Ecological and Geomorphological Analysis of Ecosystems in The Mountainous Part of The Chechen Republic

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ABSTRACT

The high lithological and morphological diversity of the Chechen Republic is the basis for geoconservation activities. Conservation of geomorphological heritage is usually included in general nature conservation and should therefore be analyzed in an appropriate context. Assessment of the ecological value of dynamic geomorphosis should take into account their ability to maintain a high degree of biodiversity. There are two approaches. The first, which is by far the most commonly used, aims to give high ecological value to sites with high biodiversity or the presence of interesting or rare species. According to the second approach, there is an assessment of the impact of the existing ecosystem on specific geomorphological features. The climatic conditions of the mountainous country are determined by its geomorphological structure, which entails a significant variety of climate features of the Chechen Republic, crossed with six main ridges, each of which plays a certain climate-forming role.

Keywords: *mountainous region, geomorphology, lithological diversity, soil formation, geomorphic conditions.*

1. INTRODUCTION

Consideration of the system "man - relief" is determined by the need to identify the role of the geographic environment of the location of the city on its growth and development and, in particular, consideration of the relief as the basis of the ecosystem "City" [1]. This position in science is new. Man created a city, his ecosystem, in accordance with his needs, in which he, a man, is the first system-forming link, and the other is the natural (geographical) environment. Their interaction forms an urban area and a specific natural and anthropogenic environment - an urban environment, or an urban planning system, in which the relief plays the role of a structural planning framework and is the basis of an ecological framework [2].

Ecological and geomorphological analysis includes: assessment of the positive impact of the relief on the state of the urban ecosystem; identification of harmful effects of geomorphological conditions on the urban ecosystem; development of recommendations to reduce these impacts; preservation and controlled change of the geomorphological conditions of the city.

The study of the proportionality of the natural relief, the peculiarities of geomorphological processes in the territory of the city with one or another type of architectural relief can give a new development of the direction - landscape architecture, or the organization of relief. The extremely diverse geological history and the complex nature of the tectonic structures of Mountainous Chechnya led to the formation of the main macroforms of the modern relief and their morphological appearance [3-4].

In mountainous regions, the activity of geomorphological processes usually prevails over soil formation. Due to the increase in socio-economic use over the last century, there has been a rapid fragmentation of ecological patterns and geomorphic conditions in many mountainous regions. The imbalance created by the irrational use of land resources has increased the intensity and occurrence of geomorphological processes. Among other things, this is reflected in soil damage, which is often irreversible in fragile mountain ecosystems.

For this, it is important to understand the geomorphological parameters and processes occurring in a particular area. Some examples of management strategies based on geomorphological information are: improving protective forest management, preparing natural hazard maps, and promoting landscape conservation.

Generally speaking, current trends in landscape maintenance in mountainous areas require a full understanding of the susceptibility or vulnerability of the environment to degradation processes [3]. Consequently, knowledge of glaciation models, river transport systems and gravity processes is necessary, for example, to explain the spatial distribution of loose material, the emergence of the weathering mantle, and the activity of geomorphological processes. To a large extent, this geomorphological knowledge can facilitate the understanding of soil degradation and thereby assist in soil conservation in the mountains. Key questions in this regard [5]:

How should geomorphological information be identified, collected and presented / visualized by analyzing past and future trends?

What specific geomorphological information can make the greatest contribution to the maintenance of general life in mountain areas?

Landslide effects occur in two main environments: built environment and natural environment. Sometimes they overlap; for example, agricultural and forest land that has been cut down. Landslides affect man-made structures. Regardless of whether they are directly on the landslide or next to it [6]. Residential buildings built on unstable slopes can be partially damaged or completely destroyed as landslides destabilize or destroy foundations, walls, surrounding property, and ground and underground utilities.

Landslides affect the environment:

• morphology of the Earth's surface - mountain and valley systems both on continents and under the oceans; the morphology of mountains and valleys is most influenced by the movement of large masses of landslides down the slope;

• Forests and grasslands covering most of the continents;

• Local wildlife that exists on the surface of the Earth, in its rivers, lakes and seas.

2. RESEARCH METHODOLOGY

Geomorphology is more than the study of landforms. Physical geography was conventionally divided into geomorphology, climatology, hydrology and biogeography, but now the main focus is on the systematic analysis of recent environmental changes. It draws on expertise in mathematical and statistical modeling and remote sensing, develops research to inform environmental management and environmental design, and benefits from collaborations with other disciplines such as ecology, geology and engineering. Accordingly, geomorphology has changed over the past 50 years from descriptive science to process-based science and is now a “computational” science that uses simulation models, remote sensing information and integrated GIS-based analysis in a variety of studies and applications [7].

Traditionally, one of the foundations of geomorphology is the geomorphological map. An ideal geomorphological map should not only describe and explain landforms based on the morphogenesis of individual landforms, but also, more importantly, explanations must be based on relationships between different landforms, to varying degrees, affected by multiple processes. It seems realistic; however, there are many different geomorphological mapping systems. While geological maps appear to be very consistent in presenting geological information, various geomorphological schools in Europe have developed their own unique representation of the earth's surface. Attempts have been made to increase the uniformity of geomorphological legends and international efforts by the International Geographic Union (IGU) Commission on Applied Geomorphology - the Sub-Commission on Geomorphological Mapping. Despite these efforts, it was unsuccessful. However, many applications have been released based on geomorphological maps, especially in hazard zones [8].

By the end of the twentieth century, the number of studies and review articles and books aimed at the application of geomorphology increased. This has been accompanied by the introduction of new tools and techniques such as data analysis in geographic information systems, remote sensing and modeling.

The same trend has been recognized in soil studies. It seemed necessary to create a more 3D soil model instead of sticking to the catena concept; therefore a link was made to geomorphology. This marked the beginning of pedogeomorphological research and paved the way for the integration of geomorphological concepts into soil science. In some articles, even the geomorphology of soils was explained as [8] "... the study of the landscape and the influence of landscape processes on the formation of soils." We are now seeing that integrated approaches, especially in soil erosion studies, use the concept of terrain units. These landscape units have homogeneous environmental properties such as geology, soil, geomorphological conditions, etc., and similarly respond to changes in threshold values (eg precipitation, land use) in the landscape. Remote sensing and GIS are essential tools in the process of locating units and storing data.

Modeling is a useful technique for predicting runout zones during rockfalls and thus can help in taking preventive measures. A regional scale rockfall model developed by Dorren et al. Is used at Montafon to predict exit zones and traces of falling rocks, and to assess the role of protective forests. By defining these zones, obstacles such as fences and horizontal tree trunks can be placed on rockfall paths to protect people living below the valley and to reduce soil mobility. In addition, the model provides information about the conditions of the slope, as it identifies, for example, zones of rock accumulation (material renewal) and areas of rockfall sources (material destruction) [9]. A detailed study has shown the applicability of geomorphological information about the terrain to validate the simulation results. The simulation results with and without trees were compared with geomorphological maps 1: 5.000 and gave sufficient accuracy. An extended version of this model (Asselen et al., In preparation) is used to simulate the 3D development of a talus cone generated by the fall of the talus. Such models can simulate changes in surface topography and can even better match realistic terrain situations [10].

These examples show that models can help in land management as they provide insight into natural processes and thus provide important information about where and what preventive measures can be taken.

3. RESULTS

The purpose of this article was to discuss the methodology for assessing the ecological value of dynamic mountain geomorphosis. We have proposed approaches and assessment criteria for one aspect of ecological value: vegetation diversity. We have demonstrated that an approach based only on plant diversity does not provide a complete and objective assessment of the ecological value, since all information on the dynamics of geomorphosis is missing. Indicating the number of species (species richness) and the presence of rare or protected species are really not enough to assess the ecological value, since they do not provide information on the role of geomorphological forms and processes in the formation and conservation of specific plant communities. For this reason, it is important to consider several criteria, which also take into account the influence of geomorphological processes, and to carry out the assessment at the relief level. Therefore, we proposed to measure the influence of geomorphological processes on plant diversity and the conditions of existence of rare species according to three criteria: disturbance, movement, and soil, regrouped into the morphodynamics index [3-4].

The orographic system of the Black Mountains is represented in Chechnya by a chain of low-mountain monoclinal ridges, mainly of latitudinal and sub-latitudinal strike, separated by deeply cut transverse gorges. The Black Mountains are characterized by the highest heights up to 1000-1300 m, average dissection depths of 300-400 m (maximum □ in 500 m) and the predominance of erosion and denudation processes. The monoclinal ridges of the Black Mountains are characterized by a more dissected structural-denudation relief in comparison with the Peredovye ridges. The northern slopes are strongly dissected by shallow gorges and ravines. The southern slopes are often steep up to 40 °, and sometimes they are steep. The peaks of the Black Mountains are smooth, with smooth, rounded outlines.

Studies have shown that only about 21% of the territory is covered with forest. The Black Mountains have a forested area of about 65%, the Chechen Plain and the Tersko-Sunzhenskaya Upland - less than 4%, the North Chechen Lowland, excluding pasture-protected forest belts - less than 1% of its territory [5].

The numerical assessment of the influence of geomorphological processes is based on the index of morphodynamics. The existence of disturbances affecting the soil can be associated with numerous geomorphological processes: surface movement can be caused by periglacial processes, solifluction. or frosty weathering; erosion of surface sediments or deposition of sediments can be associated with gravity processes, avalanches, post-glacial decompression, storm activity, etc. The frequency and intensity of these disturbances are key factors in understanding the impact they can have on soil and vegetation development. Because they restrict soil development and can damage vegetation, disturbances can reduce the number of plant species. However, at the same time they act as a restorer and allow for the existence of pioneer species that would otherwise have been replaced by alpine pastures or other species adapted to stable terrain. He suggested that the application of the morphodynamics index could lead to fundamental results for assessing where plant communities are subjected to more intense geomorphological pressure. This index assesses the frequency of geomorphic disturbances (score from 0 to 4), landform stability and soil development (score from 0 to 4). The sum of the three criteria ranges from 0 (stable landform) to 9 (high-activity landforms) [6-7].

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4. DISCUSSION

The dynamics of geomorphological processes (erosion and sedimentation, slope movements) causes constant micro-changes in the earth's surface, which alter plant diversity and help in establishing mechanisms of interaction between plant communities and geomorphic processes. This geomorphological disturbance acts as a habitat renewer and allows different plant species to coexist on a small surface. High intensity or high frequency disturbances usually reduce species numbers because they restrict soil development and can damage vegetation. On the other hand, these constraints allow the existence of pioneer species that would not necessarily find suitable conditions without geomorphological disturbances. The ecological value of dynamic mountain geomorphosis thus lies, on the one hand, in the fact that they allow the creation of many micro-habitats and thus contribute to the existence of many different species, and on the other hand, in the maintenance of pioneers. species that would no longer exist without disturbance from various geomorphological processes. The ecological value must also be considered in perspective according to the scale considered for the analysis of these parameters; ecological value of national importance can exist only if geomorphological forms and processes determine the existence of rare or protected species on a national scale [9].

More generally, since some geomorphological processes and landforms allow early species or a high degree of biodiversity, the ecological value of geomorphosis should be better taken into account in conservation policies or in environmental impact studies. To facilitate this, we believe that the geomorphosis assessment process should better take into account the influence of geomorphological parameters on the creation and maintenance of special conditions for plant communities, rather than focus only on geoscientific or aesthetic values. In this case, we would like to emphasize the importance of collaboration between scientists from different disciplines to maintain a strong relationship between geodiversity and the management and protection of biodiversity, as they are highly interrelated.

5. CONCLUSIONS

In mountainous areas, geomorphologists are increasingly involved in land management practice. The trend in geomorphological exploration has shifted from traditional descriptive field mapping to the automatic extraction of quantitative data from digital elevation models and satellite images. GIS tools are often used to analyze such data. Thus, new available sensors are increasing the temporal and spatial resolution of remotely sensed images, and digital elevation models with a resolution of 1 m are becoming available. These will increasingly be combined with other data such as soil data. Improving resolution is especially important in mountainous regions because these highly dynamic regions cannot be summarized in a 1 km2 grid dominated by assumed homogeneous terrain conditions. End users must process detailed geomorphological information about real terrain units that have physical significance. In addition to the application of remote sensing and GIS techniques, geomorphologists support land administration by proposing models that describe various landscape processes. Geomorphological studies of soil erosion should focus on fundamental processes, but it is equally important to continually develop and evaluate models that match real-world data availability, geomorphic conditions and information needs [10].

It should be noted that traditional geomorphological expertise recorded on many maps is often inappropriate for modern databases - there seems to be a lack of experienced geomorphologists who can “translate” this knowledge into a coherent digital format, but this is still critical and necessary step. On

On the other hand, recent trends in data mining and modeling using digital elevation models and satellite imagery should be combined with this terrain-based approach, preferably using large-scale data in mountainous areas. Specific geomorphological information such as slope stability, material distribution, hazard occurrence that will most contribute to overall mountain livelihood activities will be integrated into decision support and management systems.

strategy and in GIS systems. However, it seems that measurements in the mountain environment will not be enough, and that the development and application of new integrative methods will be faster; therefore, the application of expertise in such new designs is of paramount importance to validate the terrain conditions.

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