# QUANTITATIVE MODELING OF SOIL EROSION BY WATER IN LARGE-SCALE RIVER BASIN USING REMOTELY SENSED DATA

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## 1. INTRODUCTION

Soil erosion by water is the most important land degradation problem worldwide. It creates strong environmental impacts and high economic costs by its effect on agricultural production, infrastructure and water quality, and even threatens global food security. Furthermore, erosion results in emission of soil organic carbon to the atmosphere in the form of CO2 and CH4, causing impact on global warming. Global warming in turn is expected to increase erosion rates. Therefore, accurate estimation of soil loss by water is of great significance to both catchment managers and other stakeholder groups.

Most of the soil erosion models that have been developed in the past to provide information on erosion are inappropriate for providing catchment scale, event-based predictions of sediment loads, because a majority of the erosion research is based on biophysical measures implemented at the field, hillslope or watershed scale. The main limitation for this task is data availability and quality. In general, water erosion is controlled by climatic characteristics, topography, soil properties, vegetation, and land management of the catchment. These characteristics vary within a given catchment in spatial domain. Remote sensing provides homogeneous data over large regions with a regular revisit capability. Recent developments in geographic information system (GIS) techniques have enhanced the capabilities to handle large databases describing the heterogeneities in land surface characteristics. Together these tools of remote sensing and GIS can therefore greatly contribute to catchment-scale erosion assessment.

This study aims to develop a soil water erosion model in large-scale river basin using remotely sensed data and GIS, trying to resolve the problem of erosion assessment at catchment scale.

## 2. METHODOLOGY

Firstly, analyze the advantages and disadvantages of RUSLE model, and develop a water erosion model in a large river basin scale using remotely sensed data and GIS. Although RUSLE is used widely in United States and worldwide, it is limited in the application on large scale area, because of it’s conventional parameterization methods. Due to the identified limitation of RUSLE, a number of modifications are made to develop a water erosion model based on remote sensing and GIS-(Revised RUSLE, $R^2$USLE model). It includes erosion and sediment yield module. The erosion module adds the land use restraint coefficient to describe the influence of land use, besides the consideration of rainfall, soil, topography, vegetation and soil conservation measures characteristics. Also, new approaches for erosion factors calculation based on multi source remotely sensed data are established to describe the rainfall and land surface factors more accurately. As to the sediment yield module, SDR(sediment delivery ratio) is taken into account for the calculation of the sediment yield at the outlet section. The implementation of $R^2$USLE model is based on GIS platform, it is easy to control. It provides an effective approach for water erosion estimation at a catchenment scale.

Secondly, establish a new procedure to estimate R factor based on TRMM data. The rainfall-runoff erosivity factor (R) of the revised universal soil loss equation is generally recognized as one of the best parameters for the prediction of the erosive potential of raindrop impact, and therefore on the potential transport capabilities of runoff generated by erosive storms. In the definition of RUSLE, R factor is calculated by the product of maximum 30 minutes intensity ($I_{30}$) and the total rainfall energy (E).Thus it needs the rainfall process data in a continuous long period, which are always difficult to obtain, especially in ungauged cathchments. Thus, researchers try to take the conventional raingauge rainfall amount data (daily, monthly or annually level) as the substitute of EI30. These data are often unsatisfactory because spatial variability in rainfall is poorly represented in regions where data are scarce; furthermore the catch of conventional raingauges is representative of only a small radius around the instrument. More recently, several efforts have been directed to the use of satellite images to estimate rainfall. In this paper, TRMM satellite-estimated precipitation data is used to calculate R factor. As the data is 3 hour rainfall intensity data, R factor is calculated by the product of maximum 180 minutes intensity ($I_{180}$) and the rainfall energy (E). Also, the TRMM data was compared with formatted daily raingauge data in Dalinghe river basin in a continuous 3-month period in 2005. The result shows that TRMM data has a significant relation with the interpolated raingauge data. What is more, TRMM data is rainfall intensity-based data, and can present the impact on erosion more accurately.

Thirdly, put forward a synthetic factor-Cs to describe the reduction impact of the vegetation and land surface characteristics in soil water erosion processes. The cover-management (C) factor and support-practice (P) factor are very important in RUSLE soil-loss estimation for mined land and construction-site reclamation planning because these factors represent practices designed to reduce erosion. In the application, C is calculated through vegetation coverage. P is obtained by filed investigation. This approach is not feasible to regional scale assessments. Also, it neglects another important factor- land use. While different type of land use may lead to different level of erosion even with the same coverage of vegetation. So this study adds a land use constraint coefficient (α) to describe the influence of land use, beside C and P factor. Then the Cs is established based on α, C and P factor. In the application of Dalinghe river basin, the vegetation coverage is calculated by the dimidiate pixel model and NDVI from Landsat ETM images, and the support practices are retrieved from FOCSAT-2 high resolution images.

## 3. APPLICATION

The $R^2$USLE model is applied in Dalinghe river basin, Liaoning province, China. In the application, the soil data uses the 1:100,000 digital soil map, and the sacle of DEM is 1:250,000. The TRMM 3B42 girded data are choosen as the precipitation data. Landsat ETM and FOCAST-2 are the mainly remotely sensed data. Then the rainfall erosivity R, K, LS, Cs factors are calculated individually according the above mentioned procedures. At last, the erosion of Dalinghe in 2005 is computed from annual erosion, monthly erosion (Jul., Aug. and Sep.) and event-based erosion. The result shows that 69.7% of the river basin is undergone soil erosion to various degrades. And the area where the vegetation is less than 30% and slope is greater than 35 is the main erosion source. Then a series of suggestion of soil conservation practices are put forward.

## 4. CONCLUSITON

Through work of this thesis, there come some conclusion: a) TRMM precipitation data is a new choice for rainfall erosivity estimation, as it can reflect both the rainfall amount and rainfall intensity accurately; b) the land surface synthetic factor of water erosion give a whole consideration of the influence of vegetation, land use and support practices, and made full use of remote sensing technique, and suit the water erosion calculation in large river basin scale; c) $R^2$USLE is good tool to estimate the soil erosion and sediment yield in large river basin scale.

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