Study on Soil erosion Dynamic monitoring Based on “3S” technology

Shuang Wu [1], Chao Zhang [1, 2, 3, *], Changxu Lv [1], Zhurong Xing [1]

1. Shandong Agriculture And Engineering University, Jinan 250000, China.
2. College of geography and environment, Shandong normal university, Jinan 250000, China.
3. Shandong Jiaotong University, Jinan 250000, China.

*Corresponding author e-mail:naonao81@126.com

Abstract. Dynamic remote-sensing monitoring based on the “3S” technology is conducted in areas suffering from severe water and soil loss in the northern mountainous region of the Dagu River Basin to quickly and accurately extract information factors about water and soil loss in this region. The research focuses on analyzing the correlation between water and soil loss of the northern mountainous region of the Dagu River Basin and influence factors such as land utilization, vegetation cover, landform features and human factor. The results of the dynamic monitoring are analyzed to figure out the causes of water and soil loss in this region so as to provide data support for following effective governance and regional planning.

Keywords: Soil erosion; Northern mountainous area of dagu river basin; "3S" technology; remote sensing dynamic monitoring.

1. Introduction

The Dagu River flows through the western part of the Jiaodong Peninsula and has a large drainage area. As the largest and most stable water source in Qingdao, it is called the “Mother River” of the city. In the northern part of the Dagu River Basin are mountains and hills, where soil erosion has been the focus of governance over the years. Therefore, it is essential to find the reasons for serious soil erosion in the northern part of Dagu River Basin, with a view to protecting the local ecological environment and improving the living standards of the people along the bank.

In the present study, the 3S technology was used as the primary means to dynamically monitor soil erosion in the northern mountainous area of the Dagu River Basin. The focus is on analyzing how the factors such as land use, vegetation cover, landform and human activities influenced soil erosion in the study area. By processing the data related to the northern mountainous area of the Dagu River Basin, the relationship between the impact factors and soil erosion was analyzed and the results of dynamic monitoring were obtained.

2. Research area overview

2.1. Landform
The Dagu River originates from Fushan, Zhaoyuan, Shandong Province. Located in the west of jiaodong peninsula, It flows through Yantai and Qingdao. The central and southern parts of the Dagu River Basin are dominated by piedmont plains and plain depressions, while the northern part is dominated by mountains and hills.

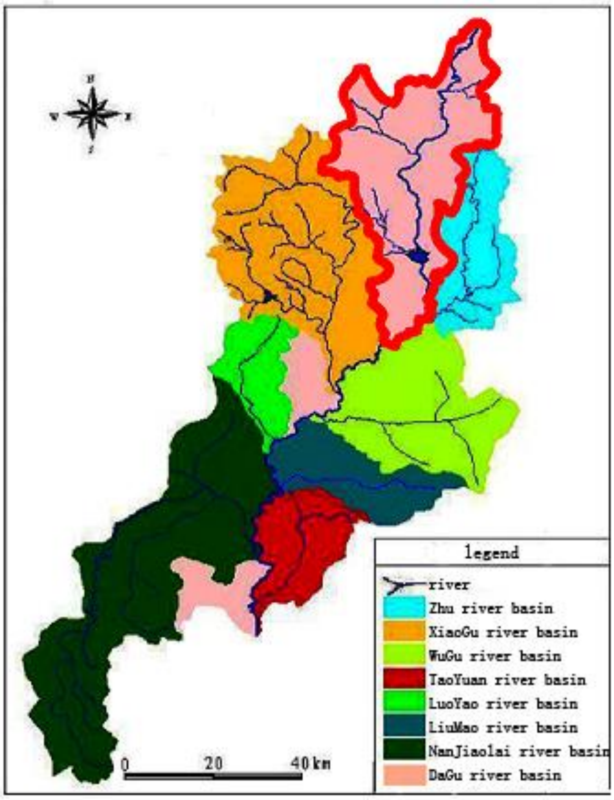

Fig. 1 Schematic diagram of dagu river basin “the area red indicator in the north is the study area”

2.2. Vegetation coverage
The forestland of the Dagu River mainly is evergreen broadleaf deciduous forest in the study area. Shrubs are also planted in the basin. The forest coverage is 15.4% and the rate of woody plant cover is 18.4%. The lack of various tree types on both sides of the basin, the imbalanced proportion of forest types, Humans cut down perennials, and the unreasonable planting structure of forest result in low-level water storage.

2.3. Hydro-meteorological
The climate within the basin is a warm temperate climate in north China, with little difference in temperature. Hot and rainy summer, winter cold and dry, the interannual variability of rainfall cause the interannual variability of runoff, and interannual variability of runoff is more intense.

3. Research content
Based on the LANDSAT satellite image data, DEM elevation data and river vector data in the study area, the vegetation coverage, land use status and slope of the northern mountainous area of the dagu river basin were dynamically monitored. Using ENVI and ArcGIS software to process and analyze the data, and obtain the dynamic monitoring results of soil erosion in the study area.

4. Data processing and analysis

4.1. Remote sensing image interpretation of land use status

Remote sensing image interpretation mainly consists of two processes: (1) establish interpretation keys of remote sensing map; and (2) extract land use information. To extract land use information, land use was divided into four categories: forest and grassland, farmland, waters and construction land in accordance with the norms and standards for classification of land use status, specific geographical environment of the northern mountainous area of the Dagu River Basin as well as actual needs of the present study. The remote sensing images in the study area were supervised and classified. Next, by classifying and processing the results, the maps of land use status in 2008 and 2017 were shown in Figure 2 and Figure 3.

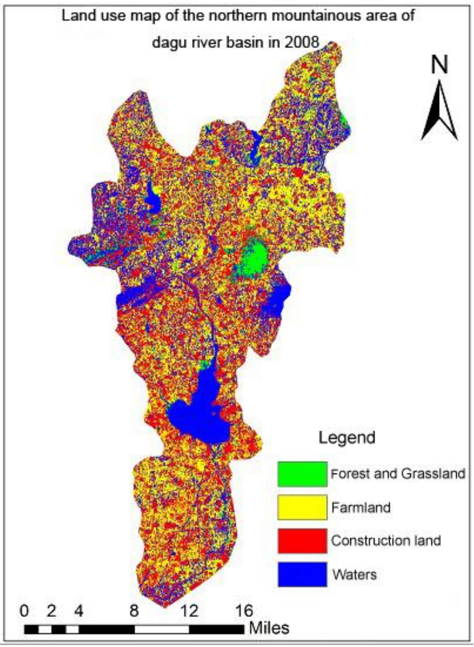

Fig. 2 Land use map of the northern mountainous area of dagu river basin in 2008

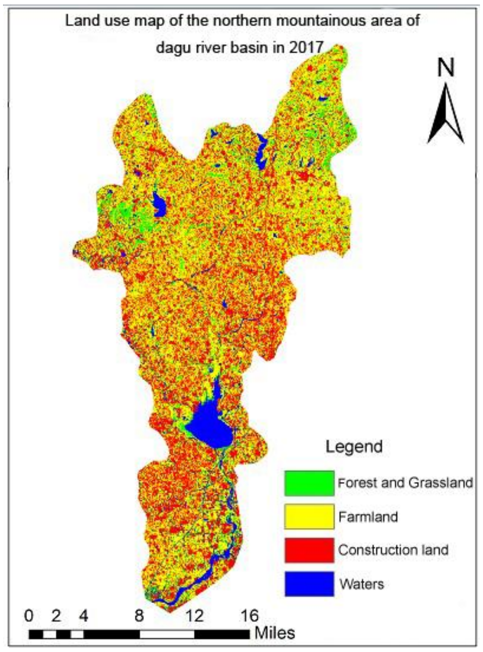

Fig. 3 Land use map of the northern mountainous area of dagu river basin in 2017

4.2. Remote sensing image interpretation of vegetation coverage

As required by dynamic monitoring accuracy of soil erosion, the vegetation coverage was treated by the transformation method of normalized difference vegetation index (NDVI). The acquired image data was used to calculate NDVI. The dimidiate pixel model was then used to calculate the pixel-based vegetation coverage. Finally, the thematic map of vegetation coverage was obtained.

Calculation formula of NDVI shown (1):

$$NDVI = (NIR - R)/(NIR + R) \tag{1}$$

Calculation formula of the vegetation coverage shown (2):

$$F_c = \frac{NDVI - NDVI_{soil}}{NDVI_{veg} - NDVI_{soil}} \tag{2}$$

In the formula: Fc is vegetation coverage, NDVIsoil is the NDVI $_{value}$ of bare soil or Unvegetated area, NDVIveg is the NDVI $_{value}$ of pixel that completely covered by vegetation.

Classification of vegetation coverage refer to Soil erosion classification and classification standards (Table 1), In combination with actual research area, conclusion vegetation coverage.

Table 1. Soil erosion intensity grading standard for surface erosion (erosion)

Land type / slope		≤5°	5°～8°	8°～15°	15°～25°	25°～35°	＞35°
Bare place	60%～75%	slight	mild	mild	mild	moderate	moderate
Forest grassland	45%～65%	slight	mild	mild	moderate	moderate	strong
Coverage	30%～45%	slight	mild	moderate	moderate	strong	extreme strong
	＜30%	slight	moderate	moderate	strong	extreme strong	severe
Sloping land		slight	mild	moderate	strong	extreme strong	severe
Water, town and residential land		slight	slight	slight	slight	slight	slight

4.3. Spatial analysis of terrain slope
The slope spatial analysis of terrain was based on the DEM elevation data and completed by using the “Slope” function in “Surface Analysis” under the “Spatial Analysis” toolbar in ArcGIS. The data was then reclassified in accordance with the division criteria to obtain the slope classification results of the northern mountainous area.

4.4. GIS analysis of soil erosion intensity
Take Overlay analysis to the land use data, vegetation coverage data and slope classification map in 2008 and 2017 that above collected. The Frequency command in ArcGIS was started to analyze and summarize the frequency of the attribute field and the area field of the data provided by superposition analysis. The area, as well as the number of changes of each erosion intensity type, were finally calculated. The classification of soil erosion intensity was determined according to the Classification Standards for Soil Erosion.

5. Monitoring results
The thematic data of impact factors were obtained, and the attribute data was calculated in ArcGIS according to the Classification Standards for Soil Erosion. The types that meet the intensity criteria were assigned, followed by the calculation of area.

The area statistics of soil erosion intensity show that the total area of soil erosion in 2008 was 592.816 square kilometers, and the figure in 2017 was 927.348 square kilometers. Specifically, the proportion of slight erosion is the largest, followed by the mild and moderate erosion. The proportion of strong and extreme strong erosion is small, while the proportion of severe erosion is the smallest.

By analyzing the area of soil erosion intensity in the northern mountainous area of the Dagu River Basin, it is found that the total area of erosion in 2017 is higher than that in 2008. Specifically, the growth of mild, moderate and strong erosion is obvious, followed by slight erosion. The area of extreme strong and severe erosion changes slightly. Mild erosion shows the largest growth, while extreme strong erosion has a certain degree of decline.

6. Conclusion
The results of dynamic monitoring show that the continuous increase of construction land and farmland and the decline of vegetation coverage in the study area are the main reasons for soil erosion; the slope factor in terrain is another cause of soil erosion. So, the rational planning of the land and the re-layout of the land and the ratio of the land to the land, is the main work that we're going to do in the future. In addition, I think human activity is also a major cause of soil erosion. some people are engaged in sand mining in the Dagu River Basin without realizing the importance of environmental protection. Improper

sand mining seriously damages the ecological environment of river wetland, exacerbating the progress of soil erosion. Therefore three reasons above are localed government departments should pay attention.

References

[1] Zhang xinchang, zeng guanghong, et al. Urban geographic information system. Beijing: Science Press, 2001
[2] Dang anrong, hai-feng jia, etc. 8 ArcGIS Desktop geographic information system application guide, Beijing: tsinghua university press, 2003.
[3] Chang 'an Sun. Development of soil and water loss monitoring using "3S" technology at home and abroad. China soil and water conservation, 2008, (6):54-57.
[4] Hongyan Wang. Dynamic monitoring of soil and water loss in hongshui river basin based on remote sensing and GIS. Applied technology of soil and water conservation, 2014, (5):18-21.
[5] Huaiyong Shao. Study on the landscape pattern of different elevation zones in the three gorges reservoir region based on 3S technology - a case study of wushan county. Water and soil conservation bulletin, 2005, 25(3):54-57.
[6] Yongjun Zhao, wu mingqiang. Application and prospect of "3S "technology in soil and water conservation. Department of water resources comprehensive enterprise bureau, 2001(05): 49-50.
[7] Yijiao Wu. On the particularity of soil and water conservation discipline and classification of management measures. China soil and water conservation, 1990, 47-51
[8] Shanlun Zhao, Min Yin, WeiZhang. Analysis of spatial characteristics of soil erosion in shandong province supported by GIS. Geoscience, 2002, 22 (6): 694-699
[9] Wu B, Xiong Z G, Chen Y Z, et al. Classification of quickbird image with maximal mutual information feature selec-tion and support vector machine. Procedia Earth andPlanetary Science, 2009, 1(1):1165-1172.