LOADING THE DECISION SUPPORT SYSTEM WITH KNOWLEDGE FOR EMERGENCY MANAGEMENT UNDER NATURAL DISASTERS

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ABSTRACT

A methodology for identifying information to be included in decision support systems (DSS) is offered for use in emergency management. The developed classification of impacts and associated recommendations are applied in the creation of DSS for emergencies.

INTRODUCTION

The most complex and laborious tasks in developing decision support systems (DSS) for various emergency cases are the creation of knowledge bases which characterize the impact of natural disasters (ND) on functioning industry objects, and working out recommendations depending on the full description of situations, type of information, etc. (Vyazilov *et al.* 1991).

Acquiring knowledge is a process of searching various information sources, converting the information to the forms needed, and transference of the information to the data base of the intelligent system. Knowledge sources can include handbooks, books, papers, manuals and instructions, other bases' contents, and other such commonly available information sources. Another type of knowledge is experts' personal knowledge, which is not documented in published sources or stored in depositories.

These sources include personal knowledge, intuition, experience, and problem-solving skill which is passed from teacher to pupil via joint problem-solving and analysis of achievements and failures. Another type of subjective knowledge is empirical knowledge, obtained for the intelligent system via observations and processing of the data base on the environmental state. By identifying the impacts and working out recommendations, it is possible to use historical data from different reports and documents of the services that take preventive measures prior to and manage recovery following disasters.

It is common knowledge that a person cannot inform you about the general abstract rules that he applies in solving some specific task. Most often, a human skill is practiced on a subconscious level. Acquiring knowledge involves a process similar to the creation of a DSS, including different types of activity: stating a problem, acquiring the data, making a choice, and developing a knowledge presentation format (designing, programming, documenting, etc.). This process comprises several stages: analyzing the application of information on the environmental state of the object, identifying the environmental parameters affecting the considered object; choosing the proper information on different kinds of activity in various sectors of the national economy; determining the ND impact on the object; working out recommendations for considering the impacts; creating a logical knowledge base scheme; and, entering knowledge and data bases on computer media.

Let us consider in greater detail the problems related to the determination of ND impacts on industry objects and preparation of recommendations for decreasing or preventing those impacts.

DETERMINATION OF IMPACTS

When assessing ND impacts, in order to make the damage or benefits evident, and determine a range of possible actions, it is necessary to: estimate the extent to which the region has been developed; find out what disasters occur and estimate their probability of occurrence; classify regional environmental challenges with respect to the specific fields of activities; prepare the scheme of applying this information in managing technological processes at the industrial object; and, assess the extent to which the consumer is vulnerable to a change of environmental conditions and dependent upon information quality. After damage is correctly estimated on the basis of joint information, on both the environmental state and economic information, a study should be made of the choice of preventive measures to diminish the damage or increase the benefits. Estimation should also be made of possible effects of the preventive measures and their effectiveness in the course of time. Techniques should be developed for information processing to serve the user, as well as to work out algorithms for decision making, reasoning from some certain information.

Natural disaster impact on an object depends on its intensity (environmental parameter values), characterized as a numerical index. Hence, in assessin environmental impacts on an object, it is necessary to single out the critical values of environmental parameters. Because the need to take measures depends on the probability of prognostic and climatic values of environmental parameters, this characteristic can be included in the knowledge base.

In text these impacts can be expressed using the following verbs: causes, affects, perishes. Depending on the situations for their proper estimation, the verbs are given in different time aspects with respect to information type:

prognostic—may be, possibly;

climatic (background)—hinders, subjects, reaches;
current—loses, shifts, gets;
past weather (with respect to the situation)—broken, damaged.

The character of impacts can be physical, dynamic, heat, chemical, pollution, or social. The results of natural disasters' impacts can be negative and positive.

By evaluating the results of impacts, dangerous areas of an object can be determined as well as the intensity of an impact. Having determined the dangerous areas it is possible to detect the causes of negative effects and eliminate them. It is somewhat difficult to plan and carry out special actions to decrease ND impacts, especially when none of the environmental parameters reaches a critical value. Therefore, integral indicators are to be introduced, such as the climate severity, reasoning from which certain preventive and rescue measures should be taken relative to human resources and property.

WORKING OUT RECOMMENDATIONS

The last stage of processing data on the environmental state is working out recommendations. On the basis of all available information and the character of impacts, a list of recommendations is prepared for making decisions at the objects. The recommendations are presented by non-formalized information on decisions which must be realized under natural disasters. Plans of actions (recommendations) to be undertaken in case of emergency are necessary for making fast reports to the heads of objects. Such plans are prepared beforehand with respect to specific disasters, their consequences, and certain groups of objects or separate technological processes.

In recommendations produced by DSS for emergencies, the functions of groups representing emergency commissions should be given, along with their heads' names, office, and home telephone numbers. In addition, agreements should be reflected with enterprises and governing bodies who are able to render assistance from outside in case of an emergency on the local scale.

After a disaster occurs specific measures are taken to remove the damage caused depending on the character and intensity of the phenomena. Hence, in the data base description there should be a corresponding section, "after a disaster occurs".

There is a great variety of recommendations, since a specific plan of action should be provided for each disaster impact. The types of measures taken may be biological, technical, organizational, economical. or legal. They can also be defined as warning, prohibiting, and ordering, or as measures of prioritizing services.

Depending on the type of information used and the promptness of the decision, tactical or strategic operations can be recommended. Prompt operations are needed for making fast decisions. They are prepared on the basis of short-term prognostic information or on current emergency information and are needed for different purposes, such as: planning a port's work schedule, making up daily projects for fisheries and drilling, taking measures to prevent the damage, or choosing the optimal shipping route through the oceans.

Tactical operations are needed for taking decisions for the nearest period of time (a few weeks or a month), and are prepared on the basis of long-term prognostic information and information on the state of the object. These are necessary for the effective use of the national economy objects, such as choosing efficient methods for the use of fishing tackles, information for the monthly planning of a port's work, providing safe realization of hydraulic projects, etc.

Recommendations for strategic actions involve providing advice to decision makers on decisions to be made in the coming months and years on the basis of extra long-term prognostic or climatic information. These are also needed, for example, for making shipping plans for a season, a year or five-years; for planning hydraulic projects realization; and for choosing the most effective construction of oil derrick depending on the area of its future location.

Recommendations for taking tactical actions are represented by information necessary for decision making for the coming day or weeks, and are partially prepared on the basis of short-term and long-term forecasts. These recommendations are needed for planning work in a port for a week, cargo stowing, fisheries engineering, etc.

At a lower level, objects for which the recommendations are produced are represented by individual enterprises such as middle level municipal governing authorities; at a higher level, by ministries and agencies. Each level is characterized by the range of decisions made over a span of time for which the forecast holds true, the extent of decision accuracy, and a complete description of the resources used. The functions of each level of management are realized through the corresponding algorithm of management, including a number of management procedures—a set of interrelated operations, actions and calculations, carried out within a certain span of time in the process of working out the decisions.

At a lower level, recommendations are made for every enterprise, ship, port, or drilling platform, with specific actions to be taken in each case separately. Prompt actions are recommended for municipal (district) leaders. Recommendations are prepared for the state bodies and also agencies under municipal authorities (civil defense, municipal engineering, communication, militia, sanitary service, etc.). Both prompt and tactical actions are used here.

Recommendations on an industrial scale are needed to perform the control of an enterprise's activity, to provide assistance to them under natural disasters, and to draw up promising projects in developing sectors of the national economy and their output products. Such recommendations are dependent on environmental conditions. Tactical and strategic actions should be used.

Recommendations on a regional scale are prepared for standard objects irrespective of the branch of industry they are related to. These are, for example, ships, water-development projects, populated areas on the sea coast, and a number of enterprises of the same type under one agency (such as fish canneries).

Recommendations to be realized on a large-scale are prepared for planning construction of large-sized installations whose operation can influence the climate of separate regions of the country, such as construction of high and low tide electric power stations, flood protection construction in St. Petersburg, and water intake from Amu-Darya and Syr-Darya feeding the Aral sea. Because the realization of such projects can have unfavorable effects on the natural environment of other countries, the national interests of the countries concerned should be considered in the recommendations.

Specific recommendations can include:

WARNING—if a disaster warning is given, preventive measures should be taken to avoid or decrease the damage and losses.

RESTRICTION—if a restriction warning is given, reasoning from information about poor conditions in a certain region or the ocean area, limitations are imposed on shipping routes and optimal routes are offered to avoid cyclones, floating ice, etc.

PROHIBITION—a prohibition recommendation is given to close a specific region for shipping due to a dangerous disaster; or to withdraw all ships from the region under severe icing, icebergs, poor icing conditions, or hurricanes; or to prohibit a ship's travel into a port or region, when the ship's displacement is less than 1000 tons.

ORDER—ordering recommendations are produced to increase the efficiency of technological processes output, such as identifying promising fishing regions; determining an optimal assurance factor in water development projects; or imposing restrictions on cargo shipping or the speed of vessels.

SPECIFIC INFORMATION—such information may include, for example, data on depth, synoptic conditions in the region, orplaces to take shelter in nasty weather.

Additional information can contain the following: distance to a dangerous area, type of danger, its duration, and limitation on the time of staying in that area.

The choice of protective measures depends on the time of warning, ways of protection, technical facilities availability and their efficiency, and also on other peoples' activities.

Recommendations for decision-making are prepared by experts by drawing on their previous personal experience, on the basis of analysis and generalization of the experience of a group of experts, and also by board advice, considering options both with and without optimization.

If some certain measures are taken at a higher level, they are subsequently realized as specific operations at a regional and local level. Under such circumstances along with the objective of the work, it is of great importance to consider the safety of people and property, as well as the efficiency of plant functioning.

THE POSSIBILITIES OF COMPUTERIZATION OF KNOWLEDGE ACQUISITION

The process of knowledge acquisition is a difficult one. Two directions of studies are possible: 1) computerization of the knowledge base, and 2) automatization of the process for providing completeness and correctness of the recommendation and message bases for various situations. To computerize the data base creation, an editor is applied in the shell SPRINT which makes possible transference of the parameter and function names along with other attributes into the data base. But, computerization cannot solve all problems. The second direction seems to be more important at the present stage of the DSS creation, because many messages and recommendations prepared for one subsystem can be applied to other subsystems. Relying on available messages and recommendations, the experts can perform updating and editing.

It is important to identify the list of standard ways in which natural disasters impact industrial objects. Having the list of standard impacts in the base one can make a prognosis of the impact results.

We offer the theory of solving inventive tasks, particularly the method of "diversion analysis" (Zlotin and Zusman 1991), as a methodology for computerization of the process providing completeness and correctness of data knowledge. On the basis of an accumulated base of messages, classification is made and the standard results of hazardous impacts are identified for natural disasters. Thus, the new or edited messages are entered into the proper DSS bases.

CONCLUSION

A methodology for identifying information to be included in decision support systems (DSS) is offered for use in emergency management. The developed classification of impacts and associated recommendations are applied in the creation of DSS for emergencies.

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