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Assessing impacts of ecological restoration projects on water conservation function in the Taihang Mountain area, China

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Abstract

The ecological restoration projects (ERPs) sig[1](#fn-0002)nificantly affect the water conservation function (WCF) of the Taihang Mountain area. However, a comprehensive understanding of the ecological effects of water conservation (WC) in different ecological engineering (EE) areas still needs to be improved, which limits the optimization and implementation of ERPs in semi-arid climate areas. In this study, we employed the integrated valuation of ecosystem services and trade-offs (InVEST) model to evaluate the differences in WCF among different ERPs in the Taihang Mountain area. Additionally, we used the structural equation model (SEM) to explore the influence of various factors on WCF, including EE factors. The results showed the following: (1) The total amount of WC in the Taihang Mountain area increased yearly from 2000 to 2020, with an 85.25% increase in 21 years. The WCF showed a trend of transferring to a higher level. (2) The forest recovery (FR) project showed the highest average WC, followed by the grassland recovery (GR) project. FR and GR together provided 61.12% of the WC amount in the EE area. The cropland recovery (CR) project increased the WC by 22.85% compared with the non-ecological engineering area. The WC capacity of the 21-year artificial forest could only reach 70.92% of the natural forest. FR was found to be the most potential ecological restoration type, while CR and GR were the most effective. (3) The enhancement of WCP in the study area resulted from multiple factors. The composite variable SEM revealed four main factors affecting WC (R^2 = 0.427), ranked as follows: climate change > site conditions > EE > society-economy (0.390 > 0.247 > 0.177 > 0.043), of which the EE factor accounted for 20.65%. Precipitation and root depth were the most critical factors affecting WCP, according to the random forest model. (4) The impact of EE on WC varied with altitude, and the effect of the hilly zone was 1.5 times that of the sub-alpine zone. Therefore, the WC effect of ERPs is different due to different types and regions. EE measures should be optimized according to the actual situation to cope with the uncertainty of WC caused by probable extreme climate in the future. Overall, our study provides scientific support for evaluating the impact of ERPs on WCF in semi-arid areas of China.

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