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Ecosystem function for water retention and forest ecosystem conservation in a watershed of the Yangtze River

Abstract

The ecosystem function for water retention in a watershed of the Yangtze River was discussed in this study. The watershed was divided into 90 types of vegetation–soil–slope complex. A GIS-embodied spatial database was used to explore the relationships between the capacity of water retention by a complex and its types of vegetation, soil and slope. Furthermore, the capacity of water retention of every complex was estimated statistically by using estimation models. The spatial distribution of various capacity of water retention in the watershed was demarcated on a map based on the attributions and the locations of complexes. In addition, we evaluated integrally the situation of water retention in the watershed based on the estimation for the complexes from which it was distinctly recognized that the serious situation mainly results from the poor capacity of water retention of vegetation. The variation-location effect describes the phenomenon in which an identical variation of a factor may produce different effects on overall situation, when this variation occurs in a different spatial location. According to the variation-location effect on the expansion of forestland, a strategy 'spatial pattern-based forestland extension' was proposed to conserve forest ecosystem and improve the situation of water retention in the watershed.

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Ecosystem function for water retention and forest ecosystem conservation in a watershed of the Yangtze River

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Key words: conservation, ecosystem function, forest, spatial pattern, the Yangtze River, water retention, watershed

Introduction

Ecosystem services such as climate regulation, water regulation, water supply provide a major contribution to human society and accrue directly to humans without passing through the money economy (Costanza et al. 1997). To better recognize the multiple benefits of ecosystem services, a number of studies (McNeely 1993; Cacha 1994; Groot 1994; Hyde and Kanel 1994; Kramer and Munasinghe 1994; Lacy and Lockwood 1994) have conducted the economic and ecological assessments of ecosystem services. Peters et al. (1989) assessed the economic value of a tropical Amazon rainforest in Brazil and proposed a strategy to use rainforests in this region. Pearce and Moran (1994) discussed the methods of economic valuation used in different biological resources and their interpretations, and estimated the economic values of tropical forests, wetlands, rangelands and marine systems worldwide. Gren et al.

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(1995) calculated the economic value of Danube floodplains. In addition, Costanza et al. (1997) evaluated the world's ecosystem services and natural capital. Recently, Guo et al. (2000) assessed the ecosystem service for forest ecosystems regulating water flow to increase the output of a hydroelectric power. These researches have shown that ecosystem services are of great importance to human society.

Ecosystem services represent the benefits human populations derive, directly or indirectly, from ecosystem functions. Ecosystem functions refer variously to the habitat, biological or system properties or processes of ecosystems. In some cases a single ecosystem service may be the product of two or more ecosystem functions whereas in other cases a single ecosystem function contributes to two or more ecosystem services. Therefore, the valuation of ecosystem service should always be based on the estimation of the capacity of ecosystem function. Here we primarily concentrated on the estimation of the ecosystem function relating to water retention – the absorption and storage of rainwater. This contributes to two types of ecosystem service, i.e., water supply and water regulation (Costanza et al. 1997; Guo et al. 2000). In the upper and middle stretches of the Yangtze River, water retention is a chief function of terrestrial ecosystems (MOF 1992; MOF 1995; Li et al. 1999). These ecosystems retain rainwater in wet seasons to decrease flood in the river and supply water in dry seasons to supplement the flow. However, this kind of ecosystem function is usually ignored because of lack of understanding. A striking illustration is that the area of forest ecosystem, providing the largest capacity of water retention in this basin, is being progressively reduced. Inappropriate exploitation and strong economic pressures have resulted in ecologically sensitive natural forests being harvested but not well regenerated. Land conversion was also a common phenomenon. These factors have led to decrease the capacity of water retention of the Yangtze River basin. The loss caused by the catastrophic flood in1998 was shocking. It was reported that the regular life of about 24 million people suffered from that flood and that 2000 persons died as a consequence. The area of farmland affected by this flood reached 2.2 million ha (PDN 1998). Scientists have repeatedly stressed the connection between the recent rapid loss of tree cover in the southern provinces and the reduced capacity of water retention, increased erosion, and more destructive floods in the Yangtze River (Wang 1993). To improve the situation, Chinese government has planned to establish protective forest system to conserve water and soil in the whole of the Yangtze River basin (Albers and Grinspoon 1997). The scale of this project makes it one of the largest afforestation undertakings in the developing world (World Bank 1992; Mather 1993). However, massive campaigns of afforestation in degraded areas were not very effective until the last decade (Yin 1998).

In this study, we have discussed the ecosystem function for water retention in a watershed of the Yangtze River. The watershed is located in the Xingshan County of Hubei Province, China (110°25′–111°06′ E, 31°03′–31°34′ N). It has an area of about 231 600 ha and forestlands of 107 000 ha (about 46.2% of the total country).

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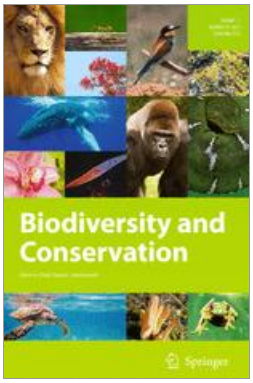
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