Social Risk Assessment from Natural Hazards Using Fuzzy Logic

P. Zlateva, L. Pashova, K. Stoyanov, and D. Velev, *Member, IACSIT*

***Abstract*—The assessment of the social risk is a major issue for the responsible risk management and the sustainable regional development of SouthWestern Bulgaria. The paper presents a fuzzy logic model for social risk estimation from natural hazards in the SW Bulgaria region, based on the available information sources and the expert knowledge. The risk assessment problem is defined as a multicriterial task that evaluates several input variables (indicators for natural hazards and social vulnerability). A hierarchical fuzzy logic system with five inputs and one output is designed in the Matlab software environment using Fuzzy Logic Toolbox and Simulink. The simulation investigations are done for six areas in SW Bulgaria. This fuzzy system is part of the Web Integrated Information System for risk management of natural disasters which will be developed.**

***Index Terms*—Bulgaria, fuzzy logic, natural hazards, risk assessment, social risk.**

I. Introduction

During the last decades the frequency and severity of natural disasters like earthquakes, landslides, floods, etc. have significantly increased [1]-[3]. Combination of hazards, concentration of the population often in hazardous areas, lack of adequate infrastructure and management risk policy cause a devastating impact on human life, economy and environment. Despite tremendous progress in science and technology, natural phenomena considerably affect the socioeconomic conditions of all regions of the globe. It is almost impossible to fully recoup the damage caused by natural disasters, but it is possible to minimize the vulnerability and reduce the risk. The monitoring of natural hazards, the evaluation of their impact and the complex risk assessment are decisive steps towards the selection and dimensioning of adequate protective measures [1], [3].

The territory of Bulgaria, located on the Balkan peninsula, SE Europe is exposed to natural hazards, such as earthquakes, floods, landslides, debris flows, forest fires, hail storms, rock falls, snow avalanches, storm surge and wind storms [4]. In particular, the Southwestern part of the country is the region with the most expressed tectonic and seismotectonic activity on the whole territory of the country. Besides the seismic activity, the simultaneously influence of many endogenous and exogenous factors (recent vertical crustal movements, erosion and ground water level fluctuations) provoke the activation of gravitational processes [5]-[13].

In this region the international transport corridor № 4 (Dresden/Nuremberg - Prague - Vienna - Bratislava - Győr - Budapest - Arad - Bucharest - Constanța / Craiova - Sofia – Blagoevgrad - Thessaloniki / Plovdiv - Istanbul), connecting Western with Eastern Europe is situated (see Fig. 1) [5]. This corridor is formed from the highway I-1 /E-79/ of the national transport system and the V-th main railway line /C-E-855/. The E79 highway, railway line and gas pipeline along the Struma River are a part of the national critical infrastructure. Hence, there is a need that the complex risk management to be performed in respect to the natural hazards. In conditions of global economic crisis and limited financial resources the efficient prevention and risk mitigation require the decision making process to based on the comprehensive investigations and complex risk assessment.

There are many qualitative and quantitative methods for the risk assessment. However, it is necessary to point out, that the social risk assessment from the natural hazards is done under the subjective and uncertain conditions. The fuzzy logic approach is an appropriate tool for risk assessment. This method provides adequate processing the expert knowledge and uncertain quantitative data [14]-[17].

The aim of this paper is to assess social risk applying the fuzzy logic model for the region of SW Bulgaria and using the available information, and the expert knowledge. The social risk of the studied region is assessed based on the hyrdo-meteorological and seismic information taking into account the social vulnerability. The fuzzy logic model is designed as a hierarchical system with five inputs and one output. The studies for six local areas (Blagoevgrad, Simitli, Kresna, Strumyani, Sandanski, and Petrich) in SW Bulgaria are performed in the Matlab software environment. The obtained results can support the social risk management.

II. Description of Studied Region and Used Data Sets

The territory of Bulgaria represents a typical example of high seismic risk area in the eastern part of the Balkan Peninsula. The tectonic activity is confirmed with a large number of strong and weak earthquakes, some with significant catastrophic consequences in the recent past. Up to now the seismic activity of the SW Bulgaria territory is the

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most remarkable in the country. Several main fault structures build this region as the Krupnik and Struma fault

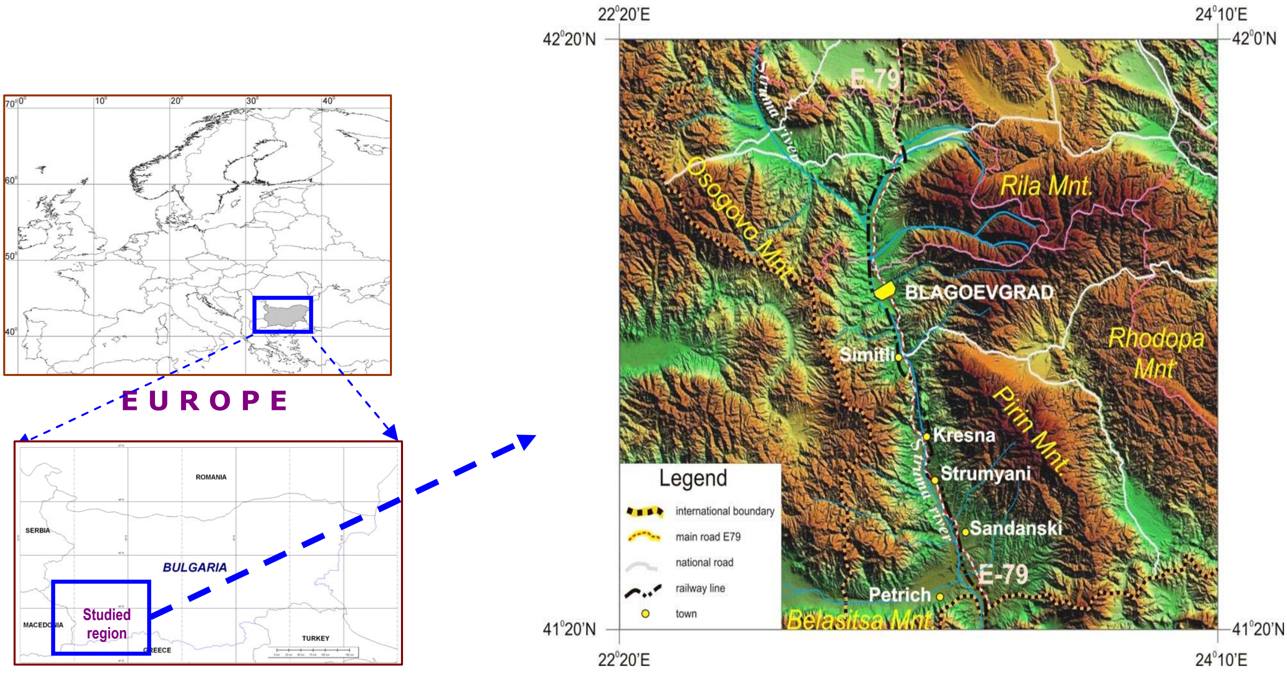

Fig. 1.Location of the studied region.

zones are the most significant of them. The Krupnik fault is assumed to be the most active fault structure in Bulgaria. The earthquake in04.04.1904 in this region is characterized with highest magnitude M=7.2 in the continental Europe through the last two centuries. The surface outcrop caused by the earthquake still can be seen in the Kresna gorge. The present-day weak seismicity, as monitored by the National Operational Telemetric System for Seismic Information network indicates the formation of two seismic zones with obvious differentiation as one of them is a large active polygon spread over one-third of SW Bulgaria [5], [7]-[10].

The particular information and the expert knowledge for the natural hazards mentioned above are available in the form of the thematic maps (for example: seismic hazard, geological hazard, gravitational processes), the quantity statistical data and the quality expert evaluations. In this paper, the social risk from natural hazards is assessed for Blagoevgrad, Simitli, Kresna, Strumyani, Sandanski, and Petrich, the quantity statistical data and the quality expert evaluations (Fig. 1). The international E-79 road, part from the international transport corridor N4, includes connecting Bulgaria with Greece, which partially collapsed due to natural disasters in the beginning of December 2010, has been fully repaired and is already functioning. The torrential rains in Southwest Bulgaria two weeks ago led the Struma River to rise by five meters in the Kresna gorge, causing a landslide that undermined the road, which collapsed into the river.

These six areas are characterized with different level of vulnerability according to the natural hazards typical for the SW Bulgaria region. The investigated area includes the valley of the Struma River in the territorial scope of Blagoevgrad district. It is located in the western part of Rila-Rhodope region. The area includes the eastern part of the moderate Osogovo-Belasitsa mountain group, the Struma's valleys, and the western slopes of the Rila and Pirin mountains. The Struma River watershed is characterized by its mountainous terrain and high altitude denivelation. The highest point is Mount Vihren (2914 m) in the Pirin Mountain and the lowest - the Struma River (65 m) at the village Kulata at the Bulgarian-Greece border.

The main river artery in the region is the Struma River. The total area of its catchment's area (10,797 square kilometers) in the study area includes 3490.7 square kilometers. The river valley is formed by a deep, complex graben superimposed on the Struma fault – the fault structure with a length about 180 km long on the Bulgarian territory and a 30 km wide. The graben is filled up with restless sediments, mainly from Miocene time - sands, clays, gravels, and conglomerates. This complex geological-tectonic setting determines the high frequency and intensity of active geomorphological processes [7]-[11].

Over the last century several big and destructive landslides have been observed with different degree of the landslide hazard, as part of them happened in SW Bulgaria. In this region the manifestation of active landslides and mud-rock falls can be closely connected with the contemporary tectonic activity, the erosion and the rainfalls [5], [7]. The Simitli graben is one of the typical landslide zones in SW Bulgaria.

The studied middle valley of the Struma River is characterized by a transition between the moderate-continental and continental-Mediterranean climate. Its main features are: long, hot and dry summers; mild and wet winters. The mean annual temperatures vary between 12^0C to 14^0C from north to south for the studied area. The rainfalls are relatively low 500-650 mm and are unevenly distributed. They are rare, but intense with overflowing character. These rainfalls in combination with easily-disintegrated rock cause the intense erosion, mud-rock flows and floods.

High summer temperatures, which frequency over the las• Input 3 “Seismic hazard”; t decade increases, are a serious danger for the population. Throughout in the flat part of the Struma valley the annual maximum temperatures reach 38-40^{0}C. In very hot summers of 2000, 2006, 2007 and 2009 the absolute values over 40^{0}C are reported, for example in Sandanski - 44.6^{0}C (2007). For the past 12 years (2000-2011) the average maximum temperature for this town is 40.3^{0}C.

The six municipalities - Blagoevgrad, Simitli, Kresna, Strumyani, Sandanski, and Petrich according to the administrative-territorial structure of Republic of Bulgaria belong to the Blagoevgrad district. The area of these municipalities is 3521 km^2, the population is 197419 [18], and the average population density of 56 persons/sq.km. The population is concentrated mainly in the municipalities centers along the Struma River as follow: Blagoevgrad - 77441, Simitli - 14282, Kresna- 5441, Strumyani -5778, Sandanski – 40470, and Petrich – 54006 inhabitants. The economy, technical and road infrastructures are concentrated in the considered municipalities of the Blagoevgrad district.

In accordance with the strategy for regional and social-economical development of the Blagoevgrad district [5], the municipalities are separated in the following groups:

- I-st group – Blagoevgrad;
- II-nd group – Snadanski and Petrich;
- III-rd group – Simitli, Kresna and Strumyani.

III. Fuzzy Logic for Social Risk Assessment

The fuzzy logic model is designed as a hierarchical structure with several inputs and one output. The number of inputs corresponds to the linguistic variables (indicators), which described the environmental risk and social vulnerability. The output represents a social risk assessment from natural disasters. Among the qualitative approaches, the Fuzzy Logic technique is based on subjective judgments about the relative importance of the predictive variables and their various states

In this study, five indicators for the social risk assessment for the SW Bulgaria region are defined using the expert knowledge, statistical data and published thematic maps for the seismic, and flood hazards [7]-[10],[19], [20]. The indicators of the fuzzy logic model are input variables of the designed fuzzy system. The fuzzy system inputs are defined as follow:

- Input 1 “Extreme temperature”;
- Input 2 “Floods”;
- Input 3 “Seismic hazard”;
- Input 4 “Population density”;
- Input 5 “Socioeconomical status”.

The proposed fuzzy logic model is designed as a three-level hierarchical fuzzy system with previously defined five inputs.

The first level includes one fuzzy logic subsystem. The second level includes two fuzzy logic subsystems. The third level includes only one subsystem. The each fuzzy subsystem has two inputs. The fuzzy logic system output gives the social risk assessment of the natural hazards in studied region of SW Bulgaria. A scheme of the three-level hierarchical fuzzy system is presented on Fig. 2.

The inputs of the first fuzzy logic subsystem are the Input 1 “Extreme temperature” and the Input 2 “Floods”, and the linguistic output variable is defined as Intermediate variable 1 “Climatic risk”.

The inputs of the second fuzzy logic subsystem are Intermediate variable 1 “Climatic risk” and the Input 3 “Seismic hazard”, and the linguistic output variable is defined as Intermediate variable 2 “Environmental risk”.

The inputs of the third fuzzy logic subsystem are the Input 4 “Population density” and the Input 5 “Socio-economical status”, and the linguistic output variable is defined as Intermediate variable 3 “Social vulnerability”.

The inputs of the fourth fuzzy logic subsystem are the Intermediate variable 2 “Environmental risk” and the Intermediate variable 3 “Social vulnerability”. The output of the fuzzy subsystem is output of the whole fuzzy system.

The system output variable gives the complex assessment of the social risk from natural hazards relevant to the studied region. The value of the complex assessment is a criterion for final decision making about the degree of social risk for the considered six areas. The higher value corresponds to the higher risk degree.

Inherently qualitative features of the indicators are rather than quantitative values, which are usually represented by linguistic variables. Information and decision are closely linked and different methods exist to make a decision on the basis of imperfect information. Expertise is always required to define the types of possible phenomena, to assess the environmental hazard, social vulnerability and risk levels and to propose prevention measures. Expert judgments depend on quality and uncertainty of the available information that may result from measures,

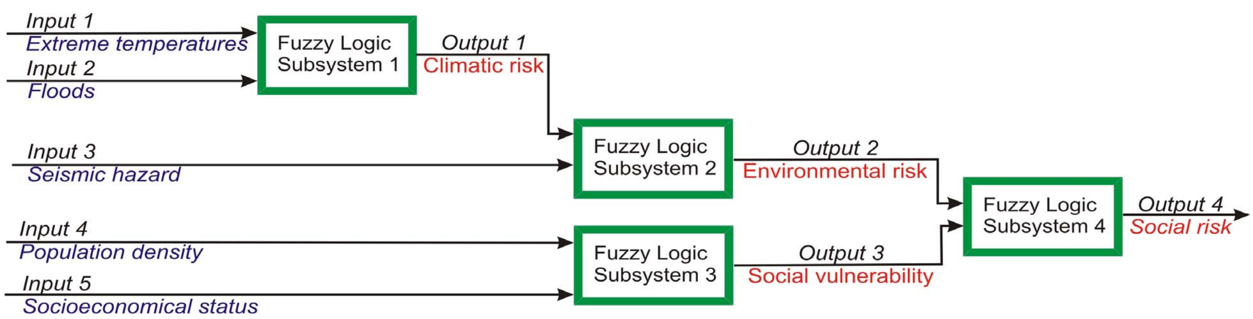

Fig. 2.Three-level hierarchical fuzzy system

historical analysis, subjective testimonies, possibly conflicting, and assessments done by the experts themselves.

In fuzzy logic system the input linguistic variables (five indicators and three intermediate variables) are represented by three fuzzy membership functions: “Low“, “Middle”, and “High”. The input variables are assessed in the interval [0, 10] using trapezoid membership functions (Fig. 3).

The fuzzy logic system output (complex risk assessment) is described by five fuzzy membership functions: “Very low”, “Low”, “Middle”, “High”, and “Very high”. The social risk from natural disasters is assessed in the interval [0, 100] using triangular membership functions. The input and output membership functions are shown in Fig. 4.

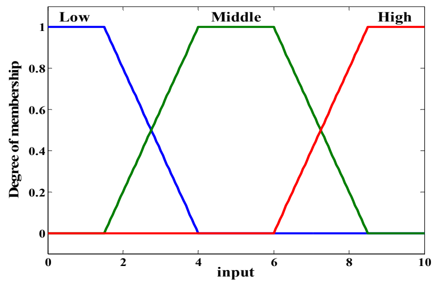

Fig. 3. Membership functions of the input variables.

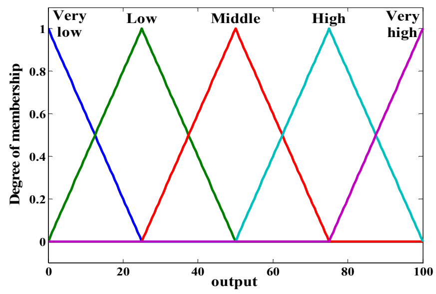

Fig. 4.Membership functions of the fuzzy system output.

The inference rules in the fuzzy logic system are defined through “IF - THEN”-clause. Rule numbers of the knowledge base per each of the fuzzy logic subsystems are 9. Some of the inference rules are defined as follow:

IF “Extreme temperature” is “Middle” and “Floods” is “Low” THEN “Climatic risk” is “Middle”;

IF “Extreme temperature” is “High” and “Floods” is “Middle” THEN “Climatic risk” is “High”;

IF “Climatic risk” is “Middle” and “Seismic hazard” is “Low” THEN “Environmental risk” is “Low”;

IF “Climatic risk” is “High” and “Seismic hazard” is“Middle” THEN “Environmental risk” is “Middle”;

IF “Population density” is “Low” and “Socio-economical status” is “Middle” THEN “Social vulnerability” is “Low”;

IF “Population density” is “Middle” and “Socio-economical status” is “High” THEN “Social vulnerability” is “Middle”;

IF “Environmental risk” is “Low” and “Social vulnerability” is “Low” THEN “social risk from natural disasters” is “Very low”;

IF “Environmental risk” is “High” and “Social vulnerability” is “Low” THEN “social risk from natural disasters” is “Middle”;

IF “Environmental risk” is “High” and “Social vulnerability” is “High” THEN “social risk from natural disasters” is “Very High”.

The fuzzy logic hierarchical system is designed in Matlab environment using Fuzzy Logic Toolbox. The fuzzy subsystems are built in the Mamdani type fuzzy inference system [21]. The inference surfaces in 3D for the fuzzy logic subsystems are given on Fig. 5.

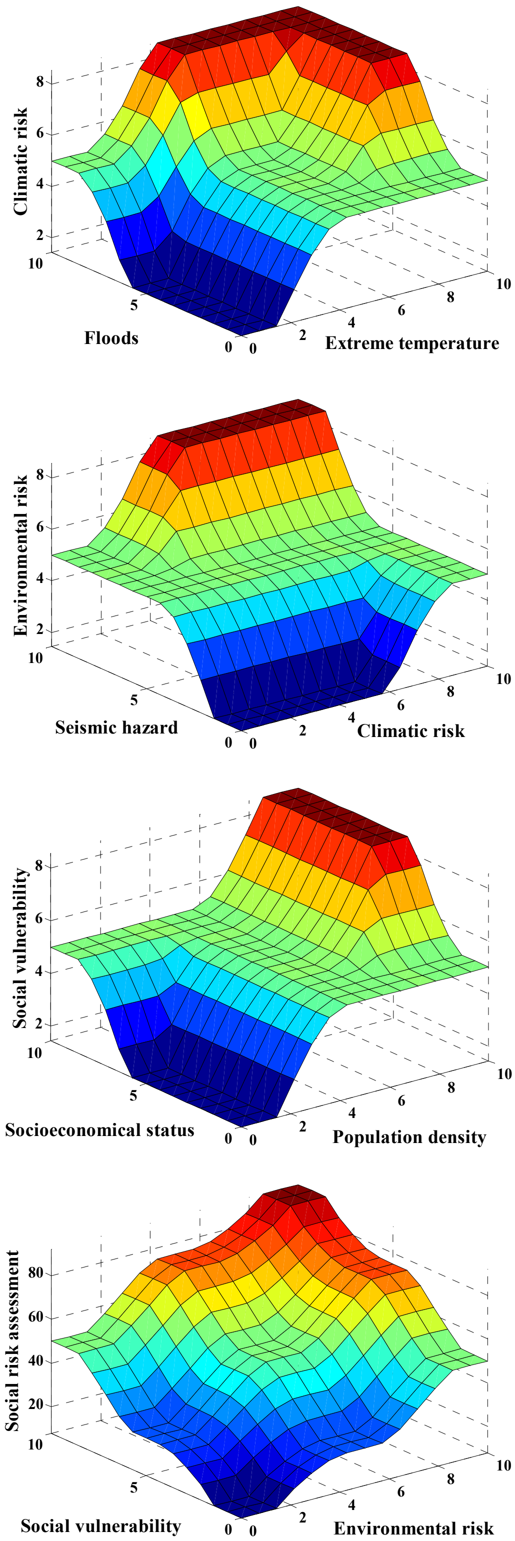

Fig. 5.Surfaces of the fuzzy logic subsystems

IV. Application of Fuzzy Logic Model for The SW Bulgaria Region

The designed fuzzy logic model is used to assess the natural risk of five areas in the SW Bulgaria region. These areas - Blagoevgrad, Simitli, Kresna, Strumyani, Sandanski, and Petrich - are exposed to the several types of the natural hazards. The values of the all input variables are choosen to be relative each to other for the six areas in the interval [0, 10]. Input data indicators for the six local areas and the obtained results are presented in Table 1. Risk-based prioritization incorporates the scientific decision making aspects, such as vulnerability estimation (value of indicator), and potential damage value, such tolerance to the consequence of failure. The definition of risks zones is based on the extrapolation of historical information known on particular natural events using morphology based analysis.

TABLE I: INPUT DATA AND SIMULATION RESULTS

Criterion	Blagoevgrad	Simitli	Kresna	Strumyani	Sandanski	Petrich
Input 1 Extreme temperature	1	2	6	7	10	10
Input 2 Floods	2	8	10	6	1	3
Climatic risk	*1.4*	*5.4*	*8.6*	*5.9*	*4.8*	*6.7*
Input 3 Seismic hazard	6	8	10	7	3	1
Environmental risk	*4.9*	*7.5*	*8.5*	*6.1*	*4.1*	*2.8*
Input 4 Population density	10	3	1	1	5	7
Input 5 Socioeconomical status	9	3	3	3	6	6

The results show the Kresna area has the highest value of the climatic risk according to the defined input indicators. The areas ordered by the decreasing degree of this risk are Petrich, Strumyani, Simitli, and Snadanski respectively. The climatic risk is lowest for the Blagoevgrad area.

The combination of climatic risk with seismic hazards changes the risk degree of some areas. The environmental risk again is higher for Kresna area, but the Petrich area has a lower risk value comparing to the Blagoevgrad area.

The social vulnerability is significantly higher for the Blagoevgrad area due to its population density as the district center. Sandanski and Petrich have a similar vulnerability, following by Simitli, as the lower equal values are obtained for Kresna and Strumyani.

Blagoevgrad area has the highest level of the social risk according to the considered natural hazards and social vulnerability. The rest areas are ordered by risk degree as follow: Simitli, Snadanski, Kresna, Petrich, and Strumyani. The social risk assessment is almost two times lower for Strumyani and Petrich comparing to the area of Blagoevgrad despite of the relatively higher climatic risk for Petrich and higher environmental risk for Strumyani areas. The stakeholders have to take the relevant management decisions using the obtained social risk assessment for the six local areas to mitigate the potential dangerous consequences.

V. CONCLUSIONS

A fuzzy logic model for social risk assessment from the natural hazards in the six regions of the SW Bulgaria is proposed. This model is based on the models described in [14]-[16] and it is expanded with additional input linguistic parameters, related to the social vulnerability. The social risk of the studied areas is assessed using available map, hydro-meteorological and seismic hazards information, and expert knowledge. The fuzzy logic model is designed as a hierarchical system with five inputs and one output in Matlab software environment using Fuzzy logic Toolbox and Simulink. The simulation investigations are done for six geographic areas in SW Bulgaria (Blagoevgrad, Simitli, Kresna, Strumyani, Sandanski, and Petrich). The social risk assessment results can support the stakeholders to take more informed decisions for the sustainable regional development of SW Bulgaria.

The designed fuzzy system is a part of the Web integrated information system for risk management of natural disasters which will be developed [22]. Full-value usage of the useful information from different sources for effective social risk management requires establishing an integrated information system that addresses complex geological, geo-technical and other issues. Such system combines different methods and tools [23]. The system will be most effective if it is implemented in a web-based GIS environment, thus it might serve as a unified platform for interdisciplinary research of the impact of natural disasters. Major goal of this system is to support the effective management of the decision making process regarding risk prevention and risk mitigation for given areas. Stakeholders on different administrative level could use this Web integrated information system for an efficient risk management. A consolidation of knowledge integrating programs for fostering innovation and new strategic approaches, and timely coordination across infrastructures is a crucial factor for social risk reduction from environmental hazards.

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Natural Hazards".

REFERENCES

[1] J. Pollner, J. Kryspin-Watson, and S. Nieuwejaar. *Disaster Risk Management and Climate Change Adaptation in Europe and Central Asia*. Global Facility for Disaster Reduction and Recovery: The World Bank, 2010.

[2] *Risk Management - Principles and Guidelines*, ISO 31000, 2009.

[3] Ch. S.Melching and P. J. Pilon (Eds.) *Comprehensive Risk Assessment for Natural Hazards*, WMO/TD No. 955, 2006.

[4] L. Pashova, P. Zlateva, and M. Kouteva-Guentcheva, "An approach to comprehensive information systematization for complex risk analysis of the natural hazards", in *Proc. of 6th Int. conf. "Global Change and Regional Development"*, Sofia, 2010, pp. 30-36.

[5] *Regional Strategy for the regional development of Blagoevgrad District for 2005-2015*, Blagoevgrad district, Bulgaria, 2005. Available: http://www.bl.government.bg

[6] R. Jelínek, J. Hervás, and M. Wood. *Risk Mapping of Landslides in New Member States*. EC, JRC41245, 2007.

[7] I. Bruchev, N. Dobrev, G. Frangov, P. Ivanov, R. Varbanov, B. Berov, R. Nankin, and M. Krastanov, The landslides in Bulgaria - factors and distribution", *Geologica Balcanica*, vol. 36, no. 3-4, pp.3-12, 2007.

[8] I. Georgiev, D. Dimitrov, T. Belijashki, L.Pashova, S. Shanov, and G. Nikolov, "Geodetic constraints on kinematics of Southwestern Bulgaria from GPS and leveling, *Geological Society*, no. 291, pp. 143-157, 2007.

[9] L. Tzenov"and E. Botev, "On the earthquake hazard and the management of seismic risk in Bulgaria", *Information&Security,* no. 24, pp. 39-50, 2009.

[10] D. Solakov, S. Simeonova, L. Hristoskov, I. Asparuhova, P. Trifonova, and L. Dimitrova, *Seismic Zoning of the Republic of Bulgaria*, Final report, Contract-170-1, MRRB-Government, Bulgaria, 2009.

[11] B. Rangelov, *Natural hazards – nonlinearities and assessment*, Sofia: Prof. M. Drinov Acad. Publishing House, 2011.

[12] A. Kreimer and M. Arnold, *Managing disaster risk in emerginf economics*, Washington, D.C.: The World Bank, 2000.

[13] P. Blaikie, T. Cannon, I. Davis, and B. Wisher, *At risk: natural hazards, people's vulnerability, and disasters*, London: Rutledge, 1994.

[14] P. Zlateva, G. Kirov, and K. Stoyanov, "Fuzzy logic application for eco-tourism potential assessment of villages", *Automatics&Informatics*, no. 4, pp. 20-23, 2005.

[15] P. Zlateva and L. Pashova, "Fuzzy logic application for assessment of the environmental risk in SW Bulgaria", in *Proc. of Third International Scientific Conference FMNS-2011*, Blagoevgrad, Bulgaria, vol. 2, 2011, pp. 509-515.

[16] P. Zlateva, L. Pashova, K. Stoyanov, and D. Velev, "Fuzzy logic model for natural risk assessment in SW Bulgaria", in *International Proc. of Economics Development and Research*, IPCSIT vol.13, IACSIT Press, Singapore, 2011, pp.109-113.

[17] L. Pokorádi, "Risk assessment based upon fuzzy set theory", in *Proc. of 15th Int. Conf. "Build. Serv., Mec.*, Debrecen, Hungary, 2009, pp. 311-318.

[18] National Statistical Institute (NSI), 2011, http://censusresults.nsi.bg/

[19] K. Stoyanov, "Analysis of the threats and frequency from natural disasters in the Simitli municipality", in *Proc. of Third International Scientific Conference FMNS-2009*, Blagoevgrad, Bulgaria, vol. 2, 2009, pp.269-278.

[20] K. Stoyanov and P. Zlateva, " Changes in the field of the extreme temperatures in Bulgaria during the last decade", in *Proc. of 6th Int. conf. "Global change and regional development"*, Sofia, 2010, pp. 384-387.

[21] A. Gilat, *MATLAB - An Introduction with Applications*, 4-th Ed., N.Y.: Wiley, 2011.

[22] D. Velev, P. Zlateva, and V. Velev, "A Framework for Web Integrated Information System for Risk Management of Natural Disasters", *in International Proceedings of Economics Development and Research*, IPCSIT vol.13, IACSIT Press, Singapore, pp.114-118.

[23] J. Wang (Ed.), *Information Systems and New Applications in the Service Sector: Models and Methods*, N.Y.: BSR, 2010.

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