Research Article

Investigation and Analysis of Debris Flow Phenomenon

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Abstract: The debris flows are one of the most dangerous types of landslides, which mostly occur suddenly and cause enormous losses. These flows are among the natural hazards of steep and mountainous areas around the world that are highly sedimentary. debris flow containing particles of clay, silt and Rubble, large trees or parts of buildings. this flow is movement by high velocities and it has highly destructive due to its high specific gravity and high sedimentary load (with 70 to 90 percent of the sedimentary load) and can carry very large and heavy rubble in the flow path. Factors affecting the formation of debris flows include: steep slopes, sparse vegetation cover, abundant rock with soft particles and fine-grained rocks, and sufficient and intermittent moisture. How the formation, fluid characteristics, type of sediment, sediment load, the calculation of discharge as well as control and damage of debris flow much different from floods. Unfortunately, in Iran, most of the time, experts are making a mistake in identifying these flows and behaving like floods with these flows. Therefore, it is important and necessary to know the characteristics of these types of flows. In this study, the phenomenon of debris flow has been studied and analyzed.

Keywords: debris flows, sediment load, steep slopes, sparse vegetation cover, adequate moisture

1. Introduction

The debris flow is a flood and roaring stream with a mixture of water, mud and boulder that is suddenly influenced by the force of gravity often advancing on steep surfaces with large volumes. These flows are the intermediate between the sudden fall of rocks (Rock avalanche) and sediment-laden floods. in Properly expression in a debris flow, moving materials should be smooth and prone to flow, and at least 50% of the material should be sand-sized or larger. The sediment concentration in this type of flood is high and accounts for approximately 30-70% of the volume of flow. According to the above explanation, this phenomenon is one of the exciting wonders of nature that has prompted researchers to be curious about how this phenomenon occurs. This phenomenon was first recognized in Japan and, in various ways, made people aware of its dangers (Takahashi, 2014). The presence of steep slopes, lack of extensive vegetation cover, heavy rainfall, increased snowmelt and high floods, abundant storage of loose and non-sticky debris, the source of abundant moisture and so on is one of the main causes of debris creation and relocation. as well terrestrial event also causes events such as earthquakes, volcanoes, and falling slopes, sometimes altering or closing rivers, causing water to drain and causing flooding. Figure 1 shows the debris flow. Communities have long experimentally dealt with the dangers of debris flows and avoided areas susceptible to these flows, but over time and population growth have come to these areas without sufficient time to understand or experience them. From the beginning, human beings have been frightened by the debris flow because of the severe catastrophe. The speed and volume of debris flows make them extremely dangerous, leaving a large amount of rock and sand behind, causing considerable damage. These damages include the killing of people, the destruction of homes and facilities, the damage to roads, farmland, water supply systems, railways and pipes and many other damages that are difficult to determine. In the scientific community in order to answering has been studied by geologists, geotechnical engineers, and skilled hydrologists in order to meet the challenges of assessing the risk of these currents and to prevent the occurrence of damage. According to the above explanation it is necessary to understand the characteristics of the debris flow and to predict the methods of its creation (Takahashi, 2014). Figure 2 shows image of the damage debris flow.

Figure 1- debris flows (Comiti et al, 2014).

Figure 2-Image of debris flow damage (Schuster and Highland, 2007)

2-Research Method

The research method in this study is analytical-descriptive. In order to carry out this research by documentary method, information was collected and analyzed. At the documentary stage, maps, studies, publications, information from aerial photo books and websites are discussed.

3-Discussion

3-1-Investigations on debris flow

Nikolopoulos et al. (2014) evaluated the impact of uncertainty on rainfall estimates to determine the for precipitation thresholds for debris flow in the upper basin of the river Adige in northern Italy evaluated. Their findings show that with increasing rainfall duration, the amount of error in rainfall estimation decreases. Also, estimates of high-intensity short-term precipitation are associated with more uncertainty than lower-intensity long-term rainfall. Jomelli et al. (2015) evaluated the impact of environmental and climate change using the hierarchical Bayesian model on 124 cases of debris flow between 1970 and 2005 in 27 basins located in the French Alps. In terms of the effects of factors such as the number of rainy days, the maximum daily temperature, and the morphological changes of the basins as climate and environmental variables, they showed that the likelihood of an outbreak of floods could be as high as 77%. Zhuang et al. (2015), in a study on the determination of rainfall thresholds that led to a debris flow event in Jian Jia Valley, Yunnan, China, from rainfall data related to 47 flood events that occurred during the years.1993 to 1994 and 1998 to 2001 and 2004 to 2006 were collected. The results showed that the intensity-duration threshold curve can determine the probability level of 50, 70 and 90% of the debris flows. Guo et al. (2016) investigated the intensity-duration threshold of precipitation based on 252 post-seismic debris flow events that occurred after the earthquake. The results showed that the relationship I = 5.25D-0.76, the rainfall duration that results in these flows, is calculated between 1 and 135 hours, which in the above relationship I and D, respectively, indicate the intensity of rainfall and the duration of rainfall. Lin et al. (2012) used the Kalman model to evaluate the occurrence of debris flow in areas of Hualien in eastern Taiwan in 2007 and 2008. In their study of six factors including mean slope, basin area, effective basin area, cumulative rainfall, rainfall intensity and geological conditions as input variables to the model. According to the results, the relative error of the model was 4.65% and the probability of flow forecast was 96%. By introducing geographical parameters into the model, the error index decreased from 4.65 to 3.39% and the probability increased to 100%. Marra et al. (2014) investigated the limitations of rainfall estimation using meteorological radars to determine the threshold of a debris flow event in the Upper Adige river basin (Eastern Italian Alps) and the intensity-duration threshold using Radar and ground rain gauges were acquired. They considered the estimated rainfall from the radar using the correction algorithm as the reference scenario. Their findings showed that using the accuracy correction algorithm increases the radar rainfall estimation plus the threshold limit obtained from the rain gauge data was significantly different from the reference scenario. Xu et al. (2013) used the GIS model to evaluate the debris flow sensitivity analysis of Sichuan province in China and the effect of seven environmental factors including elevation, slope, direction, flow accumulation, vegetation cover, soil type and land use type. Examined the northeast, central, and south of Sichuan as the most dangerous areas for these flows to occur. Shieh et al (2009), a study on changes in precipitation thresholds for debris flows following the Chichi earthquake in central Taiwan in 1999, showed that the threshold limit for debris flows was only after the Chi-seismic earthquake came down and gradually improved. Jakob et al. (2005) predicted future debris flow volumes using the relationship between the volume expected from the event (flow rate) and the time elapsed since the last debris flows. The results showed that if the normalized relationship between flow discharge and elapsed time is available, the average channel discharge can be estimated with respect to the elapsed time since the last debris flow. Hirano (1997) used a system analysis method in his study of debris flow to predict the critical rainfall that would result in debris flow. The results indicated that if the rainfall amount at the time of concentration exceeds a certain value on a steep slope with a specific slope, a debris flow would occur and then present the results of their study as a mathematical model to analyze the runoff. Hirano et al. (1995) used a neural network model to predict the occurrence of debris flow and to identify the critical conditions and runoff analysis of this flow. To compare the accuracy of the model, they compared the results with data from the Mizunashi River in the Unzen volcanic area. The results of their study showed that the neural network model provides a better estimate of the time of concentration. Papa et al. (2012), by simulating the intensity and duration of rainfall and previous rainfall and according to the results database, obtained rainfall threshold curves (RTC). In order to do this, they conducted experiments on a small basin of the Amalfi Coast (South Italy). They used the results to obtain the lead time these debris flows. Campbell (1975) stated that in southern California, when the seasonal rainfall reaches about 250 mm, a rainfall of 6 mm/h will cause a debris flow on slopes at an angle of 27 to 41 degrees. Guzzetti et al. (2007) examined the precipitation threshold needed to start landslides around the world and proposed a new threshold for the Danube Adriatic region in central and southern Europe. Their results show that a lower average rainfall intensity is needed to initiate landslides in a mountainous climate region than in the Mediterranean climate.

3-2- Characteristics of flood debris

The appearance and importance of debris flows in each region are subject to climatic conditions, tectonic and human activities that pose problems for agricultural, industrial and communication networks (Hashemi Tabatabaei et al, 2010). The motion of these demolished masses is due to the force of gravity downstream of the slopes, in terms of flow characteristics that is intermediate of slip phenomenon and flood flows which is very weak and irregular sorting. (Hashemi Tabatabaei et al, 2010). In the case of some rapid movements of crushed stone fragments and any canto on the slope surfaces they have used the term debris (Wilford et al, 2004). These floods have a very high concentration of sediments and carry a large volume of sediments, often occurring in steeply mountain rivers, where the movement of fine grains is directly influenced by gravity (Costa, 1984). In these floods, the proportion of liquid to solid is very low and almost zero (Hashemi Tabatabaei et al, 2010). In normal floods, sediments only move due to hydrodynamic force of water, but in debris flows, sediments move both by their weight force and by hydrodynamic force of water (Borga et al, 2014). In this type of floods, debris or rocks are concentrated at the top of the debris flow and move downward by rotational or sliding motion (Hashemi Tabatabaei et al, 2010). This type of flow has a lot of erosion power (Hashemi Tabatabaei et al, 2010). If the material is fine-grained, it is called earth flow, and if there is little water in the stream, it is called debris avalanche (Hayashi and Self, 1992). Waterless and fast flows, including aggregates or sand, the named sand flow or aggregates flow (Iverson et al, 2010). Factors affecting debris flows include precipitation, air temperature, frost, land use, and sufficient sediment volume (Hashemi Tabatabaei et al, 2010).

3-3-Factors affecting debris flows

The occurrence and displacement of numerous debris flows at the foot of steep slopes and outcrops are related to climatic factors, terrain structure and flows from rainfall and gravity. Ice and melting processes are important factors in the formation of rock debris. Some researchers have examined the effects of human activity on the increase and relocation of debris flows (Baroni et al, 2000). Generally, factors affecting flood debris can be divided as follows.

1) Rainfall: rainfall is a major factor in determining the intensity of debris flows. Increase in precipitation intensity increases debris flows., but in the present study only precipitation intensity affects the rate of debris flows., but the precipitation is not affected (Crosta and Frattini, 2001).
2) Temperature: The increase in air temperature causes the melting of piece of ice, an increase in the height of debris events, and an increase in the amount of human use of the earth. therefore, indirectly affects the rate of debris flow (Johnson and Jones, 2000).
3) Elevations: The rise in temperature has caused more severe debris flows to occur at higher altitudes. Generally, flood debris occurs more at higher altitudes because of rising temperatures at higher altitudes have greater impact (Lugon and Stoffel, 2010).
4) Frost: The presence of frosts causes the rock debris to condense and as the temperatures rise and melting of piece of ice, these debris are displaced at once and form a debris flow (Hashemi Tabatabaei et al, 2010).
5) Volume of debris and Sediments: Another major factor in the formation of debris flows is the existence of sufficient sediments and debris, and if not, even heavy rainfall cannot cause debris flows. In areas where several debris have occurred, the possibility of subsequent debris due to decrease the debris is very low (Dong et al, 2009; Benda and Dunne, 1997).
6) Land use: Human activities include agriculture and livestock and destroying trees for fuel production cause soil erosion and increase the severity of debris flows. Mining along with explosions and slashes are also intensifying factors in the generation and movement of debris flows (Cheng et al, 2005).

In addition to the factors mentioned how the positions and location debris flow event can also affect the severity of the phenomenon.

3-4- Suitable locations for the occurrence of debris flow

Debris flows due to climatic conditions and geological characteristics will have different behaviors. The prone locations for this type of flow can be divided into three categories.

1) Semi-arid areas with heavy rainfall: Severe thunderstorms in small watersheds cause rapid saturation of soil and increase pore pressure and cause unconsolidated soil to move on bedrock. Gully erosions that occur on high-erosion-covered soil with no cover are another trigger for these types of currents in semi-arid areas (Youberg, 2013).
2) Mountainous areas with steep slope: the soil in mountainous areas, the soil receives sufficient moisture from thunderstorm and rapid melting of snow for rapid saturation and mass movement of the soil and it is source of flow with high concentrations of sediment (Kostaschuk, 1987).
3) Volcanic Areas: Volcanic activity produces a large amount of ash that is easily erodible. These ashes are saturated by rainfall, rapid melting of ice and snow, rapid destruction of volcanic lakes by volcanic activity, or

movement of saturated soil masses by volcanic earthquakes, causing mass movements of soil and water to initiate flow. With high concentrations, these flows can create many life and financial risks (Scott et al, 2001).

3-5- Prediction models of debris flow occurrence

Risks of flood debris can counter-measures such as the construction of dams and reservoirs reduce. However, the topography of the areas or the lack of space may cause problems to construct them. In addition, the impact these structures have on the landscape of the area may be significant. This problem is more pronounced in areas of high ecological and historical value. For these reasons, non-structural countermeasures such as using flood forecasting models to reduce these hazards are more appropriate. In addition, lower cost of non-structural control methods can be another advantage of this method than structural control methods (Papa et al, 2012). Hence, in the last decade, extensive research has been conducted by various researchers (Peng, 2016; Zhang et al., 2013) to assess the risks of debris flows, using different statistical methods, geographic information systems, and multiple methods. Artificial intelligence is done. Yu et al. (2012), with emphasis on the significant impact of prior rainfall on the occurrence of debris flow, from the logistic regression model, for comparative analysis of the effect of two categories of rainfall composition as (a) daily rainfall and rainfall in period of 10 days ago, b) daily rainfall and previous humidity) in Sichuan region, China. They used daily rainfall data from 54 meteorological stations in China over the period 1981 to 2004 to investigate the relationship between rainfall and debris flow. Also, the Kriging interpolation method was used to estimate the daily rainfall and precipitation 10 days prior to locations that are prone to debris flow. then obtained the previous moisture content by multiplying the daily precipitation by the reduction coefficient using statistical methods. The results showed that the effect of the second category of precipitation on the phenomenon of debris flow was 3% more than the first one. Xu et al. (2013) compared statistical methods of logistic regression and Bayesian analysis to predict the occurrence of debris flow in high-risk areas in Sichuan province. Their results showed that with previous probabilities of average scale, the prediction accuracy of Bayesian analysis method is more than logistic regression method. With previous probabilities equal and intense, the prediction accuracy of the logistic regression method is higher than the Bayesian analysis method. Xu et al. (2013) used GIS model to assess debris flow sensitivity analysis in Sichuan province in China and examined the effect of seven environmental factors including elevation, slope, slope direction, vegetation, soil type and land use. They concluded that northeast, central and southern Sichuan are the most dangerous areas for these flows to occur. Lin et al. (2012) applied the Kalman model to assess the occurrence of debris flow in areas of Hualien in eastern Taiwan in 2007 and 2008. In their study, they considered the six input variables as the input variables to the model including mean slope, basin area, effective basin area, cumulative rainfall, rainfall intensity and geological conditions. According to the results, the relative error of the model was 4.65% and the probability of flow forecast was 96%. By introducing geographical parameters into the model, the error index decreased from 4.65 to 3.39% and the probability forecast increased to 100%. Hirano et al. (1995) used a neural network model to predict the occurrence of debris flow and its analysis. The results of their research showed that the neural network model, as an efficient tool, in addition to forecasting debris flows, can work well for runoff analysis of these floods. Chang et al. (2010), by collecting data related to 154 cases of occurrence of debris flows in East Taiwan, a genetic algorithm to assess factors affecting flooding debris was used then use neural network model, factors related to use to predict the occurrence of flood debris. According to the results of their research, the average successful prediction ratio reached 94.94%. Lin et al. (2012) used a fuzzy model to analyze the potential hazards and risk assessment of debris flow in 2007–2008 in Hualien, Taiwan. They considered factors such as mean basin slope, basin area, cumulative rainfall and rainfall intensity, and geological conditions as factors influencing debris flow events. 96% correct prediction and 4.63% normal relative error indicate the ability of fuzzy model as a risk assessment system for debris flow. Zhang et al. (2013), using rainfall data and environmental factors, used the grouping data model GMDH to predict debris flows in China. They compared the performance of this model with neural network Back Propagation models and ANFIS model. They collected rainfall data from meteorological data and extracted environmental data from GIS and geophysical data. Then, using kernel linear discriminant analysis, input variables to GMDH model were determined. The results of their study showed that GMDH model with a coefficient of determination above 0.8 and average relative error of 3.54% had the best performance in training, test and validation stages and is more suitable for predicting debris flow compared to the other two models. Peng (2016) first used a GIS model to assess the sensitivity of environmental factors to assess the risk ratings of debris flow in the Ershui township located in Changhua County. Then, in order to simulate the conditions of debris flow, she used the $\mathrm{FLO-2D}$ model and applied the results to create a fuzzy expert system. The result of her research showed that the fuzzy expert system is capable of successfully ranking the risk of debris flow. Kern et al. (2017), used machine learning techniques including logistic regression, variance analysis, decision tree, neural network, K nearest neighbor and support vector machine to predict debris flow events in mountain range west of United States. In this regard, the US Geological Survey received topographic, rainfall, and soil conservation data from 15 basins containing 388 data and 26 variables. in order to ensure error estimation, they used cross validation method to train the data and used validation data set to test. The results of the new nonlinear methods have been almost twice as successful as the linear models published in previous research on debris flow forecasting.

New and Advanced Forecasting Models, these Improve Ability to Accurately Predict debris flow Events in US Western Basins. Elkadiri et al. (2014) developed a method for sensitivity analysis of debris flows located in Jazan province in the Red Sea hills of Saudi Arabia that was highly dependent on available datasets. Their research process consists of five stages (a) They used Geographic Information System (GIS) for data analysis. b) a list of satellite datasets was developed to identify debris flow events. c) conducted a spatial analysis in the GIS software environment and identified 10 factors affecting the occurrence of flood debris. d) they used both neural network and logistic regression models. e) they used models created to produce debris flow maps). Their results showed that both models with high predictive performance (neural network: 96.1% and logistic regression: 96.3%) are capable of predicting debris flow and factors such as topographic location index, slope, distance Up to the drainage lines and vegetation including the factors that are most predictive power. Kung et al. (2012) used three models including linear regression, multivariate analysis and post-propagation networks to predict the occurrence of debris flow in Taiwan. Based on the simulation results, the post-propagation networks models predict the debris flow events more accurately than the other models. Peng and Zhang (2012) used the Bayesian network model to analyze human hazards due to catastrophic dam failure. They classify the factors affecting human mortality in floods in four categories including hydraulic factors (water depth, water velocity, etc.), factors related to the region (topography of the region, type of building, roads, traffic situation, etc.), factors related to time and weather (alarm time, day time, rainy days, foggy, etc.) and population factors (age, gender, etc.) were divided, and compiled a dataset of 343 recorded dam breakage data with its death records. Then, they performed sensitivity analysis to identify important parameters that caused the loss of human life. Sensitivity analysis of mortality factors showed that flood intensity, water depth, discharge and alarm time are the most important factors affecting mortality. Ropero et al (2017), the Bayesian network model to predict changes percentage of filling reservoirs in Andalusia, Spain affected by irregular rainfall patterns Mediterranean watersheds used. Since the results are presented in the form of density functions instead of individual values, several criteria including the probability of specific values of the results are obtained and this makes the probability that the water level in the reservoir reaches a certain value, Calculated directly. Kardan Moghadam and Roozbahani (2015) used Bayesian model with two clustering and explicit structures to predict the level of monthly groundwater aquifer Birjand. To model the Bayesian network, they used the effect of factors of temperature, water level, aquifer nutrition, evaporation and groundwater harvesting. The results of their research showed that the average coefficient of explanation for 13 piezometers in aquifer was 0.83 in explicit scenario mode and 0.56 in clustering mode. Therefore, the results indicate the superiority of the explicit structure over clustering for groundwater level forecasting. Pourghasemi et al. (2013) used Bayesian theory to assess the risk of landslides in Golestan province. For this purpose, first, using the slip points of the landslide database of the country (392 slip points), they prepared a map of the landslides of the landslides in the region. Then the maps of each of the factors affecting the occurrence of landslides such as slope degree, slope direction, slope shape, height, land use, geology, distance from road, distance from waterway, distance from fault, waterway power index, sediment transport index, they prepared the soil texture and precipitation areas in the GIS environment. Finally, landslide risk zoning maps were prepared with 14 modeling approaches (using all effective factors and eliminating each factor) using Bayesian theory for the study area. The evaluation results showed that the accuracy of the probabilistic model prepared with the second approach of modeling (eliminating the factor for slope from the analyzes) in the study area was estimated to be 71.3%. Jianwei et al. (2015) used a Bayesian model with a clustering approach to predict debris flow. Thus, by using daily rainfall and rainfall data for the last five days as model input factors, they divided each input factor into two categories and showed that the Bayesian classification model can accurately 88.5 percent flood event debris to correctly predict. Liang et al. (2012) used environmental and geomorphological data and three methods of Bayesian network, neural network and support vector machine to assess the risk of zoning flooding in China at the national scale. The results showed that the Bayesian network has the highest level of risk detection and accuracy compared to other models. Jomelli et al. (2015), the effect of changes in environmental variables (lithology, land use) and climate using the new Bayesian hierarchical approach on 124 cases of debris flow occurrence between the years of 1970 to 2005 in 27 the basin is located in the French Alps evaluated. Their research showed that the likelihood of debris flow depends on two climate variables, including the number of rainy days and the maximum daily temperature, and the impact of environmental variables is much lower.

3-6-Laboratory methods to investigate the mechanism of occurrence of debris flows

Shu et al. (2017), laboratory studies using flume at the debris flows research station of Jiangjia Gully in Yunnan Province, to assess the mechanism of formation of debris flows and to investigate the relationships between the factors affecting it and the formation and The transfer process then took place. Based on this, factors such as the average size of sediment particles (d50), flow rate (Q), slope (S) and initial amount of soil moisture (W) were selected as factors affecting the formation and initial transfer of debris flows. They then evaluated the contribution of these variables in the formation of debris flows through analysis of variance and regression methods and showed that Q and S factors have the greatest impact on the formation of debris flows. Ni (2015), by selecting Xiongjia Gully in SW China, for example, the relationship between rainfall intensity and erosion of the basin, the state of failure in the soil mass and the process of initiating debris flows in the laboratory by using artificial rain simulated.

Based on several experimental groups, the results of the relationship between precipitation intensity and basin erosion, soil mass failure status, starting mechanism and characteristics of debris flows are as follows: 1) Under heavy rainfall, the amount of infiltration and soil water content at different depths is inversely proportional to the intensity of rainfall. Heavy rains help to create runoff and erosion, but do not allow water to infiltration. 2) The slope failure modes and the mechanism of initiation of the debris flow are different with different rainfall and runoff conditions. Under conditions of rainfall intensity of 55 mm per hour, the soil gradually approaches the quick condition and landslides occur. Accordingly, the mechanism for the start of the debris flow depends on landslide changes. Despite the heavy rains and runoff, the bed is easily eroded and the slope is prone to collapse and a debris flow occurs. Her laboratory results are well consistent with the occurrence of a natural debris flow from the Xiongjia Gully. Hu et al. (2014) used laboratory flume to study the mechanism of the onset of debris flows that occurred after the Wenchuan earthquake and the factors affecting it. The flume is equipped with 10 sets of combination of suction and pore pressure sensors. These sensors were associated with TDR probes to measure soil moisture. The flume has a length of 5.2 meters and width of 5.1 meters. A series of 26 experiments were performed to investigate the effect of slope and discharge on the mechanism of debris flow initiation. The amount of discharge debris flow was obtained by collecting washed sediments every 20 second. According to laboratory results, the mechanism of onset of debris flows in gentle and steep slopes is different. At steep slopes, the gap caused by runoff begins quickly and the pouring debris flow begins directly. In gentle slopes, the gap caused by runoff is reduced and causes accumulated material at the bottom of the slope, which after saturation, fails as a shallow slip and in the second stage becomes a debris flow. In general, the results of this study show that slope is an important factor in controlling debris flows, while the effect of discharge on erosion and debris flow volume is less clear. Hu et al. (2015) the investigated the mechanism of onset of debris flows caused by the Wenchuan earthquake in Sichuan Province, China, they use a laboratory flume was built in Chengdu University of Technology. Advanced equipment such as 3D laser scanner were used to monitor changes in slope topography during the experiment. TDR and tensiometer were connected to measure soil properties. With the help of a digital camera, the whole process of starting a debris flow was recorded. Preliminary experiments showed the complexity of the process of initiating a debris flow by runoff. They found that the effects of fractures were crucial to the onset and development of debris flows. Abancó and Hürlimann (2014) evaluated the process of material transfer in 17 debris flows occurring in the Pyrenees and the European Alps by topographic and geomorphological data. To this end, four factors, including the availability of sediments, the slope of the canal bed, the cross-sectional shape of the canal and the area of the upstream area, were selected and defined for 110 ranges. As a result, they used a database to develop two models, including multivariate linear regression and the J48 algorithm decision tree, to estimate erosion rates. In the validation phase of the tree model, the decision showed better results, and in the test phase, both models accurately predicted the total volume of sediments. Finally, they proposed a general decision tree that included three factors: the availability of sediments, the slope of the canal bed, and the cross-sectional shape of the canal. The proposed model can be used in other areas after adapting to the characteristics of the place. Gregoretti (2000) conducted experiments to investigate the conditions for the occurrence of debris flow caused by the instability of a sloping surface with flow infiltration. She used equipment to prevent flooding from erosion failure. The results of his experiments showed that debris flows are mainly caused by flooding, and when the slope surface angle is less than half the static friction angle, the debris flows are caused by the instability of the slope surface layers and when the angle of the slope surface is more than half the angle of static friction, the failure of local deformation of the slope as far as the beginning of the formation of flood debris. Some researchers have focused on debris flows generated by runoff, especially runoff caused by fires. Some researchers have focused on debris flows generated by runoff, especially runoff caused by fires. For example, Cannon et al (2001) observed that the progressive concentrated sediment flow caused by surface runoff instead of fracture due to water infiltration and landslides, the primary mechanism of debris flow caused by the fire was started.

4-Conclusion

Many researchers around the world have used various models in the coming years to predict the occurrence of this current, such as GIS, neural network, hierarchy, and so on. In addition, many studies have been conducted to determine the threshold of rainfall that leads to these events be conducted. Hirano (1997) has conducted studies to determine the threshold for debris flow on Sakurajima River. There are several ways to predict the occurrence of debris flow. Previous studies discharge has not included debris flow, which can be done by analyzing field data. There are also specific formulas for countries, the world and Europe, but these formulas (to determine the relationship between precipitation and events debris flows) for Iran have not been evaluated. It is recommended to identify the areas prone to debris flows in Iran and to collect data related to previous years and to classify the various factors that affect the occurrence of debris flows. Such as geological, environmental and human factors, etc. For each of the above factors, using the neural network model, the probability of occurrence of these currents for the coming years is predicted and finally it is determined which category of factors is for each region These factors play a greater role in the occurrence of the event, thus limiting all the necessary measures to control the event to that factor.

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