RS & GIS BASED ASSESSMENT OF ADSORPTIVE NON-POINT SOURCE POLLUTION IN EUCALYPTUS AND RUBBER PLANTATION AT THE WATER SOURCE AREA OF HAINAN

Hongjuan Zeng, Donghai Zheng, Shengtian Yang, Xuelei Wang,Yunfei Gao,Zhuo Fu*

State Key Laboratory of Remote Sensing Science, Jointly Sponsored by Beijing Normal University and Institute of Remote Sensing Applications, CAS, Beijing 100875, China;
Research Center for Remote Sensing and GIS, Beijing Key Laboratory for Remote Sensing of Environment and Digital Cities ,School of Geography, Beijing Normal University, Beijing 100875, China;
Email: zhj_eve@126.com

1. INTRODUCTION

Soil erosion causes nutrition transferring into the rivers with runoff and sediment, which not only drops the land productivity but also contaminates the water environment downstream, is an important cause of non-point source pollution. Reclamation of virgin forestry or grassland leads to accelerated erosion and brings lots of nutrition such as nitrogen and phosphorus because of fertilization. Non-point source pollution with soil erosion represents as the adsorptive non-point source pollution. In the last two decades, agricultural non-point source pollution with soil erosion has become a worldwide hot topic because it has brought a considerable economic loss of water pollution which has reached about 2.2 to 7 billion dollars in America. Assessment of soil erosion and non-point source pollution load is an important basis of land management and planning, while Remote Sensing (RS) and Geographic Information System (GIS) provide advantageous data and convenient analysis method.

2. MATERIALS AND METHODS

2.1 Study Area and materials

Songtao Reservoir, located in the northern fringe of tropical zone (109°10’ ~109°45’E and 18°56’ ~ 19°30’ N), is the most important water source region of Hainan Island. The Songtao Reservoir Basin, about 1496km², enjoys advantageous hydrothermal conditions and rich plant resources. The basin has a terrain of lower-mountain hill and an annual precipitation of 1896mm. According to investigation, there has been a great increase of soil erosion and sediment in the rivers in the last decade because of large area of virgin forestry’s exploitation into cultivated eucalyptus and rubber woodland, which directly threw a threat to water security. Therefore, it’s very important to analysis the situation and control scheme of soil erosion in the basin for the protection of water environment.

The main materials contains Landsat TM image which is spatially sampled at 30m, SPOT panchromatic band image which is spatially sampled at 10m, Digital Elevation Model (DEM) at a 1:50000 scale, precipitation data from weather station, analysis data of soil physical and chemical property, and some field measurements.

2.2 Model Description

In the paper, we applied Universal Soil Loss Equation (USLE) [1,2]: $A = R \cdot K \cdot L \cdot S \cdot C \cdot P$ to assess levels of soil loss, where R is rainfall and runoff erosivity factor, K the soil erodibility factor, LS the topographic factor, C the cover management factor, P the supporting erosion control practices factor. The estimation of adsorptive non-point source pollution load is based on $C_a = A \times Q_a \times \eta$, where Q_a is the enrichment ratio of contamination, η the loss

coefficient of nutrition [3].

2.3 Data Acquisition for Modeling Analysis

We estimated the factors of soil erosion and non-point source pollution load by integrating RS and GIS techniques. R was calculated using monthly precipitation[1]; K was estimated using Williams' equation[4] integrating soil map and soil physical and chemical characteristic; LS was calculated using Van's AML arithmetic[5] based on DEM; C was estimated from vegetation cover which was calculated integrating Landsat TM bands and afield measurements; the distribution of eucalyptus and rubber woodland was extracted from a fusion image with TM multi-spectrum band and SPOT panchromatic band and P was set to 1 because the eucalyptus and rubber are cultivated downward grade; Q_a and η was estimated from field observation and experiments[3]. The model was developed by Interactive Development Language (IDL).

2.4 Scene Analysis

We discussed the situation and control scheme of adsorptive non-point source pollution through scene analysis: 1) soil erosion and adsorptive non-point source pollution on eucalyptus and rubber woodland under the status in quo. 2) Adopting soil and water conservation facilities such as parallel ditch and fish-scale pits where the slope gradient was upwards 5 degree, 15 degree, 25 degree, respectively; 3)Conceding the eucalyptus and rubber woodland upwards 25 degree to forestry.

3. RESULTS AND DISCUSSION

The result showed that: 1) Most of the area was lightly eroded while some area has low vegetation cover and steep terrain was strongly eroded and reached acuity degree; 2) In the middle mountain and upland, non-point source pollution with soil erosion was severe because of cracked terrain and concentrated storm rainfall; 3) Reclamation of virgin forestry could brought heavy non-point source pollution especially there was no appropriate measures; 4) Adopting soil and water conservation facilities could control adsorptive non-point source pollution effectively; 5) The government should pay attention to the environmental effect of the reclamation and made some local management policies, such as conceding the land to forestry and implementing soil loss control projects.

4. REFERENCE

[1]Wischmeier W H, Smith D D. Predicting rainfall-erosion losses from cropland east of the Rocky Mountains. USDA Agricultural Handbook, No.282, 1965.

[2]K.G.Renard, G.R Foster, G.A. Weesies, et al. Prediction soil erosion by water: a guide to conservation planning with revised universal soil loss equation. USDA Agricultural Handbook, No.703, 1997.

[3]M.Mihara, N. Yamamoto. Application of USLE for the prediction of nutrient losses in soil erosion processes. Paddy Water Environ(2005)3:111-119.

[4]Williams J R, Renard E P. A new method for assessing erosion's effect on soil productivity. Journal of Soil and Water Conservation, 1983,38(1):381-383.

[5]Van Remortel,R.D., M.E.Hamilton, R.J.Hickey.Computing the LS factor for the Revised Universal Soil Loss Equation through array-based slope processing of digital elevation data using C++executable. Computers & sciences, 2004,30:1043-1053.