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森林与径流关系的模拟与分析

Modeling and Analysis of the Forest-Runoff Relations

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关键词:

森林与径流关系； 空间变化； 植被与水文模拟； 机理分析； 长江上游山区； Forest-Runoff Relationship； Spatial Variation； Dynamic Vegetation and Hydrology Modeling； Mechanism Analysis； Mountain Region in the Upper Reaches of the Yangtze Basin

摘要:

为了揭示森林与径流关系的空间变化及原因，用生物物理/动态植被模型SSiB4/TRIFFID与TOPMODEL的耦合模型SSiB4T/TRIFFID模拟了西南山区长江上游的梭磨河流域不同气温下植被演替及蒸发与径流的动态响应过程，分析了气温变化对森林–径流关系的影响及机理。控制试验模拟结果表明：1) 由于亚高山区气温低雨季冠层湿润分数高，在蒸散三个分量中植被蒸腾最小，森林蒸腾与草和灌木差异小，流域蒸散在植被从C3草到灌木演替阶段增加并达到最大值，在植被从灌木到森林演替阶段减小甚至低于裸土蒸发，因此增加了流域径流量。2) 温度敏控制试验减小1.5℃，由于森林冠层蒸散减小幅度大于草和灌木使森林增加径流的作用增加。3) 气温敏控制试验增加2.0℃，森林冠层截留蒸发较草和灌木明显增加，蒸腾也高于草和灌木，森林对径流的影响已不明显。当气温敏控制试验增加5℃，森林蒸腾和冠层截留蒸发较草和灌木明显增加，森林覆盖流域总蒸发最大，森林减小了径流量。随着山区海拔高度下降，森林对径流的影响将发生从增加径流量到对径流量影响不大和减小径流量的变化。由于森林冠层温度和冠层阻力对气温变化比草和灌木敏感，导致对于相同的气温减小(增加)幅度森林冠层截留蒸发和蒸腾的减小(增加)幅度均大于草和灌木，通过这种机制气温变化造成森林与径流的关系发生变化。

In order to reveal the spatial variation of the relationship between forests and runoff and explore the mechanism numerical simulations of the responses of evaporation and runoff to the dynamic changes of vegetation over the Suomo basin (a tributary of the Yangtze River in the mountain region of southwestern China) are conducted under different temperature change scenarios by using the coupled model SSiB4T/TRIFFID (Plant Dynamic Vegetation Model TRIFFID and TOPMODEL are integrated into the land surface model SSiB4). The impacts of temperature changes on forest-runoff relationship and the mechanism are ana-lyzed. The results of control test show that in wet season canopy wetness fraction is high in the subalpine re-gion of southwestern China duo to low temperature. Transpiration is the minimum among three components of evapotranspiration. Transpiration of forests is no significant difference with transpiration of grass and shrub. The evapotranspiration of the basin increases and reaches its maximal value during the period of C3 grass succession into shrub and then decreases during the period of shrub succession into forest and reaches its

minimal value which may be less than bare soil evaporation. As a result forests increase the total runoff of the basin. A decrease in temperature by 1.5°C enhances such effect of forests duo to more decrease in water loss through canopy interception evaporation and transpiration of forests. An increase in temperature by 2°C enhances the rate of transpiration and evaporation of forests more than that of grass and shrub. As a result forests have no significant effect on runoff. Temperature rises to 5°C will cause forests turn to reduce runoff duo to more significant increase in water loss through canopy interception evaporation and transpiration of forests. As elevation decreases (temperature increases) in the mountain region of southwestern China the role of forests to increase runoff will change to be that forests have no significant effect on runoff and forests reduce runoff. The results also indicate that canopy temperature and canopy resistance of forests are more sensitive to temperature changes than that of grass and shrub. As a result canopy interception evaporation and transpiration of forests are more sensitive to temperature changes which cause that more significant increase or decrease in forest canopy evapotranspiration with temperature increase or decrease than that of grass and shrub. Through such mechanism changes of temperature cause the changes of forest-runoff relationship.

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