PRINCIPLES OF MITIGATING AND MANAGING HUMAN SYSTEM RISKS

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Abstract: The security situation in a territory continuously evolves and, therefore, a new safety culture is formed that takes into account the actual knowledge and experience with interdependencies among public assets, including experience with extreme social crises. In dealing with disasters, historical development of human activities has included numerous preventive and mitigation measures applied according to legal rules, technical standards, norms and public instructions, response systems and ways of recovery. As a rule, these ensure protection against basic disasters and not to 'calamities' or random combinations of phenomena that may cause catastrophes. Problem solving the complex territory safety requires proactive, strategic risk management based on qualified data, methods, knowledge and good practices in their application. This paper summarizes the set of principles that ensures qualified decision-making for risk management, or 'whole-of-life risk governance,' directed at provision of human security and sustainable development. It addresses the key domains related to effective risk management.

Keywords: Human System, Disaster, Risk, Risk Management, Safety Management.

Introduction

Present goal of humans is to live at safe space. In agreement with the EU and UN proclamations and the professional knowledge there is necessary for conservation and sustainable development of the human society to create the safe communities on all social levels. The safe space is represented by safe open dynamically variable system that we denote as the Human System 1 (next only "human system"). In detail the human system is the system of systems (SoS), i.e. several overlapping systems2. The human system security and development is disturbed by disasters, i.e. internal or external phenomena that lead or can lead to damages, harms and losses of system assets. It means that human system safety is affected by both, the processes, actions and phenomena that are under way in human society, environment, planet system, galaxy and other higher systems, and the human management acts. Therefore we must negotiate with risks of different origin and kind. The paper deals with principles of negotiation with risk at stages of its mitigating and managing in selected sections of human system management. It contains results of four national projects from period 2004-2008.

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Survey of Findings on Human System Management

The basic terms of system safety management created in professional domain of system disciplines are summarised in a recent work of the author.[1] Most important of them are: *Security* is a state of system at which the occurrence of harm or loss on system assets (protected interests) has an acceptable probability (it is almost sure that harm and loss do not origin). To this there is also belonged a certain sure stability of system in time and space, i.e. a sustainable development in time and space which means that the system is protected against to internal and external disasters. *Safety* is a set of human measures and activities for ensuring the security and sustainable development of system and its assets. Its measure is effectiveness size of appropriate measures and activities at ensuring the system assets security and sustainable development. *Secure human system* is represented by a territory including the human society that is protected against to internal and external disasters. *Safe human system* is represented by a territory including the human society the assets of which (human lives and health, property and public welfare, environment, infrastructures and technologies) are in security and they can sustainable develop. The system is protected against internal and external disasters and the system itself does not threaten its vicinity because the good symbiosis of each system with its vicinity is necessary for system existence. Similarly *safe organisation* is the organisation the protected assets of which are in security and they can sustainable develop.[2] *Human system safety management* is the management of human system directed to human system safety the product of which is security and sustainable development of all public assets. The enthusiasm that was in developed countries in the middle of last century, when humans believed that the human kind would have power over disasters (wind, rain, earthquake etc.), was replaced step by step during the time by respect to the Earth's Planet System. At present the human actions and management are implemented by a pragmatic approach based on evaluation of credible and relevant data and the humans take into account that their knowledge and capabilities are: too small to prevent the origination of disasters that are the manifestation of the Earth's Planet System development; adequate to mitigate the impacts of disasters that are the manifestation of the Earth's Planet System development; and sufficient to prevent the origination of disasters that are connected with the human actions and with development of human society (so called man-made). Generally, there is known if we want to control some phenomena or to avert them, we must know their cause, size, repeat and nature of impact effects on considered public assets. The disaster sizes, namely extreme ones have basic importance for system safety. From them it is unreeled the created protection system, i.e. the system of measures and activities for averting or mitigating the disasters and / or their impacts. There is necessary to take into account that disasters from the viewpoint of the Planet or environment development might be inventive changes supporting these system states and that human with his / her wishes and management

goes against them. If it is reasonable and profitable for human in near or distant future, we cannot estimate because our fittings in this domain are very poor and such question has been only recently appeared in professional domain. Therefore, there is necessary to use the precaution principle in the human system management. Given principle is inherently included in safety management that denotes strategic management ensuring the identification, diagnose, enforcement and implementation.[3] According to present knowledge we know five disaster origin processes. At the disaster occurrence there are originated chains of undesirable phenomena (impacts, consequences) of external and internal character, primary and secondary, which affect negatively human system assets in different intensities and in different time moments. The substantial role plays the local vulnerability and pertinent faults in human behaviour or management on all levels. The disasters are the cause of emergency situations, the severity of which substantially increases if cascade impacts occur.

Regarding to present knowledge and experience the human system safety management must arrange to: precede disasters if possible, e.g. in case of natural disasters it is impossible; eliminate the causes of severe disaster impacts or at least to reduce their occurrence frequency; mitigate unacceptable disaster impacts by preventive measures, preparedness, optimal defeating the disaster impacts and by them defeating the induced critical situations (i.e. really the reducing the emergency duration to acceptable amount); ensure renovation and start of further development of object/ territory etc. From the present knowledge viewpoint there is necessary to ensure that human society management might be proactive, strategic and might consider facts, findings, experiences and their correct evaluation. The reactive management is only admissible on operative level when emergency or critical situations have been occurred, i.e. in times when there is necessary to solve problems immediately and when no time for deep analysis and assessments that are challenging for data, methods and processing time. In practice third level management: normal; emergency; and crisis.[4]

Risk

The origins of the term “risk” are in the middle ages. There are different definitions of risk for each of several applications. The widely inconsistent and ambiguous use of the word is one of several current criticisms of the methods to manage risk. Risk is the potential that a chosen action or activity (including the choice of inaction) will lead to a loss (an undesirable outcome). The notion implies that a choice having an influence on the outcome exists (or existed). Potential losses themselves may also be called ‘risks.’ Almost any human behaviour and endeavour carries some risk, but some are much more risky then other.[5] The present concept has been developed since the 1950s. In present practice we use three important terms: disaster, hazard and risk. The disaster is a sudden set of phenomena which have inadmissible impacts on human system assets. The hazard expresses the disaster potential to cause at origin

losses, detriments and harms on assets in a given site, standardly determined. The risk expresses the probable size of undesirable/unacceptable impacts (losses, harms and detriment) of disasters with size of normative hazard on system assets or subsystems in a given time interval (e.g. one year) in a given site, i.e. it is always site specific). The risk partly depends on the hazard and partly on the vulnerability of assets in a given site (i.e. on the sensitivity of each individual asset in a given place against to physical manifestation of the disaster in a given site). It expresses a possibility what it might be happen.[6] From this fact it follows that for each management it is important to know the risk, namely in comprehensible expression. In practice it is certified the risk expression in a form that by risk analysis and assessment it was find that on specific section: there is necessary five million a year for remedy of harms caused by existing risk; each ten years ten persons die in a consequence of given disaster; and each five years the property damages caused by disaster exceed five billion, etc. Methods for determination of risk size respect both, the nature of phenomena that are their sources (i.e. disasters) and the parameters of medium in which phenomena affect. There are used methods based on the mathematical statistics, fuzzy sets, approaches of operational analysis etc., that inherently assume the certain model of phenomena occurrence, i.e. they do not permit that these phenomena are extraordinary, and methods based on scenarios that are simulated or empirically obtained.[7] In principle we can split up two basis approaches, namely: determination of hazard from disaster H and return period τ (in years) is performed by methods based on theory of large numbers, theory of extremes, theory of fuzzy sets, theory of chaos, theory of fractals, etc.[8] According to site vulnerability in an investigated land (e.g. around a given site: square 10 x 10 km; circle with radius of 5 km) it is determined the whole damage on all assets for the H denoted by S, usually expressed in money. Risk R connected with the given disaster in a given site is determined by the relation $R = S / \tau$. The result is very clear: e.g. "the risk from a given disaster in a given site is X EURs and for town it is MX EURs"; determination of disaster scenario for the disaster with size corresponding to maximum expected disaster (there is possible with regard to demands of norms to use the probable size of expected disaster, or the value of standard size of determined disaster or at least unfavourable disaster) is performed; there are used exact scenario compilation methods. According to data for a given land it is determined: the value of whole damage for all assets in affected area SS [9] usually expressed in money according to amount of assets and their vulnerability to impacts of a followed disaster in affected area, usually normed to a certain land unit S; the occurrence frequency of maximum expected disaster normalised to 1 year f according to the professional data from databases or expert opinions. Risk R is given by relation $R = S * f$. The result is in the same form as in the foregoing case. This case is often used for technological and other disasters for which we have not good long-term catalogue (this shortage the EU want to remove by special attention to compilation the MARS

database). From above given facts there is evident that risk value determined is related to certain land unit and time unit. We say that the risk is a site specific quantity. If we can negotiate with risk we must know the risk size and at its determination we must respect all assets and their interfaces. Because the human system is the SoS, we must respect its character and also to consider cross-section risks, i.e. to determine the integral risk. For such risk form we have not yet simple formula respecting all public assets because interdependences caused cross-section risks are site specific.[10]

Risk Management and Real Preventive and Mitigation Measures and Activities

Strategy of management for ensuring the security and sustainable development of managed subject consists in negotiation with risks.[11] In its frame according to present possibilities of human society we apply several ways of deal with risk: part of risk is reduced, i.e. by preventive measures the risk realisation is averted; part of risk is mitigated, i.e. by preventive measures, activities and by preparedness (warning systems and another measures of emergency and crisis management) there are reduced or averted non-acceptable impacts; part of risk is re-insured; part of risk for which there are prepared resources for response and renovation; and part of risk for which there is prepared contingency plan, i.e. it is used for part of risk that is non-controllable or too expensive or low frequent. *To this it is joined the distribution of risk defeating among all stakeholders.* The distribution in good governance is performed according to rule that all stakeholders have responsibility for risk defeat and that the defeat of real risk is assigned to a subject the preparedness of whom is the best.

In practice there are usually used two risk management models: classical risk management; and safety management (i.e. the risk governance for security and sustainable development. In the second case if we find that the safety level is unacceptable, the assessment process must return to level of integral residual risk. The residual risks from individual relevant disasters must be once again judged and they must be revealed to the causes of these residual risks. First and foremost, it is surveyed if the source of high integral risk could not have been performed by measures for reduction of risks from some of disasters that were taken into account. Because the safety is changed in time scale, the safety assessment cycle must repeat in time. Safety management in territory lean on safety assessment, safety monitoring, and risk management from individual disasters and on considering the lings among the corrective measures for reducing the real risks from disasters in system containing all relevant disasters in territory. The safety management is the base for land-use planning and for territory development planning that is a part of strategic territory planning.[12] The present cognition shows that for both classical (standard) risk management and the risk governance supporting the human system security, it is necessary: to understand the process of disaster origination and the conditions under which the process goes on; to

know the sites in which the disaster can originate and probable disaster physical and other characteristics; to identify the hazard that disaster means for a given site according to stipulated rules; to determine the impacts of disaster with size equals to a hazard on followed assets; to eliminate the unacceptable disaster impacts in cases in which it is possible with acceptable expenses, sources and technologies; for residual impacts to calculate by help of predictive models their occurrence probability respecting the fact that there are also considered possible failures of preventive measures; to calculate possible harms of assets in the investigated territory with regard to assets, that are really in the territory and by help of occurrence probability to determine the risk size; to identify and to realize the mitigation measures with regard to humans, property and environment in the way that they may be ALARP (so low as reasonable achievable); and to prove that all measures and activities for averting and mitigating the risks were performed. The acceptable risk can be achieved by hazard reduction of disasters, which are only connected with human activities, and above all by reduction of vulnerability of territory, building, equipment, humans or human society that are a subject of risk assessment.

To ensure human system security the human system assets governance must be established on the safety management that is proactive and it is based on project and process approaches that are concentrated to good handling with risks that are inherent to human system. If risks are not dealt correctly, so it is impossible to reach successfully targets, and therefore, the feasibility of procedures is reviewed in advance. The relevance of risk roles is caused by fact that the costs of project / process target implementation and the all successfulness depend on risk distribution. Therefore, it is necessary that each project may hold a special structure, risk distribution and financing that correspond to its character. The justifying consists in considering the fact that risks have different sources, i.e. they depend on the disasters, local vulnerabilities, methods of defeating and on response management, they originate on side of all participated stakeholders. To reach comprehension and following risk reduction it is necessary to perform its analysis that with regard to our knowledge summarized in work consists in the following phases: risk identification; risk assessment; risk allocation including the risk and the risk assignation to participated subjects; risk treatment; and continuous monitoring and in case of need the application of corrective measures. The risk management model directs the project medium to continuous proactive risk management that leans on the promt identification, analysis, countermeasure planning, monitoring and governance of risks. Each risk passes through these steps at least once and often several times.[13] In the first step there is determined the risk source, the character of possible failure, operational and commercial connections. In the second one there is determined the probability and impact (for calculation and mutual risk comparison). In the third one there are defined countermeasures leading to risk elimination, risk transfer to some-

body else, negotiation of risk or its impacts. In the fourth one there is obtained information on changes of individual risk elements in time. In the fifth one there are performed planning actions as reactions to appurtenant changes. Outputs from risk management process for need of public assets governance are the following: risk assessment document – including the all information on appurtenant risk; top risks list - including the list of selected risks the solution of which has the highest demands on sources and time; and retired risk list – serving as historical reference for future decision-making.

The safety management in comparison with the classic risk management uses the set of optimal measures and activities against to all possible disasters respecting the physical nature of disasters possible in a given region and it includes the precaution principle in concept promoted by the European Union at present.[14] Therefore, on the basis of present knowledge analysis, it is necessary for ensuring the security and sustainable regional development to change standard risk management to risk governance profiting the safety, called safety management. It is necessary to: establish synergic relations among the risks, vulnerability and safety; model the process of decision-making the public administration with regard to risks and uncertainties (to perform support decision-making systems); specify legal conditions and protected measures; and to improve activities of institutions (institutional changes).

Everyday facts and analyses of human system behaviour show that risks are going reality and that during the time new risks emerge. Therefore, it is necessary to live according to concept of live with risks.[15] Reduction of each risk is connected with cost increase, with lack of knowledge, technical means etc. Therefore, in practice we search for boundary to which it is reasonable risk reduction in order that expended costs may be reasonable. This level of risk reduction (certain optimality) is mostly a subject of top management and of political decision-making, at which there are used the present scientific and technical findings and considered the economic, social and other conditions.

The basic turn of human system management with regard to required targets is not possible to reach by individual partial measures but only by complex approach. To ensuring the security and sustainable development of human system there is necessary to use the co-ordinated and intentional approach. It enables step by step and in agreement with their importance and urgency to solve set of tasks in all domains and parts and by this to reach required human system state. As it was above documented at the disaster occurrence there are originated chains of undesirable phenomena (impacts, consequences) of external and internal character, primary and secondary, which affect negatively in different intensities and in different time moments. The substantial role plays the local vulnerability and pertinent faults in human behaviour or management on all levels. With regard to the historical development there are a lot of

preventive and mitigation measures that are applied into practice by legal rules, technical standards and norms and public instructions. These ensure protection against to design basis disasters. In the case of beyond design disasters this protection does not exist and severe harms, damages and losses are caused not only by direct impacts on human safety but also through interdependencies arranged by infrastructures and technologies. The secondary impacts mostly affect the human health, lives and security strongly and lengthy. Basic function of each state is to ensure sustainable development of Human Society. Therefore, the present tool is the strategic proactive management based on risk analysis, evaluation and management. Security planning the basis component of which is a land-use planning plays a big role because it ensures basic prevention against disasters of all kinds; i.e. natural, technological, environmental, social and caused by interdependencies in critical infrastructure, including terrorist attacks.

The groundwork for safety management is near the same as for the risk management plus precaution principle. The safety management aim is to enhance safety and not only to minimise risks as in the risk management. In the frame of this tool there are performed measures in the land-use planning, designing, building and operation of objects and infrastructures. The measures are technical, legal, organisational, economical etc. The most effective are technical measures applied in the land-use planning. For this type of planning there is necessary to use following principles: to consider all disaster that can occur in the area under account (so called "All Hazard Approach" [16]); at possible disasters there is necessary to take into account hazards of the 10^{th}, 100^{th} and may be more year disasters; to carry out measures for vulnerability (and risks) reduction against disasters that can have unacceptable impacts on the protected interests; to carry out mitigation measures against unacceptable impacts on the protected interests, the occurrence of which cannot be prevented; to concentrate to critical assets, critical functions and critical activities in the territory that create the base for human survive; and from the economical viewpoint of all kinds to implement only measures suitable for given locality and effective not only in the limit time interval but in reasonable time period. For realisation in practise there is necessary: formation (generation) of professional background for the decision making by the research and science support; application of suitable management structure that will ensure the rational and qualified planning the measures; building up and training the executive forces; specialist training and systematic population education; legal regulations, norms and standards; inspections and other check mechanisms including the QA system. A great role at creation of safe space there is played by level of management. The management must be proactive, come out from sophisticated grounds, be tailored to real conditions and understandable to all subjects to which it is addressed. That it is necessary in order that the top management might recognise that the safety is not something in advance given, but that it must be created by conscious, directed

and linked system measures and interventions, which from the theory viewpoint means to carry out management of safety.[17] Author's show that all stakeholders must participate in safety management of territory, e.g. for response it holds that if we consider the emergency situation scale 0 – 5, the safety management ensures that: every person / worker is capable to put under control the emergency situations of the 1 - 2 categories due to his/her education, training and preparation; public administration / organisation has the emergency management system for ensuring the putting under control the emergency situations of the 2 – 4 categories; public administration / organisation has the crisis management system for ensuring the putting under control the emergency situations of the 5 category (i.e. the crisis). In the frame of mentioned management systems the public administration / organisation and its administrative sections: build executive forces (fire-fighters, security guards, technical services, cyber safeguard etc.), that are prepared and trained for putting under control the emergency situations; form financial and material resources in order to they may put under the control all possible emergency situations; and form the temporary systems which ensure the executive forces support under critical situations. For needs of ensuring the territory / organisation stability and development there is necessary to ensure the continuity, i.e. the survival of emergency and critical till crisis situations.[18] To this aim there is necessary to perform minimally the risk management and optimally the safety management.

With regard to the national project results there is necessary for needs of safety management in territory/organisation to ensure qualified replies to the following questions: What disasters can occur in a given territory and what impacts have they? Where disasters can occur and how their impacts are spread in a given territory? Under what conditions can disasters occur in territory and what conditions can cause escalation of their impacts? How often can disasters occur in a given territory? From what disaster sizes have disasters in a given territory unacceptable impacts, that caused losses, harm and damages on protected interests? What maximum sizes could reach disasters in a given territory? What property and assets damages can be caused by maximum possible disaster on specified credibility level in a given territory and what are its impacts on a given territory and in particular on property and assets? What is possible to do in a given territory against unacceptable disaster impacts on section of land-use planning, design, construction and operation of civil and technological objects and infrastructure, and may be in other domains as are monitoring, inspection, education etc. with the aim to prevent the occurrence of disasters if possible or at least to prevent or to mitigate unacceptable impacts by preventive measures, preparedness, fit response to disaster and by renovation, at which there must be respected losses prevention losses and targets of sustainable development? What are necessary measures against real disasters in a given territory in the technical, organisational, financial, social, legal, education and training domains? What unacceptable

and residual risks (i.e. undesirable impacts with probability occurrence superior to a limit stipulated) with regard to possible disasters in a given territory will stay, when there are fulfilled rational measures that public administration can ensure in the technical, organisational, financial, social, legal, education and training domains? How does perform the response to disaster with aim to stabilize the territory state and to start the renovation. How does perform the renovation of territory and its property and assets with aim rationally to use resources, forces and means for the prohibition of further losses, the upgrade of resistance against possible disasters and for the start of further territory development with all items (environment, property and assets, infrastructure, services etc.) on which it is dependent? What is suitable the form of management and of territory renovation and its assets and property performance after disaster in organisation and how is it possible to realise it? How does create the financial / monetary reserve for rational renovation of territory and of its assets and property after disaster? Then, for the safety management there is necessary with regard to hazard size and local vulnerability to divide known disasters into the following groups: disasters which cannot have impacts on territory / organisation; disasters which have only acceptable impacts on territory / organisation, i.e. *the relevant disasters;* disasters which have on territory / organisation only such impacts that might be put under the control at performance of preventive and mitigation measures, i.e. *the specific disasters;* disasters which have on territory / organisation inadmissible impacts, and hence there is necessary to carry out the principal preventive measures the technical, organisational, legal and educational domains, i.e. *the critical disasters* which cause or can cause crisis situations.

Grounds of Risk Engineering and Procedure for Ensuring Safety, Continuity and Sustainable Development

For the risk evaluation in the territory / organisation there is necessary to apply the risk engineering methods: to determine the hazard of all possible disasters; on the basis of real organisation vulnerabilities to determine the *site specific risks*, that are disaster results and their severity. It is necessary to emphasize the reality that risk is determined by hazard size in specified time interval and by vulnerability of assets at a given place, i.e. *it is site and time specific*. There are a lot of methods for the risk analysis and assessment that are based on the different process models. E.g. check list, safety audit, what – if analysis, relative ranking, preliminary hazard analysis – PHA, process quantitative risk analysis – QRA, hazard operation process – HAZOP, event tree analysis – ETA, failure mode and effect analysis – FMEA, fault tree analysis – FTA, human reliability analysis – HRA, fuzzy set method – FL – VV, causes and consequences analysis – CCA, probabilistic safety assessment – PSA, etc. The selection of methods depends on the data set quality and on the purpose of risk determination.

With regard to results in the referenced literature, it is necessary to keep the following principles for ensuring the territory/organisation safety: to consider and to evaluate all disasters with unacceptable risks which are impossible to avert by measures performed in advance and to split up them on: specific, which may put under control by qualified and in-depth preparedness of response to these disasters; critical, which may put under control by beyond standard forces, measures and resources including the limitation of the rights and freedoms of staff and citizens. After this sorting there is necessary to specify and to apply measures and activities for averting the disasters or their unacceptable impacts there, where it is possible, and there, where it is impossible to prepare in the frame of preparedness to response the measures for mitigation of unacceptable impacts including personal, technical and financial reserves. At today's common practice the risks are reduced by the reduction of vulnerability of objects, human population, environment, state etc. (in this connection there is used the term „impact mitigation", marking the impacts that cannot be averted at disaster origin). According to majority of technical norms and standards there is performed the reduction of vulnerability at land-use planning, designing, construction and operation of assets for all risks, the probability of which is equal or greater than 0.05. By this way there is formed the inherent safety of system including the human society, objects and environment (i.e. so-called design disasters ought to be get under control by design, regulations for land-use planning and construction, operating instructions, rules for response to emergencies and by instructions for response to critical situations, and therefore, their occurrence would not threaten sustainable development). The higher management type, i.e. the safety management ensures enhancement of safety by use (application, realisation, implementation) of technical, legal, organisational, educational etc. protective measures. They also consider risks the occurrence probability of which is smaller than 0.05, but impacts are fatal (severe). Safety management belongs to a common practice at planning, designing, construction and operation of technical facilities and objects such as power plants, dams, nuclear facilities etc., and it is the basement of nuclear safety, radiation protection and protection against dangerous chemical substances that is introduced by the Seveso II EU Directive. In technical slang there is stipulated that this type of management considers beyond design (severe) accidents. Except of formation of inherent safety of system including the human society, objects and environment this management type also promotes so called principle of precaution, because it considers disasters or their sizes the occurrences of which are very low probable, that are unforeseen. For the completeness and overview there is necessary to introduce the crisis management, i.e. a management the purpose of which is effectively to respond to a possible critical situations, i.e. to ensure preparedness for response to possible critical situations, to ensure the getting possible critical situations under control in frame of power of crisis management authority and executing measures and tasks of line higher crisis management authorities (for getting

situation under control there is used legal measure „declaration of crisis situation" that temporarily enables to limit rights and civil liberties of humans and use beyond standard resources), to start renovation and next development. In some conceptions the crisis management is a part of safety management, in others it is only used for the getting critical situations caused by disasters under control and for the getting current emergency situations under control there is used emergency management.[19]

Disaster Ranking and Planning

For effective strategic management there is necessary to compare the unacceptable impacts severity of specific and critical disasters considering the probabilities of their occurrence. The disasters are not generally commensurable. They are divided into several groups according to type of processes running inside and outside the Earth like the planet that cause them, and therefore, they have different places of occurrence and different characteristics. On the basis of present knowledge their possible sizes depend on regional processes and their impact sizes depend on both, the regional processes and the local conditions. Their causes and characteristics are incommensurate. From the view of assets they have some common, namely their capability to destroy, i.e. to affect assets and to cause their detriment, losses and damages. Earlier analysis shows, that only some of the disasters which occur at the Earth, have sources or sources and impacts or only impacts on the investigated territory. Then only some of them cause or can cause the critical situation, at which it is necessary to declare crisis situation. The same holds for individual organisations.

For comparison of disasters that have different nature, i.e. which are incommensurate there are used matrixes based on the multi-criteria appreciation.[20] The specific and critical disasters are evaluated by above-mentioned risk engineering methods. By the help of verbal scales application there are assigned each mentioned disaster two data in verbal scales, i.e. the category numbers (0-5), namely one according to disaster occurrence probability on specified level of credibility and the other according to size of all possible disaster impacts corresponding to the disaster hazard on specified level of credibility. In the first case, there is necessary to carry out the classification with regard to time scale, in which the extreme disasters go on. In the other case, there is suitable to carry out for achievement of commensurateness the recalculation over money. The data obtained by this way are put into matrix (table) and resulting display allows disasters to sort into categories. The matrix interpretation from the view of safety management distinguishes: *critical disasters* - they can cause a critical situation that can grow into crisis. Therefore, from the view of ensuring the safety there are necessary to carry out new preventive and mitigation measures in land-use planning, designing, construction and operation of civil and technological objects and infrastructure; *specific disasters* - they can cause the emergency situations of the 3-4 cate-

gories, and therefore, they must be considered by response. Therefore, it is necessary continually to perform the current preventive and mitigation measures in land-use planning, designing, construction and operation of civil and technological objects and infrastructure and by the help of monitoring to study their effectiveness; *relevant disasters* - they might be put under control by the standard response means without special executive forces pursuant to human education, training and experience. Pursuant to project results the analyses and risk assessments depend on the data quality and on the fit methodologies used. Therefore, it is necessary to ensure the qualified data gathering and the application of fit methodologies. It is necessary to take care of in order that results may be correct, transparent and repeatable and in order that they may have definite declare value. Because there is a reality that it is impossible to avert some of unacceptable impacts on assets being important and mostly requiring the investments, and because it is impossible to ward off by preventive measures, because they either do not exist or are not accessible financially, technologically or personally, therefore, *it is necessary to perform emergency and crisis planning* in state/ territory/ organisation. The planning is consciously regulation of development. It is conscious activity of management subjects that consists in the selection and presuming the aims, tasks, variants and ways, which condition the achievement of these aims. The most important feature is the selection of aim. The planning is not the make-up of hierarchical commands file, which might be unthinkingly fulfilled, it is a creative activity, which must stipulate the real aim and determine the optimal way for its achievement. In practice we meet with many sorts of planning, e.g. annual, regional, perspective, territorial etc. The planning is a fundamental section of each management. Therefore, it must be: specified not only purposes, but also possible variants of achievement of desirable management aims; and carried out the evaluations of all variants and selection of optimum variant with reference to dispensable forces, means and resources. From practical reasons it is necessary at specification of variants to use not only paradigmatic cases but also marginal cases as critical, maximum variation and extreme / deviant cases.[21] Then, it is necessary to carry out the monitoring of selected variant successfulness with regard to desirable aim, and systematically to remove the discrepancies and obstacles at way to selected aim realisation and at the same time to prevent deformations and to loss of initiative of participants of the process. For achievement of the long-term aims there is used the strategic planning and for achievement the short-term aims objectives the operative planning; both have their particularities, which pre-determinate the selection of methods and ways. The human, however, wants and must either precede critical situations or put under control the emergency, critical and crisis situations, and therefore, he / she must apply higher attention to the equation "insufficient awareness and insufficient understanding to crisis = insufficient preparedness, which means bad planning"; this case is often if only paradigmatic case is presumed. Planning the measures, based on objective

evaluation must be carried out during the land-use planning, designing, construction and operation, i.e. in the EU and in other world organisations it is divided into ex ante, during and ex post. In the planning domain there is necessary for determination, specification and realisation of preventive and mitigation measures in case of every relevant disaster to know the impact sizes and their distribution on the area at paradigmatic, critical, maximum variation and extreme / deviant case. The judgement and experiences show that the measures applied in the land-use planning are the most effective. This groundwork must be prepared by pertinent research and scientific institutions, because they have data and needed knowledge to their interpretation. The role of decision making groundwork lastingly increase with the time, because also during intervention (response to disaster) there are the disaster characteristics that influence the commander decision making, e.g. the rate of disaster start (sudden or slow beginning), warning, preparation time, size of danger of, risks for participants of intervention, casualties, assessment, number of members of executive forces for intervention, stage of disaster development (beginning, period of secondary impacts etc.), main risks, used forces, number of commanders, required decision (routine, known, complex or unknown), sufficiency or insufficiency of material for intervention, knowledge of site, time of intervention, space location (one or more sites). With regard to available society resources there is necessary theoretically to evaluate the impacts of different disasters and their scenarios and in the next step to concentrate only to important phenomena, which sharply contribute to general (complex) risk, which is mainly important at technological installations. In the developed countries (as Japan, the USA), there are today compiled both, the disaster scenarios and the scenarios of processes leading to the disaster origination, because it is effort to find indicators, by the help of which there is possible to distinguish, when only one big disaster occurs and when there is occurred the group of major disasters (complex disaster), the impacts of which on humans, property and environment are much greater than in the case simple disaster. In the planning domain there is not still uniformity. Most often there is the following plan division: land-use planning, the aim of which is to arrange human needs and territory development; emergency plan, i.e. the set of response plans to emergency situations of the 3 – 4 categories for foreseeable emergency situations; continuity plan; crisis plan, i.e. the set of response plans for putting under control the critical situations; and contingency plan, i.e. the response plan for unforeseen situation. There is a problem that many often there are no clear links between the land-use plan measures and measures given in other plans. Especially the renovation plan is a plan by which it is possible to upgrade safety of territory/ organisation.

The findings and experiences show that *the planning in territory / organisation*, based on the stipulation of possible impacts and on costs, which organisation will pay for failure, *must be particularly taken to these assets that mostly require investments at the recovery stage*.

At investigating the disaster impacts on organisation there is necessary to follow up the impacts on critical technologies and infrastructures. In this respect there is necessary to apply the system concept and except of impacts on individual elements it is necessary to watch the impacts on links among elements and links across the whole infrastructure system. *Recent research results show that it is particularly important to follow complexness of interdependencies across critical infrastructures*. Just on these problems the research concentrates the attention at present. As we see on the territory / organisation like on the system, we find that some elements, links, flows are highly important for stability, continuity and development of territory / organisation. In these cases there is necessary from safety reasons to carry out specific measures and these elements, links or flows specially to upgrade (improve) and, if need to back up namely sometimes at several times, e.g. in nuclear power plant operation, critical material supplies, critical services (e.g. spare sources of electric power) ensuring etc.

Conclusion

The security situation in the world, territory and organisation has been changing with the time, and therefore, there must be systematically built the safety culture, which taking into account actual piece of knowledge and experience. The critical evaluation of present knowledge and experiences reveals principles of mitigating and managing the human system risks that are summarised as follows: the safety culture promotion into practice requires both, the aimed management and the broad participation of all staff of public administration/ organisation with emphasising that the top management has the biggest responsibility.

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