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SOIL LOSS ESTIMATION OF S7-2 CATCHMENT OF THE SHIRINDAREH WATERSHED, IRAN USING THE RIVER BASIN MODEL

Velibor SPALEVIC[1]*, Atefeh BEHZADFAR[2], Andre SILVA TAVARES[3], Milena MOTEVA[4], Vjekoslav TANASKOVIK[5]

[1*]Department of Geography, Faculty of Philosophy, University of Montenegro, Montenegro
[2]Azad University, Science and Research Branch, Tehran, Iran
[3]Universidade Federal de Alfenas, Programa de Pós-Graduaçã-Ciências Ambientais, Brazil
[4]Agrotechnologies and Plant Protection "N. Pushkarov", Sofia, Bulgaria
[5] Faculty of Agricultural Sciences and Food, University Ss. Cyril and Methodius in Skopje, Macedonia
*Corresponding author: velibor.spalevic@gmail.com

ABSTRACT

This study aims to estimate the soil loss of S7-2 Watershed of Shirindareh River Basin in Iran, using a simple but comprehensive "River Basin" model for erosion classification and prediction of erosion potential. Peak discharge from the S7-2 Watershed was calculated on 65 m^3s^{-1} for the incidence of 100 years; the net soil loss on 4397 m^3km^{-2}, specific 178 m^3 km-^{2} per year. The results of the research and earlier application of the "River Basin" model in the studied area of the Shirindareh River Basin in Iran shown that this approach is a good tool for rapid assessment of erosion risk to support decision-making and policy development.

Keywords: *soil erosion, river basin model, sediment yield, Shirindareh watershed.*

INTRODUCTION

Soil loss is a serious ecological concern (Gholami *et al.*, 2016) in various environments worldwide (Kisic *et al.*, 2016; Ballesteros-Cánovas *et al.*, 2015; Stoffel and Huggel, 2012; Ristic *et al.*, 2001). Study of soil erosion and sediment yield in the watershed is one of the basic necessities to achieve integrated land management and soil and water conservation (Khaledi Darvishan *et al.*, 2014). Direct measurements of erosion in a watershed are possible with multi-years measurement of solid transport in the closing-section (Behzadfar *et al.*, 2014a and Behzadfar *et al.*, 2014b). The water and sediment sampling in given intervals need a lot of time and is costly (Khaledi Darvishan *et al.*, 2010), assessment of sediment yield using soil erosion models have been used more and more (Spalevic *et al.*, 2013a, 2013b, 2013c, 2013d). The modelling of the erosion process has progressed rapidly, and a variety of models have been developed to predict both runoff and soil loss.

We used the computer-graphic "River Basin" model of Spalevic (Spalevic, 2011; Spalevic et al., 2000; Spalevic, 1999) for prediction of soil erosion intensity from the watershed area.

MATERIAL AND METHODS

The study was conducted in the area of the S7-2 Watershed (F = 25 km^2) of the Mountainous area of the Shirindareh River Basin, located in north eastern parts of Iran (Figure 1). The shortest distance between the fountainhead and the mouth, lv, is 10 km; and the total length of the main watercourse with tributaries is 54 km. The average slope gradient in the river basin, Isr, is calculated on 33% what indicates that in the river basin prevailing very steep slopes. The average river basin altitude Hsr, is calculated on 1480 m; the average elevation difference D, on 279 m. Basic climatological data: The volume of the torrent rain; Average annual air temperature; Average annual precipitation; needed for calculation of the soil erosion intensity and runoff from the River Basin were received from the meteorological stations located in North Khorasan province of Iran.

The geological analyses (geological formations of North Khorasan province, including those in the study area of the S7-2 watershed) were based on the research of the National Geological Survey Organization (NGS) of Bolourchi (1987).

Figure 1. Study area of the S7-2 watershed, the Shirindareh River Basin, Iran

The "River Basin" model (Spalevic et al., 2000; *link to the "River Basin" exe file available on: www.agricultforest.ac.me/Spalevic/River*) as a computer-graphic method, with the Erosion Potential Method – EPM (Gavrilovic, 1972) rooted in the procedure of this model, was used for soil loss estimation from the studied watershed. It gives a quantitative estimation of erosion intensity as well as the estimation of sediment production and transportation. According to the method sediment yield is calculated using the following calculation:

$$G_{yr \times sp^{/1}} = T \times H_{yr} \times \circledR \sqrt{Z^3} \times R_u$$

where: $G_{yr\ sp}^{-1}$ – specific annual total erosion-induced sediment yield reaching the confluence, m^3 yr^{-1} km^{-2}; T – temperature coefficient of the watershed; H_{yr} – amount of rainfall, mm; π – 3.14; Z – coefficient of erosion; R_u – coefficient of retention of soil in the watershed.

RESULTS AND DISCUSSION

The climate is continental, with the absolute maximum temperature of 34.6°C and the negative of -24.4°C, respectively. Average annual air temperature, t0, is 9.1°C and the Temperature coefficient of the region, T, is calculated on 1; The amount of torrential rain, hb, on 34.68 mm. The average annual precipitation, H_{yr}, is 317 mm (Source: Data from the North Khorasan Meteorological stations of Iran).

The studied area belongs to the Middle-East of the Kope-Dagh geographical region. The pastures and meadows are predominant and covering the area of 78%. A part under the forests is about 19% and ground without grass and arable land is of about 3% (Figure 2). The coefficient of the river basin planning is calculated on 0.62. The coefficient of the vegetation cover is calculated on 0.77.

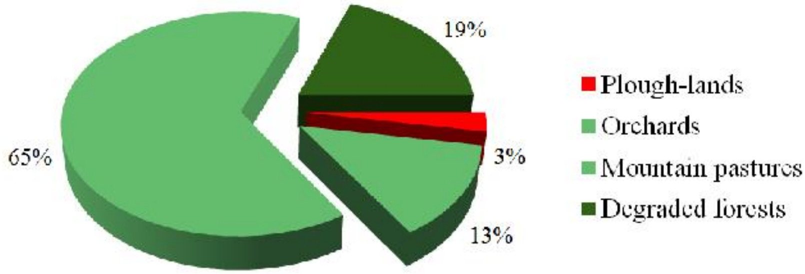

Figure 2. Land use of the S7-2 watershed, the Shirindareh River Basin, Iran

The dominant erosion form in this area is **surface erosion** and is the most pronounced on the steep slopes without vegetation cover. Calculation of Sediment yield of the S7-2 Watershed of the Shirindareh River Basin of Iran is presented at the “River Basin” Report 1.

Report 1. The “River Basin” report for the S7-2 Watershed

Inputs: River basin area, **F**, 24.65 km²; The length of the watershed, **O,** 29.95, km; Natural length of the main watercourse, **Lv,** 9.98, km; The shortest distance between the fountainhead and mouth, **Lm**, 9.48 km; The total length of the main watercourse with tributaries of I and II class, **ΣL**, 53.69 km; The area of the bigger river basin part, **Fv**, 14.27 km²; The area of the smaller river basin part, **Fm**, 10.38 km²; Altitude of the first contour line, **h0**, 1300 m; The lowest river basin elevation, **Hmin**, 1201 m; The highest river basin elevation, $\mathbf{H_{max}}$, 1825 m; A part of the river basin consisted of a very permeable products from rocks (limestone, sand, gravel), **fp**, 0.15; A part of the river basin area consisted of medium permeable rocks (slates, marls, brownstone), **fpp**, 0.18; A part of the river basin consisted of poor water permeability rocks (heavy clay, compact eruptive), **fo**, 0.67; A part of the river basin under forests, **fs**, 0.19; A part of the river basin under grass, meadows, pastures and orchards, **ft**, 0.78; A part of the river basin under bare land, plough-land and ground without grass vegetation, **fg**, 0.03; The volume of the torrent rain, **hb**, 34.68 mm; Incidence, **Up**, 100 years; Average annual air temperature, **t0**, 9.1 °C; Average annual precipitation, $\mathbf{H_{yr}}$, 317 mm; Types of soil products and related types, **Y**, 1.1; River basin planning, coefficient of the river basin planning, **Xa**, 0.62; Numeral equivalents of visible and clearly exposed erosion process, **φ**, 0.48.

Results: Coefficient of the river basin form, **A**, 0.59; Coefficient of the watershed development, **m**, 0.57; Average river basin width, **B**, 3.08, km; (A)symmetry of the river basin, **a**, 0.32; Density of the river network of the basin, **G**, 2.18; Coefficient of the river basin tortuousness, **K**, 1.05; Average river basin altitude, $\mathbf{H_{sr}}$, 1480.23 m; Average elevation difference of the river basin, **D**, 279.23 m; Average river basin decline, $\mathbf{I_{sr}}$, 32.99%; Coefficient of the region's permeability, $\mathbf{S_1}$, 0.86; Coefficient of the vegetation cover, $\mathbf{S_2}$, 0.77; Maximal outflow from the river basin, $\mathbf{Q_{max}}$, 65.06 m^3s^{-1}; Production of erosion material in the river basin, $\mathbf{W_{yr}}$, 15191.9, m^3 yr^{-1}; Coefficient of the deposit retention, **Ru**, 0.289; Real soil losses, $\mathbf{G_{yr}}$, 4397.7, m^3 yr^{-1}; Real soil losses per km^2, 178.41 m^3 yr^{-1} km^{-2}.

This approach is also in use: Bosnia and Herzegovina, Brazil, Bulgaria, Croatia, Czech Republic, Italy, Macedonia, Montenegro, Morocco, Saudi Arabia, Serbia, South Africa and Slovenia (Al-Turki *et al.*, 2015; Gazdic *et al.*, 2015; Spalevic *et al.*, 2015a, 2015b, 2015c, 2015d, 2015e, 2015f, 2015g, 2015h, 2015i, 2015k; Vujacic & Spalevic, 2016; Kostadinov *et al.*, 2014; Spalevic *et al.*, 2014a, 2014b, 2014c, 2014d). The provided methodology have been successfully used in Iran in the regions of Chamgardalan, Kasilian, Kermanshah, Razavi Khorasan (Spalevic *et al.*, 2016; Draganic *et al.*, 2015a; Draganic *et al.*, 2015b; Behzadfar *et al.*, 2015; Barovic & Spalevic, 2015; Sadeghi, 2005) and other regions.

CONCLUSION

Calculation of sediment yield in the S7-2 Watershed showed the following results:
- Production of erosion material in the river basin, $\mathbf{W_{yr}}$, was 15191 m^3 yr^{-1};
- Calculated soil losses are 4397 m^3yr^{-1} and Real soil losses were 178.41 m^3 yr^{-1} km^{-2};
- The peak discharge is 65 m^3s^{-1} (incidence 100yr).

This study confirmed the findings of Barovic *et al.* (2015); Behzadfar *et al.*, 2015, Zia Abadi & Ahmadi (2011); as well as Amiri (2010) in possibility of implementing "Erosion Potential Method" and the "River Basin Model" for the other river basins of the Caspian Sea, when hydrological stations are missing, taking into consideration the fact that the erosion modelling is cheaper than constructing hydrological stations. The results shown that this model is a good tool for rapid assessment of erosion risk to support decision-making and policy development.

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