Carbon and water relationships change nonlinearly along elevation gradient in the Qinghai Tibet Plateau

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Abstract

The terrain elevation affects the carbon and water ecosystem services by redistributing heat and energy. The Qinghai Tibet Plateau (QTP) is known as the "Third Pole of the Earth" and the "Water Tower of Asia," which has the most significant elevation range in the world. However, existing knowledge and understanding of the complex elevation gradient (EG) effects on carbon and water services and their relationships (ESR) are still limited. Here, the moving window method, generalized additive model (GAM), and structural equation model are used to explore ESR dynamics along the EG. From 2000 to 2018, the annual mean values of carbon storage (CS) and water yield (WY) in the QTP were 50.45 tc/ha and 246.14 mm·a-1, respectively. The results from GAMs show that ESR has a nonlinear relationship with the EG. With the elevation rising, the relationship between EG and CS transforms from positive to negative, and the overall ESR changes from synergy to trade-off. In the QTP, the interpretation degree of natural meteorological factors to CS and WY is higher than socioeconomic factors, while the latter is more important in affecting the ESR. The research results call attention to the influence of the four elevation thresholds (1200, 2900, 5200, and 6500 m) on ESR nonlinearity, carbon water trade-off with CS loss in the south-central part of the plateau under the EG, as well as the coordination of the services in the northeast and southern region. This study can serve as a valuable reference for considering complex terrain gradients to mitigate their potential adverse effects on ecosystem services and human well-being.

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