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RISK MANAGEMENT IN SEISMIC ACTIVE AREAS

HOLISTIC APPROACH

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Abstract

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Civilization in its stream of development had certain periods when large-scale disasters caused by natural phenomenon happened: earthquakes, floods, fires. Results are always devastating - destruction of lives of people, flora and fauna, material goods, while also resulting in constant change of topography of the country. Man in this atmosphere was forced to learn about the causes and to explore ways of how to protect and overcome effects of earthquakes and other disastrous events. The ability of reintegration and reconstruction shows the strength of humanity, endeavours, orientation to organization. There was a need to comprehend seismic phenomena, to establish national strategies and legislations for building, all for providing a safe living and working environment.

In Montenegro, which is a seismically active area, earthquakes were through time different in scale but not in tragic results of loss. Risk management of disasters, which are affecting all segments of society, to be effective is going to have to have strategies which involve all segments of society. There is a need for a holistic approach to disaster reduction. That approach has to involve education, health, civil protection and all other segments of society "organism". Specifically in situations of seismic hazard in the area of construction, where is intended to define acceptable seismic risk, to build high-quality and safe. Risk management process is therefore a long-term process, and points to the need to effectively implement initiatives in a holistic approach, such as the improvement of early warning systems, establishing national focal points, have organization based in smaller communities, municipalities, planning and legislation, volunteering for risk management activities, involving NGO sector. In response to always present and growing possibilities of natural disaster, this approach seeks to manage risk and vulnerability caused by natural disasters, so as to find what are identified gaps in the cycle of reducing the risk and to encourage the involvement and collaboration between all sector society in order to achieve an effective reduction of hazard.

1. Introduction

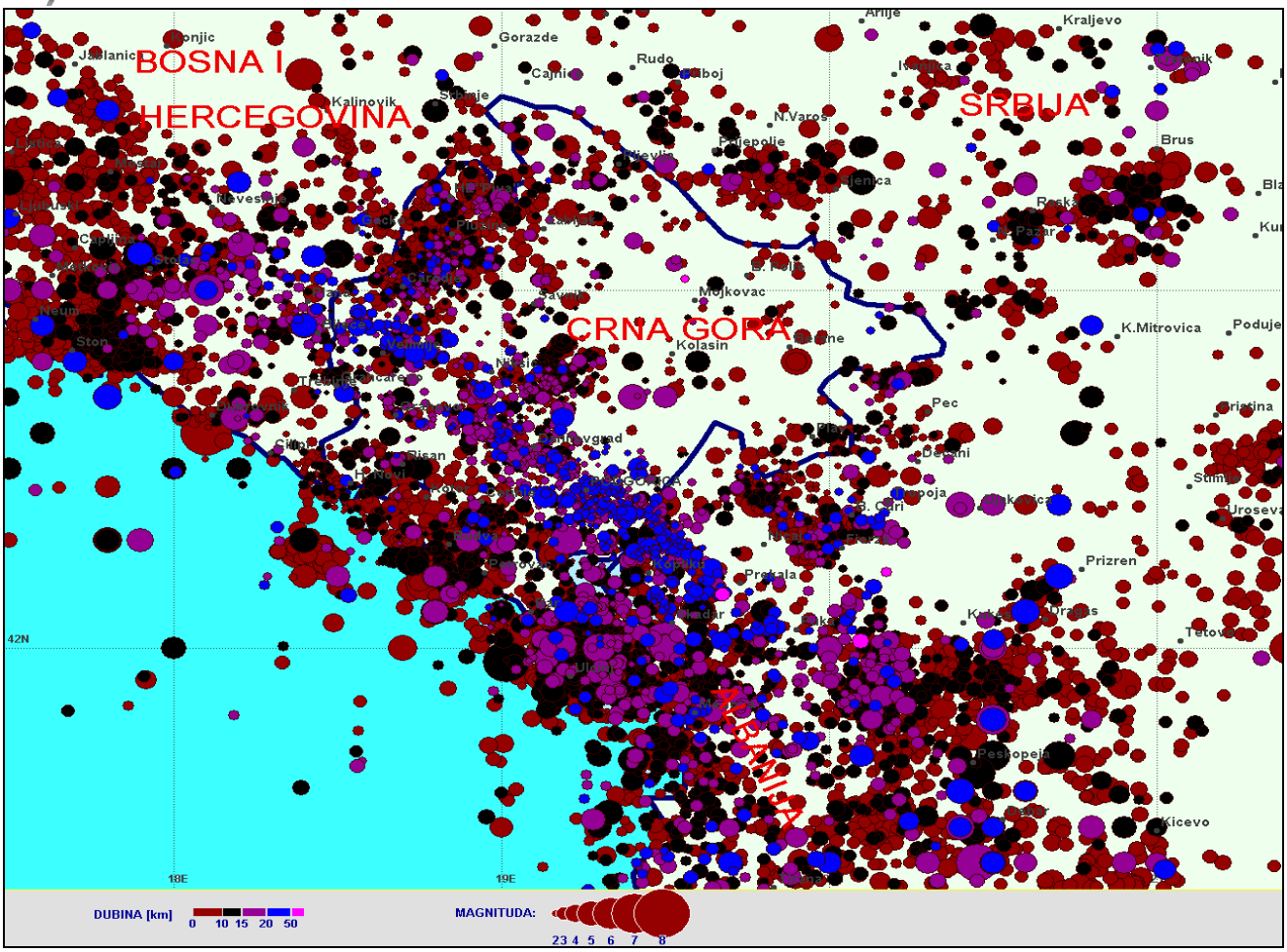
Through history of civilization, man strived to acquire knowledge on things that improve his life, contributing to advancement of culture, science, technology, providing for knowledge and functionality of environment. However, this connection is not proportional, but there are rather times when that environment – nature, makes him powerless, broken down and in awe. It often happens that disasters such as earthquakes, floods, fires and other emergencies re a consequence of men's action or natural occurrence. In the very nature and environment, various and complex processes occur, of stochastic nature, caused by dynamic and undefined interactions. Interest of man, caused by the need to overcome or prevent their affect to his survival, brought him closer to learning about these phenomena, discovering their regularities, and attempts to prevent tragic effects of their occurrence. Earthquakes causing huge casualties and damage, as well as topographic changes of territory are the least predictable natural occurrence. Effects of such events were not only the named losses, but also personal sense of fear, helplessness and incapability to confront this natural occurrence. However, attitude towards different aspects and areas of organization of life created conditions to put personal, yet different accomplishments, to function of prevention of such occurrences, or to make step forward, in case of frequent seismic activities at certain territory, through organization of functioning and assistance to citizens, through specific construction and structuring, research of materials adapted and resistant to earthquakes. Taking into consideration the suddenness of earthquake occurrence, necessity for urgent actions, difficulties in using specialized mechanisation and people, due to their endangered position, communication problems caused by interruptions and missing of information transfer, saving buried and injured people, causes that this area is subject to serious research in the part of material research and types of construction, as well as learning about standards in other countries, establishing cooperation and organisation with other entities whom with, in regular situations, the cooperation is not necessary (medical help, firefighters and security, transport services), in order to be in line with the development of expert research in civil engineering, during design development, improvement and construction at affected areas.

2. Montenegro as Seismic Area

Montenegro is situated in South-East Europe, covering the area of 13 812 km2, with, according to the census of 2003, 190 212 households and total population of 620 145 inhabitants (1) (based on so-called new concept of permanent population). Montenegro has sovereignty over the part of the Adriatic Sea and coast in the area that is 12 nautical miles away from main land (22.2 km). The climate is prevailingly continental and Mediterranean, as well as mountain. Podgorica is the capital, whereas Cetinje is the old capital. Land borders are around 614 km long, whereas the length of the coast is 293 km. There are four large national parks in Montenegro (Durmitor, Lovćen, Biogradska Gora and Skadarsko lake basin), with total area of 91.000 ha. The abovementioned shows that Montenegrin territory is characterized by huge geographical and biological diversity, linked with specific natural phenomenology which makes it interesting, but sometimes dangerous.

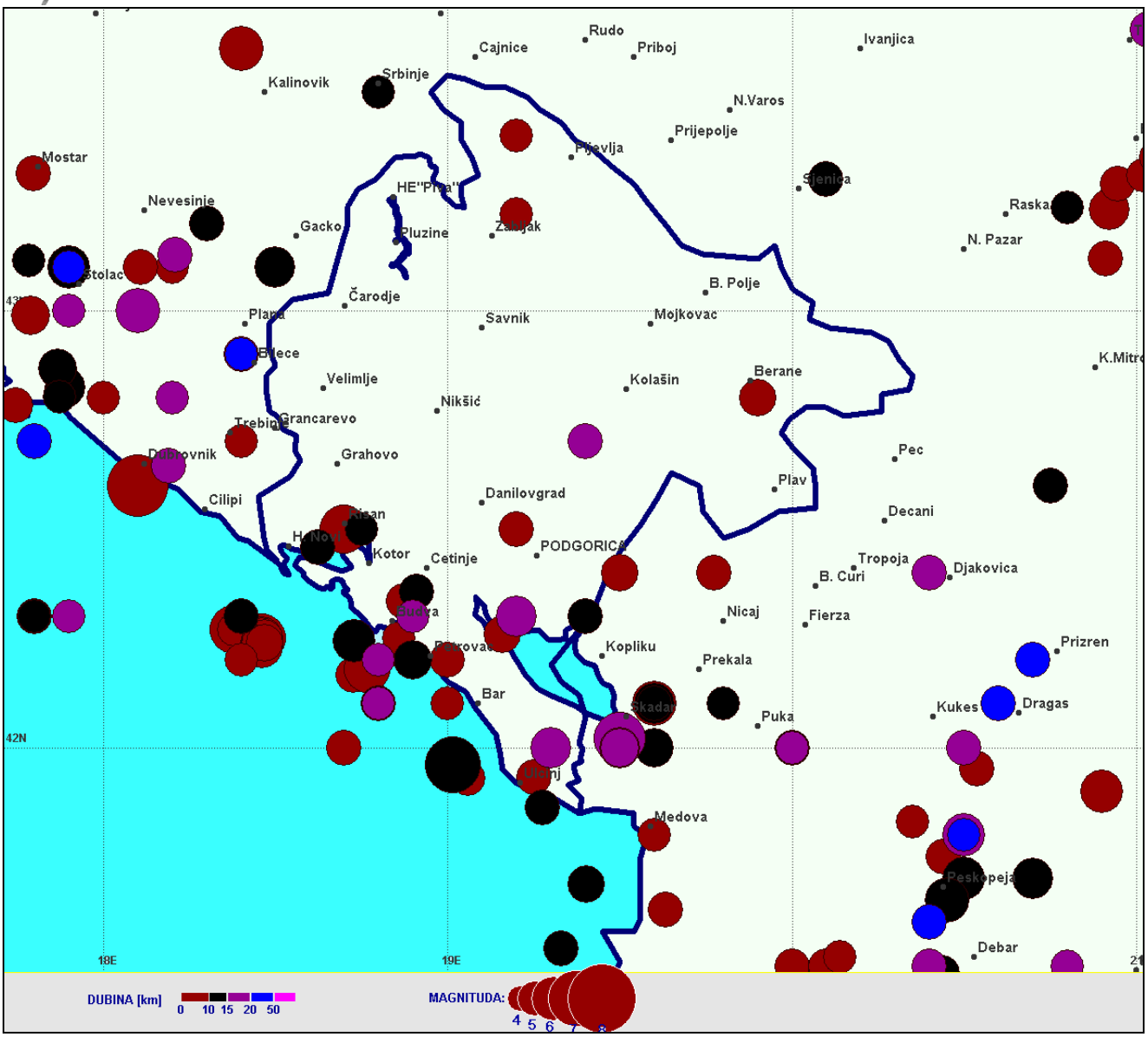
Old archive records dating back to XV and XIV centuries show that risk of earthquakes was and remained a huge natural threat and element with most difficult consequences in terms of lives and material assets in all the countries of the north margin of Mediterranean, including Montenegro. As a consequence of geodynamic processes, with regional geophysical investigations and precise satellite and geodetic observations, it is shown that the largest part of south Adriatic and significant part of south Dinarides was the place of numerous devastating and disastrous earthquakes. In terms of high seismic hazard, coastal area of Montenegro is excelling, and there are other hazards, caused by other geological processes: landslides, rock slides and soil liquefaction in dynamic conditions.

[1] Source: Statistical Yearbook of Statistical Office of Montenegro (Monstat), 2005 edition



Picture 1. Map of epicentres of all properly documented earthquakes that hit Montenegro and its neighbouring area, in the period from XV century until the end of 2005

This Picture shows the part of Montenegrin territory generating strong and devastating earthquakes that have occurred in the area over the last five centuries (Picture1). Seismically active area of Montenegro can be seen in seismogenic areas around Ulcinj and Bar, Budva and Brajići and around Boka Kotorska bay, as well in the vicinity of Berane, entire area of Skadarsko Lake, massif of Maganik, etc.



Picture 2. Map of epicentres of devastating and disastrous earthquakes in Montenegro and its neighbouring area

over the last five centuries

The strongest earthquake that hit Montenegro occurred on April 15, 1979 (at 07:19:40, local time), with 7.0 magnitude and epicentral intensity of IX degrees of MCS scale. Montenegrin coast was hit by devastation of that intensity, with 136 casualties (101 in Montenegro and 35 in Albania) and more than 4 billion US dollars of damage.

Based on research and monitoring, over the several previous centuries, seismic activities in Montenegro and its neighbouring area, frequency of occurrence of strong and devastating earthquakes is being recorded. It can be concluded that, on average, “every 3 years there was at least one earthquake of VII degrees of Mercalli intensity scale, every 15 years earthquake with VIII degrees intensity, and, on average, every 60 years, a devastating or disastrous earthquake, with casualties..“ (2) Monitoring causes of long-term geodynamic processes without changes in occurrence in the Mediterranean region bring to conclusion that identical seismic scenario will continue. It all leads to the conclusion that our community, same as anywhere else in the world, must live and

co-exist with seismic hazard. However, this phenomenon cannot be observed only as natural occurrence, but we must take into consideration that it is partly due to human activities, that do not acknowledge neither characteristics of movement of soil due to earthquakes in the region, nor techniques and methods of seismic planning, projecting and construction in practice. Seismic hazard for Montenegrin territory has been defined several times, using different methodological approaches. It is important to mention some of existing seismic basis that are being used:

- Map of seismic reionisation of the territory of Montenegro (1982),
- Series of temporary seismic maps (1987),
- Seismic hazard as part of Spatial Plan of Montenegro (1988),
- Seismic micro-reionisation of urban areas in all municipalities in Montenegro (1984-1988), and
- Seismic hazard for the new Spatial Plan of Montenegro (2005)." [(2)]

Picture 3. Map of seismic reionisation of the territory of Montenegro

First design of seismic hazard map for Montenegro, on regional level, was developed by Seismological Service of the Republic of Montenegro, in cooperation with the Bureau for Geological Research of Montenegro and Institute of Earthquake Engineering and Engineering Seismology from Skopje. It was a Map of seismic reionisation (Picture 3) for the conditions of so-called middle ground, developed during 1982. The map contains the parameter of basic level of seismic intensity on the territory of Montenegro, with several zones of seismic hazard:

- "southern, coastal region, zone of Ulcinj-Skadarsko lake, Buva-Boka Bay, with possible maximum intensity in the conditions of middle ground of IX degrees MSC,
- Zone of Podgorica-Danilovgrad, with possible maximum intensity of VIII degrees MSC,

- Middle part of Montenegro with northern region, including Nikšić, Kolašin, Žabljak and Pljevlja, characterized by maximum possible intensity of VII degrees MSC, and
- Isolated seismogenic zone of Berane, than can generate earthquakes with maximum intensity of VIII degrees MCS.“ (2)

3. The Role of Civil Engineering in Prevention of Seismic Risk Resulting From Realization of Seismic Hazard

In the area of civil engineering, the term of seismic risk is being used. Exposure of human and material resources to the dangers caused by earthquakes must be taken into consideration when spoken of seismic hazard. That is actually anticipated and expected level of loss or damage, caused by earthquake at certain place and at certain time. There, four basic components of risk and their interconnections must be known:

1. Seismic hazard,
2. Elements of exposure to seismic hazard: population, structures, economic and/or cultural and historical values, etc.
3. Location of the exposed element against the hazard, and
4. Vulnerability of elements (degree of possible losses or damage) under the hazard, which can be divided into physical, social and economic categories.

Priorities in risk management are determined based on seismic mitigations, and reduction of possible hazardous effects of earthquakes due to estimated risk. Namely, planned measures and actions are defined and implemented, through gradual activity on planned and contemporary spatial planning and design, then through elimination or reinforcing most vulnerable types of structures, redistribution of significant activities, insurance policy, all with the goal to reduce expected effect of seismic hazard, as well as various other measures.

As most common factors of the vulnerability of community against seismic hazard, are:

- Increased population density and increased investments in the areas of high seismic hazard, due to influx and increase of inhabitants;
- Lack of practice of applying adequate methods in construction, i.e. unsustainable development;
- Non-existing adequate social measures of management in urgencies in case of increased influx of population;
- Lack of strict control measures and degradation of natural resources-environment;
- Weak institutional capacities and participation of local community in addressing disasters;
- Unpreparedness of community for emergencies, as well as inadequate communication and transport infrastructure, and inadequate market mechanisms. (2)

Thus, it is necessary for engineering experts to apply to full extent advanced, state-of-the-art knowledge on construction materials, constructions, as well to apply novel approaches in designing seismically resistant structures and incorporation of analytical methods that enable use and development of complex models in estimation of behaviour of structures. Of course, in addition to all

aforementioned, there should be better understanding of seismic hazard phenomenon and more reliable determining. That will directly influence the reduction of post-earthquake soil vulnerability, improvement of communication in the community affected by earthquakes.

4. Strategic Holistic Approach

All of the mentioned considerations that are a result of the situation in Montenegro and world. They point to the need to regulate comprehensive and functional system of prevention of catastrophes, protection and rescue in potential natural disasters. That shall be accomplished only through development of adequate legislative and strategic framework on national level. Through National Strategy for Emergency Situations (adopted in 2005), Montenegro sets fundamental commitment for adequate response to emergency situations, in line with global intentions and international community commitments to disaster mitigation. In addition to legislative, foundation of organizational parts was initialized, encompassing new organizational units within governmental institutions and ministries, with the aim to suppress technical and technological emergencies, biological, chemical, nuclear and radiological emergencies and emergence of epidemic infectious diseases with high numbers of diseased and casualties. Over the last couple of decades, destructive hazards are registered on Montenegrin territory, including: earthquakes and accompanying occurrences (landslides and rock slides), floods, fires, environmental pollution. Recommendations of ***Yokohama Strategy and Plan of Action for a Safer World***, adopted by the members of United Nations in 1994, are: to strive to prevent disasters through strengthening and preparedness of society on national, regional, international levels, which is achieved through planning and development of policy for disaster prevention, through preventive measures, mitigation of effects and improving preparedness of society to their occurrence. Namely, this approach is believed to have higher benefits and to be more humane and much more efficient, than approach focused on response to disasters. Prevailingly, disaster and emergency prevention shall include at least three components: continuous technical monitoring of processes and events that can result in emergencies or disasters, simulating emergency scenarios, based on real indicators and experience, as well as defining potential emergency sources and addressing observed weaknesses of the system. Thus, National Strategy for Emergency Situations shall encompass the concept of disaster risk reduction in highly vulnerable regions and social groups, lacking in adequate institutional capacities for disaster management. National Strategy for Emergency Situations in Montenegro shall define basic strategic solutions and guidelines for risk reduction for all natural and technical hazards, primarily through implementation of following tasks:

- Creating network of existing and new institutions for timely, organized and efficient acting in emergency situations in Montenegro;
- Raising awareness and organize participation of citizens on local and regional level within organized social action in emergencies;
- Encouragement of research community for development in the field of phenomenology, influence, genesis, monitoring, forecasting disasters, in order to mitigate effects;
- Technical and expert improvement of the execute in order to monitor and prevent technical and technological emergencies with heavy effects on community, material goods, cultural heritage and environment;
- Defining the level of acceptable risk that natural and technological hazards can have on development of community and space, with existing resources;
- Defining platform for creation of solid and efficient action plan for relief of effects of natural and technological hazards, in line with possibilities.

Strategy as a framework sets basis for definition of concepts of emergency situations management that then give clear guidelines for preparation of national operational action plans addressing all types of disasters, and also stipulates passing of regulations for prevention of emergency situations and relief of effects, that will be harmonized with following regulations of European Union: Law on protection and rescuing, Law on Trade of Dangerous Substances (procurement, use, storage and transport), Law on Transport of Explosive Substances, Law on Transport of Weapons, Military Equipment and Dual-Use Goods, Law on Explosive Substances, Combustible Liquids and Gases, Law on Seismic and Hydrometeorological Activities. The harmonization is necessary in order to provide comprehensive regulation of the areas significant for monitoring, research and control of natural phenomena that can cause disasters, early warning and forecast of development of those processes. Technical norms for construction in seismic areas (in accordance with the EUROCODE 8 regulation of European Union), as well as technical regulations for auscultation of all large hydro-technical structures, Law on Protection of Forests.

The holistic approach can be achieved not only through framework for action within National Strategy for Emergency Situations caused by natural and other disasters, but also through prioritization and commitment, with encouragement of their interdependencies and coordination, in order to achieve overall social and civilizational benefit. Actions should be taken, starting with adopting legislation, establishment and coordination within the network of institutional and non-institutional sectors, implementation of public, awareness raising actions on action against and after disasters, as well as improving consumption of resources, through various innovative activities aimed at improving implementation of preventive measures, ending with post-disaster actions, i.e. mitigation of effects on lives and material resources.

5. Conclusion

Existing risks of living in seismologically active areas imposes not only strengthening and implementation of innovation in civil engineering in material goods' development, but also in coordination and better implementation of normative framework, as well as engagement of all stakeholders in the said area. Adjustment to living in high risk areas should start at the very beginning, starting with development of ethical, cultural, family and societal patterns that raise awareness, all the way to incorporating specific recommended methods of building one's living environment, with maximum preservation of natural resources. This task is by no means easy, but it is futuristic, since there is no possibility to stop the planet and get off when it becomes too crowded or destroyed. Within holistic approach, series of tendencies at all levels shall be developed, in order to transform weaknesses and difficulties into advantages through innovation in construction (respecting rules and innovation principles), materials (developing and research of new and resistant materials), social context (development and coordination of institutional and non-institutional), education (education for emergency activities, introduction of contents on emergency situations in curricula, student parliaments, camps), health and social welfare (trainings, structures, actions), as well as in public life of a community (raising awareness, fora for preservation of resources, preparation of guidelines, exhibitions).

Using holistic approach, a community builds an inclusive base of human resources in broadest sense, institutional and normative resources and segments, research and monitoring approach, trying to overcome negative effects of seismic hazard and developing personal, spatial and living environment in harmony with the largest resource – the nature.

6. Literature

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