SAFE HEALTHCARE FACILITIES
Their Place and Role in Resilient Cities

by

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Given that mankind has occasionally been exposed to the devastation of catastrophic proportions throughout its history (extreme weather events, natural disasters, bioterrorism, and pandemics are having an increased global impact), which are increasing in the 20th century due to climate change, the risk reduction measures are being taken at the global level to reduce the severity of the consequences. Natural and technological disasters in the European countries have caused significant loss of life and damage to structures and infrastructure, which has led to the ratification of conventions at the world level in the field of disaster preparedness (Hyogo Framework for Action and Sendai Framework for Disaster Risk Management). Hospitals and other healthcare facilities are amongst those most jeopardized. The paper gives an overview of the methodology in the field of defining the resilience of healthcare facilities through determining the hospital safety index. Through the application of this and other methodologies in a case study conducted in Serbia, the paper examines the direct correlations between hospital safety index and climate change. Paper gives the results of hospital safety index calculation considering modules 2-4 and possibilities for the potential use of the module 1 (research on hazards) in separate evaluation.

Key words: *healthcare facilities, resilient city, climate change, safety evaluation, hospital safety index, case study, Serbia*

Introduction

Resilience in terms of cities generally refers to the ability to absorb, adapt and respond to changes in an urban system [1-3]. The resilience and preservation of the social infrastructure, within which schools and hospitals are of special importance, is an integral part of city resilience [4, 5]. Hazards can be natural or man-made (anthropogenic hazards) and they carry with them a high probability of causing socioeconomic consequences (possible human losses, damage to property, and the economy including the destruction of infrastructure), but also the probability of harmful effects on the environment (environmental impacts) [2].

The World Disasters Report 2010 warns that 2.6 billion people in urban areas in low- and middle-income nations are susceptible to high levels of risk generated by rapid ur-

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banization, poor governance at the local level, unprecedented population growth, and poor health services [6].

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted in 2015 [7], which set long-term goals and assessed the effects of the previous Hyogo Framework (168 signatories, including Serbia) [8]. Disasters that are often influenced by climate change are even more frequent and intense, making the progress towards sustainable development much more difficult. The Sendai Framework, together with the Action Plan, sets high targets within three priority fields: understanding disaster risk, strengthening disaster risk governance to manage disaster risk, and investing in disaster risk reduction for resilience [7].

Materials and methods

Hospitals as a part of the critical infrastructure

Population healthcare in special conditions caused by hazards is addressed through the issue of critical infrastructure. The European Directive 2008/114/EC defines critical infrastructure as an asset, system or part thereof located in the member states that is essential for the maintenance of vital societal functions, health, safety, security, and the economic or social well-being of people, the disruption or destruction of which would have a significant impact on a member state as a result of the failure to maintain those functions [9]. Each country adopts its own national regulations that define these issues in more detail.

Hospitals and other healthcare facilities play an important role during disasters, as they provide *lifeline* services to reduce the disaster associated mortality and mobility, and thus minimize the impact of disasters on the community [5, 10-13]. Efficient hospital disaster management is considered an essential way for hospitals to supply continuous health services during disasters, even if the hospitals are directly affected by the disaster [14, 15].

Hospital safety index – methodology

Having in mind that hospitals represent more than 70% of a country's public spending on health, it is important to provide continuity in their work during emergencies and disasters. Consequently, it is vital to identify the level of safety and functionality a hospital will have if an emergency or disaster occurs. Hospital evaluations aim to identify elements that need improvement in a specific hospital or network of hospitals (healthcare facilities), and to prioritize interventions in hospitals that, because of their type or location, are essential for reducing the mortality, morbidity, disability and other social and economic costs associated with emergencies and disasters [16].

In order to improve resilience of healthcare facilities in emergency situations, it is important to implement a methodology based on the hospital safety index (HSI), proposed initially by Pan American Health Organization [17]. The check is carried out by determining the HSI, which is a methodology for the fast and relatively economical evaluation of the functional capacity of a hospital. The HSI not only estimates the functional capacity of a hospital during and after an emergency, but it also provides ranges that help authorities determine which hospitals most urgently need actions to improve their safety and functionality.

The check is carried out using a basic group of criteria that is diversified into two forms: (1) general information on a hospital and (2) the safe hospital checklist, divided into four modules: module 1: hazards affecting the safety of the hospital, the role of the hospital in an emergency and disaster management, module 2: structural safety, module 3: non-structural safety, and module 4: emergency and disaster management. Each of these modules contains a set of questions for evaluation, whereby the risk is quantified based on the magnitude of impact on the safety and capacity of the healthcare facilities, as well as the probability of a risk occurring. The structural safety of the hospital involves assessment of the type of structure and materials, and the previous exposure to natural and other hazards. Non-structural safety refers to architectural safety, infrastructural protection, access and physical security, critical systems and equipment and supplies. The emergency and disaster management (the functional capacity) considers the level of preparedness of a hospital's organization, personnel and essential operations to provide patient services in response to an emergency or disaster.

There are two models for weighting the modules to calculate the safety index. Depending on the hazards identified through the module 1, the research was directed to the use of one of the following evaluation models (model 2):

- Model 1 (where there is a higher risk of earthquake and/or cyclones): structural safety has a weighted value of 50% of the index, the non-structural module has a weighted value of 30%, and the emergency and disaster management is weighted at 20%.
- Model 2 (all the modules are given equal weight): structural safety has a weighted value of 33.3% of the index, non-structural module has a weighted value of 33.3%, and the emergency and disaster management is weighted at 33.3%. This model was used as a base for the research, and some significant changes were introduced, having in mind specific conditions in the local environment which has been observed.

Case study of private healthcare facility in Serbia

The recognized hazards – Serbia

Serbia is exposed to the risk of disasters caused by natural and man-made hazards. The disaster frequency is shown in tab. 1. As can be seen from this table, the damaging effects of floods are the most pronounced. The recent experience with the floods that occurred in 2014 confirms both this trend and the severe damage caused by floods [18]. Table 1 provides an overview of the specific disasters that occurred in Serbia in the period from 2000 to 2015. Natural disasters prevailed in this period, while there were somewhat smaller technological disasters (mostly transport accidents) with significantly fewer casualties. Furthermore, it can be noticed that not many people were affected by technological accidents. The floods, extreme temperatures and earthquakes affected the greatest number of people. Given that extreme temperatures and earthquakes are less frequent, the floods can be considered the most serious threat to people, infrastructure and buildings. The most frequent disasters were recognized and they were taken into consideration in forming the module 1 in the case study.

Analysis of the hospital through modules 2-4

For the purpose of creating the model, the approach to the implementation of the HSI in Moldavian, Croatian, Italian, and Iranian models [19-22] were used. The model has been adapted and adjusted with significant, locally applied changes caused by the specific conditions in the territory of Serbia.

This study is the first time in Serbia that the HSI of a healthcare facility has been established. The research was carried out in the period November 2016-March 2017 on a private hospital in Belgrade built after 2000. This healthcare facility has been chosen, having in mind tendencies for the development of small-capacity hospitals on local and national level. In this regard, such institutions will play an important role in the future development of health care system in the next period in Serbia. Also, in the last decade there is huge development in the

Table 1. Summary of disasters for Serbia from 2000 to 2015

Year	Disaster group	Disaster type	Occurrence	Total deaths	Affected	Injured	Homeless	Total affected	Total damage
2000	Natural	**Extreme temperature**	1	3		70		70	
2000	Natural	**Flood**	2		6000			6000	
2000	Natural	Wildfire	1				12	12	
2001	Natural	Epidemic	1		170			170	
2002	Natural	Earthquake	1	1		100		100	
2002	Natural	**Flood**	1		2400			2400	
2002	Technological	Transport accident	1	10		31		31	
2003	Technological	Miscellaneous accident	1		307			307	
2004	Technological	Transport accident	1	12		38		38	
2005	Natural	**Flood**	1	2	1945		1845	3790	
2005	Natural	**Storm**	1		8750			8750	
2006	Natural	**Extreme temperature**	1	3					
2006	Natural	**Flood**	2		36200			36200	
2006	Technological	Transport accident	1	46		234		234	
2007	Natural	**Extreme temperature**	1						
2007	Natural	**Flood**	1		12370			12370	
2009	Natural	**Extreme temperature**	1			500		500	
2009	Natural	**Flood**	1		3210			3210	
2010	Natural	Earthquake	1	2	25440	120	1470	27030	132260
2010	Natural	**Extreme temperature**	2	5					
2010	Natural	**Flood**	3	2	4900			4900	
2012	Natural	**Extreme temperature**	3	25	88234			88234	
2013	Natural	**Flood**	2		3000			3000	
2014	Natural	**Extreme temperature**	1		3000			3000	
2014	Natural	**Flood**	4	56	59600			59600	2048262
		Total	36	167	255526	1093	3327	259946	2180522

Source: http://www.emdat.be/country_profile/index.html

private healthcare sector with the possibility for its inclusion in the existing national-funded healthcare system.

Private hospitals are generally more co-operative and open for the collaboration in the scientific research, and the procedure for obtaining approval and permits for research is altogether more efficient. Also there is greater possibility of benefits and direct application calculations of the HSI index in practice of such heath care facilities.

The healthcare facility is made up of two buildings (one new and one old). The old building has a ground floor, two upper floors and a gallery, while the new building has three lower floors, a ground floor and two upper floors, with a total gross building area of 2042 m^2.

The healthcare building 1 is older, and it has all technical documentation regarding its present state, while the healthcare building 2 is newer and has a complete project documentation. The ground floor of the building one becomes floor 2 in the building 2 and they act as one area in the healthcare center. The capacity of the healthcare facility is 8 apartments (about 16-24 beds/patients), figs. 1 and 2.

The HSI questionnaire was filled out through an interview with the technical staff from the healthcare facility. They mostly completed questions from modules 2-4. The healthcare facility's technical documentation was used to fill in modules 2 and 3. It included architectural plans and sections, technical descriptions of the buildings, the electrical scheme, and plans, *etc.* During the research, the data and interviews showed that the healthcare center has not been at risk of such hazards so far. The model 2 was implemented for the calculation of the HSI.

The checklist for the module 2 was used to evaluate the structural safety after examining the technical documentation and interviewing the technical director and the staff. The module 3 and module 4 were most important for the risk management of this facility because improving the health center's function directly depends on implementing the risk management measures in those areas. The evaluation of the module 4, the emergency and disaster management, was mostly positive because the healthcare center has the risk management strategic documents and an action plan in case of mass accidents and accident situations.

Figure 1. Site plan of the buildings
Source*: https://a3.geosrbija.rs/*

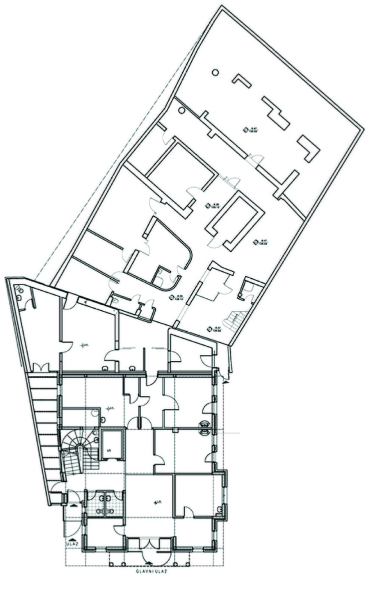

Figure 2. Ground floor elevation of the old building (southern part) and the new building (northern part). Source*: Technical documentation of the private health care center, 2016*

Results – resilience of hospital capacities in Serbia

The final part of the research included the resuming of calculation within the Summary of Safety Ratings, tabs. 2 and 3) given the percentage of risk for each element of the structural and non-structural safety of the healthcare facility. This table consists of 3 modules (module 1 was not included in the initial evaluation process, but it was elaborated as a separate part of the research).

The results were summed according to the given marks and then combined together using the corrective factors from the model 2 (equal percentage of importance 0.33 for each module).

Table 2. Calculation of the hospital safety (HSI checklist) by the separate modules 2-4

Module 2. Elements related to the structural safety of the hospital							
	Number of items			Weighted contribution to module [%]			
	Low	Average	High	Low	Average	High	Total
2.1 Prior events and hazards affecting building safety	0	0	3	0.00	0.00	25.00	25.00
2.2 Building integrity	1	4	10	2.25	12.75	60.00	75.00
Total	1	4	13	2.25	12.75	85.00	100.00
Module 3. Elements related to the non-structural safety of the hospital							
3.1 Architectural safety	2	3	9	2.30	6.90	13.80	23.00
3.2 Infrastructure protection, access and physical security	1	1	2	2.50	2.50	5.00	10.00
3.3 Critical systems	5	11	37	3.50	9.98	36.53	50.00
3.3.1 Electrical systems	2	3	5	1.30	3.60	5.10	10.00
3.3.2 Telecommunication systems	1	0	7	0.40	0.00	4.60	5.00
3.3.3 Water supply system	2	0	4	1.80	0.00	8.20	10.00
3.3.4 Fire protection system	0	0	5	0.00	0.00	7.50	7.50
3.3.5 Waste management systems	0	2	3	0.00	1.38	1.13	2.50
3.3.6 Fuel storage systems	0	0	5	0.00	0.00	5.00	5.00
3.3.7 Medical gases systems	0	6	0	0.00	5.00	0.00	5.00
3.3.8 Heating, ventilation, and air-conditioning (HVAC) systems	0	0	8	0.00	0.00	5.00	5.00
3.4 Equipment and supplies	2	6	13	1.62	4.59	10.80	17.00
3.4.1 Office and storeroom furnishings and equipment (fixed and movable)	1	0	1	0.85	0.00	0.85	1.70
3.4.2 Medical and laboratory equipment and supplies used for diagnosis and treatment	1	6	12	0.77	4.59	9.95	15.30
Total	10	21	61	9.92	23.97	66.12	100.00
Module 4. Emergency and disaster management							
4.1 Co-ordination of emergency and disaster management activities	0	3	5	0.00	4.80	10.20	15.00
4.2 Hospital emergency and disaster response planning	0	0	5	0.00	0.00	18.00	18.00
4.3 Communication and information management	0	0	4	0.00	0.00	7.00	7.00
4.4 Human resources	0	0	5	0.00	0.00	20.00	20.00
4.5 Logistics and finance	0	1	3	0.00	2.00	6.00	8.00
4.6 Patient care and support services	0	1	8	0.00	5.00	20.00	25.00
4.7 Evacuation, decontamination and security	0	1	4	0.00	1.05	5.95	7.00
Total	0	6	34	0.00	12.85	87.15	100.00

Source: Authors

Table 3. Summary of the results of the calculation of the HSI by the separate modules 2, 3 and 4

Module	Unlikely to function (Safety level = low)	Likely to function (Safety level = average)	Highly likely to function (Safety level = high)	Total
Structural safety (module 2)	2.25	12.75	85.00	100
Non-structural safety (module 3)	9.92	23.97	66.12	100
Emergency and disaster management (module 4)	0.00	12.85	87.15	100

Source: Authors

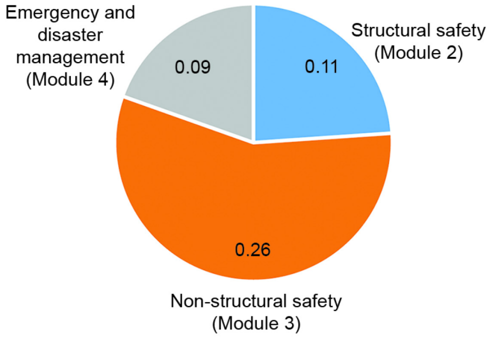

Figure 3. Results of the calculation of the HSI of the vulnerability by the separate modules 2-4.
Source*: Authors*

Also, local hazards that are specific to Serbia were mentioned in tab. 1, but were not evaluated since this healthcare center was in no way at risk of any of them, as it is not situated in the risk zone. Also, the anthropogenic hazards were observed only in the field of technical hazards. The group of social hazards (protests, migrants, *etc.*) was also not evaluated as crucial to this specific case study, since it was not the research topic. The corrective factors used in the HSI study in Serbia correspond to the given factors defined by the World Health Organization (WHO). In a specific case, the changed factors (model 1 or model 2) would not have significant consequences on the outcome of the study, since the results in all categories can be considered as favorable. On the other hand, having in mind that in Serbia the safety structure of health facilities is generally good, and the risk management is at a low level, it is important to reorganize priorities when calculating the HSI as follows: the highest priority should be given to the emergency management (promoting the preparedness of hospital staff), then to the non-structural safety, while the structural safety can have a value of 0.2 (possibly 0.3). Namely, during the study it was established that the greatest range in scores for individual categories was in the context of emergency risk management. In this way, a more precise assessment of the shortcomings in the safety structure of health facilities can be made. Considering the present state of the health center, the evaluation of module 2 is mostly good or excellent. The main problems are observed in modules 3 and 4, so they have a need for the re-evaluation in the final recapitulation. These results actually show the real vulnerability of health facilities. Evaluating the healthcare center with the given data (and based on the methodology of the World Health Organization) showed that it has a safety index of **0.85** (from max. 1) (Model 2 – module 2-4: 0,33) and **0.86** (Model 1 – module 2: 0.5; module 3: 0.3; module 4: 0.2) – which puts it in category A (values from **0.66 to 1.00)**. This means that the facility will probably function without problems in the emergency and disaster periods, but it also needs to be monitored further. The results for this case study are mostly positive (the evaluation scores were high) and, because of that, the final result does not change if we change the corrective factors of the modules, fig. 3. In further research (regarding healthcare facilities in Serbia), the corrective factors of structural safety should have a lower value than the others.

Discussion on module 1 – direct correlation between climate change and HSI

After the evaluation of the building safety according to modules 2, 3, and 4 it was recognized that it is necessary to use the module 1 not only as part of descriptive data (although represented in a table) but also as an additional parameter in assessing the hospital safety. This part of the HSI evaluation is closely related to the specific hazards (in the territory of Serbia). Thus, this module is not determined in the research, but the paper gives recommendations for its integration into the evaluation of hospital safety with a view of specific hazards in the local context.

The methodology for the HSI, in the final stage of the calculation, does not consider sufficiently enough climate change impact on the increased risk of natural disasters (flood, windstorm, drought, fire, *etc.*), which is necessary for further evaluation of resilience of certain buildings. In this case, based on the research conducted for the needs of this case study, it was concluded that the further research should be also extended to surrounding built area. In this way, the direct causes of hazards would be determined and evaluated.

This problem was treated only through the module 1, hazards affecting the safety of the hospital and the role of the hospital in emergency and disaster management. It is used to determine the hazards that may directly affect the safety of the hospital, as well as those for which the hospital may be expected to provide health services in response to emergencies and disasters, which directly determines hazards that are not included in the calculation of a hospital's safety index.

The module 1 is an initial recommendation on hazards in relation to which the vulnerability/safety is assessed, and it is necessary to carry out its further evaluation at a specific example and to include information and potential warning about the surrounding context of the building. In addition to not being evaluated in a single evaluation, there is also a lack of correlation between this and other modules.

This paper gives methodological recommendations for defining the method of assessing the parameters of the module 1, as well as for its direct integration into the evaluation given through other modules. The group of hazards directly conditioned by climate change is marked in the module 1 in the sub-chapter on hydro-meteorological hazards as follows: meteorological hazards (windstorms, *etc.*), hydrological hazards (excessive flooding, flash floods, *etc.*), as well as climatic hazards (temperature extremes, wildfires, droughts, *etc.*).

For the needs of this paper, all mentioned parameters herein were chosen as relevant, considering the local conditions given through this case study. The meteorological hazards were weighted at 30%, hydrological hazards were weighted at 20%, and climatic hazards were weighted at 50%. In this way, a significant contribution was given to a comprehensive evaluation of the HSI because the parameters that were not included in the standard evaluation were also taken into consideration. In addition, in order to establish a direct correlation between the HSI calculations, within the research were used the guidelines given in the Action Plan of the Republic of Serbia [23] and those contained in the Sendai Protocol [7] which should be implemented in the local HSI:

- establishing a set of measures within designing of buildings that would ensure the construction in accordance with: temperature conditions through a control of internal temper-

ature, the improvement of thermal insulation of buildings, passive cooling, *i. e.* enabling the natural ventilation of buildings, strategic designing of green areas, *etc.*
- establishing a set of measures within urban planning which would prohibit the construction of buildings in the areas that could be threatened by flooding, landslides, flash floods, and other natural hazards.

Conclusions

The conducted HSI analysis that was applied in the area of a private health care facility in Belgrade indicated the area for possible improvement of the methodology for the HSI developed by the WHO.

Namely, considering the fact that low indices of vulnerability of the healthcare facility were obtained through the results of the standard evaluation (modules 2-4), it is possible to conclude that the building belongs to category A, which means that it is likely that the hospital will function in emergencies and disasters. It is recommended to continue measures to improve emergency and disaster management capacity and to carry out the measures in the medium and long term to improve the safety level in case of emergencies and disasters.

On the other hand, the assessment of the safety of modules 2-4 showed a high-level safety, but the impact of hazard in a certain local context was neglected. For this reason, the paper suggests that additional criteria for the evaluation should be introduced, given through module 1. Although they were given in the standard HSI checklist, they are not valued in the overall evaluation of the building.

In order to establish a direct correlation between hazards affecting the safety of the hospital and the role of the hospital in the emergency and disaster management, on the one hand, and the structural and non-structural safety and the emergency and disaster management, on the other hand, the parameters not included in the standard evaluation were also taken into account. In addition, the guidelines given in the action plan were also used in the research to establish direct correlations between the HSI calculations.

In addition to the technical documentation which must be a part of the standard set of data for the analysis and assessment, it is also necessary to obtain data related to the hazard risk maps and other relevant documents that may be of importance for risk assessment (action plans for the adaptation to climate change, national action plans related to the natural hazard risk assessment, action plans for the responses of public buildings to risk, strategies, spatial and urban plans for the area, *etc.*).

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References

[1] Tompkins, E., Hurlston, L.-A., Public–Private Partnerships in the Provision of Environmental Governance: A Case of Disaster Management, in: (Eds. E. Boyd, C. Folke), *Adapting Institutions: Governance, Complexity and Social-Ecological Resilience,* Cambridge University Press, Cambridge, UK, pp. 171-189, 2012
[2] ***, UNISDR 2009 UNISDR Terminology on Disaster Risk Reduction, Geneva: United Nations International Strategy for Disaster Reduction (UNISDR), 2009, http://www.unisdr.org/we/inform/terminology

[3] Desouza, K., Flanery, T., Designing, Planning and Managing Resilient Cities: A Conceptual Framework, *Cities, 35* (2013), Dec., pp. 89-99
[4] Chang, S., *et al.*, Toward Disaster-Resilient Cities: Characterizing Resilience of Infrastructure Systems with Expert Judgments, *Risk Analysis*, *34* (2014), 3, pp. 416-433
[5] Zhong, S., *et al.,* Validation of a Framework for Measuring Hospital Disaster Resilience Using Factor Analysis, *International Journal of Environmental Research and Public Health*, *11* (2014), 6, pp. 6335-6353
[6] ***, IFRC (International Federation of Red Cross and Red Crescent Societies) World Disasters Report 2010, Focus on Urban Risk, Geneva: International Federation of Red Cross and Red Crescent Societies, 2010
[7] ***, UNISDR Sendai Framework for Disaster Risk Reduction 2015-2030, Geneve: The United Nations Office for Disaster Reduction, 2005, http://www.unisdr.org/we/coordinate/sendai-framework
[8] ***, UNISDR, Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, Geneva: United Nations International Strategy for Disaster Reduction, 2005 http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf
[9] ***, OECD, Protection of Critical Infrastructure and the Role of Investment Policies Relating to National Security, Paris: Investment Division, Directorate for Financial and Enterprise Affairs Organization for Economic Co-Operation and Development, 2008 www.oecd.org/investment/investment-policy/40700392.pdf
[10] Albanese, J., Birnbaum, M., *et al.,* Fostering Disaster Resilient Communities Across the Globe through the Incorporation of Safe and Resilient Hospitals for Community-Integrated Disaster Responses, *Prehosp. Disaster Med. 23* (2008), 5, pp. 385-390
[11] Braun, B. I., *et al.,* Integrating Hospitals into Community Emergency Preparedness Planning, *Ann. Intern. Med. 144* (2006), 11, pp. 799-811
[12] Paturas, J. L., *et al.,* Collective Response to Public Health Emergencies and Large-Scale Disasters: Putting Hospitals at the Core of Community Resilience, *J. Bus. Contin. Emer. Plan. 4* (2010), 3, pp. 286-295
[13] Cimellaro, G. P., *et al.,* Framework for Analytical Quantification of Disaster Resilience, *Eng. Struct. 32* (2010), 11, pp. 3639-3649
[14] Sauer, L. M., *et al*., Major Influences on Hospital Emergency Management and Disaster Preparedness, *Disaster Med. Public Health Prep. 3* (2009), Suppl. 1, pp. S68-S73
[15] Barbera, J. A., *et al.,* Challenge of Hospital Emergency Preparedness: Analysis and Recommendations, *Disaster Med. Public Health Prep. 3* (2009), Suppl. 1, pp. S74-S82
[16] ***, WHO News Release, Protecting Hospitals and Health Centers before Disasters Saves Lives, www.who.int
[17] ***, World Health Organization, 2015, Hospital Safety Index – Guide for evaluators, Pan American Health Organization, http://www.who.int/hac/techguidance/hospital_safety_index_evaluators.pdf
[18] ***, Floods in Serbia in 2014 (in Serbian) 2014. http://www.obnova.gov.rs/uploads/useruploads/Documents/Izvestaj-o-proceni-potreba-za-oporavak-i-obnovu-posledica-poplava.pdf
[19] Pisla, M., *et al.,* Evaluation of Hospital Safety in the Republic of Moldova, Chsiinau: Republican Center for Disaster Medicine, 2010 http://www.ms.gov.md/sites/default/files/evaluation_of_hospital_safety_in_the_Republic_of_moldova.pdf
[20] ***, WHO Regional Office for Europe Assessment of Health-System Crisis Preparedness: Croatia, Copenhagen, 2011, http://www.euro.who.int/en/countries/croatia/publications3/assessment-of-health-system-crisis-preparedness-croatia
[21] Aiello, A., *et al.,* A Safety Index for Hospital Buildings, *Disaster Advances*, *5* (2012), 4, pp. 270-277
[22] Ardalan, A., *et al.,* Hospitals Safety from Disasters in IR Iran: The Results from Assessment of 224 Hospitals, 2014, 6, retrieved from: https://www.ecurrents.dis.8297b528bd45975bc6291804747ee5db
[23] ***, Akcioni plan adaptacije na klimatske promene, (Action Plan for Adapting to Climate Change - in Serbian), Official Gazette of the City of Belgrade, No. 65/2015, http://klimatskepromenebeograd.rs/wp-content/uploads/2015/11/Akcioni-plan-adaptacije-na-klimatske-promene.pdf

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