

Recent changes in the water and ecological condition at the arid Tarim River Basin

Weihong Li, Chenggang Zhu and Yapeng Chen

*State Key Laboratory of Desert and Oasis Ecology, Key Laboratory of Ecological Safety and Sustainable Development in Arid Lands, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi, China
Email: liwh@ms.xjb.ac.cn*

Abstract: The Tarim River basin, located in the mid-latitude and extremely arid region of the northern hemisphere, has experienced the most prominent warming during the past few decades. Characterized by scarce water resources and a fragile ecological system, this region is strongly affected by climate change and human activities, which has intensified agricultural water consumption, exacerbated the already-serious water crisis, and aggregated the deterioration of the ecological environment.

With the rapid increase in the use of irrigation water, ecological water has been seriously squeezed out, causing large areas of desert vegetation to die. To alleviate deterioration of the ecological environment and promote socio-economic development in the Tarim River Basin, the government initiated the “Comprehensive Control Project of the Tarim River Basin” in June 2001, focusing on water saving in the irrigation area, including reconstruction of plain reservoirs, groundwater exploitation and utilization, ecological reconstruction and construction of mountain reservoirs.

Under global warming, the climate has experienced significant warming during 1961–2020, and the most dramatic increase has occurred since the mid-1980s. The temperature increased at a rate of 0.224 °C per decade. For precipitation, about 72.3% meteorological stations experienced significant increase, with an average increasing rate of 7.47 mm per decade. The increased precipitation and temperature and the resulted hydrological and ecological changes lead to a hot debate about the “warm-wet” trend.

This study systematically investigated the changes in water resources and ecological conditions in the arid Tarim River basin under climate change and human activities. Thanks to the “Comprehensive Control Project”, the groundwater level has been lift, the surface water area has increased, the NPP has increased, and the vegetation carbon sinks also increased for the lower reaches of the Tarim River. Note that the most ecologically beneficiary area from this project is mostly located in the lower reaches of the Tarim River Basin. For the entire basin, the changes in climatic factors dominate the changes in hydrological and ecological processes. Climatic changes cause changes in the accumulation and ablation of snow and glaciers, which resulted in changes in hydrological processes. The total lake area in the Tarim River has expanded at a rate of 23.79 km² per year during 2012–2021. The runoffs of the four headwaters (i.e., Kaidu River, Aksu River, Yarkant River, Hotan River) of the Tarim River have also increased by a rate of 2.06×10⁸m³, 2.11×10⁸m³, 1.12×10⁸m³ and 2.56×10⁸m³ per decade, respectively. However, the changes in ecological systems don't reflect the wetter trend in the Tarim Basin. The negative effects of climate change on the region's vulnerable ecology have intensified. Potential evaporation decreased at a rate of 41.66 mm/10a per decade prior to the mid-1990s, and inverted to increase at a rate of 56.68 mm per decade. Prior to 1998, the normalized difference vegetation index (NDVI) of natural vegetation exhibited an increasing trend at a rate of 0.012 per decade, but from 1999 onwards, the NDVI started decreasing at a rate of 0.005 per decade. The bare soil areas of the Taklamakan Desert boundaries expanded by 7.8 % since 1990.

This study comprehensively investigated the changes in water resources and ecological conditions in the arid Tarim River basin under climate change and human activities. The human endeavours do a great job in improving the ecological conditions in the lower reaches of the Tarim River Basin, while the entire basin is greatly influenced by climate change.

Keywords: *Climate change, comprehensive control project, water resources, ecological condition, Tarim River Basin*