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Abstract

Landscape Pattern Effects on Surface Runoff: Assessment Using a Hydrologic Model in the Fuhe Basin of Poyang Lake Watershed †

Jianzhong Lu [1,*], Qingqing Yan [2], Hongzhi Wang [2] and Xiaoling Chen [1]

[1] State Key Laboratory of Information of Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan 430079, China; xiaoling_chen@whu.edu.cn
[2] School of Urban and Environment Sciences, Central China Normal University, Wuhan 430079, China; zijin18372553258@163.com (Q.Y.); wanghongzhi@mail.ccnu.edu.cn (H.W.)
* Correspondence: lujzhong@whu.edu.cn; Tel.: +86-27-68778755
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A series of urgent issues such as global warming, frequent natural disasters, and water shortages are largely the result of heavy human interference and its induced changes in landscape structure. How the landscape pattern variation impacts the surface runoff remains an unsolved issue for water resource management. In recent decades, actions of ecological environment protection and projects of returning farmland to forests and grasslands have significantly changed the landscape pattern in the Fuhe Basin of Poyang Lake watershed, which will inevitably affect the hydrological cycle of the basin. In this study, the SWAT (Soil and Water Assessment Tool) model for the Fuhe Basin was first built to predict the runoff depth for the divided 31 subbasins during three periods from 1990 to 1999, 2000 to 2008, and 2009 to 2013. Meanwhile, dynamic changes of landscape patterns were analyzed based on the land use and cover data in the years 1990, 2000, and 2008. Finally, correlations between different landscape indexes and surface runoff were quantified over subbasins through Spearman Correlation analysis. Results showed that the SWAT model was applicable in the Fuhe Basin with R^2 (coefficient of determination) and E_{ns} (Nash–Sutcliffe efficiency coefficient) larger than 0.85 for runoff prediction. As for the landscape indexes, the fragmentation degree increased and then decreased during the three periods. The landscape patches' shape became more complicated, while connectivity of different landscapes decreased and then increased during the three periods. The forest and paddy field have the greatest degree of fragmentation among all the landscape types. Forests have a larger degree of dominance, which was highly connected to patches of other landscape types. According to the changes in landscape patterns from 1990 to 2008, the smaller the fragmentation degree, the more complex the patch shape, and more uneven distribution of landscape patches led to more precipitation interception and runoff reduction. From the perspective of the landscape type, the landscape area ratios (PLAND) of dry land, paddy field, water area, and urban and rural construction land patches have a significantly positive correlation with surface runoff, while PLAND and FRAC_AM (Area Weighted Patch Fractal Dimension) indexes of forestland have a significantly negative correlation with surface runoff. The complexity of forestland patch shape strengthened the interception of rainfall and plant transpiration, which would reduce water yield. The expansion of urban impervious area, aggravating landscape fragmentation, reduced runoff interception, and increased surface runoff, which can be indicated by positive relation with PLAND and FRAC_AM of urban construction. Deeply understanding surface runoff

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alternations induced by landscape patterns changes would not only provide scientific support for sustainable utilization of water resources but also offer best management practices (BMPs) for land management.

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