capacity, electricity production and water withdrawal, using the unit-level dataset of China's coal-fired power plants(CPPs) we developed. To further shed light on the uncertainty of future electricity demand, we use the shared socio-economic pathways(SSPs) including the uncertainty from economic and population, which help us identify the regions that face serious water stress problem.

Method
(1) High-resolution dataset of CPPs
We collect and sort out large amount information of coal-fired units in China and build up a dataset including 7093 units that are retired, operating, under construction or planned in 2017. The dataset includes nameplate capacity, status, fuel type, cooling technology, types of water sources, and location for each unit.
(2) The development scenarios of coal-fired power industry
Based on a multi-regional energy system model built by Tsinghua University, we calculate the development pathway of CPPs in China under different SSPs. The rules of new constructed and retired units are set mainly depending on the lifetime, technology and pathway constraint. Also, we get the geographical distribution of the units under SSPs.
(3) Water stress module
With the help of climate projections data from CMIP5, we calculate the available water of each grid($1^\circ \times 1^\circ$) and estimate the water stress caused by coal-fired units in different regions.

Results
(1) The water withdrawal trend is different in different regions under SSPs.
Under the assumption of constant water use efficiency, the total water withdrawal will drop by 28% in 2050 compared to 2017 under the moderate development scenario (SSP2, continuing to build the already planned CPPs), and decrease by 70% under the faster coal-electricity-out scenario (SSP1, it means no new constructed coal-fired units). However, the trend is not geographically balanced because some regions increase, such as, Ningxia and Xinjiang.
(2) Climate change will lead to greater water stress in some regions.
The climate projection from CMIP5 show the overall precipitation will increase by about 5% in 2050s but little changes are observed in northwest of China. This change results in that water stress problem becomes more serious considering the water withdrawal increase in those regions under SSP2.
(3) Technology optimization will reduce the water stress
In conclusion, if no extra water-saving policy, the development of CPPs will lead to more serious water stress problems in some regions. Meanwhile, as the efficiency of air-cooled units is 5 times that of water-cooled units, the structure optimization of installed capacity will reduce half of water withdrawal if water-cooled units are replaced by the air-cooled in Northwest China under SSP1.