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Pick up pattern from logic fuzzy in mathematics for zonation of landslide hazard

(Case Study: Karaj Watershed)

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ABSTRACT

First landslide hazard zonation provided based on Fuzzy logic by landslide area laid on the Slope map, Geology(lithology) map, Aspect map. Then, these maps classes of priority and coming next determine based on existing landslides area in the geology, slope and aspect of maps. In the geology map of tuff, shale, and conglomerate rocks, about with hectare 1440.43 (about percent 23.94) and shelly limestone about with hectare 0.88 (about percent 0.01) and in the slope map, X>45 classes about with hectare 2794 (about percent 46.44) and 15-25 classes about with hectare 737 (about percent 12.25) and in the aspect map, East classes with about hectare 1882 (about percent 31.28) and west classes with hectare 579 (about percent 9.62) sequential have most and least landslide area. Then, in final drawer to dimension centimeters 2 in region watershed management of map and we counted from 0 until 863 based on geology, slope and aspect that exist only unit 624 counted from 0 until 623. Then (y) units settled sequential, numbers 0 to 105 in very low sensitivity class (one class), numbers 106 to 207 in low sensitivity class (two class), numbers 208 to 345 in average sensitivity class (three class), numbers 346 to 498 in high sensitivity class (four class) and numbers 499 to 623. then landslide hazard zonation provided base on Fuzzy logic.

Keywords: Mathematical, Geology, Fuzzy Logic, Zonation, Landslide, Watershed, Tehran province

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INTRODUCTION

landslide is a phenomena in which depend to different reasons like slope, geology, rainfall, plant covering, earthquake, …. and similar to earthquake perhaps in some countries more, because of big financial and bodily injury damage in the cities that water & electricity, gas & telephone transferring and destruction of building and roads by earthquake and also natural resource is considerable, in which decade years 1990-2000 by UNESCO organization was named comparison natural disaster and the landslide phenomena is under consideration of the natural phenomena (Ahmed 2015). Our country Iran ,because of special and reasonable & effective conditions on creation of landslide is one of the countries which sometimes will be facing with this incidentally event and it can be referred to important condition like geology, climate, forest & plant covering condition & seismic,… actually the fact is (Umar, Pradhan et al. 2014), this incidentally event in Iran in most of the time will leave financial and bodily injury damages and often cause to more damage than earthquake itself. Tehran province as a big and vast zone in country that has different condition to create landslide (Conforti, Pascale et al. 2014). And at the most of the area specially on northern zone we will be facing of different type of land slide phenomena. That we can point on landslides of north & north – east (watershed management of Karaj, around Latyandam, path of larestan, Fasham & Meygun ,….). so by consideration of damage due to landslide that we talk about it before we have to recognition it, do zonation and

reduced its damage till its possible (Gance, Bernardie et al. 2015). Area of study case which is a big part of watershed management is occurred in the Karaj – Chalus path around Amirkabir dam towards Ahuan mountain. Its geographic width is 36,8 degree, 22 -35, 44 degree, 58 and its geographic length is 51,29 deg,54-50,57 deg,46. which has area of 125000 hectare. Karaj watershed is separated in east from Jajrud river by Shemiranat height and in west from Taleghan river by Kare bozorg mountain and in north from Chalus river by Alborz mountains (Ercanoglu and Gokceoglu 2004). Because of variety effective agents at creation of land slide like geology, slope, direction, rain fall,….have number of landslides (sort of slide, flooding, falling) that type of old sliding and flooding (specially debris flow) than other type of landslide in units, formations geology (specially Karaj formation) zone is more. Generally there are different method like gravity method, experimental, statistical, analysis fuzzy, for zonation of hazard due to landslide at region with different hemisphere. That in present search with consideration of region data Fuzzy logic is surveyed (Hong, Pradhan et al. 2016). Each of this method is a general state and have different sub part and there are several scholars that offers some methods. In each of these method on the base of accuracy of job measurable agents, assessment factors involved for example factors like slope, geology, plant covering, hemisphere, soil, earthquake ,…….but in all region these factors are not measurable and assessment. What is obvious is, if they can consider more no. of factors assessment, obviously the result (plan of zonation landslide hazard) will possess high accuracy and factor of safety. What is the result by surveying of some methods is in 80 percent of their, factors like slop and geology are interference that itself shows important and effectivity of ingredient in creation of this land slide event (Mahmoud and Alazba 2016).

MATERIAL AND METHODS

By providing zonation map of landslide hazard by fuzzy logic method outset information layers needed like geology (lithology) transmittal surface landslide , slope, direction, provided and at numbered on GIS software envirnment (Mahmoud and Alazba 2016). Then by using area of landslides getting at slope map (Figure. 1) geology (lithology) (Figure. 2) & for (Figure. 3) primacy and recency , classes or existing area at as mentioned maps , are determined which in geology lithology tuff, shale, conglomerate rocks (EKT2) with 1440/43 hectare (equivalent to 23/94 percent) and lithology of lime rock with shale (TRE) with areaof 0.88 hectare (eq. to 0.01 percent) and in slope class or zone (45 less than x) with area of 2794 hectare (eq. to 46.44 %) and class of zone 15-25 percent with area of 737 hectare (eq. to 12.25 %) and also in direction slope map east direction with area of 1882 hectare (eq. to 31.28 %) and west direction with arae of 579 hectare (eq. to 9.62 %) are covered most and least land slides of region (Monmonier 1997). After processwhich mentioned on the base of Table .1 units (y) sequence classes which on each factors of geology slope and slop direction are marked have 864 units which from zero to 803 are numbered that from this unit number of 624 units at region exist. And from zero to 623 are counting and are the base of computing (Tien Bui, Pradhan et al. 2012). The summury of units are showed on Table .2 for example on the base of this table the unit consisting the class of slope (x greater than 45)and geology with lithology alluvial river (Qall) and was east slope direction has number of zero and the units which consist class slope 15-25 and geology with lithology shale silt, sand rock & shale & poor dolomit (pck) and west direction possess most unit number it means 623 (Pourghasemi and Kerle 2016). At the end with drawing of net work with dimention of 1 cm. on study case of water shed region and on the base of slope geology &slope direction specialty at each networks their number are determined from zero to 623. Then on the base of abundance land slide surface (Figure. 4) on each numbers (abundance base on amount of y in which itself is the sum of than area of land slide of each unit to total area of units) or down zone and their sensitivity than landslide divided that its summury of information with Table. (3 & 4) and (Figure. 5) are showned (Pham, Bui et al. 2016).

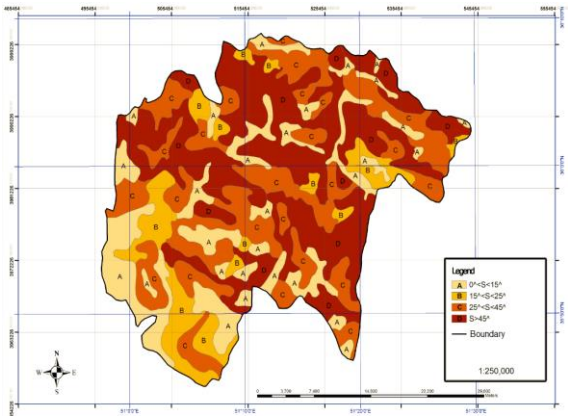

Fig . 1 Slop map in four class for zonation of land slide hazard by logic fuzzy

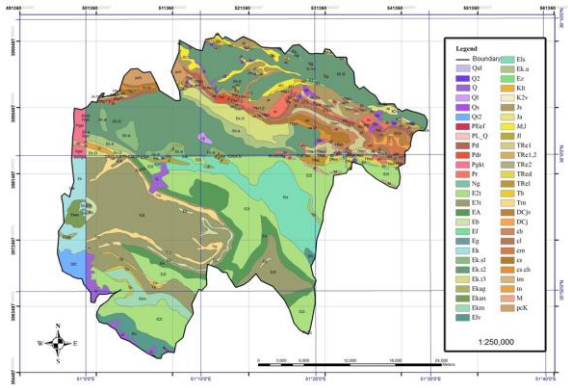

Fig . 2 Geology Map of Karaj watershed

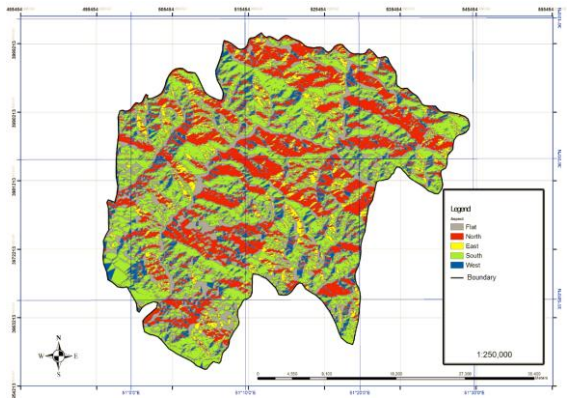

Fig . 3 .Map of four direction & flat zone

Table .1 Coding of units processing

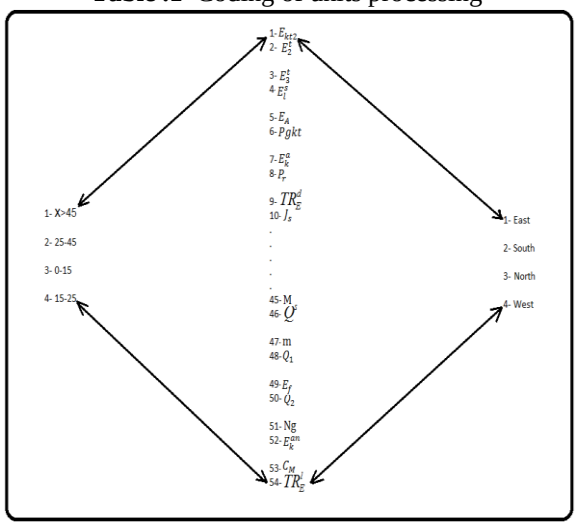

Table .2 Units number & amount of effective factors in fuzzy method

No.	No. of unit in zone	Amount of y	Slope	Geology	Direction
0	-	-	4	54	4
1	0	0	4	54	3
2	1	0/01	4	54	2
3	–	–	4	54	1
4	–	–	4	53	4
5	2	0	4	53	3
6	2	0/03	4	53	2
7	4	0	4	53	1
8	–	–	4	52	4
9	5	0/02	4	52	3
10	6	0	4	52	2
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
853	616	0	1	3	3
854	617	1/13	1	3	2
855	618	2/16	1	3	1
856	–	–	1	2	4
857	619	0/73	1	2	3
858	–	–	1	2	2
859	620	0/87	1	2	1
860	621	0/19	1	1	4
861	622	1/03	1	1	3
862	–	–	1	1	2
863	623	1/14	1	1	1

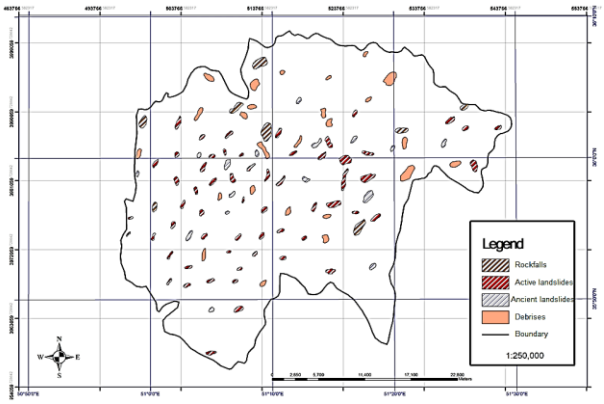

Fig .4 Map of landslide surface

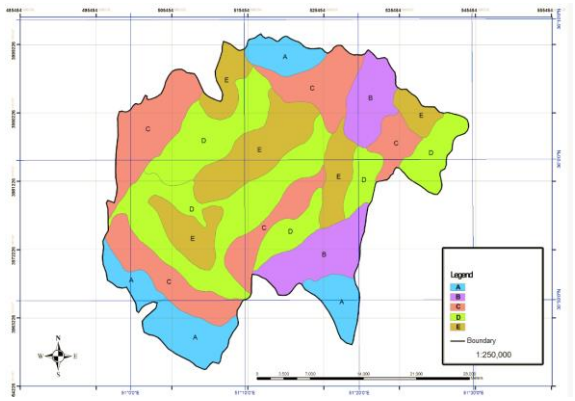

Fig .5 Map of landslide zonation hazard Karaj watershed by fuzzy method

Table.3 Zonation or classes determined by y of landsliding surface on them

Unit no.	Hazard class
(A) from 0-105	Very low sensitivity
(B) from 207-106	Low sensitivity
(C) from 345-208	Medium sensitivity
(D) from 498-346	High sensitivity
(E) from 623-499	Very high sensitivity

Table .4 Area of zones in landslide hazard zonation map & area of landslide in each zone

ZONE	AREA			
	Zone (Hectare)	Zone %	Land slid (Hectare)	Land slid %
(A) Very low sensitivity	15699	12/56	139	2.31
(B) Low sensitivity	14012	11/21	516	8.58
(C) Medium sensitivity	31909	25/53	1293	21/49
(D) High sensitivity	39077	31/26	1854	30.81
(E) Very high sensitivity	24303	19/44	2215	36/81
Sum	125000	100	6017	100

RESULTS AND DISCUSSION

As it mentioned for zonation of land slide hazard under cover of fuzzy method outset need information layers like geology (petrology) transmittal pointy and surface landslide, slope, direction, deposit slide, non-slide prepared & are numbered on GIS software environment (Ercanoglu and Gokceoglu 2002). After that on the form of present pattern the region of study case zonation that the summary of information of their set is on Table .4 on the base of refer table around 15699 hectare (eq. to 12.56%) consist of stable zone or zone with very low sensitivity around 14.12 hectare (eq. to 11.21 %) consist of generally stable zone or zone with low sensitivity around 319.9 hectare (eq. to 25.53 %) part of zone medium stable or zone with medium sensitivity around 39.77 hectare (eq. to 31.26%) part of zone medium unstable or zone with high sensitivity and at the final around 243.3 hectare (eq. to 19.44%) part of unstable zone or zone with very high sensitivity. Above table shows that more than 6338 hectare (eq. to 50.70%) region of study case under consideration of hazard due to land slide phenomena. By the form of zone with averagely unstable or zone with high sensitivity and unstable or are zone with very high sensitivity. Also on the base of Table.4 around 139 hectare (eq. to 2.31 %) land slide of region in stable or zone with very low sensitivity around 516 hectare (eq. to 8.58%) in generally stable zone or zone with low

sensitivity around 1293 hectare (eq. to 21.49%) at zone averagely stable or zone with medium sensitivity around 1854 hectare (eq. to 30.81%) part of zone averagely unstable or zone with high sensitivity and at the final around 3215 hectare (eq. to 36.81%) part of unstable zone or zone with high sensitivity .Above table shows that more than 5362 hectare (eq. to 89.11%) area of land slide in zone averagely is unstable or zone with high sensitivity and unstable zone or zone with very high sensitivity which showing the accuracy of fuzzy method on region.

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