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# Problems of natural and anthropogenic disasters in Georgia

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*Abstract*

*In the paper the problems, related to geological catastrophes in Georgia are considered. The main factors responsible for activating of these processes, their scale and negative consequences as well as objectives in disaster risk reduction activity.*

**International and national state of art in respect of natural disasters**

In the last decades of the XX century, protection of the most of the planet population against the natural disasters, ensuring safe functioning of economic and engineering objects and stable state of nature have become an important social-economic, political and environmental problem. This problem has become even acuter at the turn of the XXI century when the natural cataclysms in terms of a wide-scale human pressing, increased urbanization and use of technologies have acquired even larger scales. This has caused a dramatic disturbance of the environment balance and has made the activation of the natural-anthropogenic disasters even more irreversible. This leads to an inconceivable economic and human losses. This is why the decisions to reduce the natural disasters and mitigate their results made at the World Summit of Johannesburg (South Africa) held under the aegis of the United Nations Organization in 2002 and International Conference of Hyogo (Japan) of 2005 were recognized as a basic guidelines.

It was because the activation of the natural disasters, that a number of countries have developed their national programs of management of natural effects.

Natural hazardous processes are divided in two different events: (1) hazardous meteorological events taking place in the atmosphere and (2) hazardous geological processes taking place on the Earth surface and crust. Nevertheless, some hazards such as landslides and debris-flows are caused by simultaneous activation of meteorological and geological factors. Therefore proper specialists and institutions are engaged in the management of the given problems. However, the study of regularities of the natural disasters, their permanent monitoring, forecasting their spatial and time developmental trends and drafting the managerial measures in any country should be at the expense of the state budget.

Particularly grave situation has been created as a result of the negative results of the hazardous geological processes.

Catastrophic development of natural processes has necessitated the creation of a single information bank of the management measures undertaken in different countries of the world and development of the strategy. The coordination of the study, forecasting and management of these very complex events was undertaken by the UNO institute of environmental protection, and the decade starting from 1990 was declared by the UNO as the decade to study the natural disasters and mitigate natural disasters, and the year of 2002 was declared an International Mountain Year. A number of countries have developed the national programs for the mountain development and preventing the catastrophic events, and a number of European states have been united under the aegis of "The Alpine Convention".

Georgia joined the mentioned decisions and under the Presidential Decree No. 36 of 1995, a national committee to carry out the international decade of mitigation of hazardous disasters was established. Earlier, in 1993, a special governmental decree No. 967 "About creating a single

protection system of environmental monitoring" was adopted, whose international coordination was the function of the Ministry of Environmental Protection and Natural Resources. In 1997, a special Presidential Decree No. 66 "About the development of hazardous geological processes on the territory of Georgia and measures to protect the ground and underground hydrosphere against them" was published. The Department of Geology, aiming at operating at the level consistent to the geo-monitoring studies, together with the Institute of Geography developed a state target program, which was considered and approved by the government and was handed to the Ministry of Economic Development to be included in the indicative plan of social-economic development. Besides, in 1999, the Parliament of Georgia adopted the law "About the social-economic and cultural development of the mountainous regions of Georgia". In addition, the laws "About the protection of environment and soils" underlining the negative role of hazardous processes were adopted. Later, in 2007, the President of the country issued a special decree No. 542 "About the protection of the population and territories against some natural and anthropogenic hazards".

Despite the fact that more and more territories, population and economic and engineering objects of Georgia are prone to risk of the natural catastrophes, the priority trends of the National Environment Action Plan (NEAP) of Georgia adopted in 2000 do not incorporate the problems of management of natural hazardous catastrophes and therefore, they were not considered within the state or international organizations targeting financial plans.

Therefore, in the field of improving the system of evaluation and safety of the risks of natural disasters there are still serious problems.

**Risk of geological hazards in Georgia and relevant problems**

Georgia, with its scales of origination of the natural-catastrophic processes, their reoccurrence and with the negative results inflicted by these processes to the population, agricultural lands and engineering objects, is one a most complex mountainous region of the world (See the Hazard risk map of the population of Georgia, Fig.1).

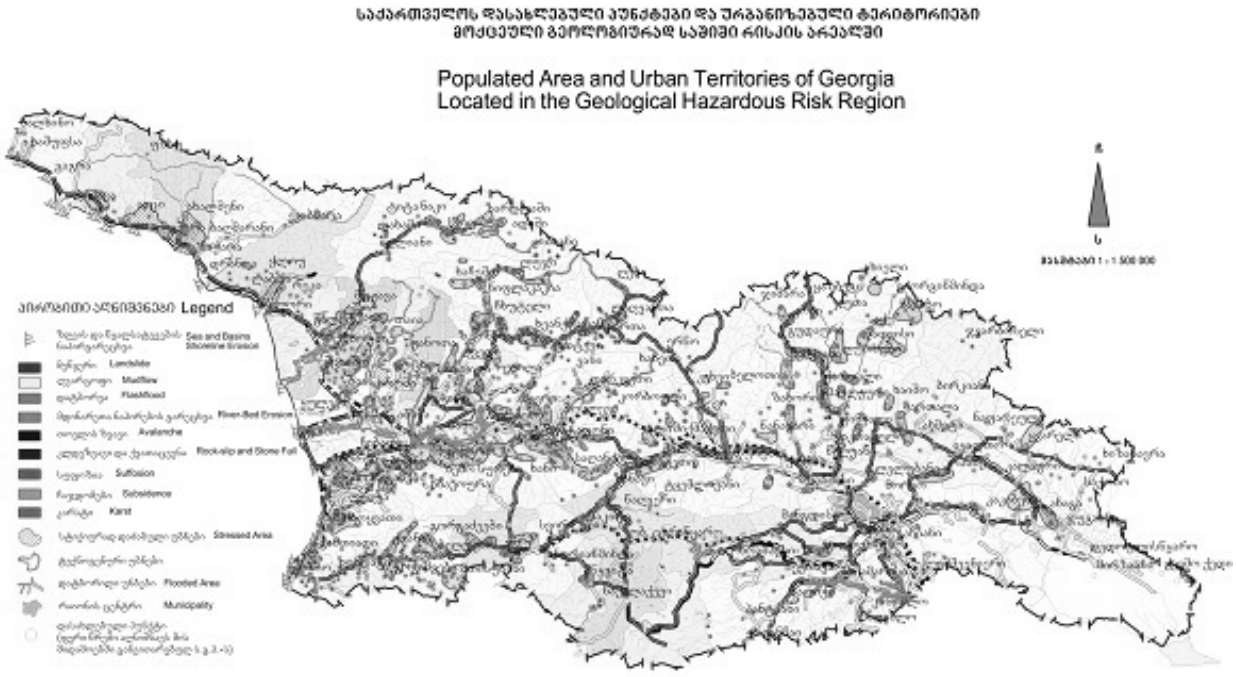


Fig. 1. Risk areas prone to hazardous geological processes on the territory of Georgia.

A strong influence of geological natural processes (frequently ending with the catastrophic results) is experienced by thousands of populated areas, plots of field, roads, oil and gas pipes, high-voltage electric power transmission towers, hydraulic structures and reclamation constructions, mountain and tourist complexes, etc.

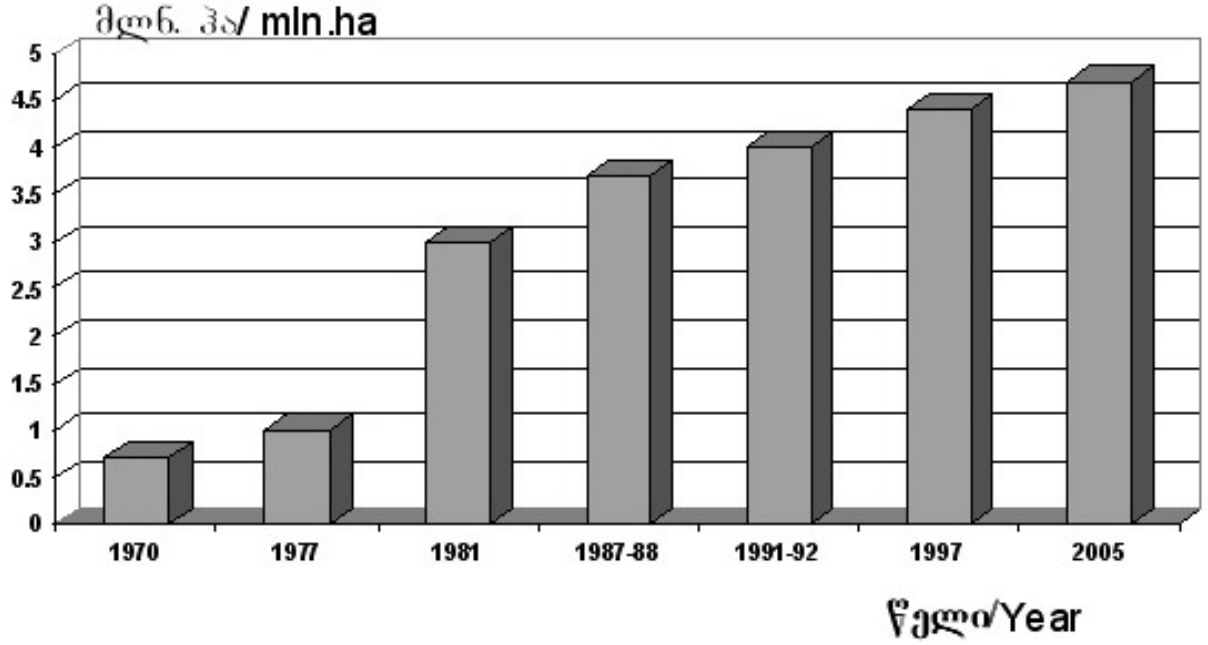


Fig. 2**.** The territory of Georgia within the zone damaged by hazardous geological processes.

Particularly grave is the situation in the mountainous regions, where due to the extreme activation of the processes, the local population is forced to abandon their historical places of residence, and sometimes to leave for other regions. This has resulted in tens of emptied mountain villages in the second half of the XX century. The most alarming thing is that these processes often cause human loss.

Below is an incomplete list of the negative results of the geological disasters since 1968:

- The hazardous area covered over 70% of the territory;
- 3000 populated areas (63%) fell within the risk area of the geological disasters;
- The human loss due to the geological disasters exceeded 1000;
- Over 400 000 residential houses and premises were damaged with different degrees or were ruined;
- 1.5 million ha of land was damaged and taken out of exploitation;
- 560 km of motorways were damaged and were to be rehabilitated.

Incomplete data of the economic loss occurring due to geological catastrophe in different years:

- In 1967-1968 – 500 million US Dollars;
- In 1973-1975 – 650 million US Dollars;
- In 1987-1990 - 1 million US Dollars;
- In 1991-1992 - 10 billion US Dollars;
- In 1995-2008 - 1. 241 billion US Dollars.

***Note:*** The cost of realization of anti-erosive measures in Georgia drafted in 1981-2000 was fixed at 1.300 million US Dollars. At present, the urgency of anti-erosive measures has doubled.

Specialized studies prove that the origination and activation of landslide-gravitational and mudflow processes increases by a geometric progression year after year. This is evidenced by the graphs of landslide-gravitational and mudflow events (Figs. 4, 5).

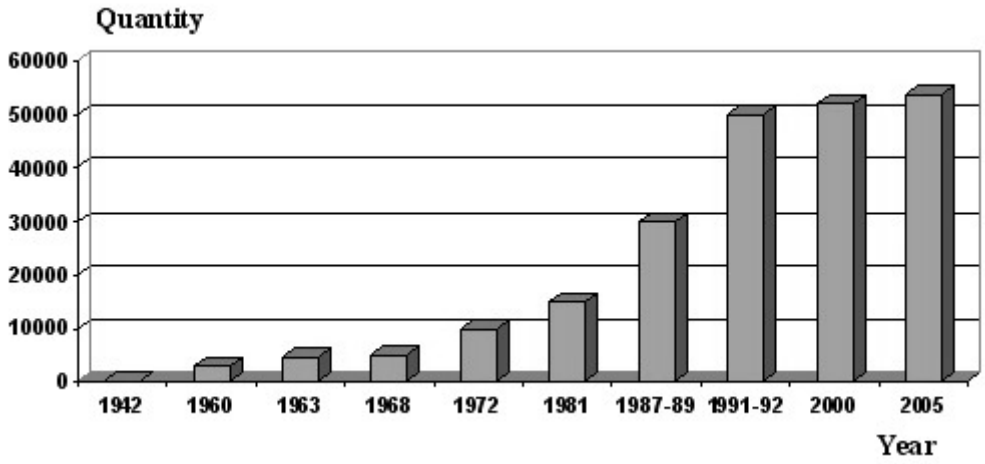


Fig. 3. Landslide-gravitational events on the territory of Georgia mapped for different years.

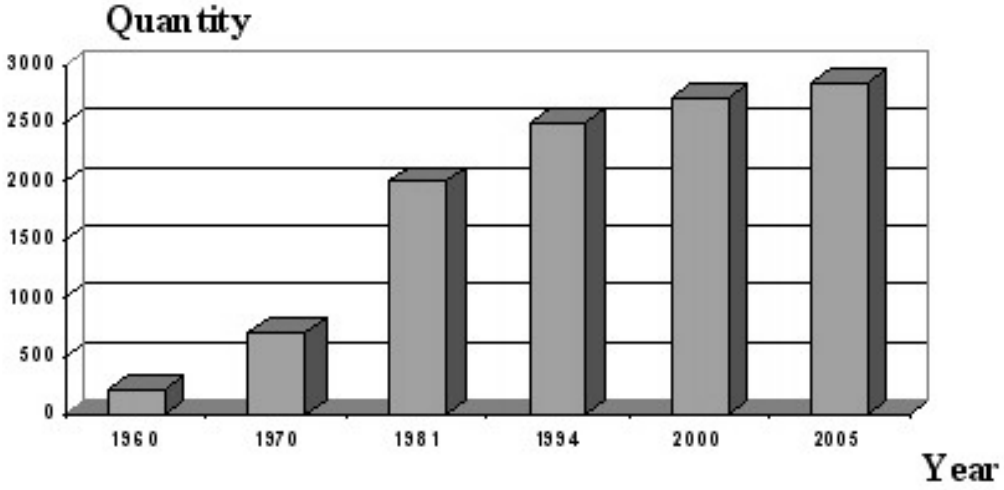


Fig. 4. Mudflow-transforming river gorges on the territory of Georgia mapped for different years.

If in the last decade of the XX century, the extremums of activation of the mudflow-gravitational processes were mostly subject to a certain cyclicity and following the geological-climatic conditions of the given area, occurred once in every 2-5 years on average, since the 1990s, the activation of the processes in excess of their mean value takes place almost every year, and the intervals of their extreme occurrences are significantly reduced. As a result, more and more new territories, populated areas and engineering-economic objects are subject to the negative impact of the processes.

**Intensity of landslide and mudflow processes on the urbanized area fixed during the regional geo-monitoring in different years and damage caused by them**

Table 1

| Year | Landslide | | | Mudflow | | |
|---|---|---|---|---|---|---|
| | Intensity (in dynamics) | Approximate direct damage (in millon lari) | Victims | Intensity (transformable mudflows) | Approximate direct damage (in millon lari) | Victims |
| 1995 | 666 | 132 | 6 | 693 | 96 | 1 |
| 1996 | 404 | 80.3 | 4 | 198 | 27 | 5 |
| 1997 | 510 | 102 | 3 | 318 | 44 | - |
| 1998 | 333 | 67 | 2 | 147 | 20 | 6 |
| 1999 | 56 | 12 | 1 | 27 | 4.5 | - |
| 2000 | 65 | 13 | 1 | 23 | 3 | - |
| 2001 | 75 | 15 | - | 26 | 4 | - |
| 2002 | 69 | 13.8 | 1 | 23 | 2.5 | 2 |
| 2003 | 71 | 14.4 | 3 | 28 | 4 | - |
| 2004 | 736 | 147 | 1 | 192 | 28 | - |
| 2005 | 480 | 96 | - | 68 | 9 | 4 |
| 2006 | 316 | 70.5 | 1 | 73 | 40 | - |
| 2007 | 236 | 54 | - | 88 | 28 | - |
| 2008 | 407 | 78 | 10 | 100 | 36 | 8 |
| Total | 4424 | 895 | 33 | 2004 | 346 | 26 |

Recent development and reactivation of hazardous geological events in an unimaginable scale and severe geological complications of the engineering-geodynamic situation taking place in a non-stationary mode in the geological environment in Georgia, together with the extremely sensitive geological conditions, were conditioned by:

1. Activation by strong earthquakes, occurred in the last decades;
2. Drastic activation of the negative meteorological events provoking the geological processes on the background of global climatic changes and their abnormally frequent occurrence (mostly increased atmospheric precipitations, temperature and humidity);
3. Large-scale human impact on the environment and severe disturbance of the environmental balance, in particular, settlement of the population and unorganized land reclamation, often without any assessment, building and restructuring of new transport objects, intensive cutting down of forests, etc.

One of the most important reasons for poor protection of the population against the geological catastrophes, unsafe functioning of the engineering-economic objects and damage inflicted to the economy of the country is the low level of the society readiness to the above-described events, meaning not sufficient awareness of the population and responsible people of the expected disasters, their possible localization and accomplishment of measures to mitigate their hazards.

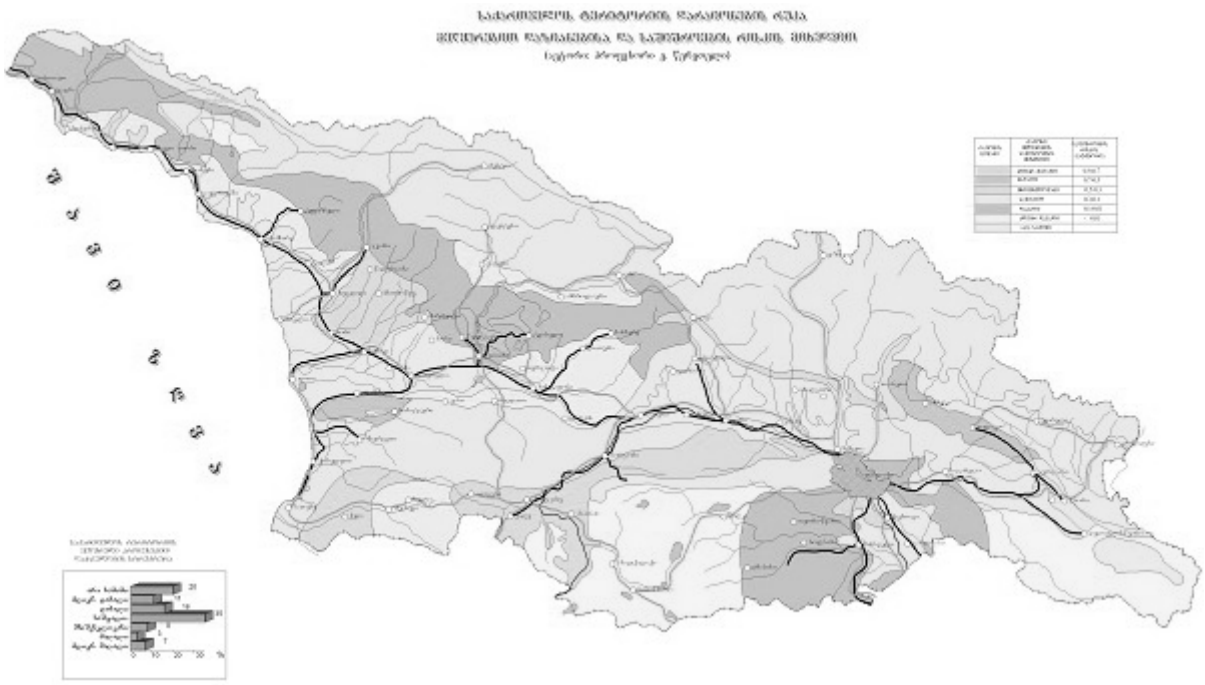

Fig. 5. Map of zoning of the territory of Georgia according to the landslide damage and risk of hazard (Author E. Tsereteli).

Fig. 6. Map of zoning of the territory of Georgia according to the damage caused by mudflow processes and risk of hazard (Author E. Tsereteli).

**Actions and results associated with the natural hazardous processes in Georgia**

Large-scale development of the hazardous geological processes in Georgia and great damage inflicted to the economy of the country since the second half of the XX century have forced the management of the country to pass more than one document about the mitigation and reduction of the risk of the geological hazards and optimization of the managerial measures.

Following the problem urgency, a number of departmental and research institutions have made their operations more intense in the given direction within the limits of their competence. First of all, the activity of the Department of Geology of Georgia (which is at present included in the National Environmental Agency of the Ministry of Environmental Protection and Natural Resources of Georgia), which identified, mapped and cataloged the hazardous geological processes on the territory of the country and identified the spatial limits and developmental regularities of these processes for tens of years. It has been establishing the risks of hazard posed by the geological processes to the population and engineering-economic objects, developing special engineering-geodynamic basic maps of the scale 1:200000, 1:50000, 1:25000 of different content:

- Specialized engineering-geological studies of agricultural lands was undertaken scaled 1:10000 with the purpose of zoning the risk of hazardous processes, accomplishing the protection and restoration measures and community land management. The processed materials were handed to the Ministry of Agriculture;
- The risk of hazard and damage of landslides, mudflows and erosive processes on the territory of Georgia, of the scale 1:500000 was assessed;
- The detailed studies (1:2000) of over 200 objects within the zone of high risk of landslides, mudflows and erosive processes with the purpose of protecting the population were undertaken, and proper preventive measures were accomplished;
- On the instruction of the government, a monograph "General anti-erosion plan on the territory of Georgia for 1981-2000" was drafted and published, which discussed all geological processes developed in Georgia and different measures to be accomplished;
- Special engineering-geological studies scaled 1:50000-1:25000 were undertaken in the coastal region of the Black Sea of Georgia, serving as the basis for drafting the scheme of integrated management and protection of the coastal area;
- A long-term prognosis of landslides, mudflows and sea coast washout (abrasion) for 1981-2000 was developed.

The basic scientific results of the studies carried our for tens of years have been analyzed in more than 300 monographs and publications, with most of them published in the international press, including the methodological publication under the UNESCO and UNEP projects.

In respect of natural hazardous events, in addition to the Department of Geology, the former research institutes of the National Academy of Geophysics, Geography, Water Wconomy and Hydrogeology and Engineering Geology (at present, Ministry of Education and Science) have accomplished significant studies, in particular.

Wide-scale studies are being accomplished at the Institute of Geophysics on the lithosphere structure, its dynamics and evolution, seismicity and physics of the atmosphere and ocean. Institute carried out the detailed studies of the generation of earthquakes in Caucasia and Georgia, in particular, their physical parameters and performed macro-seismic zoning of the earthquake hazard. Particular attention was paid to gravitational events provoked by earthquakes. Geophysical prospecting methods have been successfully applied to study in detail the structure of landslides in different regions of Georgia.

The complex geographical study of the mountainous regions has been prioritized at the Vakhushti Institute of Geography since the 1970s. One of the most important trends was the study of modern geomorphologic processes in the mountainous areas, and the study of mudflows and landslide events was undertaken at the laboratory created specially for this purpose. On the other hand, the well-organized studies of mass-movements gradually covered the whole of the Caucasus. The gained materials served as the basis for the monographs "Karst of Georgia", "Karst caves of Georgia".

There is also a laboratory of the sea coastal zone at the Institute of Geography. The laboratory undertook the detail study of the Black Sea coastal zone of Georgia, and the impact of the streams along the coast on the stability of the coast, deficit of the alluvium, formation of underwater canyons and their role and place in respect of the coast stability were defined.

Significant studies of the dynamics of the Black Sea coast and offshore zone of Georgia have been undertaken by the Institute of Engineering Geology and Hydrogeology, whose scientific studies are given in the monographs "Engineering geography of the Black Sea offshore zone and coast within the limits of Caucasus" (Janjgava, 1979); "Engineering geology of the Black Sea and protection of environment" (Khachapuridze, 1990).

So, at present, the basic foundation of information at the national and regional levels for the priority trends of action for the territory of Georgia in respect of the risk of geological hazard has been developed. The efficient management of the identification, evaluation, early notification and reaction to the geological risks should be included in the organizational, legal and political frames, what is first of all, envisaged by the Decree No. 967 of the government of Georgia of 1993 about functioning of the geo-monitoring studies system, Presidential Decree No. 66 of 1997 and Hyogo action frame plan of the 2005 on the disaster risk reduction by 2005-2015.

The practice has proved that there is no country with developed economy undertaking preventive capital measures for every existing or newly evoked geological event. Moreover quite often the measures against aggravated landslide processes with even great capital expenses do not produce the desirable effect. Therefore, the principal thing is to establish the place, kind and scale of the expected geological event and the risk of expected hazard to the population and economic-engineering objects. Realization of the scenario of reduction of the disaster risk posed to the population and strategic objects during the emergency is the principal and decisive task. Most importantly, the population should be informed timely about the hazardous situation and the recommendations should be given about simple mitigating measures, which can be undertaken easily by the local population, communities and municipalities. Consequently, one of the main directions in prevention or mitigation of geological riskd is functioning of well-organized geo-monitoring studies at the regional, as well as secondary and tertiary levels.

It should be noted that the geo-monitoring studies in Georgia, due to insufficient financing, were undertaken with a minimum funding and with interruptions, only on the particularly dangerous and geo-ecologically stressed urbanized areas. The high mountainous regions, where there are catastrophic events (landslides, rockfalls, mudflows, snow avalanches) formed were not subject to regular observations. These disastrous events often reach the populated areas and engineering objects and quite often end up with tragic outcomes. There are many examples of such disasters, especially in Kazbegi, Dusheti, Svaneti, Ajara and Racha regions.

**Strategic aims**

The principal strategic aims in mass-movement related disaster risk reduction are as follows:

- Basic evaluation of the existing level of the natural catastrophes and identification of events;
- Establishing the spatial limits and their causal effect;
- Assessment of risk;
- Establishing a reliable early warning system for forecasting natural disasters;
- Identifying the possible damage of the geological catastrophes and identifying concrete preventive measures;
- Registering the development of the hazardous processes on the territory of Georgia in a long-term perspective, cataloguing, processing, analyzing and generalizing the statistical information about the damage caused by these processes and creating the electronic database;
- Scientific long-term prognosis of the trends in development of natural disasters and changes of the geological environment due to the anthropogenic impact (for a 20-25-year-long period);
- Drafting the basic maps of risk zoning for erosive, landslide-gravitational and mudflow processes on the territory of Georgia in GIS system;

- Extending the geo-monitoring studies to every hierarchical level on the whole territory of Georgia and their permanent implementation starting from observation, control and assessment through prognosis and management, by using ground and space technologies;
- Organization of the observation test areas of the geological catastrophes for the second and third geo-monitoring levels and their operating to study thoroughly the regularities of origination of a concrete event and develop optimal contra measures;
- Urgent situation assessment in force-majeure circumstances during the extreme activation of geological elements, fixing the risk of hazard, giving geological recommendations to the population and offices in extraordinary situations in the high risk areas; developing detail conclusions about the established situation by specifying the preventive measures for the local administration and government;
- Drafting annual information bulletins of prognosis of geological catastrophs and expected hazard, developing proper mitigation and preventive measures and their urgent delivery to the relevant institutions at the regional and central levels.

Geo-monitoring studies of the natural disasters must be considered a priority at the state level and must be financed within the limits of the state target program.

**Legal basis of strategic aims**

The Constitution of Georgia; Georgian Laws about the "Environmental protection" and "Soil protection"; the 2005 UN Hyogo action frame plan on disaster risk reduction strategy in 2005-2015; Decree No. 542 of the President of Georgia of 2007 "About the protection of the population and territory against natural and anthropogenic situations"; Environmental safety concept of Georgia; the National reaction plan for the natural-anthropogenic extremal situations; Provision of the Ministry of Environmental Protection and Natural Resources of Georgia and activity of the national agency of the same Ministry.

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# Проблемы природно-антропогенных катастроф в Грузии

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**Резюме**

В статье рассмотрены проблемы, связанные с геологическими катастрофами в Грузии, оценены основные факторы, обусловливающие возникновение этих процессов, масштабы их развития и негативные последствия, даны цели и задачи уменьшения риска катастроф.

# ბუნებრივ-ანთროპოგენური კატასტროფების მდგომარეობის პრობლემა საქართველოში

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**რეზიუმე**

სტატიაში განხილულია საქართველოში სტიქიურ-გეოლოგიურ პროცესებთან დაკავშირებული პრობლემები, შეფასებულია მათი გამომწვევი მთავარი ფაქტორები, განვითარების მასშტაბები და მათგან მიყენებული ნეგატიური შედეგები, მოცემულია სტიქიის საშიშროების რისკის შემცირების სტრატეგიული მიზნები და ამოცანები.