Sediment- yield estimation, by M-PSIAC method in a GIS environment, case study:Jonaghn river sub basin(Karun basin)

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Abstract

Recent researchs on soil erosion and sediment yield of water sheds in Iran have shown that the MPSIAC method is one of the most common empirical modesl. Areason is the high accuracy of this model. In this study, erosin and sediment yield rates was estimated by MPSIAC model using geographic information system(GIS) in the junghan watershed basin. In order to run the model, the watershed area was divided to 50 homogenous unit and the nine factors used in model, were assist in each unit.

KEYWORDS: *Soil, Modeling, Landsat, Spatial, M-psiac, Land Cover, Land Use*

INTRODUCTION

Soil erosion is a process that would cause many constrains to the environmental and regional planners. Erosion on farm fields reduces potential crop production, and sediment which leaves the field can result in subsequent sedimentation problems by which, in turn, can cause off-site environmental problems (ASCE, 1975, 1982). PSIAC model with its 9 possible parameters, among other models, is the most suitable model for arid and semi-arid areas in the southwestern USA, and is believed to be appropriate forthe same environmental conditions in Iran (Sadeghi, 1993;Bagherzadeh, 1993; Jalalian, 1992). Soil erosion in different parts of Iran, as an arid and semiarid region, has been studied by several researchers. (Heydarian1996 and Tajbakhsh et. Al, 2003) used PASIC and Modified

In this reseach an attempt has been made to study the rate of soil erosion in Joneghan watershed in Chahar mahal Bakhteary west of Iran The study area is located between the longitude ٥٠° ٢٢' – ٥٠° ٤٧' north ٣٢° ٤' – ٣٢° ٢٩' east and has an area of 903.92 km2.

Materials and methods

The basic data were obtained from topographic maps, IRS map, field observations. Information on soil type, surficial geology, land use/land cover, land slopes, rainfall runoff, and climatic factors. There data were usede to generate the data layers and to evaluate the erosion factors for the model the materials are as following:

Topographic maps(14 sheet) of the study area scale :1/25000

Satellite imagery: IRS band2.3.4

Hydrological data 1954-2005)

Geology map(scale:1/250000)

Slope map

Land slopes (Fig. 7) were calculated using 1:25,000 topographic maps.. A dem was applied to produce the degetized topography. A raster grid cell of 20*20 m was generated and was applied to produce the DEM, from which, slope steepness could be determined.

Land use and land cover

Land-use and land-cover maps were generated by the use of IRS bands 2.3.4. The data was rubber sheeted to match ground control locations,(Fig5),(Fig6)

Surface geology and soil type maps

Geological data were compiled by visual interpretation of 1:250,000 Shahre Kord map(A,afaghy and afshareanzade) together with field observations Rock .exposures in the study area consist of limestone, marly limestone, marl, shale, sandstone and conglomerate, with different resistance to erosion. Lithological units were re-classified into 10 categories based on their sensitivity to erosion. Soil types were classified, to experimental data from field observation and data of water and soil research organization(Fig3),(Fig4)

Runoff

In some models, the runoff factor is considered in assessing water erosion. Runoff occurs whenever water on a slope cannot be absorbed into the soil or trapped on the surface. Runoff increases if infiltration is reduced due to soil compaction, crusting or freezing. The runoff factor was estimated by Hydrological data of catchement(1360-1386)

Channel erosion map

This factor indicates the rate of erosion in river and drainage channels. The slope steepness, type of bedrock, and the potential energy of floods are the major factors affecting channel erosion.

To determine the channel erosion factor it is necessary to prepare a map showing the relationship between the drainage and different rock units and slope classes (Fig. 4). The drainage was derived from the 1:25,000 digitised topographic data, which was overlaid on the rock-type and slope-classes data layers. The
coverage generated was reclassified based on the slope steepness, rock type, and drainage density. Each map class was then evaluated and weighted using the PSIAC guide tables (Table 8).

M-PSIAC models

This model was created to estimate the soil erosion according to nine factors consisting of, geological
characteristics, soil, climate, runoff, topography, vegetation cover, land use and present soil erosion
(PSIAC, 1968). Johnson and Gembhart (1982) improved the original model to have a more accurate
estimate of the sedimentation (equation,1).

$Qs= 18/6e^{0.036R}$ (1)

Were: Qs= sedimentation (m^3/km^2/year) , R= sedimentation rate, e = 2.718.

RESULTS AND DISCUSSIONS

The sediment creation map was prepared according to information providedin table 2 (figure, 8). The results of total erosion total sedimentation, specific erosion and sediment producing class for each watershed subunit. The results of MPSIAC model indicated that 60. % of the total watershed area was classified at class III of erosion category with medium sedimentation and 20.2% was classified at class IV of erosion category with high sedimentation, respectively. Basin erosion and sediment was calculated as 862748/42023m3/yr by MPSIAC model, respectively.

As it is clear from the(figure2), in this area the erosion process is in its high rate in the estern part. That is because of the geology and steep slopes and less vegetation cover of that area. In west and more east part and peise sout of this area, due to the factors like slope, less dept soils, feeding chattels, cultivation in the slopes and the presence of marl formation, the erosion rate is high. In center due to agricultural activities and fewer slopes the erosion rates are veryless.

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Geology map: 1/250000(a,afaghy and afshareanzade)

Table1:sedimentation valu calculated for jonghan basin

M-psiac(t)	Special deposits($m^3/km^2/y$)	Annual sediment(m^3/y)	Area(km^2	basin
1121504.11	954.67	862748.42	903.71	Total basin

Table2: the effective factors and their points calculation formula in MPSIAC model

The effective factors	The points calculation formula	Explanation Parameter
Geology	Y1=X1	X1: stone sensitive point
Soil	Y2=26.67K	K : erodibility factor in USLE
Climate	Y3=0.2X3	X3 : precipitation intensity with 2 year interval return
Water runoff	Y4=0.006R+10Qp	R : annual runoff depth (mm), Qp : annual specific discharge (CMS/km2)
Topography	Y5=0.33S	S : average watershed slope (%)
Land vegetation cover	Y6=0.2X6	X6 : bare soil (%)
Land use	Y7=20-0.2X7	X7 : canopy cover (%)
Surface soil erosion	Y8=0.25X8	X8 : points summation in BLM model
Gully erosion	Y9=1.67X9	X9 : point of Gully erosion in BLM model

Table3: Sediment evaluation and erosion classification in MPSIAC model.
Application of soil erosion model by GIS

Sedimentation yield m3/km2	Summation of nine t/km2 m3/km2 effecting factors (R)	Quality erosion class	Erosion class
<95	0-25	Very low	I
95-250	25-50	Low	II
250-450	50-75	medium	III
450-1450	75-100	High	IV
1450<	100<	Very high	V

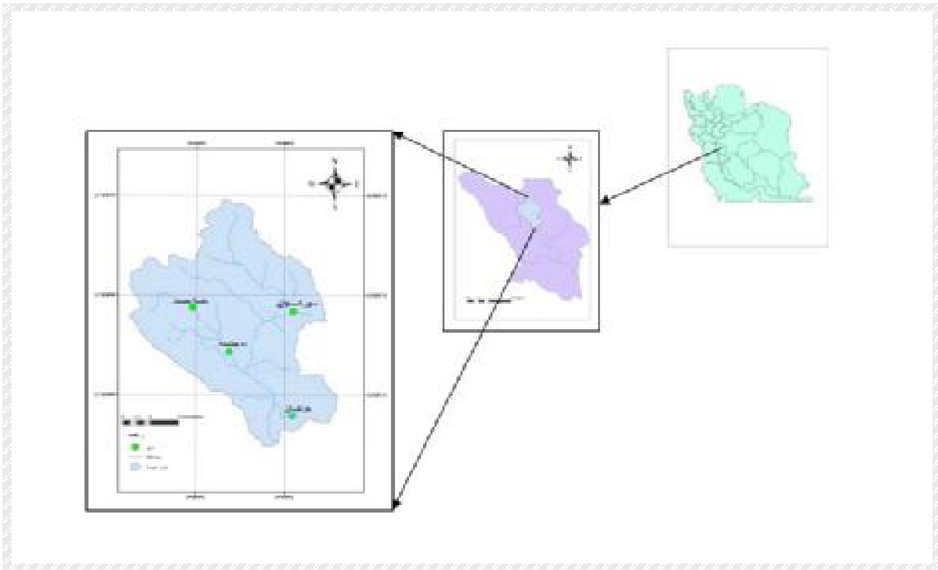

Figure 1Location of the study aria

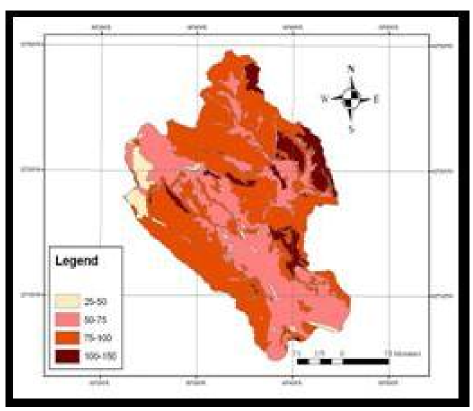

Figure 2 The R map of Jonaghan watershed Based on erosion sensitivity

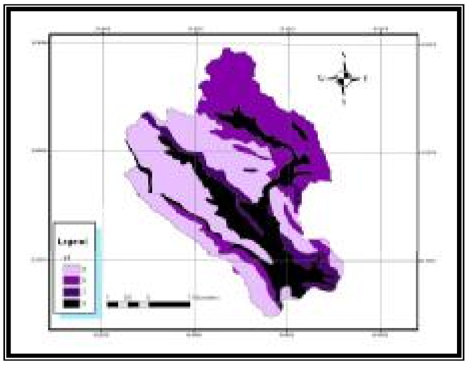

Figure 3The geology map of Jonaghan watershed Based on erosion sensitivity

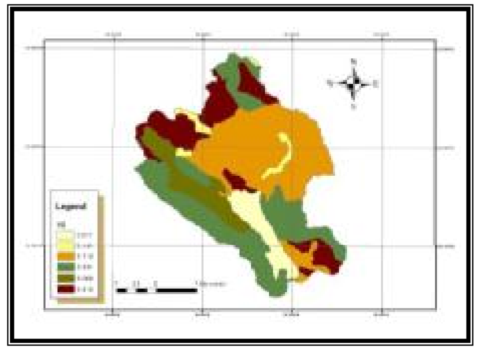

Figure 4 The soil map of Jonaghan watershed Based on erosion sensivity

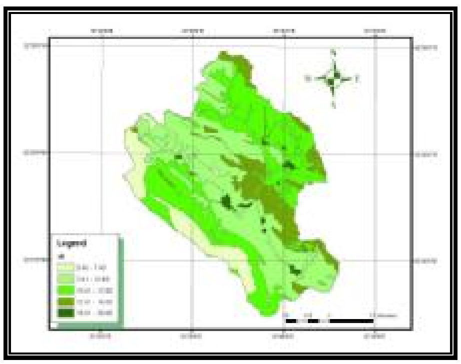

Figure 5The vegetation cover map of Jonaghan

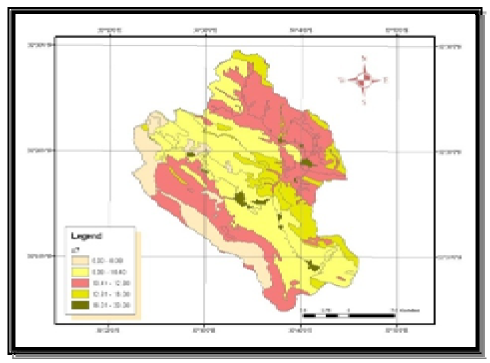

Figure 6The Land use map of Jonaghan

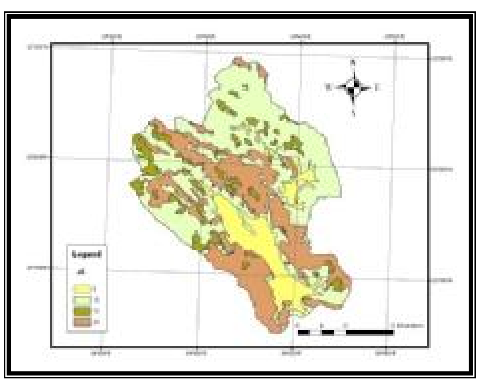

Figure 7The slop map of Jonaghan watershed

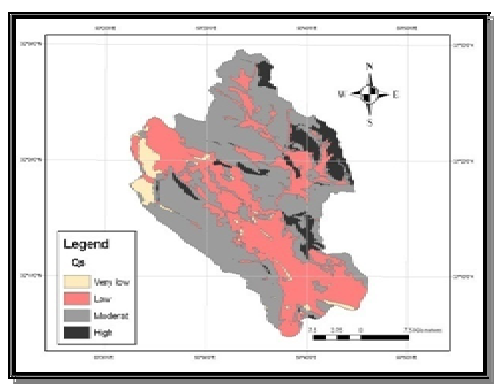

Figure 8The sediment yield (QS) map of Jonaghan watershed