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Principles of compiling an inventory map of geological processes using the example of Chiatura Municipality

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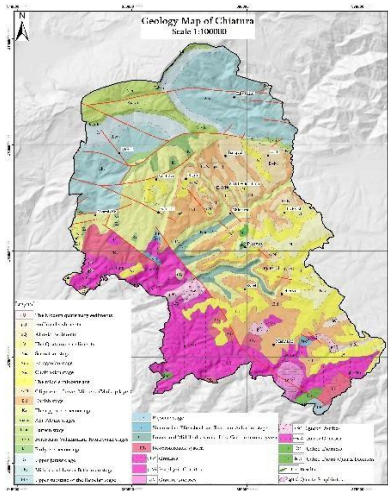
Abstract. In Georgia, in the Chiatura municipality, one of the main problems is the activation of natural disasters (landslides, mudflows, rockfalls, floods, winds, erosion, etc.), which, along with natural factors, is facilitated by anthropogenic impacts. Of the above processes, landslides and erosion are the most characteristic and the biggest problem for the Chiatura municipality, the formation and activation of which is associated with both naturally formed complex geological, morphological and climatic conditions, and human activity, including large-scale mining and quarrying activities. Within the framework of the project, a large-scale (1:25,000 or 1:10,000) geological hazard zoning map will be created, which will be one of the main results of the project and will have both scientific and applicable meaning significance. It will then be used in the municipality for a sharp mitigation of the geocological situation and as a basic basis for the targeted development of the territory.

Before creating the geological hazard zoning map, an inventory map was developed in the ArcMap program, which reflects the spatial distribution of natural geological processes. This map is one of the important bases for compiling the geological hazard zoning map. It shows natural geological processes that have occurred in the past or have recently developed, and this information was reflected on the basis of processing historical fund materials and field geological surveys. In addition, the intensity of erosion processes was assessed based on field-scientific surveys and the results obtained.

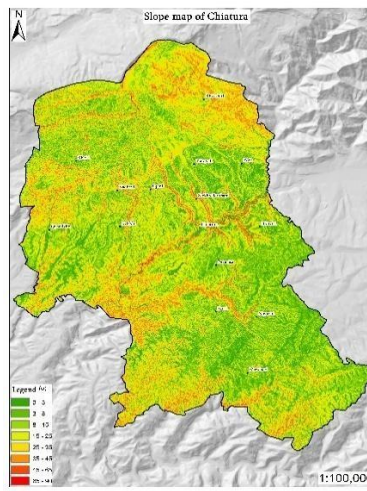
Keywords: Chiatura Municipality, natural disasters, inventory map, landslide, water erosion.

Introduction

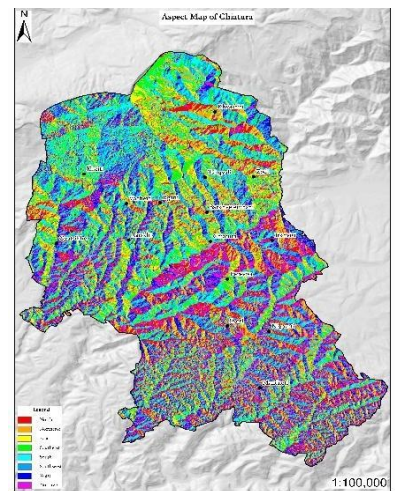
In Georgia, one of the most vulnerable places in terms of geocological conditions is the Chiatura municipality, the main problem of which, against the backdrop of climate change, is the activation of natural disasters (landslides, mudflows, floods, winds, erosion, etc.), which, along with natural factors, is facilitated by anthropogenic impacts, including the intensification of mining activities (manganese production) in the municipality. Ore mining is associated with many controversial issues. On the one hand, it is a source of income and new job creation. However, it causes significant damage to the environment and the local population. Deforestation and destruction of vegetation cover over large areas are possible; the landscape is very degraded, which has a significant negative impact on biodiversity; pollution of ecosystems and food products is likely; Soil degradation, big material losses, etc. [1]. Due to this, the socio-economic situation of the population is significantly deteriorating and migration processes are becoming more active [2,3]. The issue is important for mountainous regions, including the territory of Chiatura municipality, whose population has been experiencing extremely negative impacts of landslide-gravitational processes and ore mining for more than a century. The purpose of the study is precisely to identify natural geological processes in the target area and use modern methodology to regionalize the entire territory of the municipality according to various categories of natural hazards. This will allow us to reduce the negative consequences caused by natural geological processes and to properly plan the territories.



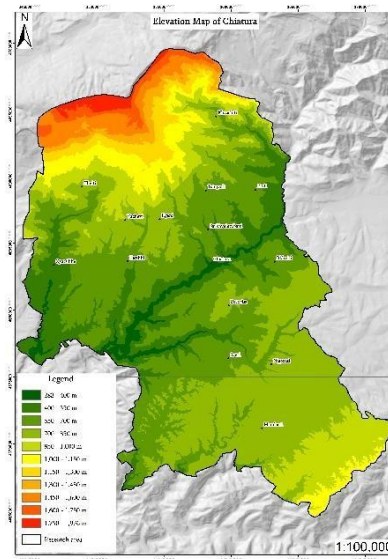
Geological map



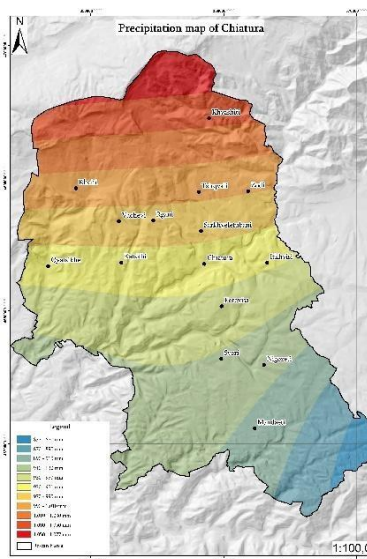
Slope map



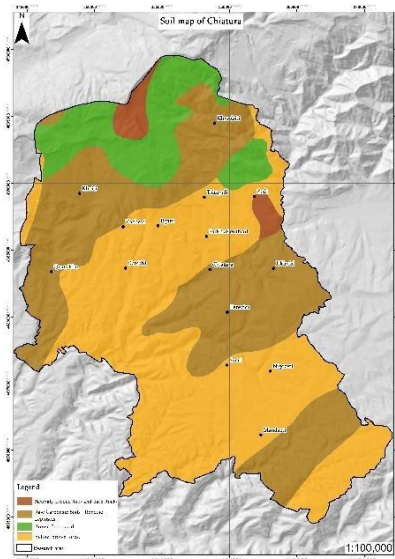
Aspect map



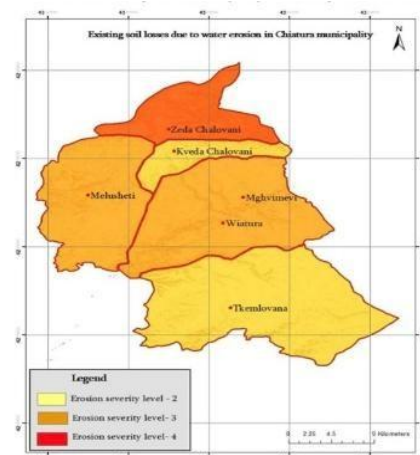
Elevation map



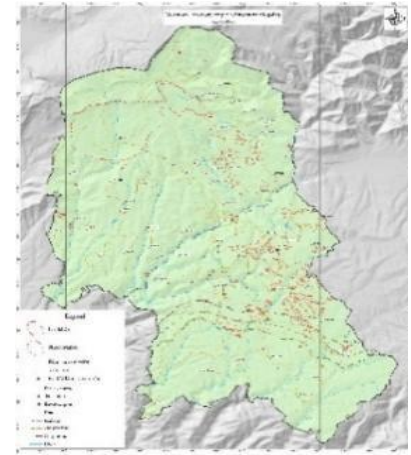
Rainfall map



Soils map



Water erosion map



Inventory map

Research area and methods

According to the morphological division of the relief of Georgia [4], the study area practically entirely falls within the boundaries of the intermountain plain zone of the Imereti Upland. The hilly, low and medium-mountainous relief of the Imereti Upland is divided by a frequent network of erosional valleys. Within the upland, the Chiatura structural plateau is distinguished, which extends over the Dzirula-Kvirila watershed and the right side of the Kvirila River gorge. The relief is mostly undulating and dissected.

The geological structure of Chiatura Municipality includes a wide range of sedimentary, magmatic, and metamorphic formations, the age range of which, with minor outliers, ranges from the Upper Proterozoic (Neoproterozoic) to the modern period. Landslide-gravity processes are widespread in Chiatura Municipality. Their development is associated with both natural and anthropogenic (technogenic) factors. Accordingly, the landslides that have developed here can be divided into two types according to their genesis or origin: landslides caused by natural factors and landslides caused by natural-technogenic factors. The development of landslides of the first type is directly related to the complex geological structure of the territory, morphological conditions, climate, etc., while the development of landslides of the second type is related to natural factors and partially to anthropogenic factors, including manganese mining in Chiatura.

Within the framework of the study, an inventory map of hazardous (natural) geological processes within the borders of Chiatura Municipality was compiled, for which both historical fund materials and field geological surveys were processed. The inventory map (8) reflects the spatial distribution of natural geological processes and serves as the basis for compiling a geological hazard zoning map. In addition, a digital elevation model (DEM) of the study area and the following thematic maps necessary for the assessment of geological hazards were processed: geological, slope, aspect, elevation, rainfall, soils, and water erosion maps (1-6) and etc. The maps were prepared in the ArcGIS program [5-7].

For erosion prediction GIS are used to detect gullies and ravines on mountain slopes, determine their geometric dimensions and the causes of their slopes, and plot them on a large-scale digital map (7). Using statistical material and the scale of the English professor Roy Morgan, the erosion class and its intensity were determined, taking into account the time factor [8-13].

Results

Based on historical fund materials and field research data, an inventory map of hazardous geological processes (scale 1:50,000) was prepared, which includes: landslide areas - 135; river bank erosion - 16; mudflow - 5; rockfall/rock avalanche - 12; sheet erosion - 9.

As a result of data processing in the ArcGIS program, the degree and areas of damage to the territory caused by the impact of natural and anthropogenic geological processes were revealed. According to which, landslide areas in Chiatura municipality occupy 9.8% (5442.3 ha) of its total area, of which 7.5% (4165 ha) are landslides caused by natural factors, and 2.3% (1277.3 ha) are natural-technogenic. Chiatura municipality is divided into the following categories according to land cover: forest cover (47%), grass-shrubland (23%), hydrological object (0.1%), road (1.5%), S/S Savarguli (28%), buildings and structures (0.4%). 5.5% of the buildings and structures in Chiatura Municipality are located in the area of landslide processes, which amounts to 2139 in quantity, of which 1509 buildings and structures are located in the area of landslide processes caused by natural factors, and 630 - by natural-technogenic factors. The total length of the road network in the municipality is 1537.1 km, of which 6.7% of the total length is in the area of influence of landslide processes, which is approximately 103.1 km. 13.6% of the agricultural lands of Chiatura Municipality are in the area of spread of landslide processes, which is 2075.7 ha. The forest cover in the area of spread of landslide processes occupies 6.9% of the total area, which is approximately 1803.1 ha.

A large-scale digital map was created in the GIS program for erosion prediction, which presents the losses caused by water erosion in the Chiatura municipality. It was determined that the activation of gullies and ravines are observed at five study sites, which, according to the scale of the English scientist, Professor Roy Morgan, ranges from 2nd to 4th class of erosion. The intensity of the corresponding water erosion processes of soil on mountain slopes is equal to 3.2-45.0 t/ha per year, which indicates a fairly high degree of soil loss on mountain slopes.

Conclusion

1. Within the framework of the study, it was planned to prepare an inventory map of hazardous (natural) geological processes within the boundaries of the municipality, for which both historical fund materials were processed and field geological surveys were conducted;
2. The study presents an inventory map of hazardous geological processes of Chiatura Municipality (scale 1:50,000), which includes: landslide area - 135; bank erosion - 16; mudflow - 5; rockfall/rock avalanche - 12; extensive erosion - 9;
3. Factors that generate and trigger hazardous geological processes, such as geological structure, tectonics, slope inclination, relief types, climate, anthropogenic impact, etc., were assessed; the degree and areas of vulnerability of the territory caused by the impact of natural and anthropogenic geological processes were identified;
4. The paper presents maps of the geological, tectonic division of the territory, land cover, slope inclination, elevation, soils and atmospheric precipitation of Chiatura Municipality;
5. Field-scientific research was conducted and the results were processed to assess the intensity of erosion processes. A large-scale digital map was created in the GIS system for erosion prediction, which presents losses caused by water erosion in the Chiatura municipality;
6. It was determined that activation of gullies and ravines are observed at five study sites, which, according to the scale of the English scientist, Professor Roy Morgan, ranges from 2nd to 4th class of erosion. The intensity of corresponding water erosion processes of soil on mountain slopes is equal to 3.2-45.0 t/ha per year, which indicates a fairly high degree of soil loss on mountain slopes.

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სტიქიური გეოლოგიური პროცესების ინვენტორული რუკის შედგენის პრინციპები ჭიათურის მუნიციპალიტეტის მაგალითზე / რიკაძე ზ., შავლიაშვილი ლ., კუჩავა გ., შუბლაძე ე., გავარდაშვილი გ., მოდებაძე ს. / სტუპ-ს ჰიდრომეტეოროლოგიის ინსტიტუტის შრომათა კრებული. -2026. -ტ.139. -გვ.137-142. - ინგ., რეზიუმე. ინგ., ქართ., რუს.

საქართველოში, ჭიათურის მუნიციპალიტეტში, ერთ-ერთ მთავარ პრობლემას წარმოადგენს ბუნებრივი სტიქიური მოვლენების (მეწყობები, ღვარცოფები, კლდეზვავი/ქვათაცვენები, წყალდიდობა, ქარები, ეროზია და სხვა) გააქტიურება, რასაც ბუნებრივ ფაქტორებთან ერთად ხელს უწყობს ანთროპოგენური ზემოქმედება. აღნიშნული პროცესებიდან ჭიათურის მუნიციპალიტეტისთვის ყველაზე მეტად დამახასიათებელია და ყველაზე დიდ პრობლემას ქმნის მეწყობები და ეროზიები, რომელთა წარმოქმნა-გააქტიურება დაკავშირებულია როგორც ბუნებრივად ჩამოყალიბებულ რთულ გეოლოგიურ, მორფოლოგიურ და კლიმატურ პირობებთან, ისე ადამიანის საქმიანობასთან, მათ შორის ფართომასშტაბიან სამთო-მოპოვებით საქმიანობასთან. პროექტის ფარგლებში შეიქმნება მსხვილმასშტაბიანი (1:25 000 ან 1:10 000) გეოლოგიური საფრთხეების ზონირების რუკა, რომელიც იქნება პროექტის ერთ-ერთი მთავარი შედეგი და მას ექნება როგორც სამეცნიერო, ისე გამოყენებითი მნიშვნელობა. შემდეგში მუნიციპალიტეტში იგი გამოყენებული იქნება, გეოეკოლოგიური მდგომარეობის მკვეთრი შერბილებისათვის და როგორც ბაზისური საფუძველი ტერიტორიის მიზანმიმართული ათვისებისათვის.

გეოლოგიური საფრთხეების ზონირების რუკის შექმნამდე ArcMap პროგრამაში დამუშავდა ინვენტორული რუკა, რომელიც ასახავს სტიქიური გეოლოგიური პროცესების სივრცულ განაწილებას. აღნიშნული რუკა წარმოადგენს გეოლოგიური საფრთხეების ზონირების რუკის შედგენის ერთ-ერთ მნიშვნელოვან საფუძველს. მასზე ნაჩვენებია წარსულში მომხდარი ან ახლად განვითარებული სტიქიური გეოლოგიური პროცესები, აღნიშნული ინფორმაციის ასახვა მოხდა საფონდო ისტორიული მასალების დამუშავებისა და სავსე გეოლოგიური კვლევების საფუძველზე.

გარდა ამისა, სავსე-სამეცნიერო კვლევებისა და მიღებული შედეგების საფუძველზე შეფასდა ეროზიული პროცესების ინტენსივობა.

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Принципы составления инвентаризационной карты стихийных геологических процессов на примере муниципалитета Чиатура / Рикадзе З., Шавлиашвили Л., Кучава Г., Шубладзе Е., Гавардашвили Г., Модбадзе С. / Сб. трудов ИГМ ГТУ. -2026. -том 139. 137-142с. - Англ.; Рез: Англ., Груз., Рус.

В Грузии, в муниципалитете Чиатура, одной из главных проблем является интенсификация стихийных бедствий (оползни, селевые потоки, камнепады, наводнения, ураганы, эрозия и т.д.), которая, наряду с природными факторами, усугубляется антропогенным воздействием. Из вышеперечисленных процессов оползни и эрозия являются наиболее характерной и масштабной проблемой для муниципалитета Чиатура, формирование и активизация которых связаны как с естественными сложными геологическими, морфологическими и климатическими условиями, так и с деятельностью человека, включая крупномасштабную добычу полезных ископаемых и разработку карьеров. В рамках проекта будет создана крупномасштабная (1:25 000 или 1:10 000) карта геологического

зонирования опасности, которая станет одним из главных результатов проекта и будет иметь как научное, так и прикладное значение. Впоследствии она будет использоваться в муниципалитете для радикального смягчения геологической ситуации и в качестве основы для целенаправленного развития территории.

Перед созданием карты геологической опасности в программе ArcMap была разработана инвентаризационная карта, отражающая пространственное распределение природных геологических процессов. Эта карта является одной из важных основ для составления карты геологической опасности. Она показывает природные геологические процессы, которые происходили в прошлом или развивались недавно, и эта информация была отражена на основе обработки исторических материалов и полевых геологических исследований.

Кроме того, интенсивность эрозионных процессов была оценена на основе полевых научных исследований и полученных результатов.