

## POSSIBILITIES OF THE REPUBLIC OF SERBIA FOR REDUCING VULNERABILITY TO NATURAL HAZARDS

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**Abstract:** Vulnerability is an essential feature of an element at risk (community, region, country, the environment) which determines the expected damage caused by a hazard. Vulnerability modified over time and it depended on physical, social, economic and environmental factors. Vulnerability became multidimensional, multidisciplinary, multi-sectoral and dynamic in contemporary circumstances. In the past decades, vulnerability to natural hazards took precedence over technological and other hazards threatening the community. The necessity to assess threat, vulnerability and the prevention of natural hazards was emphasized in the key national normative legal acts of the Republic of Serbia. A resolute commitment of the country to lay down the laws to regulate this field and establish a system to make a functional response to natural hazards through institutions was followed by difficult circumstances in practice. In addition to permanent flood hazard vulnerability, landslide and earthquake vulnerability, weak socio-economic profile i.e. the insufficient flexibility of the community and the unclear role of government bodies, municipal civil protection service and the service for protection from natural disasters were also insufficiently equipped. Nowadays, government efforts to solve problems in order to improve its own possibilities for reducing vulnerability to natural hazards are evident. The most important are those related to proper financing of the protection system. The application of SCN model would provide a more stable transfer of financial resources, as well as the transfer of necessary manpower and material resources from national to local level.

**Key words:** vulnerability, natural hazards, possibilities, SCN model

### Introduction

The term “vulnerability” and the concept of “vulnerability” are widely accepted by various analysts and in numerous scientific disciplines which approach the same “conceptual space” in a comprehensive manner. However, regardless of the evident differences in approach, vulnerability is always primarily oriented towards physical and social dimensions of the community. Vulnerability is a state of exposure which renders the community powerless to resist the incapacitating effects of the events most often viewed as catastrophes or natural hazards (Mustafa, 1998). Vulnerability is a product of physical exposure to

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natural hazard, and human capacity to prepare for or mitigate and to recover from (cope with) any negative impacts of disaster (Pelling & Uitto, 2001). Vulnerability represents a political and ecological concept and it is placed conceptually in the interaction between nature and culture. According to Oliver-Smith (2004) vulnerability acts as a connection between social and economic structures, cultural values, norms and environmental hazards. Vulnerability may be viewed as a fact that certain groups of citizens face greater risk of injury, death or loss of property as a result of their social and economic circumstances (Phillips & Morrow, 2007). Vulnerability may be defined as the extent to which communities, structures, services or geographical areas are likely to be damaged or disturbed under the influence of certain hazards (NOAA, 2006). On the quest for a new approach to vulnerability, Cardona (2004) posited that vulnerability results from a) physical weakness or exposure, i.e. susceptibility of larger and smaller social communities to the effects of hazardous events due to their location; b) weak socio-economic profile which implies relative weaknesses and limitations which define the community in a socio-economic sense; c) the lack of flexibility which is expressed by the incapacity and limitations of a society to mobilize the existing capacities. It is multidimensional, multidisciplinary, multi-sectoral and dynamic (UNEP, 2007). Vulnerability is an essential feature of an element at risk (community, region, country, the environment) which determines the expected damage caused by a hazard. Vulnerability modifies over time and it depends on physical, social, economic and environmental factors (UNU Institute for Environment and Human Security, 2004). Vulnerability is defined as a human state or processes resulting from physical, social, economic and environmental factors, which determine the probability and the extent of the damage resulting from a given hazard (UN Development Programme, 2004). Vulnerability assessment prepared by McEntire (2012) considers several aspects: 1) vulnerability as proneness or liability, 2) vulnerability as capacity or capability, 3) vulnerability as a dual concept.

Vulnerability concept comprises two opposing powers: social and cultural processes causing vulnerability on the one side and physical exposure to hazard on the other side.

In the past decades, vulnerability to natural hazards took precedence over technological and other hazards threatening the community. According to the data from the OFDA/CRED International Disasters Database (EM-DAT), the number of natural disasters appears to have increased worldwide. In the decade 1900-1909, natural disasters occurred 73 times, but in the period 2000-2005 the number of occurrences rose to 2,788. Furthermore, the International Federation of Red Cross and Red Crescent Societies reported in 2004 that 231,764 people

were killed by disasters in Asia from 1972 to 1996. (Kusumasari, Alam, & Siddiqui, 2010). According to experts who have been studying disaster losses and causes of increasing vulnerability, understanding institutional standing, power, and their perception of disaster risk reduction is first and foremost on the path of building resilient communities (Nirupama & Etkin, 2012).

Bearing in mind the significant changes in the perception of vulnerability and more serious consequences resulting from natural hazards, in this study we shall explore the real possibilities of the Republic of Serbia to reduce its own vulnerability to natural hazards.

### **Method**

The first phase of the study is based on the review and analysis of national normative and legal acts and reports, theoretical studies and research projects. Statistical data for the purposes of this study will be taken from national strategies for the most part (The National Strategy of Sustainable Development, The National Strategy for Protection and Rescue), reports (The Report on the Condition of Human Security in Serbia for the Period 2005-2006, The Report of Seismological Institute of Serbia, The Report of the Committee for Damage Assessment), Statistical Yearbook of the Statistical Office of the Republic of Serbia, as well as theoretical scientific analyses. The second phase of the study represents an attempt to explore the possibilities at a theoretical level of the application of basic organizational and mathematical principles of supply chain networks (SCN) related to financing and equipping directorates and emergency services in local communities of the Republic of Serbia.

### **Results**

The connection between the society, its cultural values, its normative, institutional and functional possibilities and vulnerability to natural hazards is explicitly expressed in the Republic of Serbia. The necessity to assess the threat, vulnerability and prevention of natural hazards was emphasized in the key national normative legal acts of the country. These acts accept the recommendations of contemporary countries related to system operation and the measures to reduce the consequences of natural hazards. Article 190 of the Constitution (The Official Gazette of RS, No. 98/06) as the highest law stipulates the role and importance of local communities in overcoming potential vulnerability and the consequences of natural hazards by their own means. Namely, apart from other municipal competences, another role of municipalities is to ensure environmental protection and the protection from natural and other hazards. The issue of activities, roles and competences of municipalities and

local communities is ever topical since it denotes their real autonomy, as well as potential resources of local governments for implementing various activities and the activities of mitigating vulnerability to natural hazards. Law on Local Self-government (The Official Gazette of RS, No. 129/07) stipulates that contemporary local authorities are obliged to, apart from preventing social issues, ensure prevention and protection from natural hazards and create conditions for eliminating their consequences. The necessity for considering natural hazards is stipulated in the National Strategy of Sustainable Development (The Official Gazette of RS, No. 57/08) as well, and it considers flood prevention and incentives in natural disasters insurance lines to be country priorities, as well as the process of institutionalization of civil protection system. National Security Strategy (The Official Gazette of RS, No. 88/09), as a general public security assessment, also encompasses the consequences of natural hazards as fundamental challenges, risks and security threats. The definitions of natural disasters, protective measures (1. Protective measures in case of imminent danger from natural disaster and other disasters, 2. Protective measures in case of natural disasters and 3. Natural disaster and other disasters mitigation and relief measures), as well as the competences of local communities to assess damage arising from the consequences of natural disasters are presented in the current Law on Emergency Situations (The Official Gazette of RS, No. 111/09). The law stipulates the preparation of Vulnerability Assessment which includes the following significant elements: a) territorial characteristics, critical facilities, critical points and areas from the viewpoint of vulnerability to natural and other disasters, b) vulnerability of specific territories to natural hazards and other disasters, c) assessment of potential consequences of natural disaster and other disasters d) demands and potential to protect people, material goods and the environment from the consequences of natural hazards and other disasters. Taking into consideration the consequences of natural hazards, the law also stipulates the obligation of local self-government units to assess the damage arising from natural hazards and to submit a report to the Serbian Government within 60 days. It is also stipulated that the Republic of Serbia is obliged to participate in providing assistance at local level in eliminating large-scale damage caused by natural disasters and other disasters, and large-scale damage implies the damage in the amount of more than 10% of GDP gained on the territory of the municipality (or town) in the previous year. The government determines the type, manner and amount of assistance and it passes regulations on the methods of assessing and registering the damage, providing and receiving assistance. The importance of the law currently in force is reflected in the fact that a whole decade after the beginning of the transition process and a decade of a chaotic situation in this field, the Republic of Serbia finally passed the Law on Emergency Situations and established a normative base for a new – integrated

system of managing emergency situations, including those which cause natural hazards. Article 1 of the law defines: (1) action, proclamation and emergency management; (2) the system of protection and rescue of people, material goods and cultural heritage and the environment in case of natural disasters and other disasters; (3) the competences of government bodies, the autonomous province, local self-government units, the participation of the police and the Serbian Armed Forces in protection and rescue; (4) the rights and liabilities of the citizens, companies, other legal entities and entrepreneurs related to emergency situations; (5) organizations and civil protection activities related to protection, rescue and relief from the consequences of natural disasters and other disasters; (6) financing; (7) inspection; (8) international cooperation and (9) other issues of importance to organizing and functioning of protection and rescue system. The other strategic document, National Strategy of Protection and Rescue (The Official Gazette of the RS, No. 86/11) accepted the recommendations by EU Internal Security Strategy as well as EU Strategy for Supporting Disaster Risk Reduction in Developing Countries. Natural hazards representing the greatest threat against life, health and property of the citizens, the environment and cultural heritage are defined: earthquakes, floods, landslides and slides, severe weather disasters and potentially harmful hydrometeorological events. The starting point for the preparation of the section of the Strategy which analyzes natural hazards was the existing Law on Protection of Natural and Other Major Disasters (The Official Gazette of Socialist Republic of Serbia No. 20/77, 24/85, 27/85, 6/89, 52/89 and The Official Gazette of RS No. 53/93, 67/93 and 48/94) which defined the following domains: 1) natural disasters, 2) the rights and liabilities of citizens regarding the protection against natural disasters, 3) the role of inter-municipal and regional communities in the protection against natural disasters, 4) protective measures and protective plans in case of natural disasters, 5) management of protection against natural disasters, 6) assessment of damage, assistance and indemnities in case of natural disasters. One of the key tasks of the Strategy is to initiate social processes which would lead to the long-term development of the research segment of society in the domain of the phenomenology of occurrence of natural hazards, their impact on a social community, as well as efficient and continuous monitoring of these phenomena with the aim of timely forecasting of their occurrence and diminishing their consequences. The significance of natural disasters in the Republic of Serbia is stressed by passing a new bylaw, Guideline on methodology for the preparation of vulnerability assessment and protection and rescue plans in a state of emergency (The Official Gazette of RS No. 96/12). The assessment represents a core document for the preparation of Protection and rescue plan in a state of emergency in the Republic of Serbia and Protection and rescue plan of the autonomous province, local self-government communities, companies and other

legal entities and organizations and it is prepared by all entities defined by the Law on Emergency Situations. The assessment is a document which identifies hazards, sources and forms of threats, possible consequences, vulnerability assessment, assessment of forces, means and prevention measures for responding to natural and other hazards, protection and rescue of people, material goods and cultural heritage and the environment. The value of the adopted acts is reflected in acknowledging our own realistic vulnerability to natural hazards, as well as accepting the directives and proposals by United Nations International Strategy for Disaster Reduction (UNISDR), United Nations Development Programme (UNDP), USAID PPES Program (preparedness, planning, economic security). A resolute commitment of the country to lay down the laws to regulate this field and establish a system to make functional response to natural hazards through institutions was followed by difficult circumstances in practice. Namely, the territory of the Republic of Serbia is exposed to numerous natural hazards which threaten to cause new consequences all the time. Floods represent the most common natural hazard in the country. The area in Serbia exposed to floods which occur once in a century amounts to 1.57 million ha, out of which 1.45 million ha is in Vojvodina. About 80% of flood exposed area is agricultural land, including 512 bigger settlements, 515 industries, 4,000 km of roads and 680 km of railway tracks. It is about 1 million ha of agricultural land in Vojvodina, 260 settlements, 3,840 km of roads and about 150 km of railway tracks. In the past 13 years, several large-scale floods were registered in Serbia. They occurred in 1999, 2000, 2005, 2006, 2007, 2009, 2010, 2011 and 2012. The largest flood occurred in the spring of 2006 and it can be referred to as one of the largest floods in Serbia recorded in the instrumental period, since the highest water levels were reached on the majority of rivers.

In July 1999, the basins of major tributaries of the river Velika Morava witnessed flash floods when eight people lost their lives, tens of thousands of residential buildings and several hundred commercial buildings were damaged and 30 bridges wiped out in the basins of the Zapadna Morava, the Jasenica, the Kubrišnica and the Lepenica (Milanović, Urošev, & Milijašević, 2010). Those floods were caused by heavy precipitation and they affected all left and certain right tributaries of the Velika Morava and Šumadija suffered the greatest damage (Smederevska Palanka, Velika Plana, Jagodina, Batočina, Kragujevac, Arandelovac, Rekovac, Kruševac, Kraljevo and Mladenovac). The inflicted damage was assessed at 20 million euros. In March and April 2000, high water levels occurred in the rivers Tisa and Tamiš as a consequence of rapid melting of snow on the slopes of the Carpathians and concurrent heavy precipitation. The situation on the territory of the municipality of Sečanj was the gravest. Floods

threatened the town Jaša Tomić as well. In the same period, the Tisa overflowed on the territory of Serbia. In this period, flood prevention measures on the Tisa lasted 61 days in the area of Novi Kneževac and 44 days in the area of Senta, and the emergency measures for flood prevention were in force for as many as 28 days in Novi Keževac and 18 days in Senta. The prevention measures on the river Tamiš were in force for a shorter period of time, so that flood prevention measures lasted 26 days in the area of Jaša Tomić and Sečanj, and the emergency measures for flood prevention only 1 day. During 2001 and 2002, only smaller-scale floodings occurred. The greatest floods occurred in June 2001 in the basins of the rivers Jadar, Ždravija, Štira and Lesnička when the municipalities of Loznica, Ljubovija, Krupanj, Mali Zvornik and Šabac were flooded. The greatest flash floods occurred in June 2002 in the basin of the river Mlava. In July 2005, the floods affected Leskovac, Porečje and Vučje, as well as certain parts of the territories of Niš and Kruševac in the south of Serbia. 27 settlements were flooded on the territory of Kruševac, 82 buildings were left damaged, 2,420 ha were flooded, 90 residential buildings were damaged and the roads suffered damage on 23 sections. On the territory of Leskovac, about 25,000 ha of wheat, corn and vegetable fields were ruined, as well as 2,500 households. In April 2006, the floods affected the municipalities of Žabalj, Titel, Sečanj and Zrenjanin in Vojvodina, as well as Negotin, Veliko Gradište, Smederevo, Požarevac and Golubac, since the Danube and its tributaries reached the highest levels in the past 100 years. 3,000 houses were flooded, leaving 11,000 people displaced or homeless. It was estimated that 225,000 ha were flooded, which makes 5% of total arable land in Serbia. The damage inflicted was estimated at 35.7 million euros. In November 2007, massive floods took place in the south of Serbia, especially in the basin of the river Vlasina. Apart from this, heavy precipitation occurred within 48 hours in the basin of the river Velika Morava. All this led to flash floods in the basin of the river Velika Morava and its tributaries: the Toplica, the Veternica, the Nišava, the Vlasina, the Kosanica, the Jablanica and the river Pusta. The floods occurred in the municipalities of Babušnica, Dimitrovgrad, Doljevac, Lebane, Leskovac, Pirot and Vlasotince. The currents wiped out 13 bridges and damaged numerous roads. Spring water and waterworks were polluted in many towns, and landslides were activated in Lebane. The biggest floods and damage were recorded in the basin of the Vlasina. At the beginning of November 2009, great floods took place in Zlatibor and Raška districts. Due to the rain which was falling continuously for 20 hours, the swollen mountain rivers caused floods in Užice, Arilje, Požega, Sjenica, Novi Pazar, Prijepolje, Nova Varoš, Priboj and Raška (Milanović et al., 2010). In the following year, 2010, the floods occurred in several municipalities. In Zaječar, the Beli Timok flooded 500 buildings, while the total flooded area was 350 ha. Rapid melting of snow and heavy

precipitation threatened the municipality of Kruševac from several rivers: the Južna Morava which threatened to flood 300 ha of arable land, the river Ribarska which flooded 70 ha of land and the river Jablanička which flooded 40 houses and 50 ha of land. Jagodina and Paraćin were threatened by the Velika Morava whereas nearly 300 ha of arable land were flooded. The greatest damage was sustained by Valjevo surroundings during 2011 and 2012 when the river Tamnava threatened to flood 200 houses due to precipitation which continued for several days, while it damaged between 1,500 and 2,000 facilities in the municipality of Koceljeva. The countries of the Danube river basin suffered great damage from floods, while the situation in the Republic of Serbia threatened to become very serious in the municipalities of Novi Sad, Sombor, Apatin, Indija and Beočin, whereas the plan to evacuate 1,200 citizens from 550 houses was prepared.

A significant increase in the levels of underground and surface waters caused by heavy precipitation led to landslides in this period and revealed a new dimension of vulnerability to natural hazards Serbia faces. Landslides occurring on the territory of Serbia have been known in 70% of cases and have been mainly explored. Landslides and slides affect about 25% of the territory whereas 3,137 active and potential landslides exist. A certain number of them threatens residential buildings, about 3,727 buildings and 7,755 residents, while the majority threaten local and regional roads. Landslides exist in the south-east of the Pannonian Plain, the northern slopes of Fruška Gora and the part of the Danube basin between Belgrade and Smederevo. In April 2006, the situation was the worst in Trstenik. About 130 houses were damaged, and about 200 residents were displaced. The municipality of Koceljeva faced the risk of 95 landslides, whereas 65 houses were damaged and 6 completely ruined. The municipality of Ljig faced the risk of 150 landslides and the local roads were damaged at more than 60 points. 100 landslides were registered on the territory of the municipality of Arandelovac, whereas the area of 87 ha of arable land was at risk. The damage inflicted by landslides in 2006 was estimated at 25 million euros. The Ministry of Defence, which was responsible for civil defence in that period, hired professional staff in order to assist the endangered population and quicken the process of repairing landslide damage. Thus 81 municipalities engaged 96 civil protection services with a total of 620 staff, who managed protection and rescue activities. Apart from that, the services engaged 134 operation teams with 669 members, totaling 1,296 members of civil protection in the field. Those forces, in cooperation with local self-government bodies, relocated almost 360 people from a total of 1,067 settlements, which were flooded or threatened by the occurrence of more than 2,000 landslides.

Seismic vulnerability in the said period was determined by the occurrence of earthquakes. According to the data prepared by the Seismic Survey of the Republic of Serbia in 2003, a series of small-scale earthquakes occurred and the epicentre was on the mountain Jadovnik, and in 2004 the epicentre was in Sjenica. At the end of March 2006, in the municipality of Mionica, otherwise famous for seismic activity (the most powerful earthquake recorded on the territory of the Republic of Serbia in the area of the municipality of Mionica in 1998, according to Damage assessment committee data, 12,000 houses were damaged in 6,500 households, whose reconstruction has not been completed yet) an earthquake measuring 4.8 on the Richter scale shook the area. The earthquake epicentre was in the area of the mountain Maljen. According to the data by the Statistical Office of the Republic of Serbia, in the period between April 1998 and February 2011, Serbia was hit by several earthquakes measuring from 3.2 to 5.4 on the Richter scale in the following areas: Trstenik, Prokuplje, Veliko Gradište, Raška, Kopaonik, Vranje, Trgovište, Mionica, Valjevo, Kuršumlija and Čačak.

The issue of community vulnerability and its realistic possibilities to eliminate economic consequences was analyzed in the Report on the Condition of Human Security in Serbia for the period 2005-2006 which included municipalities in central Serbia (113) and Vojvodina (42). The report presented alarming data related to the issue of compensation of damage arising from natural disasters in the said municipalities in the same period. The damage was great, and downright disastrous in insufficiently developed communities such as Mionica, Bojnik and Osečina, where the damage was much higher than the entire municipality budget and may be considered catastrophic. The estimated damage caused by landslides in Mionica amounted to 90,000,000 dinars, while the earthquake caused inestimable damage. In the municipality of Bojnik, buildings, infrastructure facilities and agriculture suffered 103,894,300 dinars in damage, while the municipality of Osečina suffered 18,000,000 dinars in damage to residential buildings. The damage to local roads and bridges amounted to 80,000,000 dinars. Apart from already mentioned municipalities, the greatest damage was suffered by the municipality of Sečanj (material damage to buildings about 1,000,000,000 dinars), Lazarevac (landslide damage estimated at 926,080,000 dinars), Ub (landslide damage 120,000,000 dinars and flood damage 424,000,000 dinars), Kraljevo (landslide damage estimated at 397,976,000 dinars), Novi Pazar (landslide and flood damage amounted to about 224,000,000 dinars), Valjevo (landslide damage 200,000,000 dinars), Čačak (total flood and landslide damage estimated at 177,000,000 dinars), Brus (damage to the roads in the amount of 150,000,000 dinars), Kruševac (flood and landslide damage in the amount of 96,519,740 dinars). The report showed extremely uneven

compensation of damage in different municipalities. It varies from meagre 0.41% in the municipality of Lazarevac to 100% in Lajkovac and Apatin. Naturally, the differences were related to the total amount of estimated damage, in cases where the damage amounted to hundreds of millions of dinars, there were almost no cases of high percentage compensation, which is an expected consequence of general economic circumstances in the Republic of Serbia. Local self-governments also participated in compensation of damage in different ways, ranging from the case of Sjenica where 5% compensation was payed exclusively from municipal budget, through the case of the municipality of Užice where the ratio municipality/republic was 5:1, to the case of Mionica with great natural disaster damage, but 70% compensation. Only 50% of municipalities received compensation and such low total rate of compensation prompted the citizens to file complaints against the Ministry of Agriculture and Finance and Ministry of Capital Investments.

The complaints, however, were also filed against civil protection services in 22% of cases. The reason behind the dissatisfaction of citizens were: inadequate, uneven and/or untimely compensation of damage, slow provision of assistance and elimination of damage, uneven aid distribution, slow damage assessment, uneven aid distribution or prioritizing compensation. Although the civil protection services in municipalities were not authorized to realize financial assistance, or compensation of damage, they evidently were subject to strong public pressure.

Aside from inadequate compensation, weak socio-economic profile i.e. insufficient flexibility of the community and unclear role of state bodies, municipal civil protection service and the service for protection from natural disasters were also insufficiently equipped. Lack of financial funds and the restrictions of local bodies directly cause functional vulnerability of civil protection service. The report shows that the average score regarding the equipment in municipal civil service was 2.46, which clearly shows that they were poorly equipped in the Republic of Serbia in that period. The services mainly attributed such poor conditions to a lack of technical and financial resources in the form of personal protection equipment, protection and rescue equipment (technical equipment – tools), means of communication (mobile phones, radio link and similar communication channels), vehicles (especially SUVs), computer and communication equipment (therefore there are no databases of potentials and resources for managing emergency situations, databases of emergency situations and relevant security hazards, utilization of contemporary electronic bibliography and administrative activities, contacts with citizens and other), professional bibliography. The most serious situation was

found in the municipalities of Bačka Palanka, Čačak, Čuprija, Kikinda, Palilula, Priboj, Prokuplje, Senta, Smederevo, Sremski Karlovci, Velika Plana, Veliko Građište and Vladimirci. Namely, civil protection services in the municipalities mentioned above describe their conditions in terms of a lack of equipment, the possession of only the old, insufficient and dysfunctional equipment, a lack of adequate structure of professional and operating authorities and a chronic lack of financial assets. The average score of natural disaster protection service equipment was 2.95, somewhat better than civil protection service, but also very unsatisfactory in terms of successful combatting natural and other disasters. Operating authorities, which were mainly very well equipped, were the exception owing to the funds of local self-governments in the municipalities of Vrbas, Novi Beograd and Indija. The coordination with external entities (Ministry of Defence, Ministry of the Interior, Ministry of Agriculture, Ministry of Health, Ministry of Capital Investments, Ministry of Finance, local self-governments, Social Care Centre, Red Cross, NGO, the media) scored 3.85, which places it into a category of “weak links” in service functioning. At the same time, such low score was the indicator of unpreparedness of key country resources to respond to natural hazards in a joint attempt. Utilizing the potential of municipalities, institution networks, contacts and public relations were not the areas in which the services achieved significant success.

It is evident that the consequences of natural hazards and the circumstances of operating authorities showed unpreparedness and extreme vulnerability of the society for an extended period of time. These phenomena, however, are a source of one more realistic approach to creating a new, social and integrated and humane system which would simultaneously represent a duty of the whole community, as well as everyday necessity which is developing through the recognition of authentic public interest in protecting citizens, material goods and the environment. Therefore, the appendix to the National Protection and Rescue Strategy, apart from positive steps and progress in creating a new protection system, identified certain limitations in the area of protection and rescue system which still determine the realistic possibilities of our country to reduce vulnerability to natural and other hazards: 1) institutional and organizational: (unfavorable conditions for consistent implementation of regulations, inadequate organization and implementation of prevention measures, incomplete and inaccessible specialized hazard registers, the absence of comprehensive hazard maps, uneven distribution of operating services, disconnected access to 112 system), 2) material and technical: (unsatisfactory level of transport and other infrastructure, obsolete, unreliable equipment, facilities and vehicles, inadequate financing of protection and rescue system); 3) cooperation, coordination and availability of information (insufficient coordination between protection and

rescue system subjects, insufficient cooperation between scientific research institutes, insufficient cooperation with non-governmental and private sector, the necessity to improve international cooperation); 4) human resources and education (inadequate professional qualifications and technological discipline of human resources, insufficient number of professional staff, insufficient training of professional staff, unpreparedness and low level of local community capacities, insufficient prevention awareness). The fact is, however, that financing the protection and rescue system from the budget of the Republic of Serbia, the province, municipalities and cities, the Emergency Fund and other income, has been insufficiently clarified and it is the main indicator of the possibilities of the country to reduce vulnerability to natural hazards. Therefore, we are going to analyze a possible theoretical SCN model (supply chain networks) and its applicability to the process of financing and equipping the directorates and emergency services in local communities throughout the Republic of Serbia.

### **Possible Model of Financing Local Communities with the Aim of Reducing Vulnerability**

Networks represent complex systems of elements governed by continuous mutual relationships, whereas the term chain represents a simpler type of organization in which the connection between the elements is established one-way. When it comes to supply chain networks (SCN), they suddenly appeared in theory and in practice and started developing after upgrading and mass use of technologies such as Radio Frequency ID (RFID), along with the already established use of the Internet and Global Positioning System. Over the past few decades, supply chain networks have inspired a number of interesting from scholarly studies and practical implications (Stadler, 2005).

The use of the said technologies improves standard supply model in terms of management and organization and transforms it into a supply chain network. Supply chain networks are a complicated network structure, and each specific relationship within this structure has a unique context (Chang, Chiang, & Pai, 2012). SCN is a model of distribution which is widely applied in business organizations, or in the areas where it is necessary to maintain continuity and improve the quality of feedstock or goods distribution from the place of production to warehouses, general distributors, representatives, stores, and/or individual users. This network structure covers both the dyadic level (e.g. a single supplier and buyer relationship) and the network level (e.g. the net, the upstream, or the downstream level) (Ritter & Gemünden, 2003). The importance of SCN functioning in contemporary world is of the utmost importance, mainly

for the economies of the countries throughout the world. Their importance to the timely and efficient delivery of products as varied as food, energy, pharmaceuticals, clothing, computer hardware, and even toys, etc., has fueled an immense interest in their analysis on the part of both researchers and practitioners (Nagurney, 2010). The possibilities and the advantages of SCN application in different business fields, social spheres, the protection of the most important infrastructure, environmental protection were the subject of research by Chen, Shih, Shyur and Wu, (2012), Eusgeld, Kröger, Sansavini, Schläpfer and Zio (2009), Cruz (2008).

The aim of this study is to explore the possibilities for the application of organizational and mathematical principles of supply chain networks at the theoretical level in the activities of financing and equipping the directorates and emergency services in local administrations across the Republic of Serbia. We will try to achieve this aim through two basic tasks: (a) the description of basic elements of risk assessment equations on the one side and SCN calculation model on the other side and (b) the proposal for SCN calculation model with the purpose of financing and supplying material to emergency services in local communities in our country.

From the viewpoint of management and modeling of the distribution of goods according to the network model, basic equations are those which calculate network density and the size of a group, or the cluster coefficient within which different users are located and reached by supply chains. The density – the number, ratio and border of all users are calculated according to the following formula:

$$D = 2E / N (N-1),$$

where: D – Density; E – border length (territory); N – number of users.

The number of connections between the users within one SCN is calculated according to the following formula:

$$e_i = k(k-1) / 2,$$

where k represents the number of users.

These formulas are used by production and distribution management with the aim of creating optimum models of supply chain networks, in order to deliver goods in the fastest, safest and cheapest way to their final destination, both local

distributors and end users. In this section we will present the possibilities for using these formulas to create supply chain networks which would distribute financial and material resources and equipment from Emergency sector positioned at a central, national level to local organizations of protection and headquarters. Well organized, directed and stable supply of emergency services at a local level is of importance to their equipping, continuous work and improving the effectiveness of prevention and emergency response. For this purpose, we will propose a theoretical model of supply chain network which is primarily applied in the field of economy, in order to establish whether there is a possibility and relevance of introducing such mathematical operations for better planning and more efficient management of emergency situations and the forces in charge of meeting these challenges. The model which is to be described allows for the possibility of even distribution of financial and material resources from the headquarters to local organizational units which may "cooperate" between themselves, in a manner the theoretical model defines, with the application of the equation of the shortest communication line between the two local units, it is possible to transfer necessary manpower, material or financial resources in case of emergency from the closest local units which possess the required resources. In this study, local organizations are referred to as administratively defined local self-governments - at municipality level, within which local emergency services are established.

The total area of the Republic of Serbia amounts to 77,468 km<sup>2</sup>, while the total number of municipalities amounts to 165. The data refer to the territory of the Republic of Serbia without its southern province of Kosovo and Metohija, over which republic authorities currently exercise no control.

When the presented data are inserted into previously provided and described formulas, the following data are obtained:

Density of transfer network – density amounts to:

$$D = 2 (77,468) / 165 (165-1) = 5.72 \quad (1)$$

Number of connections within a unified SCN amounts to:

$$e_i = 165(165-1)/2 = 13,530. \quad (2)$$

The above shows that it is possible to establish 13,530 connections between municipalities and their respective emergency services, i.e. money transfer connections, manpower and material resources, both from the central Emergency situation sector at a republic level to local units, and among municipalities in

case of emergency and out of necessity to transfer resources to particularly endangered parts of the territory.

Financial assets in the amount of RSD 72,418,683,000 have been allocated to Occupational Safety and Health Directorate and Budget Fund for Emergency Situations from the budget of the Republic of Serbia for the year 2013, which is approximately EUR 631,251,605.26. Decentralized and even transfer of allocated resources to local self-government units (beneficiaries), according to the formula adapted to resource distribution towards protection and rescue services where  $I = \text{money income}$ ,  $B = \text{budget resources}$ , results in the following:

$$I = B/ei,$$

$$I = 635,251,605.26 \text{ EUR} / 13,530,$$

$$I = 46,951.33 \text{ EUR}.$$

According to the given equation, every emergency service, i.e. local self-government protection and rescue service should receive EUR 46,951.33 of financial resources in 2013, which would result in a more efficient response of the country related to reducing vulnerability to natural hazards.

### **Discussion**

Vulnerability in contemporary circumstances is increasingly viewed as a cumulative process which includes various other dimensions and which causes a range of other problems which further affect each other in a detrimental way, or add others such as socio-economic problems. Vulnerability is defined by poor infrastructure and institutions and their insufficient ability and possibility to respond in terms of prevention and operation. Therefore, vulnerability is a situation which arises as a result of public policy and distribution of resources (as well as their availability) and thus it is often a major factor causing catastrophe. When emergency strikes, its power combined with the vulnerability of all the exposed elements, may lead to large-scale economic losses in poor, vulnerable areas, and especially in places with high economic investments concentration. In the most serious cases, after a natural hazard occurs, a complete or partial economic and social system “breakdown” may follow. For that reason, contemporary societies set certain standards related to the protection of their citizens which the Republic of Serbia took into account during the period of its own transition. Adopting a number of strategies and laws related to more realistic vulnerability assessment enabled the progress towards a more realistic

safety level of our citizens. The harmonization of normative acts and the creation of a conceptually more up-to-date system which would respond to the realistic level of community vulnerability in terms of organization and functionality was followed by a worrying and even alarming situation in practice. Namely, the Republic of Serbia has been perpetually at risk from natural hazards which have been an indicator of extreme vulnerability of the country and local community in the past decade, and insufficient flexibility to financially, organizationally and functionally respond to their consequences.

The Republic of Serbia made an effort to analyze the field of natural hazards by preparing strategies and laws in line with the model used in successful countries and taking into account its own requirements and previous experiences, and the effort resulted in obvious modifications. The aim of the strategies and laws is to create the atmosphere of more possibilities of the country to reduce its own vulnerability, that is: 1) reduced risk of emergency events and emergency situations, better organization and functioning of protection and rescue system which reduces material damage and the number of dead and injured in emergency events and emergency situations; 2) financing of protection and rescue system in emergency is regulated; 3) the laws stipulate efficient public administration operation related to the implementation of laws on protection and rescue in a state of emergency, define the term emergency, when it is declared, who declares it depending on the territory affected by a state of emergency; 4) define forming Emergency services at all levels with precisely defined competences, activities and tasks; 5) define protection and rescue subjects in a state of emergency at all levels; 6) precisely regulate rights and liabilities of government and other bodies, companies and other legal entities, as well as citizens in a state of emergency; 7) define direct management of protection and rescue activities in a state of emergency; 8) regulate the method of preparation and passing of planning documents, the preparation of vulnerability assessment of a territory for every possible state of emergency and depending on the assessment, passing of relevant protection and rescue plans.

Of all the listed elements, stable and directed financing of local communities and professional and operating forces and services is the key to success in reducing vulnerability to natural and other hazards. The application of SCN model, and the equation of the shortest communication line between two local units, enables the transfer of necessary manpower, material or financial resources in case of emergency from local units closest to one another which possess necessary resources, as well as equipping emergency services more adequately.

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