



China's water, energy and food nexus - an assessment of the sustainability of the "3 Red Lines" water policies in the Haihe Basin

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Population growth and economic development continue to put increasing pressures on China's limited resources which are further exacerbated by the country's substantial regional variations in both natural and socioeconomic conditions. China's pursuit of water, energy and food security faces trade-offs and tensions and the Haihe Basin exemplifies these issues. The river basin contains the capital region of Beijing, Hebei and Tianjin which are already experiencing stress and shortfalls of water resources as a result of intense competition for limited resources. To tackle water scarcity and promote more sustainable use of water, the government has implemented national and regional "3 Red Lines" water policies but they are not integrated with energy and food policies. The aim of this analysis is to assess the sustainability of the regional "3 Red Lines" water targets and their compatibility with energy and food security.

This study uses a spatially-explicit, integrated resource model which integrates a hydrological model (GWAVA) with energy and food sub-models in order to analyse current and future resource availability and demand. To assess resource futures, different demand and supply scenarios were analysed up to 2030. Results are visualised as maps and connected Sankey diagrams and outputs are compared with the "3 Red Lines" water targets as well as against indicators related to land and energy policies.

The results show that under a business-as-usual scenario, total water demands for Beijing, Tianjin and Hebei are unlikely to comply with future water targets. Reducing water use in the industry and agriculture sectors will be critical in this water-scarce region and whilst efficiency improvements are important, technology choices appear to make the most significant impact e.g. irrigation method for agriculture and cooling technology for power generation. However, both these water saving-measures have trade-offs in energy consumption. Proposed water saving plans of changing the cropping system to grow less wheat could also significantly reduce the demand for water but has trade-offs in maintaining national food security. Given the region's limited water availability, growing demands from competing sectors as well as groundwater use restrictions, future supply will become more reliant on other sources i.e. water transfer, desalination and recycled water which are all power intensive. The approach used in this study enables the identification of critical trade-offs between resource security measures and policies. This would allow decision makers to visualise and better understand the inter-dependencies between resources and not be blindsided by unintended consequences in the pursuit of energy, water and food security.