Improved Vegetation Greenness Increases Summer Atmospheric Water Vapor over Northern China

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Abstract

Northern China is an environmentally vulnerable region with a severe water shortage. Several ecological restoration projects since the 1980s have greatly increased vegetation greenness. This study aims to assess the impacts of the changes in vegetation greenness from 1982 to 2008 on the atmospheric precipitable water (PW) over northern China during the summer seasons (June, July, and August, or JJA) using reanalysis PW and satellite vegetation index data. Several statistical methods, such as linear regression (piecewise, stepwise), the Empirical Orthogonal Function (EOF), Pearson's correlation, have been used to explore the variations in and the coupling between vegetation greenness and PW. The influences of three major atmospheric circulations (the East Asian summer monsoon, the South Asian summer monsoon, and the Westerly circulation) have also been considered and excluded. The results show that summer vegetation greenness within the semi-arid western part of northern China, including the Tibetan Plateau, is closely linked to summer PW after excluding the influences

of atmospheric circulations and that vegetation accounts for as much as 30% of the total PW variance. Vegetation greenness in the central and western water-limited regions of northern China has significant (>90% confidence level) positive impacts on summer PW. After investigating the relationships among evapotranspiration (ET), PW and precipitation, it was concluded that strengthened ET driven by increased vegetation greenness makes a major contribution to increased PW. Different from the earlier hypothesis in the literature“only intact contiguous cover of natural forest having extensive borders with larger water bodies is able to keep land moisten up to an optimal for life level everywhere on land”, this study found that interior forest covered regions with adequate water supply can also provide an ET benefit of PW for other regions. This study demonstrates the implications of large-scale ecological restoration projects on the hydrological cycle in arid/semi-arid regions.

Key Words: eco-hydrology, land cover change, remote sensing, regional climate change, evapotranspiration