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SOME FACTORS OF CRISIS MANAGEMENT IN WATER SUPPLY SYSTEM

The paper presents selected factors of crisis management exemplified by the water supply system (WSS). It provided a background for the rules of crisis management formulation. The aim of such management is to prepare resources and society for the case of an undesirable event occurrence which causes threat to health, property, environment and infrastructure. The risk elements, which always accompany crisis, have been presented. The early warning systems functioning rules, information about risk and processing data obtained from monitoring were analysed.

1. INTRODUCTION

The term "crisis" is of Greek origin and is derived from the word "krino" which means strive against something, decision making and choice, process of judging, in general the final, irrevocable settlement. Crisis is not an event but a situation – a consequence of an event or a process and it is characterized by acting under time pressure. In Greek, it was associated with a radical alternative for which there were not any intermediate solutions: life or death, success or failure, salvation or condemnation. Nowadays crisis is a temporary situation and it has an evolutionary character. It follows a normal system functioning and is accompanied by a sense of loss of basic values of different nature and weight. It can develop and lead to a disaster or it can be prevented as a result of anti-crisis activity.

Nowadays safety of the technical and environmental systems functioning becomes a worldwide scientific tendency. In Poland, a ministerial document of National Frame Program has been issued and one of its strategic research areas is "safety". The priority directions of scientific research are, among others, crisis management, early warning systems in crisis situations and so on. In Europe, the program called GMES (Global Monitoring for the Environment and Security) works. Also the sixth frame

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European Union program introduces those subjects in the priority “Information Society Technologies: 2.5.12 IST for Environmental Risk Management”.

If the undesirable events have violent character and lead to some negative consequences connected with a serious failure, tragedy, catastrophe or disaster (e.g., floods, earthquakes, hurricanes, fires, terrorist attacks), then the relevant risk is the so-called “hard risk” type. The other type of risk is the so-called “soft risk”, which is accompanied by slow and often combined actions of undesirable events (e.g., bad condition of municipal water purity, air pollution, noise), that, after some time, lead to irreversible changes in human health.

2. MATERIALS AND METHODS

The crisis management system is an important element responding to an existing threat within the framework of a general safety system. It should be flexible and should offer the possibility of analysing the new threats that have not been known as the undesirable events so far. It is connected with the need to generate the new procedures that will be able to oppose such threats.

The exemples of the levels of Management Cockpit using early warning system are:

- Prediction, (information, collecting, processing, modelling, transmission).
- Warning, (identification, alert).
- Response, (decision making, action).

The methodology to determine the crisis management time in the WSS, connected with a shortage of drinking water, is as follows:

<table>
<tr><td>Needs are fulfilled</td><td colspan="2">Tolerable water shortage</td><td>Disaster</td><td>Tolerable water shortage</td><td colspan="2">Needs are fulfilled</td></tr>
<tr><td>100% Q</td><td colspan="2">~70% ≤ Q < 100%</td><td>0% ≤ Q < 30%</td><td>~70% ≤ Q < 100%</td><td colspan="2">100% Q</td></tr>
<tr><td colspan="2">Normal operating time</td><td>Response time</td><td colspan="3">Crisis management time</td><td>Normal operating time</td></tr>
</table>

A crisis situation is characterised by the occurrence of undesirable events and processes, as well as their accumulation, which finally lead to a threat that the system will not be able to work autonomously or are not favourable for the system development. The undesirable phenomena (events, processes) which are a cause for the crisis are divided into internal (a source is inside the system) and external (a source is in the system surroundings).

From decision-making point of view the features of a crisis situation are a relatively short decision time, a low degree of predictability since the undesirable events often occur in an unexpected way (surprise), a high risk level, and fear resulting from the extreme acting conditions (panic, fright).

From crisis management point of view the character of a crisis situation lies in a permanent disturbance in working, a real or colourable loss of control, threat to the execution of the basic purposes, threat of a serious failure or disaster.

Taking into account the anti-crisis strategies related to a phase of crisis situation we can distinguish active actions (anticipated and preventive) and reactive actions (repulsive and liquidation). Considering the crisis extent and intensity and the possibility of overcoming it, we can distinguish:

- A potential crisis – the first symptoms of crisis situation can be seen.
- A hidden crisis – problems in system operation can be seen, it is impossible to identify their reasons.
- A hot crisis – consequences of intensified difficulties in system operation are noticed, system safety is threatened, there is still a possibility of keeping control of crisis situation.
- A burning crisis – an accumulation of threats occurs and progress of destructive phenomena is out of control, loss of system reliability and safety, system environment is not under control any more, there is no possibility of getting crisis situation under control.

A division according to the crisis consequences extent is as follows: global consequences, affect the whole system, and local consequences, affect objects or subsystems.

3. METHODOLOGY OF DATA PROCESSING OBTAINED FROM MONITORING

The term "data fusion" means a method of data processing through their fusion (FDP), whose purpose is to convert information derived from several sources into better quality information than would be possible to obtain when these sources were used individually [2].

The term FDP can always be used when a FDP disposer has got better quality information than the original data user. Information quality increase can take place in information already obtained from system operation monitoring or it can concern some new credible correlations that have not been available before. The FDP method sets the structure of sensors output data on different levels, with respect to their hierarchy, aggregates the data gradually until the synthetic information required by the disposer, useful in making operational decisions favourable for the execution of the set goals, is obtained. The application of the FDP enables us also to process data automatically, which in many cases leads to the elimination of operator role at the given decision making level.

The sources of information from the modern water supply system (WSS) operating monitoring are measuring devices generating data about water quantity, quality and pressure in a numerical form. A conscious application of the FDP is based on the synergistic effect. From the technological point of view, such advanced FDP goes back to the 1980s, however, in living creatures this type of FDP has already been known since the origin of mankind – e.g., data from eyesight, hearing, taste and touch sensors are transmitted to our brain that generates the new accumulated information. This FDP type develops as a result of the needs of information society in which a lot of information circulates. Nowadays the application of the FDP is connected with the meteorological forecast, search for the environmental threats, etc, for which technical means of satellite and ground observation (radars) are used. The natural civilization threats connected with the WSS operating have been known for many years, therefore there is a necessity to monitor, detect and prevent them. There is, however, a barrier of the adequacy of the mathematical models using FDP from systems monitoring and their tare [2]. We can distinguish the following actions performed during the FDP:

- Selection of suitable data from different sources, unification, standardization and time and space coordination.
- Combining data through creation of a basis for a given system object.
- Rules formulation based on the determination of relations between different states of system objects.
- Estimation of current and future needs concerning the WSS operating monitoring.

The application of FDP requires the following issues to be taken into account:

- There is a barrier in a constantly valid rule – it is easier to observe and create data than to convert them into information.
- Nowadays we deal with a very high number of data and simulating models that use them to a relatively low degree.
- A tendency to constantly increase the amount of data, as well as the fact that the required operator response time, especially response to the threats, constantly decreases.
- In the framework of the WSS operation modelling, the emergency scenarios must be considered.

Generally FDP centres perform fusion of data derived from available sources by means of simulated mathematical models, as a result we obtain the estimation of a probable WSS operating state.

4. THE RULES OF EARLY WARNING SYSTEMS FUNCTIONING

The issues connected with the early warning systems (EWS) functioning in an aspect of the present extraordinary natural and civilisation threats are of crucial importance as far as the possibility of crisis management is concerned. The dictionary comprising the terms concerning the national safety gives the following definition: "warning – one of the functions of detection and alarm system, the aim of which is to convey (in advance) information about an extraordinary threat. It should be done by the relevant bodies (services) that are involved in threat detection or estimation." Whereas, "early warning is a process in which the relevant services obtain and pass information about the extraordinary threat in such advance that relevant bodies, institutions and society in the defined area could undertake the actions to minimize the negative consequences of these threats" [1].

Nowadays the methodology of the EWS tends to stress the fact that the basic issue is no longer the reliable credible information (which is generated by modern monitoring), but its distribution – such way of warning delivery that causes a proper social response to the threat level. The efficient EWS has to predict threats, monitor threats, develop emergency scenario, ensure effective warning and alarm subsystem operation, control warning delivery and reception, increase society knowledge by educating about the behaviour in the face of threat. The analyses performed so far show that priority issues concerning EWS should comprise:

- Decision time valuation.
- Ways of warning directed to different social groups (in schools, hospitals, etc).
- Development of warnings adequate to a scale of threat and favourable for protective procedures implementation.
- Scenarios of people actions in the face of threat, information of alternative sources of media belonging to the critical infrastructure (drinking water, electricity, thermal energy, natural gas).
- Society education concerning warning and alarm systems, knowledge of threats types and their consequences.
- Rules of fast response rescue service functioning.

As follows from this analysis the EWS is a special type of information system. Using the basic terms of the system theory concerning the EWS we can distinguish the three basic subsystems: functional, structural and instrumental:

The functional subsystem consists of the following elements:

- Warning information acquisition, (information needs identification, determination of observation area together with its probable division, information sources layout, monitored parameters changes measurement).
- Warning signals analysis, (establishing change measures, characteristic of acceptable change ranges, change indicators ranking, interpretation and verification of warning parameters size).
- Warning signals transmission, (establishment of subjects responsible for transmission, supervision over transmission speed and accuracy, reduction of transmission disturbances and distortions).

The structural subsystem consists of the following elements:

- Information sources, (internal, external, data bases, historical, current, prospective).

• Operational teams, (data acquisition and analysis, response to crisis, crisis management centres).

The instrumental subsystem consists of the following elements:

• Information acquisition, (data from constant monitoring recording, interviews, questionnaires).

• Data analysis, (methodology, data processing technology, indicators selection).

• Information transfer, (information technologies, data protection methods, methods of computer aided decision making, verbal communication rules).

The early warning system enables us to identify threats and supports the activation of counteractive procedures. The possibility of reducing the negative consequences results from the fact that the EWS is a response element in crisis situations. The EWSs are used in risk management since they create the possibility of estimating its risk, i.e., they reveal the extraordinary threats and contribute to the assessment of negative consequences. Besides, the EWS determines the effectiveness of the possible rescue actions. The precise threat identification and efficient information transfer allow us to edit warnings and alarms in an effective way.

5. PROCESSES CONNECTED WITH INFORMATION ABOUT RISK

One of the opportunities offered by risk analyses and quantitative assessment is that we can inform about risk on the basis of them. With regard to this the following features are distinguished:

• Describing risk – how risk is seen by the relevant people.

• Criteria for risk measurement – related to the results of risk analyses.

• Connected with the decision making process – related to the possibility as an advisory mean in decision making.

The methods of risk presentation are as follows: by means of the curves frequency vs. consequence, the use of the probability density function for consequences, the use of the curve of the probability that the assumed consequences value will be exceeded, the use of the expected values for particular types of damages, a graphic representation of risk areas by means of maps. In the process of communication about risk, the problem of using an absolute risk or a relative risk arises. A relative risk is important when the alternative solutions with regard to the question “how much is this undertaking safer than the other one?” are considered. In such case, a decision maker does not have to take into account the level of threat seen by public opinion and he does not have to decide about possible benefits and losses. The knowledge of an absolute risk is important when the priorities are established in risk reduction, resulting from financial benefits and losses analyses. Besides, it has the crucial importance when comparing risk with the assumed acceptable criteria.

The use of risk assessment from an economic point of view is justified because safety and protection systems which reduce risk require some financial expenditures. Decisions connected with risk monitoring need determining:

- Costs born to keep risk level within socially tolerated limits.
- The benefits obtained and who will be their beneficent.

In order to accomplish the economic analyses connected with risk reduction, the procedures called Risk Cost Benefits Analysis or Best Available Technology Not Entailing Excessive Cost must be carried out. These analyses will allow determining:

- The economic benefits resulting from water production in changed operating conditions.
- The potential losses resulting from the abandonment of risk reduction concerning the producer and users.
- The costs of risk monitoring.

While considering the tolerable risk level, the following issues should be taken into account:

- The public risk perception, relevant opinion can be obtained through surveys.
- The alternative decision strategies on various risk levels (tolerable, controlled, unacceptable).
- Profit and loss balance for individual operations preventing undesirable events.

In risk related decision making process, the following factors should be taken into account:

- Nationwide and local interests and customs. Luxury to use water is seen in the poor African countries differently than in the developed European countries. Similar differences take place between people using their own house water intakes and municipal water pipe users.
- Data about past options and scenarios.
- Economic conditions. They have impact on risk tolerance criteria. Firm financial situation is connected with water pipe users financial condition, which is reflected in decision making about the sum of capital used to reduce losses.
- Different risk character. For example: general risk is connected with everyday use of public water pipe and voluntary risk comprises, e.g., recreational water sports usage.
- A modification of risk perception. Education concerning risk causes awareness of its existence and counteracts the processes of underestimation or overestimation of the possible negative risk consequences.
- The establishment of financially justified safety margins, e.g., balance of alternative sources of drinking water supplied to people in the case of lack of water supply from the main water intakes.

• A dialogue with society. Easy way of making complaints in waterworks and a rule of absolute response to complaints. Periodical presentation of the results of water quality examination together with professional comments understandable for all people.

6. CONCLUSIONS

• To ensure WSS operating safety it is required to use the newest theoretical solutions, the basic category of which, nowadays, becomes the term risk. It comprises the evaluation of the relation between the occurring threats and the safety and protective barriers.

• It can be seen that there is a trend in legislation to ensure system safety through the implementation of the standard risk analysis and evaluation for the technological systems operation.

• The directions for further studies are determined by Frame Program which includes project V – safety. The following directions for operations, among others, are named: crisis management, early warning systems in crisis situations, information systems safety. This program is an extension of the Sixth Frame Program (FP6), the main aim of which is to manage risk situations through early warning and threats monitoring.

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WYBRANE CZYNNIKI ZARZĄDZANIA KRYZYSOWEGO
W SYSTEMIE ZAOPATRZENIA W WODĘ

Przedstawiono wybrane czynniki zarządzania kryzysowego na przykładzie systemu zaopatrzenia w wodę (SZW). Strategiczne znaczenie zaopatrzenia w wodę do spożycia jest szczególnie ważne, gdyż dotyczy infrastruktury krytycznej niezbędnej w skali makropaństwa. Sformułowano zasady zarządzania kryzysowego, którego celem jest przygotowanie zasobów i społeczeństwa na wypadek wystąpienia zdarzenia niepożądanego, które jest związane z funkcjonowaniem SZW i powoduje zagrożenie dla zdrowia, mienia, środowiska lub infrastruktury. Zaprezentowano elementy ryzyka zawsze towarzyszącego sytuacjom kryzysowym. Scharakteryzowano sytuacje kryzysowe związane z brakiem dostaw wody. Przeanalizowano zasady funkcjonowania systemów wczesnego ostrzegania, informowania o ryzyku i przetwarzania danych otrzymanych z monitoringu ilości i jakości wody. Zaprezentowano metodologię przetwarzania danych przez ich fuzję.