


INVITED

## Spatiotemporal variation of water resources system vulnerability in the Upper Yangtze River, China

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**Abstract:** Influencing socio-economic development and ecological environment, water resources system vulnerability (WRSV) assessment is becoming increasingly prevalent. The high mountain areas are sensitive to climate change. Increasing extreme events (drought and flood) affected by climate change may exacerbate the WRSV in high mountain areas. The Upper Yangtze River (UYZ), located in hinterland of the Tibetan Plateau, was selected for assessing spatiotemporal variations in WRSV and identifying the main influencing factors of WRSV for historical period (2001–2019) and future period with global warming of 1.5°C and 2°C. The spatiotemporal variations of WRSV were estimated considering impact of natural and human activities on WRSV, which put forward a framework including sensitivity, exposure, hazard (drought/flood intensity and duration) and adaptability. To obtain the future evolution of WRSV, SPHY (Spatial Processes in Hydrology) model and GCMs (General Circulation Models) were adopted. Moreover, the attribution analysis was applied to evaluate main influencing factors for variations of historical and future WRSV. The results indicated that basin average WRSV of UYZ corresponded to medium-low grades for historical period with higher and more pronounced increasing trend in downstream areas than that of upstream areas. In the future, WRSV under different scenarios (SSP 1-2.6, SSP2-4.5, SSP3-7.0 and SSP5-8.5) would continue to be of medium-low grade. However, the area ratio for medium vulnerability and medium-high vulnerability would increase. The attribution analysis showed that the increasing hazard level was the main factor controlling WRSV variation, which contributed more than 93% of changes in historical and future WRSV. The findings highlighted that climate change may increase the WRSV of the UYZ and negative impact of droughts/floods on WRSV should be paid attention to. These findings provide a scientific basis for suitable countermeasures to manage adverse effects brought by climate change and achieve sustainable social-economic development.

**Keywords:** *Water resources system vulnerability, Upper Yangtze River, climate change, hazard levels*