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Evaluation of geomorphological conditions in the dynamics of urban development evolution in the city of Gjirokastra

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Abstract

The current process of urbanization requires the understanding and assessment of geomorphological conditions in function of urban infrastructure. Gjirokastra is a city located on the eastern slope of the Mali i Gjerë mountain ridge, with a direct connection to the Drino valley. The urban geomorphological heritage is closely linked to urban geomorphology and the dynamics of landform transformations. Through urban geomorphology, the suitability of relief elements has been analyzed in relation to the expansion of residential and industrial objects. The dominant position of Gjirokastra Castle in relation to the surrounding segments created the conditions for the formation of the earliest urban center of the city, which then expanded toward the surrounding hills and the terrace of the Drino valley. The vertical zoning of the terrain has determined the placement of Ottoman-style houses in the hilly sector and apartment blocks along the Drino valley. Looking ahead, the gradual expansion of the city requires analysis of current terrain modeling processes. Scientifically-based criteria must be applied in the expansion of the cultural heritage zone, taking into account the evolution of landforms, which over the last four centuries have undergone significant morphological changes due to increasing urban pressure and cultural tourism.

Keywords:
cultural heritage, relief, tourism, urbanization

4.14. 1. Introduction

Urbanization is one of the major challenges that the world faces. (Schneider et al. 2009) Urbanization and correlated infrastructure building highly impact and sometimes completely destroy landforms. Nevertheless, urban areas are particularly interesting from a geomorphological point of view for three reasons:(Reynard,2017) Currently, urban geomorphology addresses new questions such as ecosystem services pro¬vided by geomorphological processes and land¬forms(Picket et al. 2001), (Gordon et al. 2012), (Gray et al. 2013) interconnections between geomor¬phological and anthropogenic systems, studied through holistic approaches, and the need to merge physical geography and human and social sciences approaches.

Geomorphological surveying is the basis of other kinds of analysis and relative applications for each case study and it consists of the following:

a. scientific literature and technical materials collection;

b. a multitemporal and multidisciplinary approach;

c. field surveying.

The multitemporal and multidisciplinary approach is based on aerial photograph interpretation, historical cartographic documents analysis and comparison to actual topography, nature of bedrock and deposits analysis through, qualitative and quantitative assessment, reference to historical documents and maps, or photograph. Field surveys are fundamental for observations and direct data checking. We also consulted numerous geographical books and papers to collect information relevant to the geomorphologic characteristics that were present.(Pica,2024)

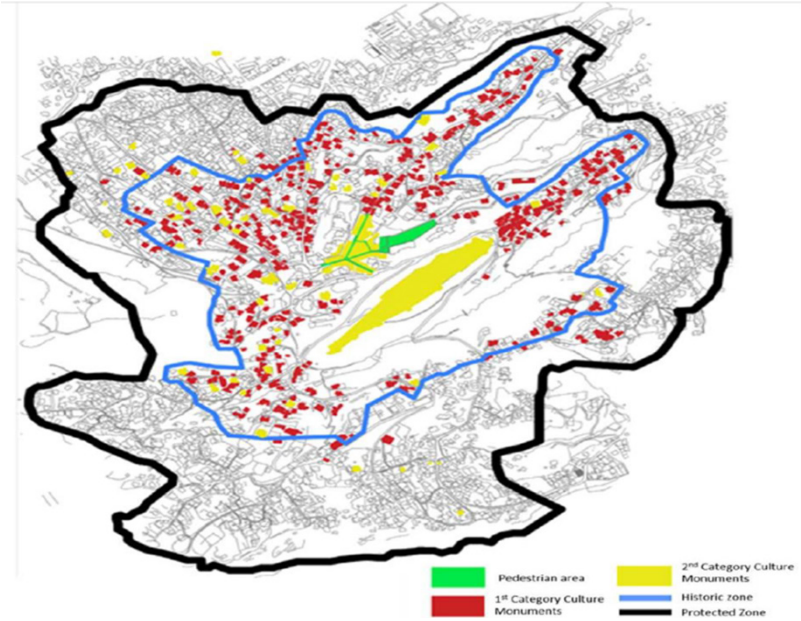
The city of Gjirokastra is included in the eastern part of the Drino River Valley, which is included in the physical-geographical subunit of the Southern Mountainous Region in the territory of the Republic of Albania. The city has a population of 16,569 inhabitants.(INSTAT,2023) This valley lies between the mountain range of Mali i Gjerë in the west and the mountain range of Lunxheria in the east. The Drino Valley serves as a connecting corridor with the Republic of Greece, and greatly influences the penetration of continental air masses towards the interior of the territory of the Republic of Albania.

1. the geomorphological context (site) of Gjirokastra City (Onde 1966) is part of his“image” and his fame (e.g. the revers of Monoclinal Crest of Mali i Gjerë);

2. Urban sprawl often interacts with geomorphological processes (e.g. landslides) and landforms (e.g. fluvial or coastal forms), and necessitates specific methods to deal with geomorphological processes;(Mohapatra et al. 2014)

The World Heritage Site of the Museum-City of Gjirokastra was inscribed on the World Heritage List in 2005. It is a compact city with a Historical Center built of stone buildings one above the other. A good part of the alleys are pedestrian streets, because they were conceived in another era. In the characteristics of these ensembles, a decisive role is played by the configuration of the terrain on

which they are built. The most picturesque ensembles that we can find in Gjirokastra are: “Old Pazar”, the “PIlakë” neighborhood and the “Hazmurat” street of “Qafa Pazarit” is part of the Museum Zone, of the first category, with a width of 5□6 m., with a high slope and paved with stones. Within the historic area of Gjirokastra there are 323 Cultural Monuments.(Fondi i Zhvillimit Shqiptar,2022)



Map 1: Map of the historical area and cultural monuments in the city of Gjirokastra. Source: Fondi i Zhvillimit Shqiptar,2022

Based on a bibliographical review, this paper addresses the main challenges of research on geomorphological heritage in urban contexts, the definition and characterization of urban geomorphological heritage and the various methods developed for describing, mapping and assessing urban geomorphological heritage;(Reynard, 2017)

Geomorphology interacts in various ways with city and urbanization:

a) Landforms contribute to the landscape and natural heritage of city. They sometimes participates to the “image” of the city. Thus, the landscape of Gjirokastra, is inseparable from the cuestas and terraces of Drino Valley.(Fernandes et al. 2010)

b) Landforms may also constitute a constraint to urban development. Some¬times it is the boundary between two geo¬morphological contexts that prevents urbani¬zation in certain directions, such as, for example, the relationship between the mountain range of Mali i Gjerë to the west and the Drino valley to the east of the city of Gjirokastra. Some specific geomorphological contexts also give rise to important urban planning constraints.(Bondesan 2017).

Photo 1. The central part of the city of Gjirokastra. Palorto neighborhood in the lower sector and Dunavat neighborhood in the upper sector. Source: Hoxha,2025

4.15. 2. Methodology

The scientific paper contain the main features of the city of Gjirokastra: the city typology, in terms of size,the geographical context, in terms of landscape; the main geomorphological processes acting; the study topic; and the methodological approach used. A brief overview neighborhoods of the city, including their geological and geomorphological frameworks. (Pica, A, et al.2024) We also consulted numerous papers and geographical books and papers to collect information relevant to the geomorphologic characteristics that were present. In addition, important information on natural landforms that are now hidden was obtained from interviews of elderly people who described the recent modifications. The analysis of the landforms in the study area was performed by means of a geomorphological survey. We obtained information on the action of surface processes over time to show how the area has been subjected to rapid morphological changes. Multidisciplinary data integration allows the recognition and reconstruction of geomorphological characteristics; in particular, anthropogenic erosion and accumulation.(Pica,2024)

4.16. 3. Results

The natural landscape in which Gjirokastra has developed was primarily moulded by fluvial processes. Specifically, the following rules were adopted:

(1) Man-made landforms were included in this category when they completely erased the natural morphology (in this case, an indication of the previous morphology was given, if possible); (Del Monte,D'Orefice, Luberti, Marini, Pica, Vergari, 2016)

(2) Natural landforms modified by man, but still recognizable, were grouped in the original morphogenetic process category.(Del Monte,2017)

In terms of lithological construction, the eastern sector is mainly composed of lower oligocene flysch rocks, which are characterized by a low degree of stability. In the western peripheral edges of the city, cretaceous limestone rocks appear.(Collective of Authors.,2014) In the eastern peripheral sector of the city, quaternary deposits of continental facies appear, with a large presence at the levels of the river terraces of the Drino valley.(Mezini,1985) During the periods of morphotectonic and morpholithological evolution, the tectonic factor, through the subsidence tectonic movements of the Drino synclinal structure during the quaternary age, as well as the uplift tectonic movements during the end of the Quaternary, has significantly determined the morphological development of the valley. While the lithological factor, through the flysch rocks that make up the arms of the Drino synclinal structure as well as the flysch and limestone rocks that make up the ridge of Mali i Gjerë, have determined the degree of selective erosion of the activity of external processes modeling the relief.(Collective of Authors.,2014) In the upper sectors above the Dunavat neighborhood, respectively along the spine of the monoclinal ridge of the Mali i Gjerë ridge, built of limestone rocks, very close to the “Ali Pasha Bridge” and the “Former Stone Aqueduct” of the city of Gjirokastra, in addition to the morphological development of karst grooves and canyons, phenomena of surface erosion of temporary water flows also develop, such as the Gjokana, Çullo, Gjonaj streams, etc. (Krutaj,1991) The spine of the monoclinal ridge of the Mali i Gjerë presents the morphological features of the structural surface, over which the dense karst hydrographic network circulates. Collapse processes often occur, due to the combination of unstable siltstones and clays in the lower part with strong sandstones in the upper part, causing the loss of the balance of the aforementioned rocks, which as a result have caused massive piles of flysch to break off in the neighborhoods of Punëtori, Cfakë, Kodra e Shtufit, Dunavat, etc. The Eocene and Paleocene sandstones, which lie in the upper sector of the city of Gjirokastra, are distinguished by their great impermeability and have conditioned morphological contrasts in the relief, causing a dense network of rocky and muddy streams, with quite diverse directions, which as a result have formed consistent valleys with symmetrical slopes.(Collective of Authors,2014) While in some fragments of the upper sector of the city, due to the opposite slope of the flows, in relation to the slope of the monoclinal structure of the Mali i Gjerë, obsequent valleys have been formed, with quite symmetrical slopes and small sandy rocky ledges of 2-3 meters, accompanied by a bottom with a linear extension of water beds. Some of the grooves and valleys in the flysch rocks have been formed due to slope processes, such as landslides, collapses and surface erosion. Karst groundwater in limestone rocks circulates to the bottom

of the Drino valley, such as the Viroi spring to the east of the city. Within the framework of the relief features formed in the monoclinal structure, it results that all these forms have reciprocal relationships between them, because some of the morphological constituent elements, such as the back and forehead of the monoclinal ridge of Mali i Gjerë and the cuesta with flysch composition, contact the consequent, obsequent and subsequent valleys. The flysch lithological scarp in the Këculla segment, appears with great height, due to the low value of the erosion base level in the Dunavat and Palorto neighborhoods. In the lower eastern segment of the city, at an altitude of 150-170m, near the 18 Shtatori neighborhood, the presence of the depositional glacis belt is clearly visible, which gradually becomes identical with the first level of the Drino river terrace. The structural terrace in the Varosh, Cfaka and 18 Shtatori neighborhoods were formed due to selective erosion during the destruction belt between the Oligocene flysch rocks and the Eocene fragmentary limestones. In the Dunavat i Poshtëm and Dunavat i Sipërm neighborhoods, the slopes have clear elements of the structural surface, mainly in limestone rocks, which are intensively cut by the Çullo, Gjinaj and Dunavat rock falls, which transport large amounts of proluvium and colluvium deposits. Erosion glacis are formed and develop in sectors consisting of Paleogene flysch rocks, which are unstable, mainly along the fragments of the slope range of the structural relief, such as along the foot of the monoclinal ridge of Mali i Gjerë, etc.(Derruau,1965) Streams glacis are mainly formed in the monoclinal structure, such as in the cuesta that appear on the hill of Hazmurat, Dunavat i Poshtëm and the Cfaka neighborhood.(Dumas,1977)

4. Discussion

In the discussion, the following strengths of the approach are highlighted: the multi temporal analysis of multidisciplinary data allows the analysis of anthropogenic erosion and accumulation of types and rates and their impact on natural morphodynamics, and to plan and manage the urban sprawl adequately: the investigation of these factors enhances the knowledge of hardly transformed natural dynamics and the interaction between anthropogenic processes and natural ones in triggering natural hazards; the above mentioned analysis and related results are useful for inventorying urban geomorphosites, testifying to the anthropogenic geomorphological evolution of the relief.(Pica,2024) Most of the hydrographic network is currently affected by linear erosion, even if the major streams are subject to erosion control and drainage management. Several ancient gullies have no topographic evidence, being completely filled by anthropogenic deposits such Gjonaj Çullo, Dunavat etc.(Del Monte, Fredi, Pica, & Vergari, 2013)In the eastern area, many scarps overlooking the Drino alluvial plain have polygenetic origin: erosion started by fluvial incision along the lines of tectonic weakness. Some stream elbows Manalat, Dunavat, Çullo etc, indicate a tecton-

ic control on drainage network development. The main ridge “Castle of Gjirokastra” presente a cuesta landform on monoclinal structure, with flysch stones mainly with siltstone and marlstone, generally impermeable which condition the temporary and fragmentary development of mud streams.(Del Monte, 2017)

In Gjirokastra City, population growth and human activities have gradually transformed natural geomorphological processes over the centuries; the rapidity of construction activities may have dramatically different impacts on natural topography. The geomorphological analysis supporting hazard assessment is important considering that human activities hardly transform natural dynamics in urban areas. Considering what we stated above about human activities and natural dynamics, in our opinion the interaction between anthropogenic processes and natural ones over time should be considered in natural hazard assessment. The analysis of landscape evolution and paleomorphologies in urban area provides useful knowledge for a better comprehension of the interactions between human and geomorphological processes.(Pica, 2024)

5. Conclusion

The geomorphological research into the urban environment has potential for enhancing basic knowledge of natural and anthropogenic morpho-evolution and for making cities and human settlements safe, resilient, and sustainable, as planned in Sustainable Development (geohazards assessment.(Pica,2024) This brief overview of the relationships be¬tween geomorphology and urbanization, and various aspects of urban geomorphological heritage, shows that urban contexts have been neglected within geomorphological heritage research in recent decades. Indeed, on the one hand, the interactions between landforms and urbanization are complex and multiple. As for the geotouristic products, they are not really devel¬oped compared to what has been done in rural and natural contexts.(Reynard, Pica, Coratza, et al, 2017) Landform designing may take into account three main factors: the integration of the artificial forms with the sur¬rounding landforms; the viewpoint design; and the composition of a view with visual ob¬jects, as such structural landforms, mass wasting landforms, fluvial and karst landforms etc.(Yamaguchi et al. 2008)

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