POSSIBILITIES OF AVOIDING NATURAL CALAMITIES AND REDUCING THEIR OUTCOMES

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1. Introduction

The global situation of the environment is characterized at present by a continuous change due to a multitude of factors, that have negative consequences on the mankind.

The profound significance natural hazards have for the development is made conscious by international organizations and the national and local decision factors that are involved nowadays in assuring the best conditions of research and management of natural hazards.

In this paper, by ***natural hazard*** we understand the probability that in a certain location, region or area disasters and calamities may take place, independent of a person's will (floods, slides, earthquakes etc.) thatjeopardizepeople'ssafetyandtheir goods.

Quantitatively, the natural hazard represents the statistic probability of producing a natural event, that is likely to have negative effects.

The attitude of the contemporary society regarding natural hazards is most of the time contradictory, because, on one hand, there are huge material efforts in order to prevent and diminish the effects, and, on the other hand, through the continuous development of our society, sometimes these disasters begin to take place or some of them can even get worse. The financial funds for the diminishing of the natural hazards depend on immediate political electoral interests, on strategic and economical influences and are given in most cases after the disaster has already been made and not before, when we can work on the prevention or on the prognosis of some of them.

The havocs caused by the natural hazards are most of the time the consequence of narrow-minded thinking, of problems concerning development, culture, environment, science and technology.

Consequently, we need to use the multidisciplinary analysis, respecting certain management principles that are based on the incorporated research of natural phenomena and of the mechanisms that determine a natural hazard to become a disaster.

Regarding multidisciplinary analysis, ***vulnerability*** is de.ned,anditrepresentsthe level of the losses that an element or a group of elements (persons, structures, goods, services, economical or social capital, etc.) exposed to a certain risk estimate after the production of a disaster or hazard and it is expressed on a scale from 0 to 1, or from 0% to 100%.

If we consider R the risk, we can say that this is the mathematical result of hazard and vulnerability, expressing the connection between a phenomenon and its consequences. The specific risk, considered as Rs, represents the level of the expected losses as a result of the manifestation of a natural hazard and depends on the characteristics of the hazard and on vulnerability.

The total risk, considered as Rt, quati.esallthehumanandmateriallossesthatw ould result from a hazard or a natural disaster and can be determined using:

$$Rt = E \times Rs = E (H \times V),$$

-where E represents the elements exposed to the risk and includes the population and all the material values exposed to the risk of being affected by a natural hazard in a certain area.

The natural disaster implies the initial existence of a major risk, capable of affecting

badly the elements of the environment in an area, and the consequences produced as a result of the realization of the risk, as material or human damage, get to the level of disaster when the local system cannot recover in a reasonable time limit without external help. The attempts of classifying natural hazards led to the identification and explanation of specific criteria, such as:

- according to frequency – from rarely to frequently;
- according to duration – from short to long;
- according to expansion – from limited to big;
- according to the way it begins – from slow to momentary;
- according to the way it takes place – from slow to fast;
- according to the way it spreads – from diffuse to concentrated;according to its evolution in time – from saltation evolution to constant evolution.

In order to prevent these natural catastrophes, Maps of Hazard need to be made at a departmental level, on the basis of which Maps of Risk should be elaborated, considering the vulnerabilities of the objectives in that area as well. It is compulsory that both Maps have a dynamic character through which we can foresee the evolutions due to some potential ulterior phenomena.

The identification, the localization and the delimitation of the areas exposed to natural hazards, earthquakes, slides and floods have as objective the elaboration of the maps of hazard for these areas, defining the conditions under which these phenomena are produced at a departmental level, as well as the establishment of the Strategy and the programme of measurements for the prevention and diminishing of their effects.

2. Ideas concerning the realization of the Maps of Hazard in Romania

As it is shown in "The National Strategy for sustainable development in Romania", elaborated in 1998, this country has been exposed over the years to disasters and catastrophes provoked by earthquakes, slides and .oods.Accordingto some data taken from the publications of the World Bank, in Romania 57% of the annual economical losses are due to slides and floods, 37,4% of the country's territory is at risk and 50,3% of the country's budget is affected by the risk of natural catastrophes.

The amount of damages caused (in Romania) only by .oodscanbeseeninthe "Reports concerning the effects of floods and ofother dangerous weather phenomena" from 2004 and 2005. Thus, in 2004, 29 counties were affected by floods, 633homes, 19 people died, the total damage consisting of 100 million Eur. In 2005, the effect of floods was even more disastrous, 42 counties being affected, 1734 localities, 76 people dead and damage of more than 1,500 million Eur. The last floods emphasized the fact that in Romania, both at a central and local level, there were no necessary instruments for the administration of the crises and there was no possibility of a management of the risk factors. The realization of the necessary instruments for the administration of the crises and of an appropriate management of the risk factors implies the execution of the following concrete actions:

- identifying, localizing and the delimitating the areas exposed to natural hazards (earthquakes, slides, .oods);
- elaborating the maps of hazard for the identified areas;
- defining the conditions under which these phenomen a take place at a departmental level – in order to establish the parameters of the risk factors;
- establishing the strategies and the steps taken for the prevention and the diminishing of the effects produced by natural hazards;
- creating a methodology for the realization of the maps of risk concerning .oods,slides,etc.; œ Establishing the content of the digital maps for every risk factor taken sep-

arately, maps that are seen as graphic data bases and as computer basis;
- conceiving the digital pattern of the field for hydrographic pools and fort he area in which slides take place;
- establishing a system to monitor the slides;
- Preparing the affiliation to networks, European platforms.

In order to facilitate the succession and the understanding of the presented elements, in order to group the problematic and in order to have a more ef.cientpractice, the actions enumerated above will be grouped in three sections:

I. The physical-geographical analysis of the territory and the analysis of the state of natural hazards, earthquakes, slides and .oodsidenti.edanddelimitated at the territorial departmental level and at the one of its territorial administrative units;
II. Diagnosis concerning the conditions under which these phenomena take place and the effects of natural hazards, earthquakes, slides and floods at the territorial departmental level and at the one of its administrative units;
III. Strategy and measures taken concerning the prevention and the diminishing of the effects of natural hazards, earthquakes, slides and floods identied and delimitated at the territorial departmental level.

2.1. The physical-geographical analysis of the territory and the analysis of the state of the natural hazards identified and delimitated at the territorial level.

The analyses concerning the physical-geographical characterization are made Possibilities of avoiding natural calamities and reducing their outcomeLandscape Architecture and New Technologies Conference73on the basis of the quantitative and qualitative components of the territory of the county grouped taking into account the following problems: ***The geographical localization, The structure of the territory, The locality network and The technical infrastructure.***

The geographical localization refers to studies concerning:

- the natural, geographical, morphological, climatic environment and the hydrographic network of the territory;
- the state of the minor river beds of the waterflows (length, characteristic sectors, the bottom's slide), including the trickling sections of the bridges and footbridges;
- the dynamic of the river beds of the waterflows and the determination of the mobility spaces of the minor river beds; the space of maximal mobility; the space of functional mobility; the space of minimal mobility;
- the form and the extension of the meadows that cannot be flooded (width, length, slide, if they are well de.ned);
- dams (location, type, dimensions, details concerning the evacuators, the volume of the lake, rules of exploitation concerning the evacuation of the flow capacity); known deficiencies, appreciations concerning the safety in exploitation in the case of extreme freshets, slooping, bottom thresholds (location, characteristic dimensions); sea inlets (location, type, the caught flow capacity);
- influences on the flow, existent fitting outs of land improvements, the geology and the lithology of the territory, the earthquakes, the identi.cationofthe areas where slides, depth and on the surface erosions take place;

➢ General conditions concerning location (geographical characterization and geological stratification, active and inactive fissures, lithological profiles, categories and types of lands);
➢ The local conditions of the field, with adepth of minimum 30m;
➢ The dynamic parameters of the end when seismic phenomena are produced, for types of land characteristic to those territories (obtained by determinations with an

triaxal cyclical machine), extra hazards (dangers), possible because of the relief elements in the area (natural slopes, moors, steep slopes that cause sliding or breaking, sands with a great degree of breaking up, that can cause upsetting or can cause liquefaction, inconsistent fill ins, terraces, fill-ins, valleys with seasonable torrent, waters etc., from land inside the city to land outside the city, that may cause slides, high .oods,torrentswithstonesand mud, snowfalls in the mountainous area; if these are lands that were turned into plots of land/house lots, with horizontal cleared areas and/or cut in the slopes, instable because of the infiltrations, risking the starting of some slides, ramming etc.; in the seaside area (eroded shores of loess) or on some river sides, terraces of rivers, etc.; the liquefaction of some sandy and loessoid lands, freshets or seasonal floods etc.;

- The characteristic features of the land determined by the distribution and the characteristics of the superflcial geological complexes; general considerations on geotechnical parameters in static and dynamic actions;
- The extra hazards (dangers), possible because of some hydrotechnical constructions (dams, reservoirs, etc.), as well as of an industrial endowment (industrial yards, chemical combines, power stations, nuclear stations etc.), heaps of sterile, ranges of electrical lines, canals and gas and oil pipes, etc.;
- The history of the preceding earthquakes: types of seismic movements/earthquakes (intermediary and/or crustal) – on the surface, in the country and elsewhere, values of magnitudes and intensities, damages and preceding effects;
- Seismic data bases for the strong earthquakes that took place in Romania; with values canned in the national seismic network for strong seismic movements;
- Evaluations concerning the geological, seismological and regional and local seismic hazard characteristics;
- Data from the dense recording networks (where they are available), using the data from the deep drilling instrumented seismically; the seismic regions of the territory – at present and between 1942 - 1992.

Considering the available data, for certain parameters qualitative appreciations can be represented.

The structure of the territory: categories of using the land, the state of the forests, the degree of forestation, land improvements, the state working is in.

The locality network: the structure, categories of size according to the number of inhabitants, localities affected by natural risks, the identi.cationofthetypesofbuildings and their number according to the construction materials, their height, construction period, according to the norms of anti-earthquake projection – age and physical state, degree of occupation, value, location in the area, vulnerability – the effects of the earthquakes, floods and of the slides produced over the years, aswellas in the last 50 years, at the level of the department and at the level of its territorial administrative units, in affected areas and localities, physical and value damages, the causes of .oodsandslides.

The technical infrastructure: hydrotechnical .ttingouts,theroleofwhichis to protect against the .oods,includinganti-drainingsystems,exploitationandmaintenance problems, hydrotechnical work that is meant to protect against floodsand slides.

The railway network etc.

The types of construction work, strategic or local importance, the possibility or replacement – devious routes, construction materials, according to the norms of anti-earthquake projection – age and physical state, value, location in the area, vulnerability – the effects of earthquakes.

2.2. Diagnosis concerning the conditions and the effects of natural hazards

The diagnosis is realized on the basis of the problems identified in *2.1.*, as well as from the major tendencies that have been manifested in the last 50 years on types of hazards. Through the diagnosis their investigation and evolution are analyzed.

Earthquakes.

Analyses of seismic hazard, based on the correlation of the geological and seismic data from *2.1.*, taking into account the characteristics of source and location: studies of seismic micro-regions, diminishing laws, intervals, recurrent environments, the apportionment of maximum values, transfer functions, etc. Scenarios for events or chains of events that can be caused by earthquake with different recurrent characteristics in the important localities of the county and in its territory:

- defining, identifying and analyzing of earth quakes with significant scenarios, from different sources, considering the main and secondary hazards, the local conditions etc.;
- establishing the basic and circumstantial hypothesis concerning the causes, the topology and the connections of the events in producing negative effects; de.ningthechainofeventswithadestructiv epotential,speci.ctothe county or to the analyzed urban localities;
- analyzing the scenario for the respective territorial administrative unit, in specific hypotheses, byanalyzing the losses estimated in thecase of a seism, referring to the localization of the effects on the exposed elements, of critical endowments, and of sources of a high risk;
- conclusions regarding the necessary level and the place of the preventive actions.

According to the available data, condensed scenarios can be elaborated, in which certain elements are appreciated quantitatively.

Scenarios for events or chains of events that can be produced by earthquakes with different recurrent characteristics at the level of technical infrastructure networks in the county:

- defning the network or the system through its elements and their role forno rmal performance;
- inventorying its elements, according to specifc vulnerabilities, of its critical elements, etc.;
- analyzing the topology problems, the basic and circumstantial hypotheses;
- defining, identifying and analyzing the scenario earthq uakes, taking into consideration the main and secondary hazards, the local conditions etc., in the different critical points;
- analyzing the scenario, evaluating the damages and the losses;
- the relationship between direct and indirect damages and possible chain reactions, their socio-economical consequences, critical points;
- analyzing the capacity of reaction and compensation of the losses (the redundancy characteristic) inside the sector or the network and during the emergency period and the one when things come back to normal;
- conclusions concerning the necessary level and the place of the preventive interventions.

Floods

The evaluation of the potential of the hazard to produce floods caused by the outflows of the arranged/unarranged or not takencareofwaters,thepresenceofhydrotechn ical working with the aim of protecting against under gauge, damaged floods, taken care of appropriately, the existence of the risk pouring trickling of the slopes, of inner waters, of winter phenomena, heavy winds at the seaside and near the Danube.

Slides

Scenarios for events or chains of events caused by extreme weather and hydrologic conditions, or by earthquakes, with different recurrent characteristics, in different

probabilistic combinations. The evaluation of the potential of the hazard to produce slides.

2.3. Strategy and programme of measures concerning the prevention and the diminishing of the effects of the natural hazards

The strategy and the measures programme aims at the prevention and the diminishing of the effects of the natural hazards, earthquakes, slides and .oods,identi.edanddelimitatedatthelevelofth ecountyterritory,throughobjectivesand measures stated on short and medium term, that have to rejoin the problems identified on every type of hazard.

Earthquakes

- Establishing a plan of annual geological, geotechnical and seismic studies concerning the characteristics of the present locations densely populated and the one on which important localities are developed;
- Completing the information concerning the land parameters, including the dynamic parameters of the seismic phenomenon, for the types of lands characteristic to the territory of the respective county; the co-operation to the expansion plan of the national seismic network;
- Creating dense networks of instruments at a local level, where the parameters of the seismic hazard justify it; coordinating and warning installation and performance under safe circumstances of some pursuance, warning and alarm systems concerning the effects of the earthquakes and/or of slides (accelographic and seismographic, abnormality witnesses, displacements, etc.) in free locations, in drilling, public and/or private constructions, endowments of the infrastructure networks etc.;
- Completing and maintaining the seismic data bases and the actualisation of the afferent maps in GIS size, at a local level, using the data supplied by the specialized institutions; establishing an inventory plan of the constructions and of other elements; elaborating some detailed earthquake scenarios and evaluations of the damage and losses; introducing in the city planning (general, regional and detailed), establishing and applying the restrictions of authorizing and placing of some constructions or endowments from the point of view of the seismic risk, correlated with the other hazards, due to local site conditions, restrictions that will be imposed through the city planning documents and the construction authorizations, in order to elaborate and inform them; adopting some measures of replacing the secondary technological risk sources (chemical, biological, .oods,explosions,.res),so that the risk of affecting the populated areas should be limited;
- Instructing the authorities and the population from the risk areas on behavior and communication rules in case of a disaster.

Floods

Works for maintaining, diminishing and preventing the effects of floods through: damming up, controlling, bank protection, .ttingoutstoextinguishtorrents,erosion.tting outs,anti-drainingsystems etc.

Slides

Works maintaining, diminishing or reconstructing the stability of the slopes through works of controlling trickling off the slopes, eliminating the excess of humidity through anti-draining, drainage, leveling works – land shaping, sustaining and ruggedizing works, afforestations, other speci.cworks. The data bases will be stocked by centralizing them, using a SGBD that is widely used (Oracle, SQL Server, DB2, Informix), following the possibility of the spatial data bases change. The data bases will contain in a topological vector form at least the following spatial information:

- Railroads;
- People's homes- administrative territorial units;

- ➢ Hydrograph;
- ➢ Vegetation covering;
- ➢ Relief (the digital pattern of the land);
- ➢ Soils;

3. The risk management

The risk management is a process of identi.cation,analysisandsystematicrelation of the risk factors. It implies maximizing the probabilities and the consequences of positive events and minimizing the probabilities and consequences of negative events.

The last floods (2004, 2005) emphasized the fact that in Romania, both at a central and at a local level, there were no necessary instruments for the administration of the crises, there was no possibility of a management of the risk factors. The main processes of the risk management are:

- ➢ planning the risk management – deciding the way in which the problems of the risk management are approached and planned;

For all these, thematic digital maps with an adequate content are necessary; they can identify the areas that will be affected the moment the conditions of manifesting the risk factors show up;

- ➢ identifying the risks – determining the risk factors that could show up at a certain point.

The risk management is realized in multidisciplinary teams – hydrologists, geologists, weather men, other categories of specialists and decision factors, that have duties concerning the identification of the risks according to certain parameters that generate them. From the experience accumulated until now, it has been proved that only knowing these parameters is not enough; what we need is a correlation of all the factors that generate risks and the realization of a physical pattern of the land is highly necessary in this context.

- ➢ the qualitative analysis of the risks – establishing a priority order in approaching the risk factors;
- ➢ the quantitative analysis of the risks – measuring the probability and the consequences of the risk factors and estimating their implications for the diminishing/ annihilation of the effects;

These analyses could not be realized/executed without the existence of some graphic and non-graphic data bases correlated in the created physical pattern, that can allow the simulation of the processes taking into account the parameters identi.edasriskgenerators,thatallowrisktotak eplace.

- ➢ planning the response to risk factors – developing some procedures and techniques in order to amplify the opportunities and the reduction of threats;

The response to risk factors and the decision-making can be accomplished only if decisional factors possess adequate instruments to monitor the phenomena, for the quantification of the parameters, to simulate the crisis situation and the analysis of the effects that followed the simulation. Based on these data and information, we can elaborate the plan of fighting and diminishing the effects of the risk factors.

- ➢ monitoring and controlling the risk factors – monitoring the permanent risk factors, identifying the new risk factors, executing the plans in order to reduce the risks and evaluating their ef.ciency;

The identification of the risk factors is a reiterative process.Thequalitativeanalysis of the risks is a process of the evaluation of the impact of the identi.edrisk factors. Through this process, we can determine the priorities when it comes to finding solutions for the potential risk factors, according to theimpacttheycanhave. The qualitative analysis of the risks implies using some speci.cinstrumentsthat can allow the elimination of the subjective factors and the reviewing of the results.

- ➢ the analysis of the probability of reaching an objective;
- ➢ the quantification of the risks at the level of the whole project and the estimation of the supplementary cost that could be necessary;

- the identification of the previous risk factors by quantifying their contribution to the risk indicator at a general level;
- the identification of some realistic changes of the cost and of the plan of activities.

The qualitative analysis of the risks is a process of evaluation of the impact of the identi.edriskfactors.Throughthisprocesswec andeterminetheprioritiesin.ndingsolutionsf orthepotentialriskfactors,accordingtotheim pacttheycanhave.The qualitative analysis of the risks implies the usage of some speci.cinstrumentsthat allow the elimination of the subjective factors and the reviewing of the results during the life cycle of the project, so that we can consider possible changes of the project.

- determining the probability of reaching an objective;
- quantifying the risks at the level of the whole project and determining the supplementary cost that could be necessary;
- identifying the anterior risk factors through the quantification of their contribution to the risk indicator at the level of the whole project;
- identifying some realistic changes of the cost and of the plan of activities. After all these analyses have been made, we can identify the plots of land, the localities, the railroads, the .oodedroads.

The existence of a geographical informational system that can integrate all the types of up-to-date information (information connected to names of localities, roads, plots of land owners, cultures, etc.) is very important in the disaster management.

4. GIS to monitor risk factors

The way the risk factors are being monitored can be done at a high capacity using, along with the classical and modern mapping techniques, GIS grade point average of analysis and synthesis.

Some of these activities are still present:

- developing new methods and methodologies for useful parameters extraction from the data provided by the spatial platforms (the ones that already exist or the ones that will be operational in the near future) in applications of agrometeorology, hydrology, climatology, supervising the areas with an antropic impact;
- elaborating and implementing Geographical Informational Systems (GIS), based on mapping and TV detection data, for the administration of the natural resources (climatic, agrometeorological, hydrological);
- using GIS and the techniques of TV detection in order to determine the water stored in the snow layer, in the winter-spring season in the mountainous basins afferent to the great reservoirs in Romania;
- developing dedicated systems based on TV detection and GIS technologies to monitor the dangerous weather and hydrological phenomena (.oods, droughts, .resinthewoods,accidentalpollutions etc.);
- developing and testing methods fusion algorithms of the spatial data derived from different data sources (TV detection systems, mapping documents, terrestrial observation systems, etc.);
- realizing up-to-date digital maps concerning the covering/using of the land, different thematic maps, based on satellite data;
- elaborating algorithms and methods of spatializing geo-information;
- developing an administration system of the spatial data bases derived from satellite information and GIS infoplanes;
- creating interfaces with the users;
- modernizing and improving the hard and soft systems of the processing, analysis and interpretation of the spatial data.

Conclusions

In Romania as well as in the world, the global situation of the environment is presently characterized by continuous

change, under the influence of many factors with negative consequences on mankind.

There are concerns to avoid the consequences of natural disasters:

1. The analysis of the state of natural hazards must result in a Diagnosis of problems, highlighted through drafts, maps and plans regarding:

- **identify hazard specic areas;**
- **identify areas with an important density of exposed elements;**
- **identify areas with a destructive effect.**

(Areas affected by natural hazards, **earthquakes** – zoning; **landslides**, - potential landslides; type of slides, primary-reactive; **floods** – water courses and torrents; areas where frequent floods occur; areas where floods occur less frequently; areas with extremely rare floods-including incidents or dam accidents; areas potentially exposed quick high water discharges; areas potentially exposed to water coming down the mountain slopes.)

2. The measurement programme regarding the prevention and damping of the effects of natural hazards, through drafts, maps and plans regarding:

- areas for territorial and urban development restrictions;
- intervention areas on the natural and arti.cialenvironment.

3. Use methods and techniques that are particular to Risk Management to identify, analyze and systematically report risk factors in order to maximize probabilities and consequences of positive events and minimize probabilities and consequences of negative events.

A geographic informational system that integrates all types of new data (information about place names, roads, parcel owners, cultures, etc) is very important in catastrophe management.

4. The use of analysis and synthesis GIS environments to monitor risk factors can be achieved with high effciency using modern mapping technologies besides classical technologies.

The drawings will be made on maps at the scale 1:25 000 – 1:50 000 while zoning will be made exclusively in a topological vector shape and will be based on adequate models.

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