The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-1/W5, 2015
International Conference on Sensors & Models in Remote Sensing & Photogrammetry, 23–25 Nov 2015, Kish Island, Iran

River sediment monitoring using remote sensing and GIS

(case study Karaj watershed)

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KEY WORDS: GIS, RS, Monitoring, Karaj Watershade, Envi

ABSTRACT:

Whereas the tank volume and dehydrating digits from kinds of tanks are depended on repository sludge, so calculating the sediments is so important in tank planning and hydraulic structures. We are worry a lot about soil erosion in the basin area leading to deposit in rivers and lakes. It holds two reasons: firstly, because the surface soil of drainage would lose its fertility and secondly, the capacity of the tank decreases also it causes the decrease of water quality in downstream. Several studies have shown that we can estimate the rate of suspension sediments through remote sensing techniques. Whereas using remote sensing methods in contrast to the traditional and current techniques is faster and more accurate then they can be used as the effective techniques. The intent of this study has already been to estimate the rate of sediments in Karaj watershed through remote sensing and satellite images then comparing the gained results to the sediments data to use them in gauge-hydraulic station. We mean to recognize the remote sensing methods in calculating sediment and use them to determine the rate of river sediments so that identifying their accuracies. According to the results gained of the shown relations at this article, the amount of annual suspended sedimentary in KARAJ watershed have been 320490 Tones and in hydrologic method is about 350764 Tones .

1. GENERAL

1.1 Soil Erosion

Erosion is a process in which soil particles separated from her bed and using a transfer agent shipped to another location. If the separation of the particles from the substrate and transfer it to the water it is called erosion. Other types of erosion, wind erosion and glacial erosion can be named. The basin is larger and higher gross erosion of sediment transport it will be smaller.

Factors that are effective against sediment transport in a point ;

1- The topography of the basin

2- Characteristics of rains and floods

3- Basin physiographic features

4- Soil and watershed

The amount of sediment carried by the river and into the reservoirs may be divided into two categories:

1- Sediment suspended in the water and above the water moving along the river bed. This material is said to be suspended load.

2- Sediments in the river bed with water flow can be rolled forward to this type of bed load sediment called.

Total Load a river of bed load and suspended load is formed.

1.2 Methods of estimating sediment

If data in a basin of water and sediment flow and annual precipitation levels are adequate Calculate the total volume of annual sediment basin is possible using conventional statistical methods. But the absence or violation of data in many countries, the use of experimental methods to determine the severity of watershed soil erosion and sediment yield is essential. One of the methods for erosion and sediment in different parts of the world, including Iran, are used PSIAC (Pacific Southwest Inter Agency Committee)

1.3 Objectives and need for research

To identify remote sensing methods and their use in the calculation of sediment in the river and then evaluate the results to determine the amount of sediment deposited by the river for a hydrometric stations is information. This will be the procedure for application of GIS information using satellite images acquired and river sediment can be used to obtain this information. Remote sensing a useful tool for monitoring suspended sediment in surface waters is due to various reasons, including multispectral nature, covering a wide area, the line is long and repetitive nature of satellite imagery.

Using remote sensing techniques to study soil erosion and sedimentation basins, compared to traditional methods with greater speed and accuracy is very efficient so as techniques should be placed. In this study, using remote sensing and satellite image processing and interpretation with the help of sediment are obtained.

2. BACKGROUND OF THE RESEARCH

Mr. Voss and his colleagues in 1997, turbidity and suspended sediments in the basin of the river Humber studied using satellite images.

Mr. Andrka in 2007, remote sensing and identification of potential areas of sedimentation in the river Danube examined

Mr. Vyfing Jao in 2008 with the global model of soil erosion (USLE) soil erosion and sedimentation tank CHAOBAIHE the main source of drinking water in the river MIYAN Chinese capital Beijing is to be examined.

3. FIELD OF STUDY

3.1. Geographical location

Amir Kabir Dam on the river in the Strait of Varian The coordinates of Longitude 51degree and 5 minutes ,Latitude 35 degrees 7 minutes Sierra called hydrometric station entrance Karaj Dam . Long-term average annual flood of about 12.452 cubic meters per second.

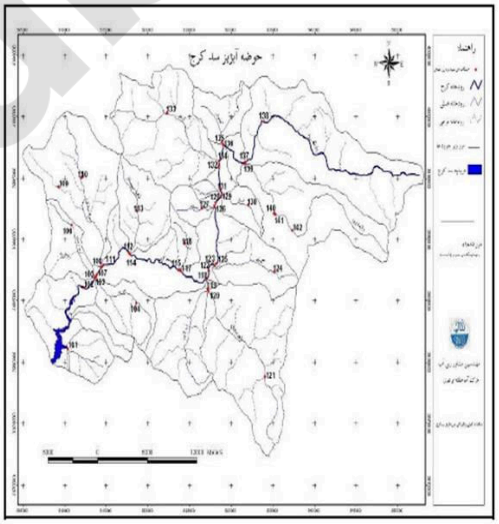

Figure 1. Amir kabir dam

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doi:10.5194/isprsarchives-XL-1-W5-675-2015

4. REMOTE SENSING METHODS

In general, remote sensing can be information technology and imaging of the Earth using aviation as an aircraft, balloons or space applications such as satellite called. In other words, remote sensing information science and art of phenomena or objects without physical contact with them say In this study, the records of studies carried out in the second season of regression equations presented in three papers in this section, we discuss about them is used. The data used in this study are as follows.

One of the methods to obtain information from the environment using remote sensing technology and its integration with GIS. Satellites can place information on the different scenarios, different scales of the electromagnetic spectrum band provided that these features adds to the importance of their role. Using remote sensing technology can be less cost and time, a wide range of projects, especially at the local scale and to conclude

the procedures that are used in remote sensing, can be discussed as follows:

According to the main objective of remote sensing technology to identify and distinguish ground objects and put them in groups or classes is clear, satellite image classification can be considered an important part of the interpretation of satellite data. Classification for surveillance and monitoring is done yet. In unsupervised classification of pixels according to their spectral values and without any user intervention in the class. In supervised classification, spectral reflectance spectrum of each pixel of the image with symptoms of training samples (which is provided by the user) and each group of pixels compared to a sampled quite separate floors and each floor is a special code.

5. GIS METHODS

The world's most famous authors, what distinguishes GIS from other similar systems, using spatial analysis of relevant studies. Among all the important aspects of GIS may be on its ability to organize and combine spatial data from different sources to create more value. The purpose of data integration, firstly, identify and describe the spatial relationships between layers within the GIS and secondly, analysis models and predict phenomena in space. One of the remarkable features the ability to display three-dimensional GIS is adverse affects. One such model is the digital elevation models.

With two different ways to explain the method of calculation and at the end of the deposition calculations using one of these Sierra station to do.

The first method :

Remote image pixels reflect the values that form the digital numbers are determined. Digital numbers by using the following equation has been modified to reflect the change;

$$L = (0.9655 * DN) - 5.1$$

L:Reflecting modified

DN: The digital number is between 0-255

A linear relationship between radians and near-infrared bands and density of suspended solids was found that the correlation equation is as follows:

Concentration of suspended solids :

$$(4.17 * L) - 43.22$$

In the above equation suspended sediment concentration in milligrams per liter. The results showed that the concentration of suspended solids in the geographical area decreases gradually.

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The second method :

By Landsat data on the volume scale, its properties can be obtained and sedimentation areas. Since water is a strong absorber of infrared radiation is the only wavelength bands 1 to 4 have the characteristics of penetration of sunlight in the water. Therefore, to measure the depth of penetration of light that is reflected by the satellite is received.

$$SSC = -427 + 7.01 * DN$$

6. ANALYSIS OF RESULTS

Satellite images of pixels in the pixel reflectance values recorded. The exchange value of zero to 255, respectively. In this thesis, we could ARCGIS software using Landsat spectral data in each band and the number of repetitions Hara obtain it. The mean of the values for each band Landsat reflection in the lake basin dam were calculated.

Figure 2 - Karaj Dam - satellite Landsat 8

Table 1- The mean reflectance of Landsat bands

BAND	The mean reflectance of Landsat bands
BAND 1	150.1
BAND 2	145.2
BAND 3	70.12
BAND 4	85.11
BAND 5	123.1
BAND 6	121.34
BAND 7	190.20
BAND 8	83.12
BAND 9	87.02

6.1 Calculate the sediment samples measured at hydrometric stations

In this method, sediment or sediment load is a function of flow rate and on the data, the following equation can be fitted.

$$Q_S = aQ_w^b$$

Qs : Sediment yield (tons per day)

Qw : River flow in cubic meters

The estimation of suspended sediment in the hydraulic method for a period of 10 years using data according to which Sierra station is as follows:

80% of suspended sediment transport in the three months of spring flooding and its value in May is 40% of annual deposits to form. Seasonal distribution of the deposits are as follows:

1) 1.3% in autumn
2) 2.45 percent in winter
3) 86.13% of the spring
4) 10.11% of the spring

The analysis conducted annual average amount of suspended sediment entering the reservoir by taking the catchment area at the dam site, the 350,764 tonnes achieved

The amount of cargo moving riverbed Karaj, about 15 to 20 percent of suspended substances

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as a result of the estimated total amount of annual sediment inflow into the lake is estimated to be 425,170 tons.

The annual amount of suspended sediments in tons of Karaj Dam basin isolated from the sediments with a mean of 10 years to hydraulic methods were as follows.

Karaj Dam catchment area = 350764

The long-term deposit rating curve Sierra station is as follows:

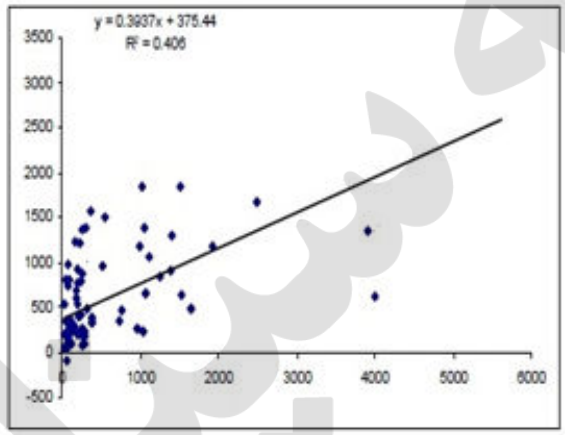

Figure 3 - Sediment curve Sierra station

7. The result of the calculation method of remote sensing

The first method

In this method, numerical values recorded in the band 7 Which is 0-255 for Lake Station Branch using ARC GIS to obtain and use the following equation to reflect any value corrected themselves.

$$L = (0.9655*DN)-5.1$$

The mean values reflect the modified 7-band account and using the following equation sediment concentration in ppm count

The resulting concentration in the annual discharge multiply and divide the basin area has an annual sediment load in terms of tons per square kilometer is achieved.

Sierra stations in the basin has been modified to reflect the average value of 178.538 obtained with respect to the above deposits amount to gain as follows:

$$(4.17 * 190.20) - 43.22 = 701.283$$

Given the upstream catchment area of 720 square kilometers and a mean annual runoff of the Sierra stations according to the annual data of the Regional Water 12.452 cubic meters per second.

$$\frac{701.283 * (12.452 * 1000) * (31536000)}{10^9} = 275384.551\ Ton$$

The second method

The method of calculating the average reflectance of Landsat bands 1 to 8 using the following formulas to calculate the concentration of suspended sediment, we (in milligrams per second).

$$\frac{625.201 * (12.452 * 1000) * 31536000}{10^9} = 245507.849\ ton$$

8. THE RESULTS

Since satellite images may be different climatic conditions and different days of the year are prepared, given that under certain conditions the surface is different, so different reflectivity of the earth's surface is reflected. As a result, there is a possibility of change in average reflectance of Landsat bands.

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Coefficients applied to the percentage	The reflection band 7	The average reflectivity change	The annual sediment (ton)
10	190.21	209.22	305455.322
15	190.21	218.73	320490.707

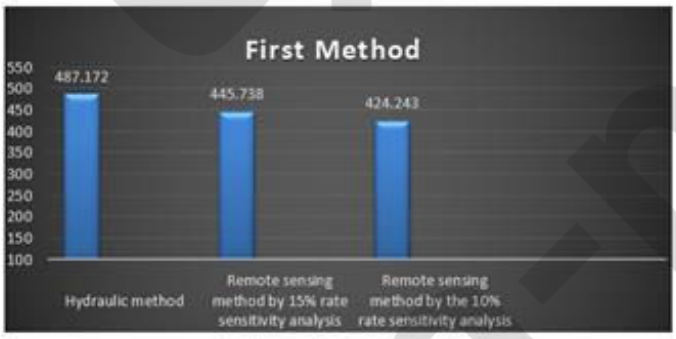
Table2-Suspended sediment Sierra station First method

Sensitivity analysis by a coefficient of 10, 15 percent and a reduction in the average reflectance of Landsat band 1 and the amount of sediment obtained from the drainage basin with sediment Sierra stations 245,507.849 tons annually in the following table will be provided:

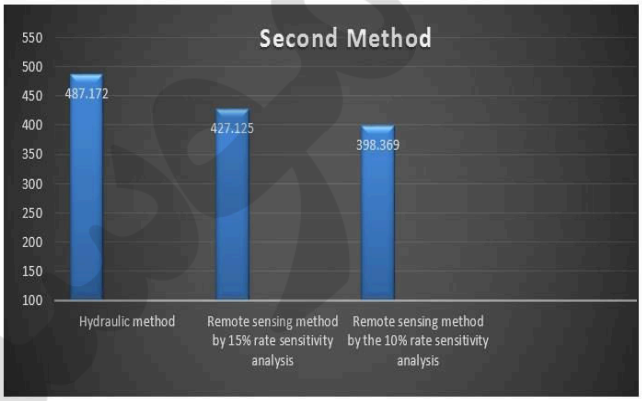
Coefficients applied to the percentage	The reflection band 7	The average reflectivity change	The annual sediment (ton)
10	150.1	165.11	286826.338
15	150.1	172.6	307444.292

Table3-Suspended sediment Sierra station second method

Landsat satellite images were used the values obtained by the correlation with the amount of sediment deposits from We compared the hydraulic method. In this paper, we show the graph.



Grafh1-Comparison of sediment remote sensing method and hydraulic method



Grafh2-Comparison of sediment remote sensing method and hydraulic method

By increasing the average values reflect the Landsat bands the amount of deposits increased and the obtained values are close hydrological methods.

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October 2015

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doi:10.5194/isprsarchives-XL-1-W5-675-2015