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Multi-Variable Location Assessment for Building Modified Stone-Concrete Dams in the Drainage Basin of Golpayegan Through Fuzzy Logic and Boolean Method, Isfahan, Iran

ZahraGhasem[1], Mojtaba Pirnazar[2], Kaveh Ostad-Ali-Askari[3*], Saeid Eslamian[4], Mohsen Ghane[5], Vijay P. Singh[6], Nicolas R. Dalezios[7], Shahide Dehghan[8], Neda Taghipour[9], Maryam Marani-Barzani[10]

[1]Department of Remote Sensing, Maybod Branch, Islamic Azad University, Iran

[2]Department of Remote Sensing, Tabriz University, Tabriz, Iran

[3]Department of Civil Engineering, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran*

[4]Department of Water Engineering, Isfahan University of Technology, Isfahan, Iran

[5]Civil Engineering Department, South Tehran Branch, Islamic Azad University, Tehran, Iran

[6]Department of Biological and Agricultural Engineering &Zachry Department of Civil Engineering, Texas A and M University, 321 Scoates Hall, 2117 TAMU, College Station, Texas 77843-2117, U.S.A.

[7]Laboratory of Hydrology, Department of Civil Engineering, University of Thessaly, Volos, Greece & Department of Natural Resources Development and Agricultural Engineering, Agricultural University of Athens, Athens, Greece.

[8]Department of Geography, Najafabad Branch, Islamic Azad University, Najafabad, Iran

[9]Department of Urban Engineering, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

[10]Department of Geography, University of Malaya (UM) ,50603 Kuala Lumpur, Malaysia

Corresponding Author:** ***Dr. Kaveh Ostad-Ali-Askari, *Department of Civil Engineering, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran. Emails: Koa.askari@khuisf.ac.ir, Kaveh.oaa2000@gmail.com*

Abstract: *Water and soil are the most important natural resources, which have a major role in the establishment and survival of human civilization. For this matter, studying water and soil resources is significantly important. These resources have been damaged by human interference, which can be problematic for the continuation of human lives. The aim of this study is to investigate an appropriate location for creating a modified dam along canals in order to reduce erosion and sedimentation and their damaging effects. In this research, the intended layers were prepared in the ARC GIS software. In a tree model prepared in ILWIS, the geographical and economic factors and limitations were taken into consideration. The map of the factors and limitations was standardized. The weight of each layer was given through the Fuzzy Logic and Boolean method accordant with a, expert's opinion. At last, by integrating the layers of the final map in which the geographical priorities for building a stone-concrete dam along the canal are displayed. The results show that the SMCE method is best for a location.*

Keywords: *modified dams, geographical multi-variable assessment, Golpayegan, stone-concrete dam*

1. INTRODUCTION

Two of the dangers that threatens water and soil resources, are erosion and sedimentation. Erosion, as an environmental destruction factor, in addition to destroying the soil and reducing lands' soil fertility, it also pollutes surface water sources and reduces water penetration in soil, which leads to destruction of rangelands and forest lands, decrease in vegetation, reduction in recharge of groundwater sources and expedition of desertification. Pollutants that accumulate along with deposits, especially fine deposits in reservoirs of dams, lakes, wetlands and riverbeds, are considered as future danger. [1] One of the simple methods for controlling floodwater and reducing flood damages in the

canals of drainage basins, is building modified dams. Most check dams are filled with coarse-grained and colluvial deposits, which the chance of the reaching the back of downstream dams is very low; therefore, it seemed necessary to study the performance of these structures in keeping these fine deposits [4]. Modified dams or sedimentation dams are small structures that by reducing the waterways' slope and decreasing the water flow, they inhibit sedimentation and reduce erosion in waterways, [3] and then lead to modifying the longitudinal profiles of waterways; thus, these type of structures are known as modified dams [1]. These structures are considered as one of the major tools in watershed activities for protecting water and soil; which during the recent years they have been used on a very extensive level by executive authorities, and have dedicated a major sum of these expenses to itself; however, despite all efforts and investments in this sector, the main problems, meaning erosion and destruction of natural resources are still increasing. Considering the desert evidence and conducted studies on downstream, investigating the type and gradation of deposits and the manner of which they are transferred to water, can determine their level of effectiveness on reducing deposits that are finally transferred to the reservoir of reservoir dams and can be a guide for selecting the place for check dams [3]. Since waterway No. 3 and 4 under study for the location of the check dams, stone-concrete dams were found to be more appropriate. Golpayegan is a mountainous region. The Golpayegan'splain is extensive and its water is supplied by rivers, qanats, springs and other groundwater resources. Iran's central mountain range goes through this county. From those who have conducted studies in the field of modified dams, Ismael Namghi and his colleagues can be mentioned, whom studied the dry-stack in the Doroodzan Dam. The reason for the inappropriate choice of gradient limit are the upstream-modified dams buried in the deposits in the downstream-modified dams. If the distance of modified dams were selected based on the gradient limit, it would have led to reducing the cost of building modified dams. Ghazavi and colleagues also conducted a study on the effect of modified dams on the waterway morphology and sediment of deposits in the drainage basin of Javan-Fars. In their study, they found that the performance of the modified dams in different parts throughout the waterway is more for trapping fine deposits in the end than the springhead. Xiang Chou and colleagues in their study on the Yellow River, they found that the modified dams were the most effective method for rapid reduction of coarse-grained deposits that had entered the Yellow River. In the hot and dry weather and infertile soil of alluvial plain in China, Goul and colleagues found that the order of modified dams in the gutter are the most effective way to protect the soil. Marston and Doulan showed that building modified dams in this region were not effective.

2. UNDER-STUDY REGION

Golpayegan is located from north to KhomeinKomreh and small part of its west to Bakhtiyari and Aligodarz mountains and from south to Khansar and Bakhtiyari mountains and from east to Meymeh and Sheikh Ahmad Mountain and SorkhMountain and Prophet Saleh Mountain and MahvarGolgaleh and from southeast to Najafabad. It is 1818 meters above sea level (base height = average water level of the Persian Golf in the Fav region that is the base for European regions). Golpayegan's climate is variable and has cold winters with a minimum temperature of 21° degrees and has hot and dry summers, which its maximum temperature reaches +37.5 degrees centigrade. This region has a longitude of 33° 02′ 03″ and latitude 50° 20′ 17″ W. Rainfall often occurs in winter and about 300mm. Gopayegan is a mountainous region.

Based on the census of year 2006, the population of Golpayegan was 86601 (24820 households). This county is consisted of three rural districts (plain, riverside and Nivan), three cities (Golpayegan, Goged and Golshahr), and 54 villages. The present villages in this county include Dareh Bid, Doshakhrat and Ghale Baba Mohammad.The altitudes of Golpayegan county that have been separated from the eastern trail of Zagros mountain range and often from the mountains surrounding Isfahan, belongs to the second geologic period and they extends from northwest towards southeast as several parallel chains. The highest summit of this county is Prophet Saleh Mountain on which there is a holy shrine. The GolpayeganRiver, which originates from Zagros altitudes that is proximity of Zayandehroud River's branches, constitutes the main drainage network of the region.

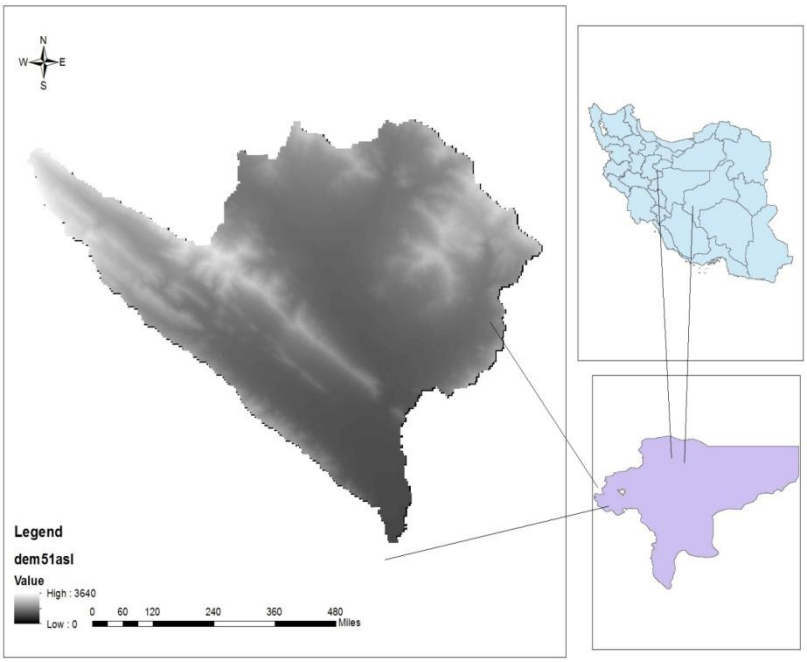

Figure1. *Location of the Under Study Field*

3. MATERIALS & METHODS

In the ARCMAP software, the intended layers' coordinates were equalized. First, the layers were converted to GCS and then, were reverted to UTM. The limitations and factors maps in the tree model that were prepared in SMCE in ILWIS software (Figure 2) were standardized and weighed. Through the priorities' map, the construction of these check dams were obtained. Generally, using this type of modelling and utilizing laws of decision causes saving in time and costs and finding a more precise location. The information layers used for locating the stone-concrete modified dam are displayed in figure 3. As we see in figure 3, the limitations are weighted by the Boolean method, until the incompatible factors are eliminated and based on their level of significance for building stone-concrete modified dam, they were placed in a factors group with a weight between zero and one. As an example, the geology of the region was weighted through the rating method. In such manner that the loose stone due to having less resistance towards erosion gets a higher rating and as the stone is harder, it gets a lower rating.

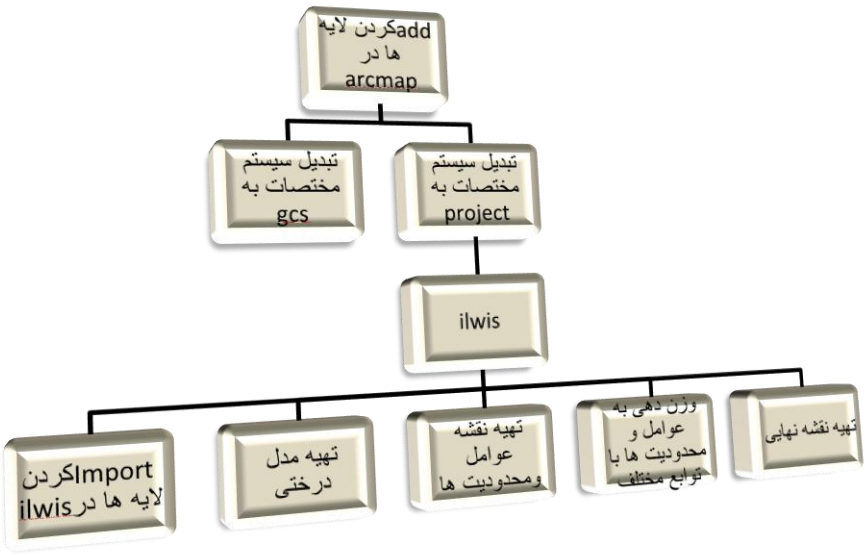

Figure2: *Working phases in the ILWIS and ARCMAP software*

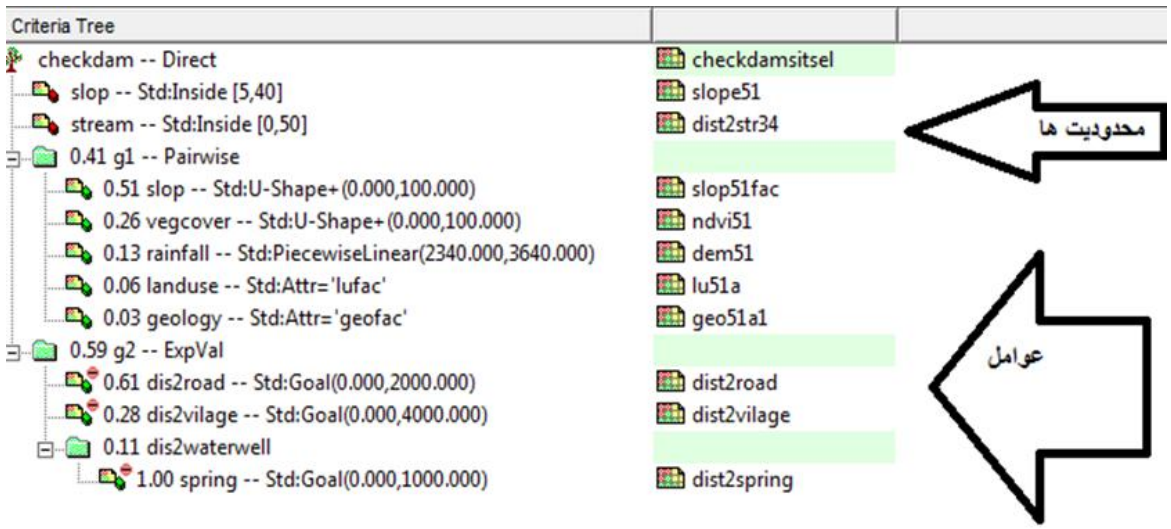

Figure3: *Tree Model for Location and Economic Factors and Limitations*

Table of Factors and Limitations

Standard	Map	Function	Reason	Weighting	Value
Limitation	Waterway	Equal to the considered pixel size.	Where the waterway	Boolean (0 and 1)	
	Slope	Boolean function with a slope between 4-50 giving a value one and the rest value zero	Medium slope because of less erosion and precipitation is from high and less slope.		
Factors	Slope	Standard (high slope has more value)	Higher slope is more appropriate because of more erosion	Paired Comparison	0.51
	Geology	Ranking (the looser stone gets a higher ranking and the harder stone gets a lower ranking)	The looser stone goes through more erosion		0.03
	Land Usage	Ranking	Owned properties or those with economic value are not appropriate for building a dam and get lower ranking		0.06
	Vegetation	Ranking	If the vegetation is inappropriate, there is a need to create a dam because erosion will be more		0.26
	Precipitation	Standard (Higher altitudes due to more precipitation are of more significance)	Precipitation causes erosion to increase		0.13

	Road	Ranking (closer to rural district has more value)	Closeness to road has is economically advantage.	Rank Ordering	0.61
	Rural District	Ranking (closeness to rural district has more significance)	Due to supplying human resources and facilities, closeness to rural has more significance.		0.28
	Spring	Standard (closeness to spring has more value)	Due to economic value of spring, closeness to that gets more significance.	Direct Rating Method	0.11

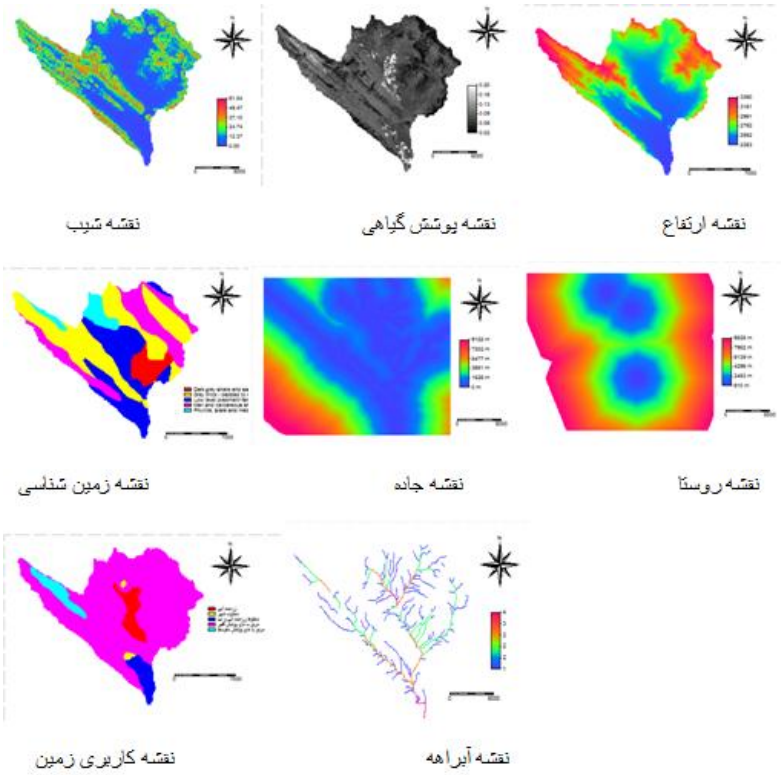

Figure4: *Map of limitations and economic and location factors*

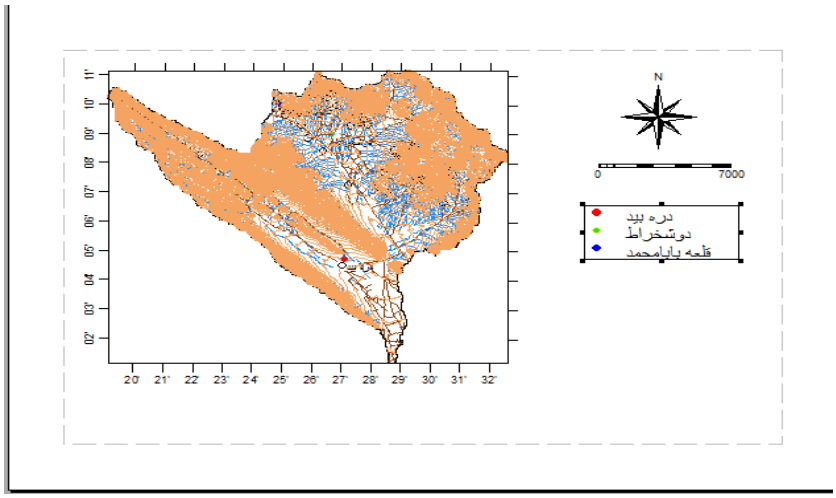

Figure5. *Map of Drainage Basin*

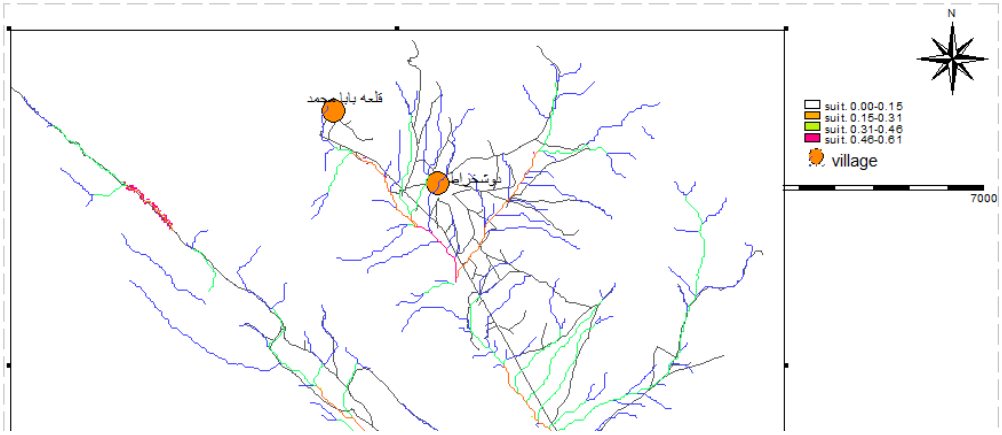

Figure6. *Priority regions for building stone-concrete modified dam*

4. CONCLUSIONS

In this research, the priority regions for building a stone-concrete modified dam was determined (figure 5). Among those who have worked in this field, the study conducted on dry-stack dams in sedimentation of deposits in the Dom Tang Darab region, which was an indication of good performance of these dams in sedimentation of fine deposits. In another research in regards to the role of modified dams in controlling the deposits in the Taham drainage basin in Zanjan Province, which was a representation of the difference in the level of deposits in the downstream is variable. The chosen criteria were based on the expert's opinion. In the prepared tree model, economic factors such as distance from rural district and distance from road have more significance compared to natural factors. Based on the weighting and integration of factors and limitations, the priority locations for building stone-concrete dams have been specified as in figure No. 6.

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