Recommendations for protection in areas prone to flooding and landslides

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1. Introduction

Climate change, as one of the biggest problems of today, results in intense and frequent occurrences of large and catastrophic fires, **floods**, extreme meteorological events (strong winds, extreme precipitation, extreme air temperatures, icing, fog and drought), earthquakes, **landslides** and rock falls and other natural disasters, which in addition to affecting lives and health of people, adversely affect the environment and pose a threat to survival of many plant and animal species, as well as cultural heritage. In this text, the characteristics of floods and landslides are presented briefly as a type of natural disaster, followed by recommendations for better planning and implementation of rescue and protection measures in three phases (prevention, operational and remediation).

1.1. ABOUT FLOODS

Floods in the area of Montenegro manifest differently depending on characteristics of the watercourse which causes the floods. Along the valleys of most of river flows, short-term waves of high waters affect settlements, industrial facililties and agricultural land. Agricultural areas located in these valleys, although relatively modest, have a great importance for agricultural production, since the total resources of agricultural land of Montenegro are very limited. Due to such concentration of goods in river valleys, flood damage can be significant.

The floods in Montenegro mostly affect large areas of land along the edge of Skadar Lake, in the zone of the lower flow of Moraca River, as well as along Bojana River. In addition, floods along Lim, on Tara River near Kolasin and Mojkovac, as well as in the valley of Cehotina near Pljevlja are also of great importance. The specific type of floods in Montenegro are floods in closed karst fields of Niksic and Cetinje, which are equally important as other types of floods.

1.2. CHARACTERISTICS OF GEOLOGICAL HAZARDS – LANDSLIDES

The territory of Montenegro is made of various types of sedimentary, magmatic and metamorphic rocks. Most of the terrains of Montenegro are built by Mesozoic formations of carbonate composition, while magma and clastic silicate rocks are much less represented. **The tectonic structure** of the territory of Montenegro is complex. In the mainland of Montenegro, four tectonic units are separated: Adriatic zone or Paraautohton, Budva Zone, High Karst Zone and Durmitor Tectonic Unit.

Engineering-geological characteristics of the terrain are a key factor in defining the occurrence of soil instability and defining physical-mechanical, resilient-deformable and structural characteristics of the rock mass. Based on the engineering-geological characteristics of the terrain, the following engineering-geological groups are classified on the territory of Montenegro, and they are: 1. bound rocks 2. semi-bound to unbound rocks and unbound rocks.

The geomorphological characteristics of the Montenegrin relief are essentially a precondition for the emergence of smaller or larger natural hazards, and even disasters. The formation of landslides, rock falls, avalanches etc. are particularly related to steep or canyon parts of the relief. On the other hand, the flat regions are subject to flooding with great consequences. However, it

should be noted that **geological factors** (structural-tectonic, engineering-geological, hydrogeological and geomorphological) as one causing the emergence of natural hazards (landslides, rock falls, floods, etc.) are interrelated and they are always analyzed through their interaction, or cause-and-effect relations.

In Montenegro, landslides occur on a wide area, from the coastal belt of Boka Kotorska Bay, hinterland of Budva, Becici, Sveti Stefan, Petrovac, Bar, to the areas of Zeta, Moraca, Tara, Lim and Piva river basins. Landslides affect terrains built of bound unpetrified rocks of hard and plastic consistency and unbound large-grain poorly complex rocks, and the basis of sliding are bound slightly petrified rocks of the flysch complex. The most common cause of the landslide is the high groundwater level and unfavorable engineering-geological structure of the terrain. Depending on the engineering-geological structure of the terrain, several types of landslides are identified, which differ from each other according to their representation and dimensions. On numerous locations throughout Montenegro, there are landslides, of larger or smaller dimensions, which affect the environment.

2. FLOODS – RECOMMENDATIONS AND MEASURES

Legal framework of Montenegro – Directive 2007/60/EC on the assessment and management of flood risks in Montenegro

Flood protection in Montenegro is regulated by the following:

- Law on Waters ("Official Gazette of the Republic of Montenegro", no. 27/07, "Official Gazette of Montenegro", no. 32/11, 48/15, 52/16 and 84/18),
- Law on Water Management Financing ("Official Gazette of Montenegro", no. 65/08, 74/10 and 40/11) and
- Law on Rescue and Protection ("Official Gazette of Montenegro", no. 13/07, 5/08, 32/11 and 54/16).

Law on Waters and its bylaws transpose the Floods Directive into the national legislation of Montenegro and define measures for its implementation.

Pursuant to Law on Water Management Financing, funds are provided for financing structural and other measures to protect against harmful effects of waters (these funds are reduced every year and they are insufficient to achieve an adequate level of flood protection and to reduce the risk of flood damage in accordance with the Floods Directive).

Law on Rescue and Protection regulates the field of rescue and protection against floods.

Protection against harmful effects of waters in Montenegro is currently organized and implemented in accordance with the General and Operational plans of protection against harmful effects of waters, which relate to waters of importance for Montenegro and waters of local importance. General and operational plans define preventive and operational implementation of flood protection, but the framework for long-term planning and flood risk management is not

provided in the manner defined by the Floods Directive. In order to conduct harmonization with the EU legislation in this area, Law on Waters prescribes the following:

1) Transposition of the Floods Directive:
   development of the Rulebook on the Content of Preliminary Assessment of Flood Risk and Flood Risk Management Plan;

2) Implementation of the Floods Directive:
   drafting a preliminary flood risk assessment, determination of areas significantly affected by floods, mapping hazards and developing flood risk maps for areas significantly affected by floods for three return periods (floods of small, medium and high probability), development of flood risk management plans for areas significantly affected by floods.

Rulebook on the Content of Preliminary Assessment of Flood Risk and Flood Risk Management Plan was adopted in December 2015 ("Official Gazette of Montenegro" no. 69/15) transposing into the national legislation provisions of Articles 4, 6, 7 and 9 and the Annex of the Floods Directive, thus completing the transposition process of this Directive into our legislation. The Rulebook prescribes the content of the preliminary flood risk assessment, the content and manner of mapping hazards and developing flood risk maps, the content of the flood risk management plan and the manner of its updating and implementation.

In the upcoming period, it is necessary to take actions related to the implementation of this Directive.

For the preliminary assessment of flood risks, there are data on: floods which occurred in the past, flooded areas and flood protection facilities in the Water Management Basis of Montenegro dated 2001. All data are systematized according to water regions of river basins and sub-basins but they should be updated with recent data and aligned with the Floods Directive. Also, data are available in the Flood Rescue and Protection Plans, developed for 17 municipalities in Montenegro in the framework of the Disaster Risk Management Project implemented by the UNDP Office in Montenegro and the project "Climate Change Adaptation in Western Balkans " (CCAWB) implemented by the GIZ Office, which were coordinated by the Directorate for Emergency Situations of the Ministry of Interior. These plans were developed in the period from 2012 to 2017 and contain updated information compared to the Water Management Basis of Montenegro.

Based on the preliminary flood risk assessment, the areas will be identified as significantly affected by floods, which constitutes an important step in the implementation of the EU Floods Directive, because in the next steps of implementation, for areas which are identified, the hazard maps, flood risk maps and flood risk management plans are to be developed.

Flood rescue and protection plans contain maps of the most vulnerable areas to floods for the period of the last recorded large floods in municipalities for which they were developed. These maps can be a good basis for creating maps of hazards and risks in accordance with the Floods Directive, which defines that maps are to be developed for three return periods.

Flood Risk Management Plans should be developed, as well as the Water Management Plans for the water region of the river basin. The plans will be developed:

with mandatory inclusion and information issued to the public, in accordance with the water management plan for the water region of the river basin, in coordination with countries the territory of which is a part of that water region, respecting the principle of solidarity – measures established in one country will not increase the risk of floods in others countries upstream or downstream the same river basin or sub-basin, taking into account the impact of climate change on the occurrence of floods.

2.1. Flood protection in Montenegro must be based on following principles:

- Flood protection must be carried out using all available capacities, ranging from passive protection to strict definition and adherence to flood protection regulations;
- it is necessary to strengthen the forecasting service within the Institute for Hydrometeorology and Seismology in human resources and technology, so that the early warning in case of floods is always at the level of providing timely alarm. Thus, the prognostic activity would enable timely preparation and implementation of protective measures;
- an essential condition for ensuring efficient operation of constructed flood protection facilities is their regular maintenance and upgrading, i.e. reconstruction;
- to reduce direct and indirect flood measures, non-investment prevention measures in flood affected areas should be applied, primarily by preventing the realization of major investments in affected or insufficiently protected zones. To this end, it is necessary to define vulnerable areas on appropriate maps and plans, to define elements of flood protection in spatial plans;
- the requirement for ensuring the efficiency of flood protection system and watercourse regulation is also the works related to protection against erosion and torrents in the upper parts of the basin. Exploitation of materials from riverbeds must be carried out in a planned manner, in accordance with characteristics of the watercourses, in order to avoid negative impacts to the watercourse and constructed facilities.

Protection against harmful effects of waters is organized and implemented in accordance with the General Plan for protection against harmful effects of waters and the Operational Plan for protection against harmful effects of waters, which are adopted for waters of importance for Montenegro and waters of local importance.

The General Plan of protection against harmful effects of waters, for waters of importance for Montenegro, was adopted for the period from 2010 to 2016, and it defines certain works and measures to be undertaken for protection against harmful effects of waters, manner of institutional organization, duties, responsibilities and powers of the head of protection against harmful effects of waters, institutions and other persons responsible for protection against harmful effects of waters, manner of observation and recording of data, announcement of occurrences and notification. The operational protection plans, which are adopted every year, determine the measures necessary for the efficient implementation of protection, relevant water levels and criteria for proclaiming regular and emergency defense against harmful effects of waters. Units of local self-government adopt General and Operational plans for protection against harmful effects of waters for waters of local importance. General and operational plans define preventive and operational implementation of flood protection but they do not provide a framework for long-term planning and flood risk management, as defined in Directive 2007/60/EC on the assessment and management of flood risks.

In accordance with the Directive on the assessment and management of flood risks, Montenegro is obliged to develop a preliminary flood risk assessment and on the basis of it to determine the areas significantly affected by floods, and then to develop hazard maps and flood risk maps for these areas, for three return periods – floods of small, medium and high probability. Based on hazard maps and flood risks maps, flood risk management plans for areas significantly affected by floods are developed. In the context of integrated water management, it is important to identify objectives and strategic principles in order to be able to efficiently protect against waters, to improve the level of protection against harmful effects of waters to fulfill conditions of the process of accession to the European Union in this field, defined by the Directive on Assessment and Management of Flood Risks.

Protection against harmful effects of waters is carried out in order to:

- perform preventive action and create conditions for reducing the possibility of occurrence of floods;
- reduce harmful effects of floods on human health, environment, cultural heritage and economy;
- provide conditions for protection and sustainable usage of waters and protection and improvement of environment.

All measures which result from goals and strategic principles of protection against harmful effects of waters must be a part of spatial planning and other documentation for future use of space and development planning.

Integrated flood risk management involves the participation of all interested social segments at the local, national and international levels, through adjustment and harmonization of their interests.
Institutions responsible for protection against harmful effects of waters in Montenegro are:
• Ministry of Agriculture and Rural Development – Directorate for Water Management and Water Administration,
• Ministry of Interior – Directorate for Emergency Situations,
• Institute for Hydrometeorology and Seismology,
• Units of local self-government.

The Water Management Directorate in the Ministry of Agriculture and Rural Development is responsible for proposing and implementing water policy and it is primarily responsible for transposition and implementation of the Directive on the assessment and management of flood risks, while the Water Directorate performs tasks related to provision and implementation of measures and works regulating waters and watercourses, protection against harmful effects and management of water facilities for protection against harmful effects of waters. The Directorate for Emergency Situations of the Ministry of Interior is responsible for implementation of operational rescue and protection measures.

The Institute for Hydrometeorology and Seismology is responsible for monitoring hydrological situation, forecasting flood waves and submitting reports on hydrological situation, forecasting and warning institutions responsible for flood risk management, while local self-government units are responsible for protection against harmful effects of waters of local importance. Flood protection in international basins should be carried out in cooperation with countries on which territories the parts of the basin are located, in line with provisions of recognized international and bilateral agreements on cooperation in the field related to waters.

2.2. Flood rescue and protection measures in accordance with flood rescue and protection plans at national and local levels include the following:

- ✓ developing and updating flood rescue and protection plans;
- ✓ inspection supervision;
- ✓ construction and reconstruction of protective embankments;
- ✓ detection and recording of changes in watercourse riverbeds (sediments, narrowing and expansion of riverbeds etc.);
- ✓ cleaning and regulating river beds at certain critical sections (below bridges, narrowing in river beds, etc.);
- ✓ monitoring water level in hydro accumulations before rainy period and assessment of need for regulated water discharge;
- ✓ protective, anti-erosion and regulation works on watercourses;
- ✓ develop research, studies and projects related to improving the state of rescue and protection against floods;
- ✓ adopt urban plans which would prohibit construction below 614m level in the municipality of Niksic;
- ✓ influence the amount of water in reservoirs so as not to cause major problems, in cooperation with Elektroprivreda CG;
- ✓ continue the professional training and specialization of members of operational units for rescue and protection against floods;
- ✓ manage and coordinate in flood rescue and protection system;
- ✓ in order to better prepare for flood rescue, it is necessary to perform human resources strengthening and material equipping of Rescue and Protection Services for this type of risk, as well as to draw up an overview of human and material resources on the territory of municipalities to be engaged in rescue and protection;
- ✓ provide first medical aid to the injured;
- ✓ conduct evacuation of affected and killed citizens and material goods from the affected area;
- ✓ rescue and protect animals;
- ✓ protect plants and plant products;
- ✓ continuous and timely informing the population at the affected area;
- ✓ informing the population;
- ✓ arranging zones for accommodating the affected population (construction of settlements – placing containers);
- ✓ organizing the collection and distribution of assistance to the affected population;
- ✓ relocating and placing important material and cultural assets;

- ✓ implementation of health, veterinary and hygienic–epidemiological measures of protection and implementation of other activities and measures to mitigate or eliminate the immediate consequences caused by floods;
- ✓ sanitation of water facilities and watercourses;
- ✓ removing objects and materials which can significantly affect the water regime;
- ✓ creating conditions for normalizing the lives of people and work in an affected area;
- ✓ engagement of professional teams of health, veterinary, communal and other services for implementation of sanitation;
- ✓ conduct disinfection, disinsection and pest control (DDD) and undertake other activities and measures to prevent effects of the consequences of floods;
- ✓ protect watercourse coastal parts from floods by ensuring completion, upgrading, reconstruction and regular maintenance of water facility systems for protection against floods;
- ✓ ensure the functionality of existing protective structures against harmful effects of waters;
- ✓ support planning and formation of "multipurpose water systems" with the primary cooperation with the sectors of energy, agriculture and spatial planning;
- ✓ preservation and improvement of natural retention capacities of land, watercourses and flooded areas and natural marshes;
- ✓ modernize the existing system for monitoring and forecasting hydrometeorological phenomena;
- ✓ develop hazard maps and flood risk maps as a basis for developing flood risk management plans;
- ✓ develop a methodology to determine the assessment of flood damage;
- ✓ establish Water Information System (VIS) as a basis for integral water resources management, to be based on distributed processing of data and
- ✓ other rescue and protection measures.

3. LANDSLIDES – RECOMMENDATIONS AND MEASURES

Landslide process is one of the most important exodinamic processes which causes disruptions to the terrain stability and at the same time it is the most frequent geological hazard in the Balkans. The process itself and its consequences affect nature, material goods and people in the areas where the process occurs. For this reason, one of the basic goals of applying the results of analysis and assessment of hazards and risks is the reduction of negative consequences of landslide process to natural and social values in an area, which together with the measures treating risks makes the risk management process.

Risk management process consists of a series of procedures – starting from data collection to risk treatment. The basis of risk management process is the analysis and assessment of landslide hazard. Geological hazards, i.e. the landslide process is generally a factor limiting the use of space so the application of risk assessment results, as well as **the process of risk management itself, is largely related to different levels of spatial and urban planning, as well as to different phases of design and exploitation of objects, i.e. various study research.**

Geological hazards are all processes in a geological environment the origin of which is directly related to contemporary dynamics of the Earth or they arise as a result of interaction of the geological environment with other Earth spheres. In the natural and social environment, they cause

harmful consequences not only at the moment of their activity, but also over a long period of time, as long as the consequences of the process have implications to nature and society as a whole. The need that landslide process, as a modern geodynamic process, is regarded as a natural-geological hazard, is derived from the efforts to predict the evident negative consequences of the process to nature, material goods and people and to reduce them through forecasting, to the extent which is realistic and possible, both through professional as well as legal framework.

Minimum natural conditions due to which hazard and risk assessment i.e. the process of managing the risk of landslide must be implemented in the spatial planning are:

- There are landslides in the area or there are historical written documents to confirm this,
- In an area there is no historical record of landslides, however, all morphological and geological parameters indicate the possibility that the process can be activated,
- The areas in which the objects are built – the demolition of which, due to instability of the terrain, leads to landslides which can affect human lives,
- The areas with intensive soil degradation which cause changes in microrelief and favor development of erosion processes.

It is also suggested that hazard and risk assessment should be carried out in the following cases:

- For individual locations of infrastructure facilities (roads, railways, pipelines, etc.),
- For individual urban locations for which detailed research was carried out and hazard assessment was completely carried out,
- For capital facilities of vital importance for functioning of the system (hydroenergetic facilities, infrastructure facilities, energy facilities),
- Material goods of special social importance,
- In areas on which landslide process is recorded as a limiting factor of wider urbanization and space planning in general,
- In areas of particular cultural, historical or other importance which are affected by the landslide process at individual locations or in a wider area.
- In areas in which there is evidently a possibility of multiplying natural, geological hazards, or where the process of landslide is closely related to other geological hazards (e.g. earthquakes).

Although it can be said that in theory **the risk management methodology is standardized** in terms of definition, terminology, content of particular phases, as well as presentation of obtained results, there are numerous problems, the impact of which is mostly pronounced in practice, i.e. in applying the methodology to concrete, real-life conditions in the field.

The first group of problems relates mainly to different stages of hazard and risk assessment. As noted, hazard analysis and assessment should result in estimating the likelihood of activating a landslide of a given magnitude for a specific time period in a particular area, and that the results of the assessment can be expressed in a manner which is understood by different users. Such an analysis can only be carried out if there are documented data over a longer period of time.

The landslide process is to a certain extent specific because the data on process and phenomena must be collected separately, or for each event – landslide, **taking into account all specificities**

of each individual case. For all analyzes and assessments which are not at the level of individual, detailed surveys, the collection, systematization and processing of relevant data is often a serious problem, as there are no centralized data for wider spatial units and the adequate professional documentation is completely absent. Also, any serious analysis requires homogeneous data, for which the system of classification is first and foremost harmonized. Otherwise, with the analysis which necessarily contains the elements of abstraction and generalization, non-homogeneity of the data gives completely unrealistic results.

Data analysis, i.e. the analysis of the cause of emergence and the causes of activation of the process is most often done after the landslide occurs and based on the analysis, conclusions are drawn, which as a result give an assessment of parameters which in the future have a decisive influence on further activity of the process. Analysis is carried out at the present moment, under static conditions and as such it necessarily emphasizes the influence of one parameter in relation to others, the summarized influence of which, at previous moment, led to activation of the process. On the one hand, the analysis and assessment of the hazard is based on the assumption that the activation/reactivation of the landslide will occur in the same or similar conditions under which it occurred in the past, although the landslide process itself changes the basic properties of the terrain on which the landslide occurred.

The analysis of the frequency of the process activity and assessment of the event probability also depends on a number of factors which often causes in practice the inability to obtain reliable data. In most cases, the lack of data is the basic problem in the frequency analysis, and therefore in the assessment of the probability that the process will be reactivated.

Certainly, the most important application of the risk management process relates to the planning field (spatial and urban), but also to the early phases of design, or the exploitation of objects, while specific study researches can be conducted independently, with the goal being the later implementation in one of the mentioned frameworks. The field of spatial and urban planning, as well as the phases of project design and construction are defined by national legislation, and it would be logical that the implementation of the risk management process is defined by the legal framework. However, there are rare examples of compliance with legal framework or in which the local self-governments decided to fund some of the stages of activity in the risk management process. For this reason, the last stage of the process in which the risk level is assessed and risk treatment measures are proposed, are rarely or almost never implemented, although the process itself provides an optional solution in the previous stages as well.

The territory of Montenegro is made up of different geological formations, of which one part of formations, according to physical and mechanical characteristics, can represent the natural potentials causing the terrain instability. Such formations are primarily different flysch formations, which are developed on about 10% of the territory of Montenegro.

Along the terrains built of flysch formations, and especially **along the courses of Moraca and Tara rivers**, regional and massive slides and detachments are possible, with catastrophic consequences to traffic and hydro-technical infrastructure. These terrains are naturally located in the boundary state of balance, and potentially planned formation of reservoirs poses a great danger related to formation of larger landslides or rock falls.

In the coastal part of Montenegro, the south-west slopes of Rumija, Sutorman, Lovcen and Orjen mountains, according to engineering-geological characteristics, belong to unstable terrains, where massive slides of the terrain and detachments of large blocks of rigid rocks are possible, which could significantly affect parts of urban units on the slopes and at their base.

Engineering-geological characteristics of geological formations and rocks in other parts of Montenegro, along with coexistence of other natural factors and influences, can contribute to the emergence of landslide and rock falls with local consequences.

Starting from detected problems with managing, arranging, maintaining and archiving data related to previously performed research of unstable terrains, the **development of a conceptual model of a comprehensive database** is an imperative in the efficient remediation of the said instabilities. Creating a database of detected instabilities will significantly improve the process of planning and designing future remediation works, thus creating possibilities for full compliance with the method of gradual and multidisciplinary research. Also, the creation of this record provides a wide range of possibilities for studying natural processes and occurrences and conducting analyzes, indicating their interdependence.

The presented landslide consequences should add to **understanding the need for organized work on risk reduction measures among the rescue and protection function holders as well as to strengthening preparedness of the whole community**. In that sense – referent bodies and institutions should make constant efforts to systematize the existing as well as to collect the new relevant data on detected unstable terrains.

The possibility to use data related to landslides is large, primarily through the more efficient work of all organizations dealing with construction and geological works on the territory of Montenegro, as well as through potentially more efficient work of many services using the data.

The importance of creating a database of registered instabilities for the whole territory of Montenegro can be best understood if taken into account that within the boundaries of today unstable terrain, the occurrence of instability over a certain period of time repeats. Very often, microlocations along which remediation works are carried out, are subject of a repeated violation of the boundary balance.

In practice, the remediation works on the aforementioned microlocations are difficult to perform due to the lack of records on results of previously performed researches, as well as on the manner and type of performed remediation works. It is important to note that results of today performed research do not become obsolete with time, and that in the future they represent precious data when designing the research and performing remediation works.

The rapid pace of urbanization of the terrain of Montenegro is not accompanied by the development of appropriate engineering-geological bases in design, and in practice, it occurrs that spatial and urban plans are adopted in which the terrain properties in terms of stability have not been studied in details. These bases are the basis for adoption of municipal urban plans in Montenegro. The said bases present all terrain properties which affect the occurrence of instability, and they present areas according to stability criteria. However, due to the sudden pace of urbanization, the entire parts of urban areas are no longer covered by the aforementioned bases, and when adopting urban plans for new urban units it will not be possible to perceive the properties

of terrain stability. Therefore, especially in the coastal municipalities, special attention should be paid to the above-mentioned bases, which should be a mandatory part of the urban documentation.

Also, the construction of hydrotechnical and traffic facilities should be accompanied by the development of engineering-geological and other appropriate bases, which will reduce the risk of the occurrence of major instabilities.

When designing future traffic/hydrotechnical facilities it is necessary to look at alternative solutions or reduce the vulnerability of the most affected parts/sections in order to fulfill the condition of making them functional in as shorter period of time as possible, in order to avoid further negative consequences.

The occurrence of instability along the terrain of Montenegro was certainly influenced by the earlier savings policy related to designing and implementation, which often led to the fact that the constructed facilities could not obtain the use permit.

The main characteristic of this manner of designing and carrying out works is that preventive measures for ensuring land stability are non-existent and they were applied only after activating major landslides, rock falls etc. In addition, it is important to emphasize that some facilities have the need to provide a continuous function, and it is important to assess their expected vulnerability in order to take appropriate measures in due time.

3.1 Measures of rescue and protection against landslides and rock falls on the territory of Montenegro

Preventive protection measures

Due to the growing devastation of urban terrains and the planned construction of capital hydrotechnical and traffic facilities, it is necessary to consistently apply the **principle of gradual and multidisciplinary research** in solving the problem of terrain stability for the territory of Montenegro. Respecting the principle of gradual and multidisciplinary research can only be achieved by forming a comprehensive database of unstable terrains on the territory of Montenegro and insisting on the use of engineering and geological bases in planning and design.

In order to reduce the risk of major landslides and rock falls on the territory of Montenegro, it is necessary to take the following measures:

- establish a comprehensive database on unstable terrains for the territory of Montenegro;
- develop engineering-geological maps as well as maps of terrain stability during urban planning, as well as for design and construction of larger facilities, and
- other measures.

Operational measures

The operational rescue and protection measures against landslides and rock falls include the following:

- evacuation of population;
- engagement of municipal rescue and protection services;

- engagement of other operational units;
- engagement of members of the Army of Montenegro;
- engagement of utility and transport services;
- engagement of the Police Administration for regulating the traffic and establishing its regular course;
- engagement of experts of the Public Institute for Geological Research and others to make a quick assessment of damage caused by landslides and rock falls;
- engagement of other state bodies, organizations, local government bodies, companies and other legal entities and entrepreneurs in implementation of operational measures and
- other measures.

Remediation measures

The remediation measures of rescue and protection against landslides and rock falls include the following:

- development of planning projects to permanently solve the issue of landslides and rock fall remediation on the territory of Montenegro, which is at the same time the best type of preventive measure;
- engagement of all available human and material resources of state bodies and organizations, companies, other legal entities and entrepreneurs and local self-government bodies in implementing the measures for removing the consequences from landslides and rock falls;
- engagement of municipal and national commissions for damage assessment to develop assessment of damages caused by landslide and rock fall activation and
- other measures.

LITERATURE

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- HAZARD AND RISK MANAGEMENT RISK BY BILJANA ABOLMASOV1 1 University of Belgrade, Faculty of Mining and Geology, Đušina 7, 11000 Belgrade, Serbia, biljana@rgf.bg.ac.rs

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