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ORIGINAL ARTICLES

The Study and Modeling Land Slide Hazards By Using Logistic Regression. Case Study: Syahdare Watershed, Hamedan, Iran.

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ABSTRACT

Understanding where the landslides are most likely to occur is crucial in reducing property damage and loss of life in future landslides. In this research logistic regression analysis is used because of requiring to less statistical assumption comparing whit other multiple statistical models and creating the best relationship between presence and absence of landslides and asset of causative factors to supply landslide susceptibility map in Syahdare basin .at first based on field surveys, local interview and review of previous works in similar region, ten primary causative factors on landslide occurrence such as elevation, slop gradient, aspect, rainfall, distance from fault, distance from drainage, distance from road, land use and lithology in study area recognized and their information layers has been created in GIS by using ARC GIS 9.2 softwares based on photograph interpretation and field surveys 75 landslides were recognized and also another 75 non landslides were selected randomly all over the basin. After overlaying all points (landslides and non-landslides) with causative factors layers 1 and 0 codes were belonged to presence and absence of landslides respectively. After entering independents variables including all coded classes and dependent variables including 150 landslides and non-landslides in to SPSS 12 and selecting forward stepwise method, data analysis were performed. Interpretation of coefficients obtained of logistic regression function analysis indicates that aspect and lithology, being miscorrelated with landslide occurrence by more than 0.05 significance are deleted from the model. At last, statistical model was performed based on the most effective factors on landslide occurrence including slope, elevation, rainfall, distance from drainage, distance from fault, land use and distance from road respectively. After transmitting this model to ARC GIS9.2 soft ware, landslide susceptibility map of Syahdare basin was performed whit four classes. Therefore 51.94 residual area is located in high hazard regions. Model and then susceptibility map verity was then susceptibility map Verity was assessed using -2LL, and Snell R2, Nagelkerk R2, occurrence ratio comparison and considering the deference percentage between landslide observed density and predicted probability and it was reliable.

Key words: *Land slide, Land slide hazard zoning, Logistic regression, syahdare, Watershed.*

Introduction

Mass of unstable rock and soil factors affected because of earthquakes, rainfall severe human activities such as road building or takes a combination of the above factors. Slip results in addition to change the earth and cause serious risks in many regions in the world. Landslides in Iran was one of the most important natural disasters each year play an important role in the destruction of road communication, the destruction of pastures, orchards and residential areas and erosion and sediment transport high volume of our watershed. Studies indicate that early 1378 landslide occurred around 2590 in the death of 162 people, destroyed 176 Bob House, an amount of financial losses 1,866 billion IRR, destroyed 6763 hectares of forest destruction and creation of 170 kilometers Communication annual sediment volume is 963,807 cubic meters (Myrsany, R, *et al*, 1378). Several factors such as geological conditions, hydrology, topography status, morphology, climate change affect the stability of a slope and can be cause slip (Garfy, J., *et al*, 2007), (following rat M. And colleagues, 2005). Freshwater river basin in the province based on seven factors that influence landslides including altitude, slope, rainfall, land, geology, space and distance from road fault, landslide risk zone classification to do four ways and expressed in all four methods, land areas many changes are considered among the high risk areas (Khameh chiani and colleagues, 1384). While mapping of landslide risk zone classification in Sefidargaleeh, Semnan province showed two factors Petrography (especially units Chile) and the most important variables for estimating the risk of slope in the region have been studied (Gray BC, 1385). The degree of slope factors, geology, altitude, slope direction, geology, land use and distance from the road landslide risk zone classification in Lajym River basin has done (Learn, and Lee and colleagues, 2002). While mapping of slope instability in

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Hong Kong Island Lantaav reported that the slope angle, Petrography, height, slope and land in order to predict the slope stability and the significant slope near the drainage lines are not important and are outside the model. (Vanzy and colleagues, 2004) during the effect of geological factors on the occurrence of shallow landslides Apona mountainous region (north-west Tuscany - Italy) that were expressed Petrography integral and influence important factors in determining location landslide occurrence posts have been noticed (Yalyv and Yamagyshy, 2005), while mapping of landslide susceptibility in Kakvda - Yahykvy Japan, factors such as geology, relationship with the rock bed slope, altitude, slope degree, slope and distance to of road factors as landslips area have introduced. The results also investigated the occurrence of landslides in sensitive river basin in the mountains Santabryan Nalvn U.S. showed more instability relate to the slope of south-west - North East slope curvature between 6 - and 7/0- and 16 degrees to 30 degrees slope is (Kvastan, M.. J. Jan. and colleagues, 2007). In this study to evaluate the effect of factors occurring black earth landslips Valley watershed method multivariate logistic regression analysis was used because the statistical assumptions for less than other multivariate statistical methods require a function that best illustrates the relationship between occurrence and non-landslip and a set of factors is the occurrence creates (Yalyv and Yamagyshy, 2005).

Materials and Methods

Characteristics of the study area:

Syahdareh watershed, one of the following watershed basins Gamasyab Â¬ Â¬ Nahavand city of Hamadan Province in the northern mountain range is green Â¬ that area is about 54/69 square kilometers. This watershed basin between the length Â¬ Â¬ Geographic "44 53 47 to" 5100 Ëš 48 east and latitude geographical Â¬ "24 13 Ëš 34 to î £ 4318 34 North is located. Maximum and minimum height of the region and 2830 respectively 1600 meters above sea level. The average annual rainfall in the region is 593/2mm. Terms of higher altitude vegetation most of area of land covered by forest and pasture in the lower elevations, mostly garden and farm land converted said. Petrography area includes limestone changed, Aslyts black, limestone destructive, dark limestone riverbed alluvial color is used to. Sediments in the fourth period, is that the river sediments are often marginal.

In this study, digital distribution map based on interpretation of landslides and aerial parts of registration slip by global Positioning system (GPS) were detected during field hits in the software environment ARC/GIS9.2 prepared for processing in GIS was prepared (Figure 2). According to the interpretation of satellite images, aerial and field visits and studies, the 9th primary factor affecting landslips area including altitude, slope degree, to the slope, mean annual precipitation, distance from the fault, distance from drainage network, distance from roads, land and petrography were identified using a topographic map 1:25000 digital elevation model map (DEM) Bapyksl of 10 meters and 10 meters produced the map based on height class, degree of slope, slope direction (Figures 3, 4, 5, and 6) and Floor Plan rainfall zone (Figure 7) were prepared. Map distance from road and drainage network periodically based on classification of the road network and a digital hydrographic network was produced (Figure 8 and 9). Petrography map and distance map of the fault zone were digital (Figure 10 and 11). Watershed land use map with black valley separating the different 8 were prepared (Figure 12). Factors with overlapping maps and map landslips distribution region Distribution of landslides in each class of factors were analyzed.

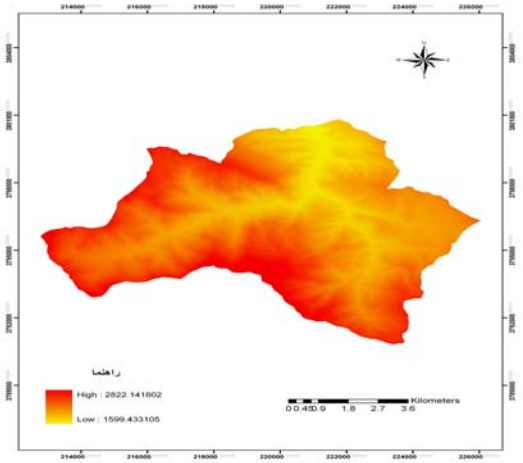

Fig. 1: Map digital elevation model.

Res. J. Fish & Hydrobiol., 6(4): 467-475, 2011

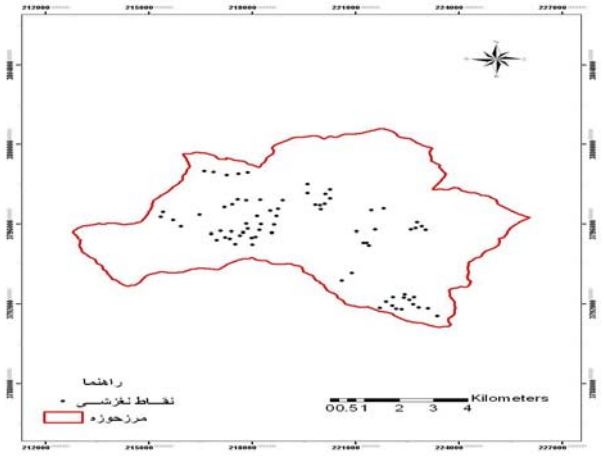

Fig. 2: Map of landslide distribution.

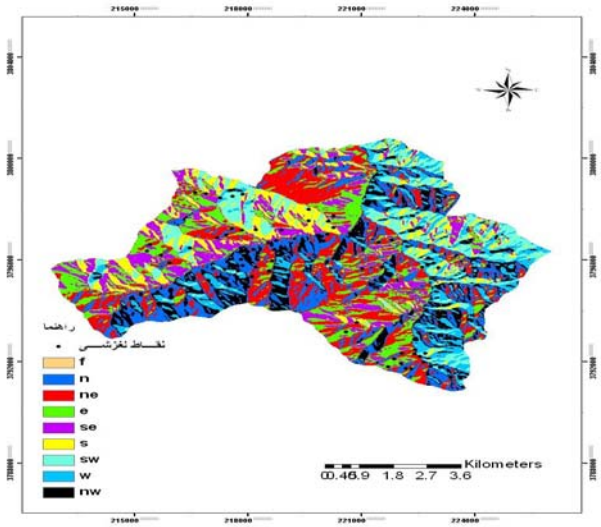

Fig. 3: Map direction Slope.

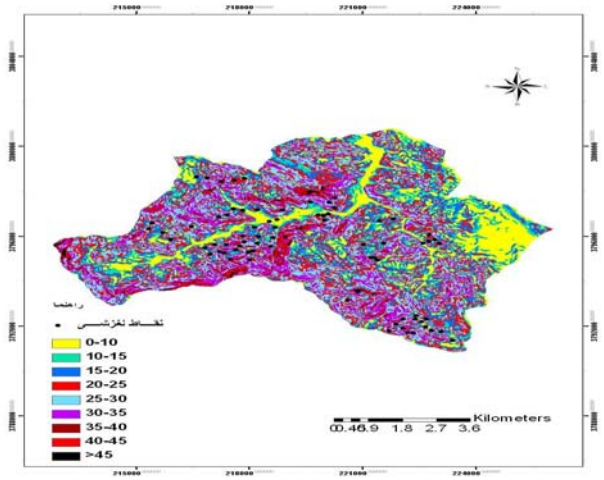

Fig. 4: Map degree slope.

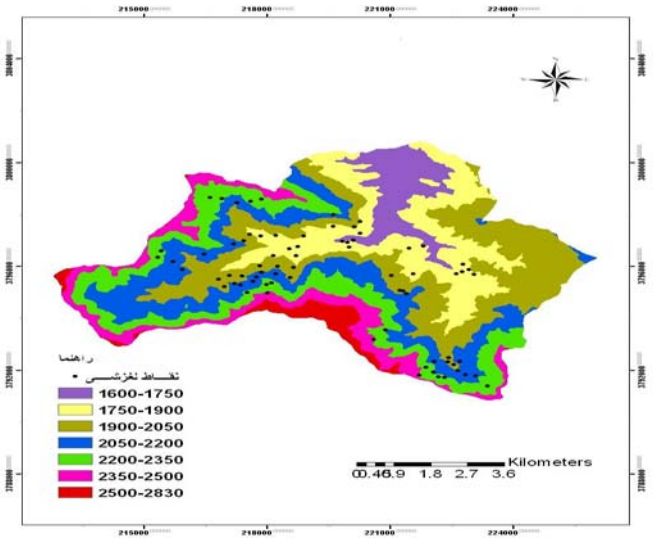

Fig. 5: Map Class height.

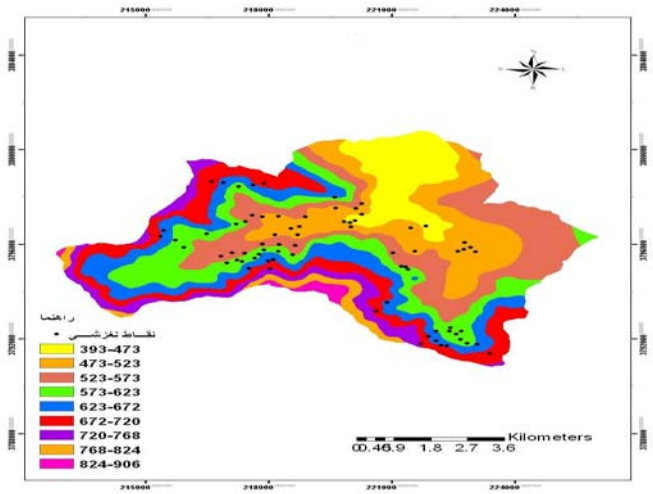

Fig. 6: Map Class rainfall.

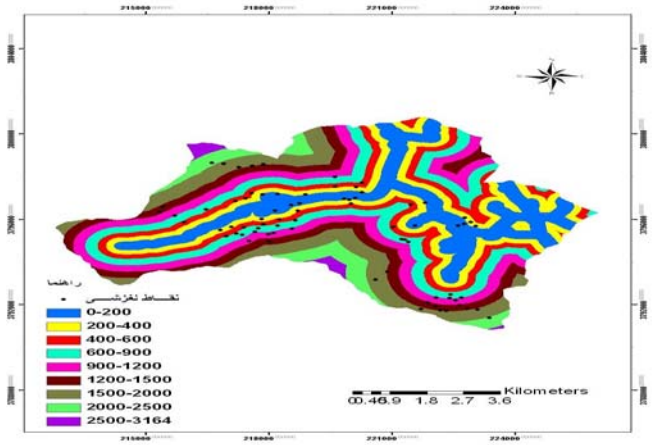

Fig. 8: Map distance from road.

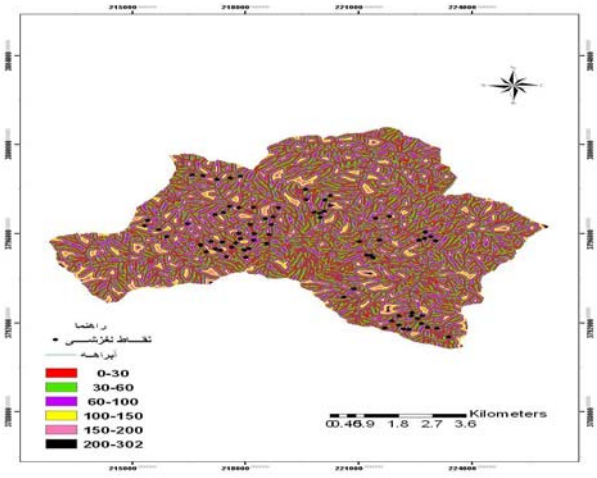

Fig. 9: Map Class from drainage network **’**Figure.

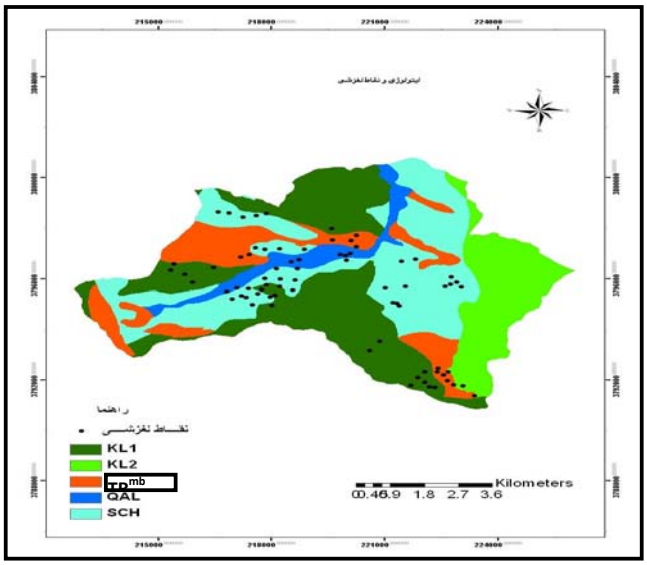

Fig. 10: Floor Plan distance from the fault.

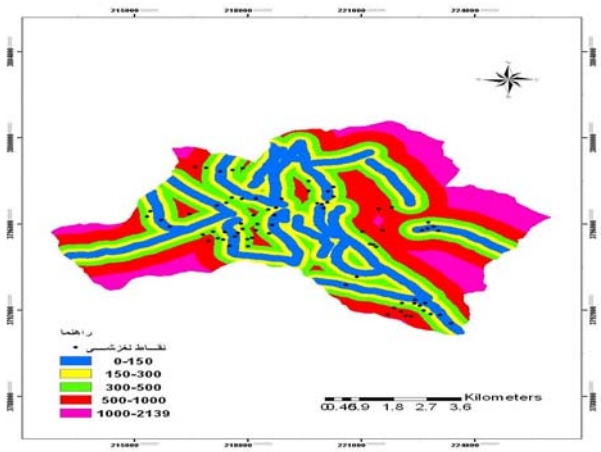

Fig. 11: Map units Petrography.

Res. J. Fish & Hydrobiol., 6(4): 467-475, 2011

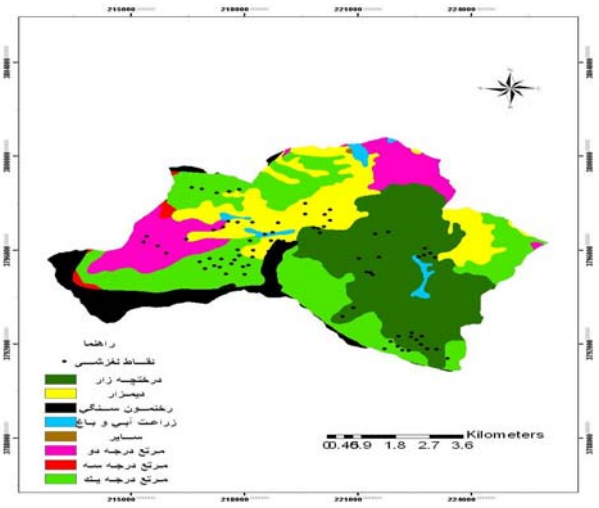

Fig. 13: Landslide risk zone classification.

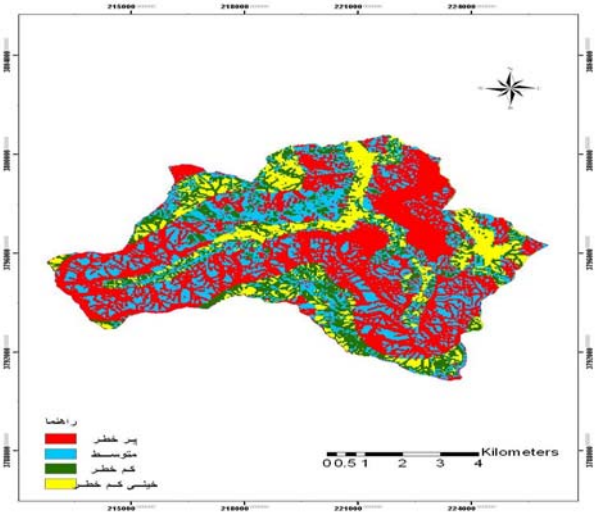

Fig. 12: Map Class land-Vse Planning**.**

Conclusion:

Since the logistic regression statistical model used to create the relationship between factors and dependent variable slope instability occurrence and the occurrence of landslides is also identified 75 point slide in the region or point 75 pixels and other randomly selected across the basin up to as non-slip areas in the logistic regression analysis used. the overlap and non-slip sliding 150 points to map classes to factors including the occurrence points of presence, the code to other class 1 belong to the code was zero. Also, the non-slip 75 point overlap, the factors include the floors non-slip parts of the presence of number 1 and the other classes, the code will receive zero. With the independent variables included all dependent variables and coding classes, including 75 point slide (number 1) and 75 non-slip random point (number 0) to select software and methods SPSS12 Progressive stair logistic regression statistical model, data analysis been no correlation between independent variables and the statistical confidence level of 5% with the occurrence of landslides, the final equation removed and the other independent variables based on correlation with the dependent variable, coefficients were awarded (Table 1). Coefficients from the logistic regression analysis, a positive Î² coefficient means that more variable as the dependent variable occurrence (landslides) and vice versa is a negative Î² coefficient indicates correlation weak correlation with the dependent variable (landslide).

Table 1: Statistical model to determine the coefficients region logistic regression analysis.

Independent Variables	Marked	Regression coefficients	$Exp\,\beta$
10-15 degrees	$Slope_2$	2.798	16.19
15-20 degrees	$Slope_3$	2.63	14.005
2350-2500 m	$Conture_6$	2.46	11.706
473-523 mm	$Rain_2$	2.31	10.072
0-30 m	$River_1$	1.912	6.766
150-300 m	$Fault_2$	1.834	6.256
Agricultural irrigation and Garden	$Landuse_4$	-4.6	0.10
0-20	$Road_1$	-5.95	0.003

The general formula logistic regression probability function (year 1), landslide risk probability (P) in the range between zero and one is numeric Any number that is a closer, more probability of landslides and everything is closer to zero , probability, will be less.

$$p = 1/1 + e^{-z} = \frac{1}{1 + e^{-(\beta_\circ + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots + \beta_n x_n)}} \quad (1)$$

p = probability of landslides
β= constant model
xi (i = 0,1,2,3, ... n) = independent variables
i (i = 1,2,3, ... n) Î² = coefficients of independent variables
The role of the factors affecting Landslide occurrence in the region and mapping of the area classified risk equation derived from logistic regression probability function obtained from the following.

$$z = 2.44 + 2.798(slope_3) + 2.63(slope_2) + 2.46(contoure_6)$$
$$+2.31(rain_2) + 1.92(viver_1) + 1.834(Foult_2)$$

Model accuracy assessment:

First method:

Evaluate the statistical accuracy of logistic regression model, factors Nagelkerk R2 and Cox and Snell R2 and 2LL) (-2Loglikelihood were studied. These changes range from zero to one factor and higher values indicate higher accuracy of the model. In linear regression R2> 0.9 Model for accuracy assessment is considered if the logistic regression, the coefficients can be small and this does not necessarily reduce credit model (Chav *et al*., 2004).

Factor-2Logliklihood (-2LL) similar to the Chi-square treats this factor and smaller values indicate higher accuracy of the model. Thyq-2LL is the factor with the presence of all selected model variables including degree of slope, slope direction, distance from drainage network, drainage network distance, road distance, the 208/98 land use planning and Petrography and coefficients, and Cox and snell R2 Nagelkerk R2, respectively 519 / 0 and 692 / 0 are. Table 2 shown the factor-2LL is the presence of all independent variables selected by the model, the absence of shift variables and coefficients mentioned below Cox and Snell R2 and Nagelkerk R2 have been more appropriate model that demonstrates compliance with data observed landslides and statistically significant independent variables in the model with the occurrence of effective landslides region.

Table 2: Evaluation of model accuracy compared eliminating separate independent variables selected by model.

Variables	-211	Cox and Send R_2	Nagelkerke R_2
With the Present of all Variable	98.208	0.519	0.692
Without Slope degrees	123.199	0.432	0.572
Without Lithology	98.208	0.519	0.692
Without drainage	116.49	0.467	0.590
Without Road	102.042	0.506	0.675
Without Land use	110.168	0.476	0.639
Without Fault	115.331	0.469	0.614
Without Rain fall	119.439	0.457	0.589
Without altitude	132.189	0.441	0.576
Without Slope direction	98.208	0.519	0.692

Res. J. Fish & Hydrobiol., 6(4): 467-475, 2011

The second method:

Another way to evaluate the accuracy of the model test percent correct prediction model is called to evaluate the classification table and a zero for all points and predicted probability (P) is. In logistic regression, predicted probability (P) for points landslide occurrence and non-occurrence (75 point 75 point non-slip and slip) were calculated. If the predicted probability (P) for landslide points higher than 5/0 and for non-slip points lower than 5/0 has been obtained, the model prediction is successful. In this study, the classification table (Table 3), the success rate before 75 point prediction model for slip basin 7/86% and for non-slip 75 point 7/90% and therefore the overall success rate model 7/88 which is acceptable.

Table 3: Classification success rate forecasting model for the region.

Point Observed		Point Predicted		
		Location		Accuracy
		0	1	%
Location	0	68	7	90.7
	1	10	65	86.7
Percent accuracy Overall model		----	---	88.7

Table 4: Risk limits and boundaries in the slip frequency.

Percent Land Slide	Percent area	Frequency Of landslides	Area Class	Range of risk
0.6	8.8	5	5.6339	0-0.05
12	21.17	9	14.7239	0-05-0.55
25.23	18.776	19	13.0578	0.55-0.95
56	51.94	42	36.1259	0.95-0.1
75	100	75	69.5415	Total

To evaluate the role of factors occurring earth landslides Black River basin, information on factors floors slip 75 point and 75 point codes as non-slip and zero into a logistic regression statistical model and results analysis model Delete as independent variables without statistical correlation with 95% confidence level dependent variable and significant Î² coefficients assigned to each of the factors based on significant statistical correlation with the dependent variable in Table 1 was determined. The highest coefficients of the table significant Î² distance classes from 20 to 10 degree slope is awarded. Mty to the assumption that other factors remain constant with increasing degree slope, landslide probability 798/2e will double or 19/16. Distribution of the highest landslide in this class, we can deduce the slope factor was most important role in the occurrence of landslides play to the region (Yalyv Vyamagyshy, 2005).

The logistic regression coefficient Floor height 2350 - 2500 meters above sea level the second factor in the incidence of landslide area chosen because the height factor as one of the influential parameters on the phenomenon ground shaking, on this basis that are accompanied with increasing altitude, temperature and rainfall conditions be change. Height on the other hand phenomenon pedogenesis role is because they (Lee, RSS and colleagues, 2006).In the study area rainfall class (473-523 mm) the most effect on the occurrence of a landslide area and maximum slip distribution in This category was that findings (and by colleagues, 2005). The final model, distance from the channel next factor is the occurrence of slip region. So that the 50 percent slide in the 30 meters distance channel have occurred. Drainage network to reduce soil shear strength and failure caused erosion in the slope and along the river. Effective and direct role as a close network of hydrographic landslides occurred in areas stressed. Operating distance from fault due to having a positive coefficient results, the next occurrence of slip agent region. The active faults with create movement around the stones to each other, factor for increasing the number, density and depth of seams and gaps in the rock is used to slip most of the region up to 300 meters away from the fault occurred Posts said fault operating role by other researchers, including Lee and Pradhan 2007, Grykv and colleagues 2008, Leonardo 2006 has been approved.

Black Valley watershed overall effect due to a series of internal and external factors affecting the occurrence of human intervention to capture slip, especially natural resources and Road User changing principles irregular non-slip prone slopes, this area one of the basins of high risk landslides have occurred in terms of conversion that if serious measures to prevent landslides growing area is not done, the future control more serious injuries and casualties in this basin we will.

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