International Journal of Material Science Innovations (IJMSI) 2(2): 29-36, 2014
ISSN 2289-4063

Research Article

Sensitivity analysis of effective factor on sediment production in order to environmental management

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A b s t r a c t

Keywords:

Sediment Production,

Sensitivity analysis,

peak flood index,

DEFINITE Software.

In many parts of the world, soil erosion and production sediment affects the stability of ecosystems, often causing irreversible land degradation.The most important concern of related engineers and executive experts is selection effective variable that that mobilize a lot of sediment. In this study, about twenty characteristics of each sub-basin include physiographic, climatologic, hydrologic, and geologic and vegetation cover, were considered. The First, using principal component analysis (PCA) the influential factors was determined which have great influences on erosion process and sediment production. Finally, DEFINITE software package was used has been developed to improve the quality of environmental decision making for estimating of effective factor on sediment production. Results showed that peak flood index is the most effective and significant and there is much sensitivity to Sediment Production in the region.

Accepted:30 April2014

1. Introduction

There are many prevention and remediation practices that can curtail or limit erosion of denuded soils. Due to the severity of its ecological effects, and the scale on which it is occurring, erosion constitutes one of the most significant global environmental problems we face today [1]. Monitoring and modeling of erosion processes and production sediment can help us better understand the causes, make predictions, and plan how to implement preventative and restorative strategies. However, the complexity of erosion processes and the number of areas that must be studied to understand and model them (e.g. climatology, hydrology, geology, chemistry, physics, etc.) makes accurate modeling quite challenging. [2-3]. Sensitivity analysis can be used as an aid in identifying the importance of uncertainties in the model for the purpose of prioritizing additional data collection or research. Sensitivity Analysis can also be used to provide insight into the robustness of model results when making decisions Sensitivity analysis is the assessment of the impact of changes in input values on model outputs [4].Hence, sensitivity analysis is considered by some as prerequisite for model building in any setting, whether diagnostic or prognostic, and in any field where models are used. Quantitative sensitivity analysis is increasingly invoked for corroboration, quality assurance, and validation of model-based analysis [5]. Sensitivity analysis can be helpful in verification of a model. Verification is a process of checking that the model is correctly implemented. If a model responds in an unacceptable way to changes in one or more inputs, then trouble-shooting efforts can be focused to identify the source of the problem. Sensitivity analysis can be used to evaluate how robust risk estimates and management strategies are to model input assumptions and can aid in identifying data collection and research needs [6].This paper reports of sensitivity analyses in the context of the formulation of a risk problem, including the scenarios and the model, the source of information in order to reveal the role of effective factor on production sediment.

2. Experimental procedures

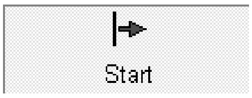
The study was carried out in the Zidasht Cachment and it is located between latitude 50° 40′ N to 50° 44′N and longitude between 36° 05′E and 36° 10′ (in the NW of the province of Alborz) with a drainage area of 64.86 km^2. The study area is an active erosional environment because of the presence of easily erodible material including marls and quaternary deposits and sparse vegetation cover. A large part of the region is devoted to agriculture owing to the lower steepness and has being cultivated in different directions and after years, has been abandoned which has been producing sediment in large scale. This area was subjected to a soil conservation project that was started in 1997. According to the studies implemented by experts, the produced sediment enters the lake of the dam without any cessation, and endangers dam’s stability and strength [7].

In current investigation, in order to Sensitivity analysis of effective factors in Cachment, about twenty features including physiographic, climatologic, hydrologic and geologic and vegetation were determined. For estimation of each feature, relative maps were produced and with regard to topographic maps acquired from Mapping Organization of Iran, the final values were elicited. Factor analysis is used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of manifest variables. With factor analysis we can produce a small number of factors from a large number of variables which is capable of explaining the observed variance in the larger number of variables. SPSS has a procedure that conducts exploratory factor analysis. There are three stages in factor analysis [8].

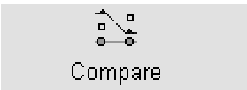
- First, a correlation matrix is generated for all the variables. A correlation matrix is a rectangular array of the correlation coefficients of the variables with each other.
- Second, factors are extracted from the correlation matrix based on the correlation coefficients of the variables.
- Third, the factors are rotated in order to maximize the relationship between the variables and some of the factors.

Finally, DEFINITE software package was used has been developed to improve the quality of environmental decision making. DEFINITE (decisions on a finite set of alternatives) is a decision support software package that related procedures such as weight assessment, standardization, discounting and a large variety of methods for sensitivity analysis are also available. This procedure determines the sensitivity of the rankings calculated with multi criteria methods for uncertainties in the assigned weights and effect scores. The calculated rankings can also be compared with each other. In this way you get an impression of the sensitivity of the determined rankings for the choice of an evaluation method, standardization or weights. The step 'sensitivity analysis' consists of procedures for ranking and for the appraisal of alternatives [9].

Steps menu

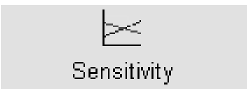


Start sensitivity analysis

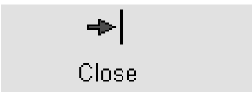


Compare all saved results

Specify uncertainties and produce probability table



Sensitivity of results for changes in a score or price



Close sensitivity analysis

3. Results and Discussion

The first item from the output is the scree plot is a graph of the eigenvalues against all the factors. The graph is useful for determining how many factors to retain. The point of interest is where the curve starts to flatten. It can be seen that the curve begins to flatten between factors 3 and 4. Note also that factor 4 has an eigenvalue of less than 1, so only three factors have been retained, called a scree plot in which the eigenvalues are plotted from largest to smallest. In the scree plot, one looks for a "bend" in the eigenvalues to determine where to stop the retention of factors. For our data, the solution is obvious, and we would only retain the first two factors. Figure 1 illustrates the alternations of Eigen values associating with the factors. This graph is used to determine factors optimally. As could be seen in the graph, from the third factor afterward the alternations of Eigen values decreases. As a matter of fact, all variables are summarized in three principal axes. According to the graph, the first axis itself is responsible of 37% of the current variance compared with the minimum number of 9% in the third axis. Analyzing these relationships has revealed 5 factors including peak flood index, major water way slop, total length of stream, land-use changes and peak flood index as the factors gaining maximum frequency among independent variables imported to the model that peak flood index is the most effective; hence, it is regarded as the influential factor in sedimentation of the region.

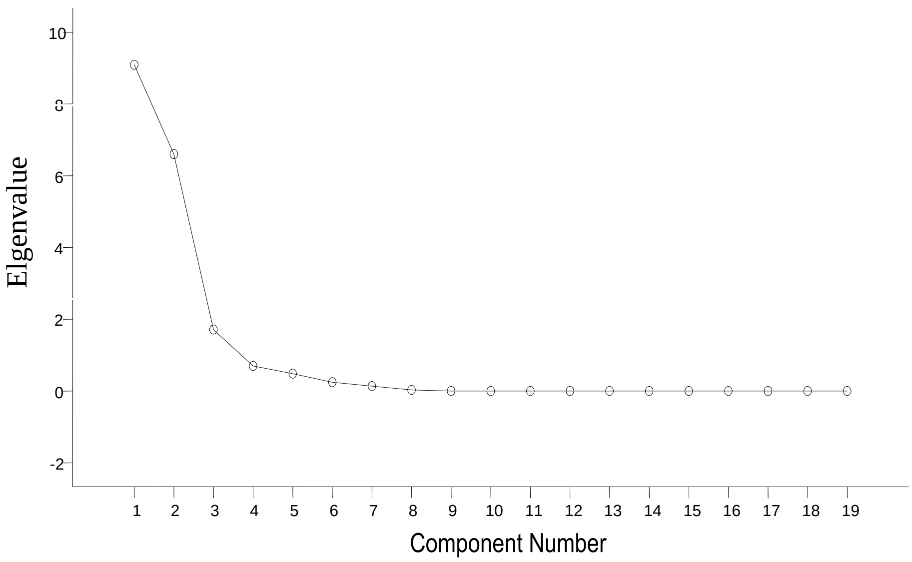


Fig.1: The alternations of Eigen values associating with the factors

Step1. Start

due to the hydrologic analysis 9 alternative options based on sediment production identified. For this alternatives, important peak flood index has been identified and quantified. the quantitative value are transferred to DEFINITE to do the sensitivity analysis.

Step 2. Compare

In this way we get an impression of the sensitivity of the determined rankings for the choice of an evaluation method, standardization or weights. Important information retrieved from this step is the fact that the alternative 1 is almost always better than 3. The graph also shows that the alternative 9 is always worse than the 1 and the 2.

Step 3. Uncertainty

This procedure assesses the sensitivity of a ranking obtained by one of the available multi criteria methods for uncertainty in the scores of all effects, in the weights of the effects, or both. In the screen Fig.2you have to fill in percentages per effect. These percentages indicate to what extent the assigned scores can deviate from above or below. The percentages have to be filled in the column ‘Score Unc. [%]’. To illustrate the procedure you fill in a percentage of 50 % for each effect [9].You see the result in the probability table graphically displayed in fig2. The large sized circles on the main diagonal indicate that the ranking of the alternatives under 50 % score uncertainty is rather stable.

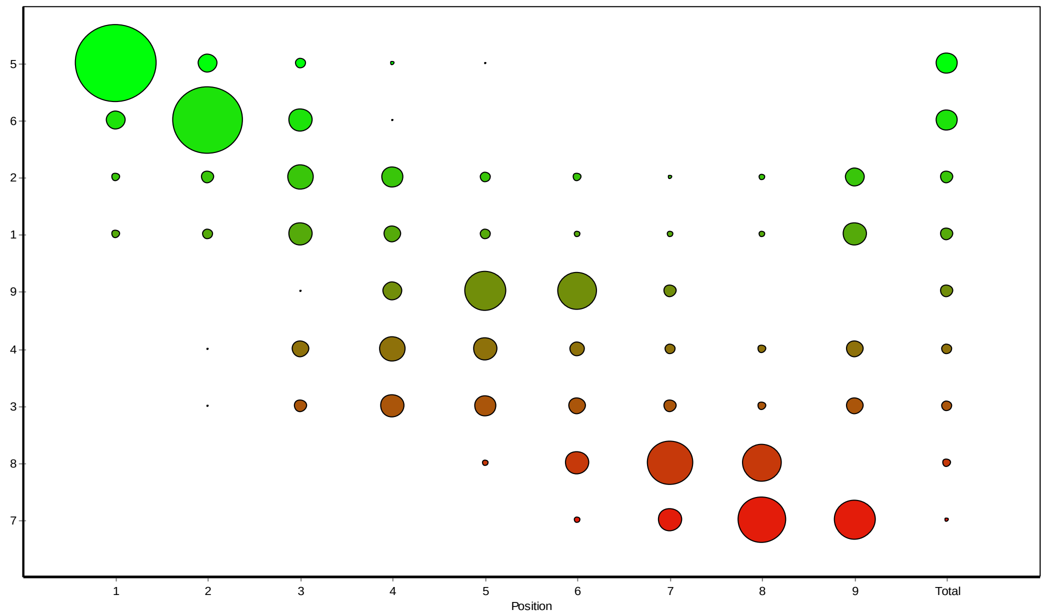


Fig. 2: result the ranking of the alternatives in probability table graphically

Step 4. Sensitivity

This procedure determines the sensitivity of a ranking for a selected score or weight. This procedure also determines a combination of weights, most similar to the original combination of weights, that changes the rank order of two alternatives. The course of this score is displayed on the horizontal axis and the score of the alternatives in the ranking is displayed on the vertical axis (the higher the better). For the main effect perspective: peak flood index, this method has been carried out and the results are given in figure 3. It can be seen that be considering the given weight to the peak flood index effect 0/2 on the Sensitivity analysis the first rank of alternatives is stable if the variation of peak flood index weight is between 0-0/35 .It means that if the given weight gets smaller till 0/35, still the alternative5 is the first rank. Meanwhile if it increase a little and comes to 0/4 the first rank alternative5will be reversed by alternative1 and will remain stable by decreasing the weight of till 0/6. Based on the weight of effect factor, If the weight of peak flood index increase by the end, the alternative7becomes better than 1 and is the best region to production sediment.

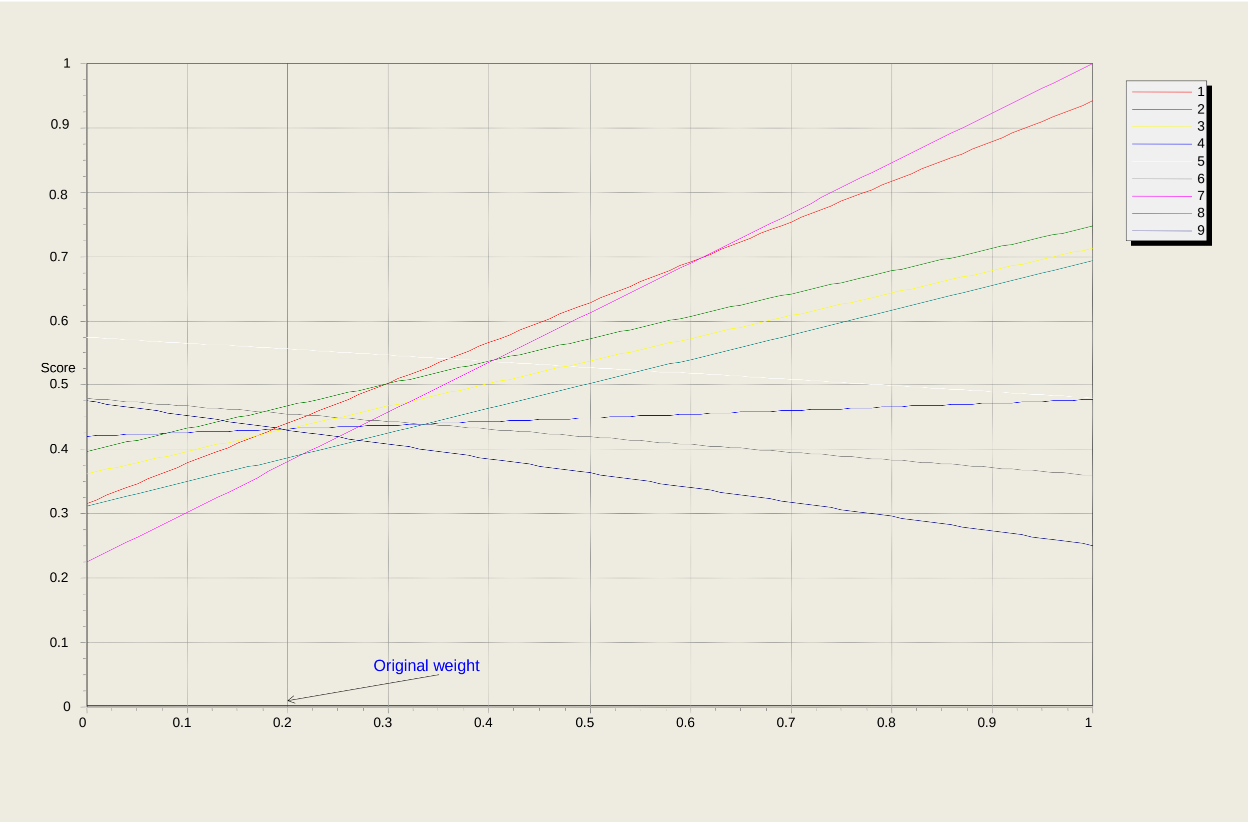


Fig. 3: Sensivity of ranking for sediment reduction criterions

4. Conclusions

flood index is an significant component of sediment control studies. it is necessary to study the different floods in catchment, because they are related with the resistance of materials to soil erodibility. Regarding the results this paper, peak flood index itself is responsible of 37% of the current variance. Check dams are the mostly commonly used measures on sediment control projects. The number of needed check dams, to make proper decisions national policy on sediment control projects, will be determined based on the prioritizing of suitable alternatives for implementing and starting soil conservation projects. In order to achieve more reduction sediment in region where they are more sensitive to changes in peak flood index with quantitative investigation such changes should be considered to capture the higher amount of sediment.

Acknowledgments

This study was supported by Department of Rehabilitation of Arid and Mountainous Regions, college of Agriculture & Natural Resources, university of Tehran. Thanks go to my colleagues and friends who gave their inputs and improved the quality of this research work.

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