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ANALYZING THE IMPACT OF INFLUENCING FACTORS ON WATER CONSERVATION USING THE XGBOOST–SHAP MODEL: A CASE STUDY IN EASTERN GUANGDONG, CHINA

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Abstract

Assessing water conservation trends and associated drivers across spatial and temporal dimensions is fundamental to supporting data-driven environmental planning. Although prior studies have examined the roles of environmental and anthropogenic variables, limited attention has been given to their nonlinear responses and interactive effects. This study employed the InVEST model to simulate spatial patterns of water conservation in Eastern Guangdong from 2000 to 2020. To further explore the contributions of different variables, an eXtreme Gradient Boosting (XGBoost) model was combined with SHapley Additive Explanations (SHAP) to evaluate the relative importance, nonlinearity, and interaction effects of natural and socioeconomic factors. The results revealed significant spatial differences in water conservation, with higher values concentrated in the northern mountainous areas and lower levels in the southern coastal and urbanized zones. From 2000 to 2020, water conservation capacity declined in rapidly urbanizing regions, while localized increases were observed around reservoirs and river corridors. Natural factors remained dominant, with NDVI as the most important variable, followed by elevation, slope, and precipitation. After 2010, the effects of GDP and population increased, reflecting stronger socioecological coupling. Interactions among drivers became more complex—NDVI generally synergized with elevation and precipitation, but these effects weakened under high development or extreme topography. These findings highlight evolving eco-hydrological mechanisms under urbanization and offer guidance for spatial planning and ecological protection in rapidly developing subtropical regions.

Key words: Eastern Guangdong, InVEST model, water conservation, XGBoost-SHAP model

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