The Environmental Effect of Soil Erosion and Element Runoff in the Songhua Lake Valley

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Abstract: Under the condition of the different precipitation intensity, different gradient, different land use and different vegetation coverage, the soil erosion and transference of element (or pollutant) are researched by simulating and sample analyzing for the experimental-district of the surface runoff in the catchment area which is about 43,370.8km^2. And the influencing factor that produces the spatial difference is analyzed and assessed. It's put forward that the irrational utilization of land is the reason of soil erosion and pollutant runoff. The gradient of agro-land, the growth period of vegetation and the vegetation coverage are the chiefly restricted factors which lead to the soil erosion and pollutant runoff. Our study provides the fundamental data for comprehensively planning and mainly harnessing of the non-point source pollution in the valley.
Keywords: soil erosion, pollutant runoff, type of land use, vegetation coverage

Introduction

The soil erosion and pollutant runoff are the main origin of water pollution in the valley. Because of the complexity and the uncertainty of the non-point source pollution, the investment and assessment of pollutant load are very difficult and the calculation of the pollutant load quantity is inaccurate. By far many scholars have studied the course of rainfall, the soil erosion, the influencing factors and transference rules of the pollutant[1—5]. And they have made such academic and practical models as chemical pollutant runoff model[6]. But the study methods have restrained the analysis on the soil and pollutant runoff under the complicated conditions.

The article researches the influencing factors and transference rules of the pollutant and analyzes the restricted factors under the condition of different precipitation intensity, different gradient, different land use and different vegetation coverage by simulating and sample analyzing for the experimental-district of the surface runoff in the catchment area. According to the conclusion we can comprehensively harness the soil erosion in the valley.

1 Study area and test methods

1.1 Study area

Songhua Lake lies in the east half-mountain area of Jilin Province (41°40′—43°48′N, 125°41′—128°48′E). The lake is strait, long and curving along the valley. The area is 550km^2 , the capability is 1.08×10^{10}m^3 and the catchment area is 43,370.8km^2. The lake water is controlled by the

power plant. The songhua lake is the biggest manpower lake in Jilin Province. It has such functions as providing drinking water, breeding aquatics, generating electricity, irrigation, shipping, junketing and so on.

Songhua lake is the typical northeast plain-hill lake. The terrain is complicated, the southeast is high and the northwest is low in the valley. The type of physiognomy is various which includes mountain, hill, mesa and plain, so it is also called"seven-mountain, two-hill and one- plain". In the past decades of years, the type of land utilizing has changed greatly and the soil erosion is very serious because of the increasing of population and the development of industry and agriculture. The water quality of Songhua lake is worsen and worsen and it is an eutrophic lake now[7].

1.2 Test methods

According to the type of land utilizing we built up the experimental-district and monitored the rainfall in order to study the rules and influencing factors of soil erosion and pollutant runoff in the valley. Under the conditions of different rainfall, different gradient, different type of land using and different vegetation coverage, we analyzed the single and synthesis effects on soil erosion and pollutant runoff.

According to the new aviation photos, we simulated such physical geography factors as the terrain gradient, soil type, land using type and vegetation coverage by GIS, then we calculated the quantity of soil erosion by USA current soil erosion equation under different rainfall. We built up 10 kinds of experimental-districts including dry land, paddy field, woodland, grassland, residential area, bare land, bottomland and so on in different gradient. The area is 2m×2m—5m×5m.Under the condition of rainfall＜20mm/h,30mm/h and the rainfall＞50mm/h, we took the runoff samples and filtrated the runoff by 0.45μm film, then we calculated the pollutant erosion modulus and erosion quantity on the analysis of the N, P and Hg concentrations under the different conditions.

2 Analysis and discussion of the results

We analyzed the pollutant concentration and the pollutant erosion status under different conditions such as different rainfall intensity, different terrain gradient and different land using type.

2.1 The effects of rainfall intensity

In the different type of experimental-district with the same gradient, we collected the runoff samples and analyzed the N, P and Hg concentrations in the condition of different rainfall.(Table 1)

Table 1 The pollutant concentration in the condition of different rainfall and different land using type

Concen-tration \ Rainfall / Land using	＜20mm/h			＞50mm/h		
	Total-N (mg/L)	Total-P (mg/L)	Total-Hg (μg/L)	Total-N (mg/L)	Total-P (mg/L)	Total-Hg (μg/L)
Dry land	7.42	1.74	0.30	9.73	3.01	1.30
Woodland	2.22	0.44	0.34	6.54	1.68	0.34
Grassplot	6.03	0.65	0.59	9.87	0.48	0.30
Residential area	3.21	0.65	0.98	5.04	0.79	0.61

It was revealed from above table that the effects of rainfall intensity on the soil erosion and pollutant runoff are obvious and regular. The more the rain is, the more the soil erosion and the more the pollutant

concentration. Because the rain splash down and scour the soil, the soil erosion is controlled by the rain intensity. This is a universal rule and it could not be changed by human.

2.2 The effects of gradient

Under the same rainfall(＞50mm/h) and different gradient, the soil erosion and pollutant runoff changed regularly.(Table 2)

Table 2 The pollutant concentration in the condition of different gradient

Rainfall / Concentration / Gradient	＜20mm/h			＞50mm/h		
	Total-N (mg/L)	Total-P (mg/L)	Total-Hg (μg/L)	Total-N (mg/L)	Total-P (mg/L)	Total-Hg (μg/L)
＜17.5°dry land	3.084	0.579	1.05	5.477	2.675	1.77
＞17.5°dry land	7.328	1.414	1.53	8.08	2.565	1.81
18°woodland	0.47	0.09	——	1.21	0.05	——
29.5°woodland	0.12	0.11	——	1.75	0.35	——

Under the condition of middle rainfall, the concentration of total-N in big gradient dry land is 1.3 times of the concentration of total-N in small gradient dry land. Under the condition of strong rainfall, the erosion of total-N in big gradient dry land is 0.5 times of the total-N in small gradient dry land, the difference of total-P and total-Hg is small. The effect of gradient in woodland is not obvious. The results show that the terrain gradient is not the mainly restricted factor of physical vegetation but it is the important restricted factor of plowland because the crop could not hold up the soil in the condition of strong rainfall.

2.3 The effects of the land utilizing type

Under the condition of same rainfall intensity and same gradient, the land using type affects the pollutant erosion strongly.(Table 3)

Table 3 The pollutant concentration and erosion modulus of different land using type

Concen-trion / Land / Pollutant	Dry land		Woodland		Grassplot		Residential area	
	concentration (mg/L)	erosion modulus (g/(m^2 • a))	concentration (mg/L)	erosion modulus (g/(m^2 • a))	concentration (mg/L)	erosion modulus (g/(m^2 • a))	concentration (mg/L)	erosion modulus (g/(m^2 • a))
Total-N	7.38	5.69	2.22	1.42	4.28	2.86	5.04	0.0126
Total-P	0.71	0.46	0.44	0.28	0.65	0.42	0.79	0.002
Total-Hg	0.30	0.23	0.34	0.20	0.59	0.38	——	——

Notes: concentration unit of total-Hg is μg/L, erosion modulus unit of total-Hg is mg/(m^2 • a)

The pollutant concentrations in dry land and residential area correspond to the study of other academicians in China[8]. It was revealed from above table that the pollutant erosion modulus in dry land is 1.5—2.5 times of that in woodland and 0.5—1.5 times of that in grassplot. First, there is a great deal of N and P fertilizer, only 20%—30% of them has been absorbed by crops, and other of them moved with rain; Otherwise N and P in woodland and grassplot mainly come from dead vegetation, so the soil erosion

is only a little[9]. Second, the retain ability of plant root system is stronger than that of crop root system. So the type of land utilizing is the mainly restricted factor of soil erosion and pollutant runoff.

2.4 The effects of the vegetation coverage

Under the condition of 50mm/h rainfall, we took samples in different growth period dry land and in different vegetation coverage woodland, then analyzed the results. (Table 4)

Table 4 The pollutant concentration and erosion modulus of different vegetation coverage

Concentration / erosion modulus \ Pollutant / Land using		Total-N		Total-P	
		concentration (mg/L)	erosion modulus ($g/(m^2 \cdot a)$)	concentration (mg/L)	erosion modulus ($g/(m^2 \cdot a)$)
Dryland (corn)	Growth period (short-seeding)	5.86	3.61	0.58	0.29
	Mature period	4.83	3.09	0.393	0.23
Wood-land (arbor)	coverage＜25%	2.2	1.42	0.44	0.28
	coverage＞50%	0.12	0.08	0.17	0.098

It was revealed from above table that the vegetation coverage is an important restricted factor of pollutant erosion under the same rainfall, gradient and land using type. The effect of vegetation coverage is not obvious in dry land because there is fertilizer[10]. The pollutant erosion in mature period is more than that in growth period. The effect of vegetation coverage is obvious in woodland. The concentration and erosion of N and P in low vegetation coverage woodland are more than those in big vegetation coverage woodland, especially more than 2m high shrubs. The results show that the vegetation coverage is the mainly restricted factor of soil erosion and pollutant runoff in physical vegetation; The soil erosion and pollutant runoff are complicated in plowland, they are related to vegetation coverage, growing period, fertilizing period, ridge in a field and crop type.

3 Conclusions

The restricted factors and environmental benefits of soil erosion and pollutant runoff are researched by simulating and sample analyzing for the experimental-district of the surface runoff in Songhua lake valley. The conclusions are:

(1) The change of land utilizing type is the main reason of soil erosion and pollutant runoff. The soil erosion and pollutant runoff are very serious in agro-land because of fertilizing. The soil erosion and pollutant runoff lead to the water pollution so the land utilizing planning in valley is very important.

(2) The pollutant runoff is related to the terrain gradient and crop growth period in agro-land. The pollutant runoff is very serious when monsoon come before the mature period. The effect of gradient in plowland is also obvious. So the gradient and the field-management of crops are the main restricted factors of soil erosion.

(3) The vegetation coverage is the main restricted factor of soil erosion and pollutant runoff in the condition of physical vegetation. The type of vegetation affects the soil erosion indirectly. So the protection of vegetation is very important.

So we should take measures to harness the soil erosion and pollutant runoff. First, the plowland area should be controlled in order to protect the soil, the small-valley management and planning are very important to the land using. Second, many trees and grasses should be planted in the big gradient

plowland, the biological engineering method is good to seed-protection in sloping-plowland. Third, we should plant a great deal of trees to increase the vegetation coverage and reduce the soil erosion.

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