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A distributed integrated flow and salt transport model of Yanqi Basin, Xinjiang, China

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Abstract

Water resources play an important role in economic development, especially in arid and semiarid areas with little rainfall and high evaporation. Consequently in China's arid and semi-arid West, the water resources are under great pressure to satisfy the increasing water demand in agriculture and urban and industrial expansion in the last decades without jeopardizing water dependent ecosystems. The Yanqi Basin in Xinjiang is a good example. The enlarged cultivated area, long-term flood irrigation and an inefficient drainage system have resulted in the rise of groundwater levels under the irrigated area. Phreatic evaporation led to salinization of the top soil. Due to the water abstraction by agriculture, the level of the downstream Bostan Lake has dropped. While the drainage has improved the soil salinization problem, it has increased lake salinity and caused damage to the lake ecosystem. Finally, the riverine forests of Populus Euphratica in the downstream area are endangered by the reduction of water flow. This results in a big challenge for decision makers to achieve sustainable water resources development. As the salinity is the limiting parameter for sustainability, the salt distribution in the soil, the lake and the rivers as a function of agricultural activity and water management decisions has to be adequately understood. An integrated 3D distributed model of Yanqi Basin based on MikeSHE/Mike11 software is constructed considering the channel flow, unsaturated flow, saturated flow and their interactions as well as the transport of dissolved salts expressed as TDS. The integrated flow and transport model is calibrated on the basis of 46 years of observation data concerning groundwater level, lake level, river discharge, river water concentration, lake water concentration, irrigation drainage, salt drainage and others. The model is used in the analysis of scenarios to identify a strategy of sustainable water resources management in the Yanqi basin. Results indicate that present intensity of agricultural use is not sustainable in the long-term. Reduction of water use by drip irrigation and reduction of phreatic evaporation by partially using groundwater for irrigation go a long way to ensure sustainability but are not sufficient.