CONCEPTUAL FOUNDATIONS OF CONSTRUCTION OF THE MODELS AND PROCEDURES FOR PREDICTION OF THE AVALANCHE-DANGEROUS SITUATIONS INITIATION

Alexander Kuzemin, Vyacheslav Lyashenko

Abstract: The conceptual foundations of the models and procedures for prediction of the avalanche-dangerous situations initiation are considered. The interpretation model for analysis of the avalanche-dangerous situations initiation based on the definition of probabilities of correspondence of studied parameters to the probabilistic distributions of avalanche-dangerous or avalanche non-dangerous situations is offered. The possibility to apply such a model to the real data is considered. The main approaches to the use of multiple representations for the avalanche dangerous situations initiation analysis are generalized.

Key words: avalanches, probability, set, situation, model, avalanche danger, avalanche slide.

Introduction

Creation of an adequate system for analyzing forming conditions and taking measures for improvements in prevention of such situations becomes an important problem in connection with the increasing number of arising emergency situations of natural and technogene nature, increase in their scales. Transition to the management methods based on the analysis and estimation of the risk of the danger quantitative characteristics in the case of initiation of hazards for population and environment is possible as one of such measures.

Avalanche-dangerous regions occupy 6% of the land area. But despite this the problem of such phenomena investigations is rather important and urgent as analogous phenomena can become the cause of people's death and considerable destructions [1, 2].

As a whole, one of the directions, i.e. the risk of emergency situations management and, in particular, situations initiated by the snow-slip, should be considered constant monitoring and building of interpretation models for prediction of such situations initiation. Hereinafter, such models form the basis for the system of decision–making support; this is favorable to development recommendations on modern performance of maintenance measures directed to natural calamities prevention.

Among the most essential and important problems in the given aspect one should note substantiation of the utility to use the corresponding mathematical apparatus intended both for investigation of the avalanche dangerous situations development dynamics and for development of methods for estimation of the potential avalanche cells, prediction of avalanches volumes and descent frequency. This concerns the fact that every avalanche can be regarded as a unique phenomenon of nature with its specific peculiarities. At the same time despite its uniqueness it is possible to single out the climatic conditions variations characteristic ranges which are prerequisites to prediction of the feasible avalanche descent. Eventually, the totality of these two factors defines the presence those approaches to prediction and warning of avalanches descent, at present these approaches are used in geoinformation systems (GIS) which make it possible to accumulate continuously meteorological information, carry out various calculations, reveal regularities and realize spatial tie of the obtained results [3, 4].

Available methods of the avalanche dangerous situations initiation prediction and shortages of the traditional approaches application. Considering methods and models of avalanches descent prediction the method images of similarity and regression analysis are singled out the most often [3, 5]. At the same time, there is no doubt that the foundation of avalanche dangerous situations initiation prediction consists in the procedure of the preliminary analysis of such events. In this case, as a rule, the solution of the formulated problem is based on the statistical analysis methods. In particular, the approaches of such analysis make it possible to substantiate the most significant system of the facts which is expedient to use in the avalanche-dangerous situations prediction procedures. Such approaches found their development in the predictions of snow avalanches descent based on application of the nearest neighbors' method or through the application of the regression equations [5, 6]. But results of the prediction obtained with such methods are not always applicable and demonstrate a number of shortages: they require significant computational resources; they don't embrace existing variety of causes resulting in avalanches formation. The shortage is also the impossibility to define the degree of the avalanche hazard, number and dimensions of avalanches [7].

The data of nomograms which in a general case extend the interconnection of such indices as temperature, value of snow cover and precipitations are also used for estimation of the avalanches descent probability. But in spite of this the remaining non-predictive nature of the avalanche dangerous situation doesn't always allow to prevent negative consequences of emergencies caused by their descent. This is associated with that the available procedures of the avalanche dangerous situation initiation prediction are not sufficiently precise. At the same time the severity of the problem and variety of the ways to solve it motivate the necessity to search alternative methods which can give more argued answers.

Thus, as the main aim of the given investigation one can single out consideration of the approaches, alternative to the available methods, to the avalanche-dangerous situations initiation prediction. First of all, in this case the consideration of the conceptual foundations of the models and procedures of such a prediction is significant in our opinion.

The probabilistic aspects of the avalanche climate initiation medium analysis. Analysis of different characteristics of the avalanche climate initiation medium makes generally the foundation of the avalanches descent prediction. Among such characteristics the most abundant ones are: the air temperature, humidity, atmospheric precipitations volume, wind velocity, angle of the slope of surface (descent angle) where the avalanche descent is possible. In general, the variation dynamics of both individual of the above characteristics the avalanche climate initiation and their totality can, with some probability, characterize initiation either avalanche-dangerous or avalanche non-dangerous event. As this takes place, a feasible range of the studied avalanche climate initiation characteristics variations describes a definite region of avalanche-dangerous and avalanche-non-dangerous situation. In the conceptual plan the essence of the probabilistic aspect of the avalanche climate initiation analysis can be reduced to the definition of the probability to assign some point as the considered medium current characteristics either to the region of the avalanche initiation or to the initiation of avalanche non-dangerous situation. Otherwise the given approach can be treated as a correspondence of the current characteristics of the avalanche climate initiation medium; parameters of these characteristics define some region using probabilistic distribution of avalanche dangerous or avalanche non-dangerous situations preceding this. Consequently, it is possible to speak about so-called probable conformity of the researched characteristics of the avalanche-dangerous climate environment to probabilistic distribution of the avalanche-dangerous or avalanche non-dangerous situations.

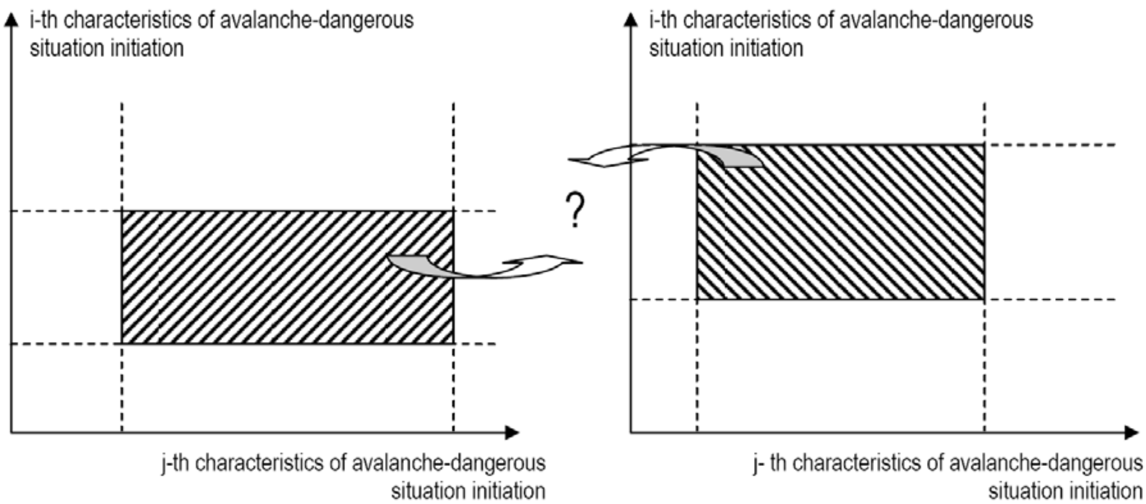

Fig.1 On the explanation of the probabilistic aspect of the avalanche climate initiation medium analysis

In particular, procedure of such analysis can be considered proceeding from the pairwise analysis of various characteristics of the avalanche climate initiation. The advisability of such a transition is related to the fact that at the stage of the preliminary analysis it is possible to omit less significant factors of impact on the avalanche-dangerous situation initiation. Thus, the base element of the analysis procedure being considered is estimation of the probability of the avalanche climate initiation current parameters to fall within the regions typical and atypical for the avalanche climate initiation. The given regions can be presented in the plane in the form of the rectangle; its metric values correspond to definite parameters of variation of the avalanche- dangerous and avalanche non-dangerous situations initiation medium characteristics (Fig.1) [8].

To explain the offered aspect and substantiate its significance let us analyze the probabilistic aspects of some characteristics of the avalanche climate initiation medium using the real data of the avalanches descent in ITAGAR Chychkan region Kyrgyzstan Republic within 2001–2006, obtained in the frameworks of carrying out joint scientific and research work. The essence of such analysis is reduced to the estimation of the feasible assignment of the avalanche non-dangerous situations to the avalanche-dangerous ones and vice versa in terms of different characteristics of their initiation.

First and foremost, it should be noted that the considered characteristics of the avalanche climate initiation medium follow the normal distribution law. This makes it possible to use this law for estimation of the corresponding probabilities. The corresponding probabilities with regard to the avalanche dangerous and avalanche non-dangerous situations are presented in Table 1.

Table 1.

Probabilities of correspondence of the current parameters of avalanche climate initiation medium to the avalanche dangerous and avalanche non-dangerous situations

Characteristics of the avalanche climate initiation medium analysis	Feasibility of correspondence
under condition of considering the avalanche dangerous situation and avalanche dangerous current parameters	
air temperature – wind velocity	0,854
air temperature – wind velocity	0,823
wind velocity – precipitations quantity	0,707
precipitations quantity – descent angle	0,809
under condition of considering the avalanche-dangerous situation and avalanche- non-dangerous current parameters	
air temperature – wind velocity	0,488
humidity – precipitations quantity	0,582
wind velocity – precipitations quantity	0,317
precipitations quantity – descent angle	0,341
under condition of considering the avalanche-non-dangerous situation and avalanche- non-dangerous current parameters	
air temperature – wind velocity	0,798
humidity – wind velocity	0,878
wind velocity – precipitations quantity	0,866
precipitations quantity – descent angle	0,939
under condition of considering the avalanche-non-dangerous situation and avalanche- dangerous current parameters	
air temperature – wind velocity	0,555
humidity – wind velocity	0,482
wind velocity – precipitations quantity	0,403
precipitations quantity – descent angle	0,591

As can be seen from the data in Table 1 the assumptions made above are reasonably justified i.e. the probability of correspondence of the like situations and parameters is essentially significant. This allows making generalization even for estimation of probable initiation of the avalanche dangerous as a whole. To do this one should consider:

- either generalization of the obtained probabilities reasoning from the significance of different groups of characteristics of the avalanche climate initiation characteristics analysis in the assumption that the probabilities of correspondence can be considered as conditional probabilities of the concrete situations analysis;
- or a separate group of characteristics of the avalanche climate initiation medium analysis based on the greatest/least values of the correspondence probabilities.

Microsituations classes of avalanche danger initiation. Representation of the avalanches descent factors variety in the form of a set of microsituations helps to increase reliability of their analysis and prediction. Every such a microsituation corresponds to a definite combination of factors of the avalanche initiation environment. At the same time, such representation makes it possible to brake up the whole set of causes affecting the avalanches initiation into two subclasses. One of subclasses characterizes a set of microsituations reflecting the avalanche initiation and the other subclass is typical for non-avalanche situation as a whole. Then the emergency avalanche situations risks management can be presented as a generalized description of the system with the help of a totality of different microsituations. Based on such interpretation the logical rules of the analyzed data set generalization for further their subdivision into classes of avalanche dangerous and non-avalanche dangerous situations:

$$\text{Avalanche dangerous} = \left(\{F_L^L(X)\}/\{F_N^N(X)\}\right) \cup \left(\{F_N^N(X)\}/\{F_L^L(X)\} \cup\right)$$
$$\cup \left(\{F_L^N(X)\}/\{F_N^L(X)\}\right) \cup \left(\{F_N^L(X)\}/\{F_L^N(X)\}\right) \cup \left(\{F_L^N(X)\}/\{F_N^N(X)\}\right),$$

$$\text{Non avalanche dangerous} = \left(\{F_N^L(X)\}/\{F_L^L(X)\}\right) \cup \left(\{F_L^L(X)\} \cap \{F_N^N(X)\}\right) \cup$$
$$\cup \left(\{F_L^N(X)\} \cap \{F_N^L(X)\}\right) \cup \left(\{F_N^N(X)\}/\{F_L^L(X)\}\right),$$

where $F_L^L(X)$ ($F_L^N(X)$), $F_N^L(X)$ ($F_N^N(X)$)– probability function of referring avalanche dangerous (non-avalanche dangerous) microsituation to the avalanche dangerous (non-avalanche dangerous) class, respectively, on the set of factors of the avalanche danger initiation X [9].

In this case performance of the preliminary statistical analysis of the avalanche dangerous situations initiations warning makes it possible to define discriminant functions of such situations prediction. Results of estimating the probability of referring of the investigated data to the classes describing avalanche dangerous or non-avalanche dangerous situations of the avalanches descent obtained with such functions also allow to single out different types of situations on the whole set of the analyzed data of the avalanche climate environments. Respectively, this may be the situation of the avalanche initiation (Ω_L) and non-avalanche dangerous situation (Ω_N).

In its turn the considered situations Ω comprise a definite set of microsituations $\Omega = \{\omega_i\},\ i = \overline{i,n}$, each of them corresponds to a definite group of the considered types of data of the avalanche initiation environment and representing on the one hand, certain probability of avalanche situation initiation, and on the other hand — characterizing the probability of non-initiation of the avalanche dangerous situation.

To put it differently, avalanche dangerous situations Ω_L represent the combination of microsituations $\Omega_L = \bigcup_i \Omega_{L_i}$ uniform by the type of data, and avalanche non-dangerous situations Ω_N represent the combination. Each specific microsituation represents, within certain limits, the probability of initiation either of the avalanche dangerous, or avalanche non-dangerous situation as a whole as regards a definite type (group) of data with their different values which characterize the considered situation.

Consequently, as a whole the results of estimating the probability of referring the investigated data to the classes describing avalanche dangerous or avalanche non-dangerous situations of the avalanches descent can be regarded as a basis for transition to formation of the corresponding microsituation systems, the data relative to which the knowledge base of crises situation management information-analytical system is created.

As this takes place, in any case the obtained probabilities of correspondence to the classes of the avalanche dangerous and avalanche non-dangerous situations initiations for some interval of time allow passing to the consideration and analysis of the avalanche dangerous situations initiations. As the boundaries of such sets one can consider the corresponding boundaries of the distribution polygon built using the correspondence probabilities in some temporal interval. Analysis of such sets makes it possible to formalize the totality of the avalanche dangerous and avalanche non-dangerous situations and to build the procedure of the corresponding prediction.

At the same time presentation of the avalanche danger factors in the form of the microsituations classes allowed to get an objective correspondence between the probabilistic estimates of the avalanches descent and the avalanche danger scale degrees; eventually this makes it possible to correct time of the prediction system response to the possible avalanche descent. Essence of such estimate consists in construction and analysis based on the theory of fuzzy sets, corresponding functions of prediction time correction $\mu(X)$ (Fig. 2) [10].

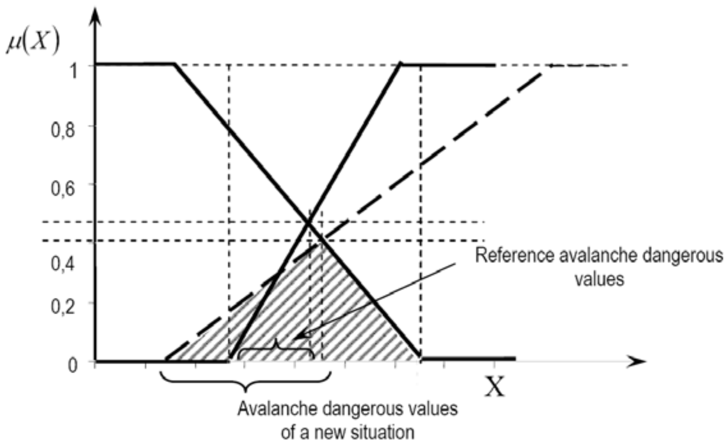

Fig. 2. Methods of the fuzzy sets theory as the basis for correction of the prediction system time response to the possible avalanche descent

As a whole, the essence of such description reduces to construction of the fuzzy model for estimating temporal characteristics of the avalanche dangerous situations. Thus, for example, it is possible to suppose that in the case of the avalanche non-dangerous situation analysis the time till the assumed avalanche descent will be the more the greater is the probability of referring current parameters of analysis of the avalanche climate initiation environment to such situation. Respectively, in the case of insufficient probabilities of referring of the avalanche climate initiation environment analysis current parameters to such situation can testify to insignificant reserve of time till the avalanche descent moment. When considering the avalanche dangerous situations the corresponding characteristics are the opposite. This allows to introduce into definition the functions of the avalanche descent time fuzzy set; their generalization makes it possible to predict the avalanche descent time.

It is possible to pass to the distribution functions in the estimate of the avalanche descent time on the basis of the corresponding probabilities analysis of the fuzzy set available data separation into avalanche dangerous and avalanche non-dangerous situations.

Thus, the model construction generalized scheme and construction of the procedure for prediction of the avalanche-dangerous situations initiation is reduced to:

- sequential obtaining of the probabilistic characteristics of the avalanche climate initiation medium;
- construction of the corresponding sets of subdivision into avalanche-dangerous and avalanche-non-dangerous situations;
- analysis of the avalanche descent initiation time using fuzzy models of its interpretation.

Conclusion

This work presents the general concept of building models and procedures for prediction of the avalanche-dangerous situations based on the probabilistic and multiple approaches to its interpretation. Such an approach allows, first and foremost, taking into account the range of variations of the factors acting on the avalanche-dangerous situations initiation, to build adequate procedures for their prediction. Moreover, the essential characteristics of the problem under consideration which is confirmed, in particular, by the feasibility of the probabilistic model of the general approach based on the real data.

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Authors' Information

Kuzemin A.Ya. – Prof. of Information Department, Kharkov National University of Radio Electronics, Head of IMD, Ukraine, e-mail: kuzy@kture.kharkov.ua
Liashenko V.V. – senior scientific employee, Kharkov National University of Radio Electron, Ukraine

THE APPROACH TO DEVELOPMENT THE HUMAN RESOURCES INTELLECTUAL MANAGEMENT SYSTEM. MANAGEMENT PROCEDURES.

Roman Benger, Elena Antonova

Abstract: The Article suggests an approach to designing the Human Resources Intellectual Management System in order to increase Human Resources reliability, using the management methods known from the Theory of Management.. The Article examines the realization of the Subsystem of implementing management methods by the number of management procedures, executing the corresponding management method.

Keywords: The theory of unreliable elements, The knowledge system, The intelligent control, KDS.

Introduction

Management is a complex and multi-level process, covering all the spheres of human activity, and the most complex and unreliable elements of this process are people (human resources). In any managing system, the person's actions depend on numerous factors, and many actions are carried out spontaneously or thoughtlessly.