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Determining the Best Method of Stability Landslide by Using of DSS (Case Study: Landslide in Hasan Salaran, Kurdistan Province in Iran)

S. Kamyabi, M. Salari, and H. Shahabi

Abstract**—**One of the processes of slope that occurs every year in Iran and some parts of world and cause a lot of criminal and financial harms is called landslide. They are plenty of method to stability landslide in soil and rock slides. The use of the best method with the least cost and in the shortest time is important for researchers. In this research, determining the best method of stability is investigated by using of Decision Support systems. DSS is made for this purpose and was used (for Hasan Salaran area in Kurdistan). Field study data from topography, slope, geology, geometry of landslide and the related features was used. The related data entered decision making managements programs (DSS) (ALES).Analysis of mass stability indicated the instability potential at present. Research results show that surface and sub surface drainage the best method of stabilizing. Analysis of stability shows that acceptable increase in security coefficient is a consequence of drainage.

Keywords**—**Landslide, Decision Support systems, stability, Hasan Salaran landslide, Kurdistan province, Iran.

I. Introduction

ACCORDING to ecological, geological, topographic and quake Iran is one of the countries that has experienced many landslides. In some cases occurrence of landslides has brought up great fatal and economical damages. On the other hand a large number of country's villages on rough slopes are susceptible to the hazard of landslide. To confront such slides three solutions are suggested:

Stabilization of the unstable slop, Risk taking and Risk avoidance (movement of the region).

Regarding the damages of landslides and also having in mind these aspects, added to risk prevention, suggestion of optimal methods for controlling this natural phenomenon must be included too. In various parts of the world, depending on the topographic, ecological, available materials, and more importantly, engineering structure of the region, various methods and preparations have been developed for confronting this problem [6]. On every slope based on its characteristics, a combination of two or more different methods may result in the optimal conclusion. These methods may prepare stability of the slope through one of these two ways: reduction of the forces liable to create the movements, and increasing the forces resisting against the movements.

S. Kamyabi is with Department of Geography, Islamic Azad University, Semnan Branch, Iran (phone: +989126473622, e-mail: saeidkamyabi@gmail.com).

M. Salari is PhD student of physical geography (geomorphology), University of Tehran, Iran (e-mail: mamandsalari@gmail.com).

H. Shahabi is M. S. student of physical geography (geomorphology), University of Tabriz, Iran (corresponding author, phone: +989122769357; fax: +984113342950; e-mail: saeidkamyabi@gmail.com).

Methods for changing the slope and height, surface drainage, sub-surface drainage, and weight reduction, are some of the actions which reduce the movement forces. For increasing the resisting forces we can employ methods like: leveling soil materials bio-tectonic stabilization, controlling soil by construction systems, stabilization by chemical, electro-osmotic and heat methods, and sub-surface drainage [11].

The history of employment of Decision Support Systems (DSS) goes back to 1965; at the end of 1970s a group of researchers and companies developed some information systems which through application of some data and models supported managers in analysis of semi-structural problems. These systems were named Decision Support Systems. Since then, it turned out that DSS can be designed in a way that supports the decision makers in any level[7].

II. Case Study

The village named Hasan Salaran, is one of the villages of Saqqez Township in Kurdistan province, located on the middle Zagross heights. Hasan Salaran aquifer basin with an area of 4.5 hectares, is expanded from 45˚ 16' 32" to 46˚ 16' 41" eastern longitudes and 36˚ 39' 12" to 36˚ 13' 52" northern latitudes. This area is considered as one of the hydrologic units of Saqqez aquifer basin. The region has mountain climate, its average annual rainfall is 285.3 mm, plant cover of the region on mountainous parts is mainly goat's-thorn and small shrubs, and on inhabited parts gardens and farming fields are found. Saqqez River which sources from Chehel Cheshmeh mount flows through downer part of the village, and in spring season causes lots of floods in the region. The springs, waste-waters, and draining water of agricultural watering from the upper part of the village enter into this river. Regarding tectonic and geological status, the studied region is located along with Zagross Reverse Fault and almost on the same direction of the fault, it stands on the border of tectonic zone of Broken Zagross and Sanandaj-Sirjan Zone. This region is 53 kilometer far from Saqqez on south eastern part.

Hasan Salaran's slide is of circular type with 200m width and 500m length. Surface slope of the sliding part differs between 10 to 15 degrees and its movement direction is toward northwest (NE).

III. Research Methodology

In order to define the optimal method for confronting the landslide hazard of Hasan Salaran region, characteristics of the landslide were defined by using various sources; moreover we studied a simple method for analysis of the slope stability, and also different methods of landslide stabilization.

Then visiting the region, we compiled the information needed for answering a professional questionnaire, and entered the data into Decision Support Systems (DSS). After analyzing the data by the software, the best method of stabilization was defined as the final result of surface and sub-surface drainage.

IV. Discussion

Decision Support System is a kind of data management systems, which supports the analyzers, designers and managers in the process of decision making. As some advantages of this system we can refer to: capability for supporting the operator in solving complicated problems, quick answering to unexpected situations resulting from change of the conditions, easy contact, control and execution of optimal management, being economical, taking decisions on the basis of reality, improvement of management influence, and … [9].

Decision making via this system includes the following three steps:

1) Recognition and Understanding Step
2) Model Designing Step
3) Selection of the Optimal Choice Step

In the first step, the decision maker studies the environment to recognize the problem and define the related targets. In the next step, a decision making model of the status of the problem, which is reflective of the influences of a decision on the system, is designed and tested. In the last step, which is the most important and final level of decision making process, the designed choices of former step, are evaluated with some criteria, and the optimal choice, which is the best and most acceptable solution for the problem is selected and displayed [2].

ALES1, is a computerized program which enables the analyzers to create professional systems for evaluation of land, in accordance with FAO's2 method [8]. The software is not a professional system by itself and has no information about land and land function, but there is a framework with which the analyzer, considering local and regional conditions and purposes, can make their needed professional system [10].

In this research, the purpose is to find the optimal method for stabilization of a landslide with the help of this software. The first step for fulfillment of the purpose is recognition of different methods of stabilization of landslides and the conditions for employment of each method. Therefore, various methods of landslide stabilization were studied through checking different sources, and application of any method, and advantages and disadvantages of methods, and the best conditions for employment of any of them was defined [1,5,11], finally those methods which are suitable for the common facilities and equipments of the country and are employed more, were separated.

These methods were placed in a model designed in software form. The methods applied in the model based on their priority were respectively as: surface drainage, sub-surface drainage, geometric correction of the slope, organizing the river, and constructing and embankment.

Hasan Salaran landslide was analyzed geomorphologic through studying aerial photos, geologic maps and the existing reports of the region, field studies, and profiles of the wells dug within the area of the landslide. Type of the landslide, influencing factors in its occurrence, geometric dimensions, characteristics of the materials composing the mass, conditions of level, situation of the road for getting access to the peak, excavation capability, …were recorded in a questionnaire prepared for this purpose.

Composition of the studied slide and topography are considered as innate parameters, and water and under-washing of Saqqez River as environmental parameters for disruption of sliding mass in the region.

Hasan Salaran village is located on a thick layer of clay sediments under which lies semi-crystallized dark small bead and bright small bead lime sediments from Jurassic sediments (jlm) [3]. Since, permeability of lime sediments is very low, permeation of water into this part and its accumulation results in increase of hole-water pressure and contributes to instability of the mass.

As the directions of the sediment layers slope and topography slope of the region both are toward the village, underground water level comes up and the lime sediments become saturated fast, and this phenomenon leads to a potential for sliding.

The research conducted on Hasan Salaran slide shows that surface waters and underground waters have an influential role in occurrence of the landslide. Water permeation into the holes and pits or cracks on the surface of the slope causes results such as: reduction in slicing resistance of soil resulting from adhesiveness reduction, increase of underground waters level and soil saturation that leads to effective of the soil. Water is considered as the main factor for occurrence of this landslide. The main sources for saturation of the sliding mass are rainfall in the upper part of the region and entrance of agricultural water and waste waters.

One of the tasks done in the study of Hasan Salaran landslide was analysis of slope stability. The purpose of slope stability analysis in various conditions was to obtain a clear figure of the present status of slope stability, and to predict critical conditions and probable occurrence of instability. The most important step before performing stability analysis was geo-tectonic operation, and obtaining stratification of the region soil and parameters needed for the analysis. For stability analysis of Hasan Salaran sliding mass, we divided the mass into two congruous layers, and then using the first method of Hung (1978) which is designed for direction of circular slides in congruous masses, we analyzed the stability parameter.

To test the model designed formerly, the recorded data about Hasan Salaran landslide was entered into the system (Fig. 1), and then analyzed it. The results of the model were evaluated in a matrix (Fig. 2), and more explanations for the selected stabilization method were shown in Fig. 3. The suggested method for this slide is surface drainage together with sub-surface drainage. To make sure of practicality of this method in increase of certainty coefficient and stability of the slope, stability analysis was conducted with Huang's second method after and before execution of stabilization method. The findings show that the method of certainty coefficient employed before and after stabilization method, increases certainty coefficient considerably. It is clear, that for those cases in which the suggested method does not

[1] . Automated Land Evaluation System
[2] . Food and Agriculture Organization

supply the certainty coefficient, other than suggestion of the suitable method, it also prepares the existing limits for the operator, and he/she can get other suitable methods from the system by changing some of the conditions if possible.

V. Conclusion

DSS can be a suitable system for decision making about landslides in a short period of time with the least costs. In this research, the optimal choice for controlling landslides is prepared by application of ALS decision support system (DSS). Stability analysis was done on the basis of the findings of field studies and the data compiled recorded in the system. Case study of Hasan Salaran landslide by the model indicates that the methods of surface and sub-surface drainage are the best methods for controlling this phenomenon. DSS can be a suitable system for decision making about landslides in a short period of time with the least costs. Completion of these systems in accordance with the characteristics of landslides in the country will increase practicality of the systems, and make it applicable by experts of executive departments too.

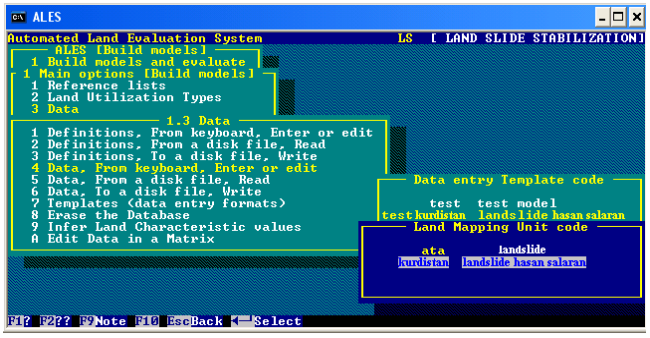


Fig. 1 Entering the recorded data of Hasan Salaran landslide into Ales software for evaluation

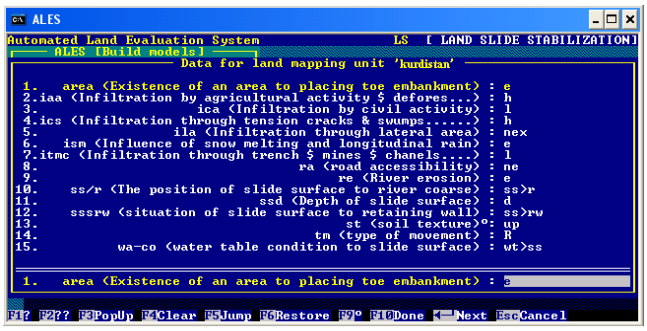
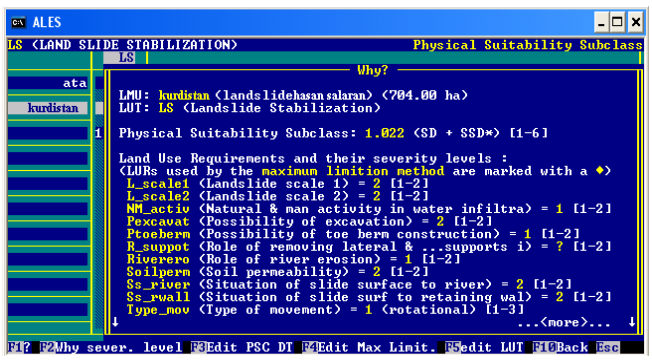
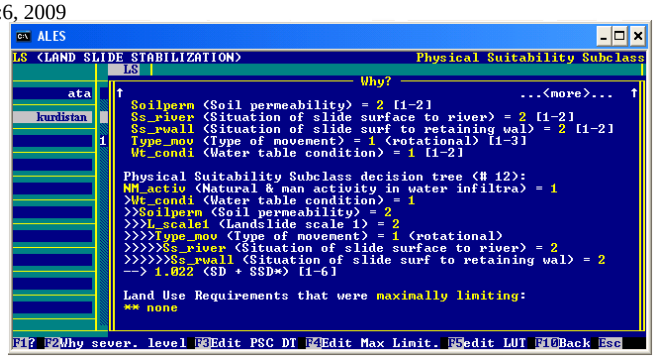


Fig. 2 Results of the model in an evaluation matrix



(a)



(b)

Fig. 3 More explanations for the selected stabilization method

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