ORIGINAL ARTICLES

Determination and Making Dimension Less as the Most Important Physical Factors Effective on the Erosion, Sedimentation and Flooding: Case Study of Qareh Chai Watershed Basin, Hamedan, Iran.

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ABSTRACT

Understanding and the most important effective factors of Watershed on erosion, sedimentation and especially flooding that play significant role in erosion process, directly and in directly is a first step in the most erosion and flooding frequency analytic methods. In order to analysis of erosion and sedimentation of Qare Chai watershed basin is selected and its physiographic features with morphometry analysis are considered. In this relation hydrological factor affecting flood peak Debi and introducing of regression model and non-linear optimization of flood Debi data and its physical features of sub-basins are used. Then, using pi-pakinham and making dimension Less physical parameters of basin and making relations between Debi-flood and other dimensionLess parameters of present basin error are considered. Results indicated that such away in nonstatistic auriferous basins especially in arid and semiarid areas is one of the best ways in estimating of erosion, sedimentation and flooding. According to the results, most Watershed sub-basins of Qareh Chai have high erosion.

Key words: Regional analysis of flood-water, erosion, pi-pakinham, sedimentation.

Introduction

Disequilibrium between soil formation rate and its erosion has caused the soil become one of the important production factors in the world so that several ways to estimate erosion and soil maintenance are presented by researchers.

For this purpose part of basin characteristics such as height, slope, climate and vegetation to understand of Watershedsituation directly and indirectly are considered by specialists (wood ward 1997). Benchmarking and dimensional Less analysis also are of the important techniques that are considered less in modeling while using these techniques one can simplifies the analysis through elimination of ineffective or marginal variables (Lauereence 1996). Furthermore, understanding of climate factors and morphometry effect on flooding Debi and hydrologic understanding of homogeneous area is the first step in some of the regional flooding frequency analytic methods (Brayson, 1990). From among effective physical factors of basin one can first examines regional flood analysis and then its effects on erosion and sedimentation rate (Jalmarson 1998, Rigres, 1993). In the most areas regional floodinganalysis is implemented by determination of important effective factors and have good results (Regres, 1993). In this relation various ways are introduced that the most important of them are through homogeneous grouping and alternation relations for each area (more, 1997, Esnamy and Hes, 1994). This way is used in America and British auriferous basins and the results of integrating of both ways represented a good model (Genti and moislow, 1997). In Iran is also represented models in this relation using multi-variable regression (Bagheri, 1993, Mosavi 1987) and comparison of the different ways (Honarbakhsh, 1995). Ravanbksh (1998) has analyzed flooding and determined effective. Hydrologic parameters in karun examination. Asadi (1997) determined morphometry parameters effective on basin by examination of karun hydrologic situation of Karun head branches. Dastourani (1996) Concluded in a study that duration of statics can vary in taking results. Thus, given the limited number of stations and also presence of no statistics basin number with small statistic length in Iran is essential to evaluate and analysis of erosion, sedimentation and flood risk rate by analysis of morphometry basin properties.

Material and Methods

In order to examine morpheme try basin properties first using topography maps 1:50,000 Qareh Chai basin in Hamedan, one of the important basins in water supply in the west of Iran, is demarcated. In this relation dimension Less Hypsometry curve and below relations for erosion and sedimentation are used.

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Where $Y$ is calculated height theoretically, $a$ is selected distance from origin ($d=1+a$).

In addition physical basin parameters from linear regression relation and also optimized non linear relation between average peak Debi and selected parameters are as follow:

Equation (3) : $Q = aA^bB^cC^dD^e$

Where $Q$ is an annual average peak Debi, $A$, $B$, $C$, $D$ are independent physical parameters used and $a$, $b$, $c$ and $d$ are coefficients.

In this study area ($A$), mean basin slope ($s$), flood way length ($L$), basin perimeter ($P$), mean height ($H$), mean slope of main floodway ($L$), Gravlious coefficient ($C$) and concentration time ($T$) parameters are used and desired relation is obtained, then it is used taking to consideration parameters from pi-pakingham theory for non dimension factors so that the relation is obtained and used as for cow:

Equation (4) : $F(A_1, A_2, A_3, ..., A_m) = 0$

Equation (5) : $F\left(\pi_1, \pi_2, \pi_3, ..., \pi_{(n-m)}\right) = 0$

Equation (6) : $\pi_1 = A_1^{x_1}, A_2^{x_2}, A_3^{x_3}, A_4^{x_4}$

Equation (7) : $\pi_2 = A_1^{y_2}, A_2^{y_2}, A_5^{y_5}$

Equation (8) : $\pi_{(n-m)} = A_1^{y_1-n}, A_2^{y_2-n}, A_3^{y_3-n}, A_m^{y_m}$

In above equations powers are determined that each parameter be without dimension. A values dimensions in alternative relations and $T$, $L$, $M$ powers are considered to be equal zero. This led to create three unknown equations from $\pi$ parameters. Thherefore, $X, Y, Z$ powers are obtained due to $\pi$ parameter and finally There is a regression or optimized relation between obtained non dimention parameters. That this relation is used to evaluate sedimentation of flood.

**Fig. 1:** different steps of a basin erosion diagram

**Geographical situation in the studied Region:**

The area of this region located 2,745 km$^2$ in the north Slope of Alvand, (the height of central province of Hamendan). In the parts of 48° 45” till 48° 44’ 29” latitude of eastern and 34° 35’20” till 39° 50’34” latitude of northern, in the central Zagross (figure 1) the rocks of the region is influx granite, shiel, Eslite and shist in the Jurasic period/era (Figure of 2). According to the statistic of climatology in Asad Abad station (1997-2007) annual average temperature of this region is +10.75°C that during of winter and summer, changed from -15°C to +34°C. The coldest month is Bahman (February) and the hottest month in Mordad (August). The annual average precipitation of this region is 443.11mm. According to ambrothermic graph the driest month is Ordibehest (May) till Shahrivae (September). The regional climate is accorded to Ambrege method between Semi-arid cold and Semi-humidity Ildoromi, (Ildoromi, Alireza, 2002).
Results and Discussion

In order to erosion according to mathematical relations Hypsometry values are calculated for a whole Qareh Chai basin and its sub-basins and their dimension Less Hypsometry curve are drawn.

Fig. 3: non dimension observational and Fig. 4: dimension Less observational and Theorical Hypsometry curve of Qareh Chai basin theoretical Hypsometry curve of Ekbatan dam sub basin.

Its theoretical and observed curve is also calculated from relative relation and obtained from correlation coefficient \( r = 0.97 \) this coefficient is meaningful in 95% confidence level.

Equation (9) : \( \gamma c = 1.037 \left[ \frac{0.2 \left( 1 - x^2 \right)}{0.2 + x} \right]^{0.36} \)

Observational curve in Qareh Chai dimensional Less Hypsometric graph implies balanced plain extension and height of this basin. In this curve 30 percent of basin upstream area in that theoretical curve is in the top of observational curve is exposed to erosion. Small distance between two curves indicates reduction in erosion intensity and trend to basin balance. Both curves position is reversed in 70% area extent, in other word, theoretical curve is in the bottom of observational curve, so there is sedimentation in this region. Little difference between two curves indicates the approaching to the relative equilibrium.

Approximately 3.5% of upstream region area in Ekbatan of Qarah chai watershed is precipitated due to presence of plains among mountain in Abroo and Yalfanvally which is in the top of theoretical curve. Other parts of basin are almost in the top of observational curve that indicate high to moderate erosion and is to be young mentioned basin. Physical characteristics of Qareh Chai basin is considered and regression equation for data are as follow.

Equation (10) : \( Q = 7.56 A^{-0.38} S^{0.48} H^{-2.31} S_t^{0.14} P^{0.9} T C^{0.31} \)

\( n = 12 \quad r = 0.956 \)

\( r = \) regression coefficient, implies that above relations are accepted with more than 95%

Equation (11) : \( Q = 2.7 A^{-1.15} L^{0.43} H^{-1.23} S_t^{-0.137} P^{2.3} T C^{1.93} \)

In order to compare the 10 and 11 equations from mean squared relation relative error square is used as follow:

Equation (12) : \( RE = \frac{\sqrt{(Q_{obs} - Q_{cal})^2}}{12} \)
Where $RE, Q_{obs}, Q_{cal}$ are relative error, observational Debi and calculation Debi, respectively. Non linear regression relations and non linear optimization are 2.23 and 1.61, respectively so that it is observed that equation resulted from optimization relation is met more credit.

Non dimensional parameters are formed in different forms using 10 and 11 and 12 relations and calculations are implemented on them and finally the best relations are taken as follow:

**Equation (13):** $F (Q.A.P.H.Si.S.TC.L) = 0$

**Equation (14):** $\pi_1 = \frac{QTC}{AL}, \pi_2 = \frac{LS}{A^{\frac{1}{2}}}, \pi_3 = \frac{Asi}{Z}, \pi_4 = \frac{HL}{B}, \pi_5 = \frac{PH}{L^2}$

Then, relation between non dimension parameters using multivariable regression relation is resulted as follow:

**Equation (15):** $Q = 1.17 \left( \frac{LS}{A^{\frac{1}{2}}} \right)^{-0.41} \left( \frac{Asi}{L^2} \right)^{0.92} \left( \frac{HL}{A} \right)^{1.12} \left( \frac{PH}{L^2} \right)^{-0.16} \frac{AL}{TC}$

$n=12$ $r=0.901$

Relative error or non linear regression relations and nonlinear optimization were 3.84 and 1.13, respectively. So, the relation resulted from optimization relation in the use position of dimensional analysis has more credit than other relations.

**Results:**

Although in the most area of Qareh Chai basin Theorical curve is in the bottom of the observational curve and this situation indicates sedimentation in the region, little distance of two curves in the all points shows the approaching to relative equilibrium position in this basin. Also plain extension and height is balanced. Now this basin is young and erosion forces are active in it. This issue is observable in the most 12 Qareh Chai sub basins such as Ekbatan dam watershed. Also the results from hydrologic examination of basin showed that making dimensionless method of physical parameters is used to estimate the flood in homogeneous area and reasonable mathematical relations are obtained. Basins physical characteristics are the most important parameters in non statistical basins which are used in hydrologic estimations.

According to the results, methods used to observational and calculation ways which are comparable, are reliable and we can rely on them in management and exploit water resources.
Results showed that making dimensionless way and its advantages such as facility in regional calculation and evaluation of flood particularly in the Qareh Chai arid and semiarid watershed has little difference with recorded statistics and has reasonable accuracy, so that it is meaningful in the 95% calculations level and indicates that the most of 12 Qareh Chai sub basins are relative water flooded.

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