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Conference Paper

The features of periglacial processes in Shpat-Polis mountainous range

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Abstract

Shpat-Polis mountainous range lies in the average geographic latitude, while the highest fragments of the relief are also modeled by the periglacial processes. Factors such as lithological construction, tectonic, climatic, hydrological, plant and pedogenetic elements have influenced to the active development of periglacial processes. Human impact is also present in the current period. On the highest mountainous crests, in particular in the fragments created from limestone and magmatic rocks during the morphological evolution of the relief, periglacial processes are also present. Due to special microclimatic conditions, particularly reflected by the temperature inversion phenomena, the periglacial processes appear in the quotas from approximately 1700 to 1950 m above the sea level. Cryogenic phenomena have influenced to the modeling of the relief, along the central sector of the mountainous ridges of Shpat, Polis, Shirok and Guri i Zi. Data of meteorological parameters, such as air temperature, rainfall and wind, have been used from the Hydro-Meteorological Institute for the period 1960-1990. The periglacial forms with the smallest dimensions are cracks created by frost and solifluction phenomena, which are generally more visible in the escarpments of slopes, karst dolines and coves. After intense carvings, the rocks are destroyed in some of their fragments, producing massive fall of them, closely related to the gravity phenomenon, until they are accumulated at the lowest base of the restricted slopes foots of the mountainous ridges, taking on full morphological features of small size cones.

Keywords: relief, periglacial processes, frost, climate, lithology, snow.

1. Introduction

In some fragments at high elevation elsewhere, prevailing temperatures are so low that the ground remains frozen for much of the year. In such environments the effects of repeated freezing and thawing and the growth or ice masses in the ground are so pervasive they give rise to a characteristic range or landforms which merit special consideration. This is the realm or periglacial processes and landforms. Although their present extent is impressive, the Pleistocene saw the extension of periglacial conditions well into mid-latitudes as the glaciers advanced southwards. The term "periglacial", describe the landforms and processes occurring around the margins of the great Pleistocene ice sheets. Subsequently it was aplied more broadly to encompass those processes landforms {regardless of age) associated with very cold climates in areas permanently covered with snow.[1]
The upper fragments of the mountainous range Shpat-Polis represent very prominent traits of periglacial morphology. The appearance of periglacial relief features is a result of the mutual interdependence of geological, geomorphological, climatic, vegetational and pedological features. The structural and lithological features of the complex rocks and the inclination of the slopes play a very important role in the modeling of periglacial relief features. Climatic elements are also very important, because they affect the intensity and duration of development of periglacial processes. The low values of temperature and the relatively high precipitation levels during the last ice age - Würm served as factors to the intensify the activity of periglacial processes and modeling of the upper fragments of the mountainous ridges Bukanik, Zavalina, Polis, Shirok, Guri i Zi, Lukova etc. The interactions among ground temperature, the snow cover and the wind parameters play an important role on periglacial processes. In addition to the slopes inclination, the penetration of warm winds (jugo), and the effect of the snow melting phenomenon on the north-eastern and northern slopes, are also very important factors in destabilizing the snow cover

[1] Summerfield.S. Global Geomorphology. pp 293.

and triggering avalanches.

Map.No.1. Shpat-Polis mountainous range.[2]

In the upper fragments of the mountainous range Shpat-Polis, with altitude higher than 1700-1900 m, besides karstic and slope processes, the periglacial processes have played a significant role in shaping the relief. The forms of relief created due to the influence of nival and cryogenic processes have been identified with more difficulty within the mountainous range.

This paper is based on field observations, accompanied also by the implementation of geomorphologic methods of quantitative character. During fieldwork, special emphasis has been given to the impact of the snow cover, melting and freezing phenomenon of some microfragments of the relief in the uppermost mountainous areas, wind activity on the slopes of different exposure values and the relevant inclination, as well as the differences in the microforms created as result of interdependence of the aforesaid factors. Meteorological data, such as air temperature, precipitation and wind speed and direction, are provided by the Institute of Geosciences for the period 1960-1990.[3]

2. The influence of physical geographic conditions on the development of periglacial processes

The physical and chemical properties of the diverse rock complex, their density, fissures and cracks play an important role in periglacial relief modeling. Along the carbonates rocks - limestone, which are associated with the rockfall to southeast, towards the upper section of Shkumbini valley. The presence of fissures within the limestone cliff of Cretaceous age appears to be quite dense, especially during the deposition of brecchies in Sopot, Gafer and Shirok.[4] The frequent development of these fissures has had a considerable impact to the cryogenic activity within the carbonate rocks, until their continual destruction, at the upper fragments of the mountainous ridges, as well as at the lowest parts of their restrictive slopes. During the coldest months of the year, characterized by temperature below the freezing point, the mass of the ice created uses cracks, providing favorable opportunities for the development of physical weathering.

Climatic elements have a great importance because they affect the intensity and duration of the periglacial processes activity. The intermediary position of the mountainous range Shpat-Polis, between the central part and southeastern part of the territory of Albania, is reflected in the values of the meteorological parameters in the highest mountainous segments. The entire northern, central and eastern part is intensively influenced by continental air masses, consequently leading to major changes in air temperature, relative humidity, wind speed, cloud coverage rate and precipitation. Almost 75% of the mountainous ridge is covered by the vegetation represented by broadleaves and coniferous forests, while the upper fragments appear alpine pastures.[5] In peripheral western and northwestern areas the average annual air temperature value is 13°C, while the winter season is characterized by the coldest month, January with average temperature of around 4°C.[6] The number of days with very low values of air temperature is about 68 days and that of days with frost is 37 days, where as a consequence the influence of cryogenic processes is considerable.[7] In addition, days with cold weather and frost

[2] Collective author. Physical map of Republic of Albania. Tirana 2017.
[3] Inst.Hidro. Meteo.Collective of authors. Meteorological Bulletin. Tirana 1984.
[4] Collective of authors. Albania's geologic map. Scale. 1: 200000. Tirana 2002.
[5] Mitrushi. I.Vegetation Map of Republic of Albania. Scale 1: 200000. Tirana 1978.
[6] Inst.Hidro. Meteo.Collective of authors. Meteorological Bulletin. Tirana 1984.
[7] Inst.Hidro. Meteo.Collective authors. Meteorological and hydrological data for the Shpat and Polis mountainous range stations for the period 1960-1990. Hydrometeorological Institute Tirana 2018.

generally are present during the cold winds period occurred in the eastern and southeastern quadrates, which enable the creation of conditions for dry weather and evaporation. These climatic conditions encourage the development of frost processes within the limestone and magmatic rocks, promoting the intensity of physical weathering.

Fig. 1: Freezing of water in Sopot Lake

During the coldest period of the year, the number of days with cold weather and frost, especially above 1600 m, freezing of water inside rocks mass is frequently present. The amount of precipitation increases with increasing absolute altitude, which appear in different values along the ridges that constitute the mountainous range. The lowest precipitation of 1600 mm occurs on the southeastern slopes, at absolute altitude 1300 m. In the central part of the range, the amount of precipitation is markedly increased, where isohyets the from 1900 mm gradually descends towards the mountainous areas with an absolute latitude of about 1000 m, along the eastern and southeastern exposure slopes. The highest precipitation value of more than 2350 mm has been recorded in the mountainous crest of Polis, Bukanik, Faqe e Madhe, Guri i Zi and Lukova.[8] In the mountainous range, the largest amount of precipitation occurs during the cold period of the year. All rain measurement stations have recorded the highest precipitation in the fall months of autumn, while the secondary maximum of precipitation occurs in the spring time. While the duration of snow cover at absolute altitude above 1500 m reaches up to 115 days a year. At the meteorological station of Sopot, the snow layer of 50 cm, was recorded for a period of 95 days.[9] In the sinkholes, at the bottom of the valleys and the small depressions in the interior part of the mountainous ridges, the massive snow layer is carried by the wind activity, producing the development of avalanches. Due to the distances of about 64 km from the Adriatic Sea and the influence of the air currents, the mountainous range ensured a sufficient amount of precipitation during Würm glaciation, maintaining glaciers at the highest mountainous areas and snow cover at lower hilly areas. Low air temperature values and relatively high precipitation quantities during Würm glaciation were suitable for the duration of glaciers activity, as well as snow cover at lower altitudes, creating good opportunities for developing periglacial processes.[10] In many fragments of the mountainous ridges of Polis, Gafer and Lisec, the intensive periglacial process is particularly evident in the destruction of early morphological features of karst forms, such as lapiez, especially along northern and northeastern slopes. Nivation is localized denudation by a combination of frost action, gelifluction, frost creep and meltwater flow in association with snow patches. It is most active in alpine environments and its major geomorphic effect is the development of nivation hollows by the incision of snow patches into hillsides. Once initiated normally in some existing slight depression, a nivation hollow increases in size as it becomes a collecting site for snow in subsequent years. Snow provides both meltwater and acts as a ground insulation. The erosional potential of nivation is controlled primarily by snow thickness or absence underlying permafrost. An extensive area of freeze - thaw phenomenon can occur both beneath the snow and aorund its margins. The thawing and hence frost action, gelifluction and frost creep, are confined to the periphery of the snow patch. As the snow patch gradually thaws the zone of maximum nivation will follow its contracting margin. A thick snow cover insulates the surface and reduces nivation by preventing frequent freeze—thaw cycles. Data on rates of denudation by nivation are lacking, but it that features extending some tens of meters along slopes with a width of 1 meter may exceptionally be produced in one winter season in areas of unconsolidated rock.[11] As a quantitative geomorphologic parameter, the slope inclination has an important role in the periglacial formation relief. Characteristics of slope inclination ensure estimation of character, volume and intensity of periglacial processes.

[8] Inst.Hidro. Meteo. Collective of authors. Meteorological Bulletin. Tirana 1984.

[9] Inst.Hidro. Meteo.Collective authors. Meteorological and hydrological data for the Shpat and Polis mountainous range stations for the period 1960-1990. Hydrometeorological Institute.Tirana 2018.

[10] Summerfield.S. Global Geomorphology. New York pp. 261.

[11] Summerfield.S. Global Geomorphology.New York pp 299.

While on slopes with inclination from 15-30º, the snow cover glide and forest cover, partly prevents the development of the snow avalanche. Slopes with a inclination over 45° comprise a small part of the field researches for the area in word, but in all slopes released from the snow cover, the development of periglacial or cryogenic processe is possible due to the lack of snow, which serves as a thermal insulator. But in some cases, when the slopes have an inclination less than 10-15º, fragmented materials generated by the nival processes and periglacial (cryonival) ones move more slowly. Even gravitational collapses are still intense on slopes with inclination over 50º, as in the upper sections of Gostima and Radicina rivers. Most of the different types of mass movement are active in periglacial environments to some extent, but mechanisms frost creep and solifluction are of particular significance. In periglacial environments, solifluction frequently occurs in association with seasonally frozen ground, and under these circumstances it is more specifically described as gelifluction. In reality it often operates in conjunction with frost creep to the extent that it is frequently difficult to distinguish between the action of the two mechanisms.

Fig. 2: Solifluction lobes in Polis mountainous ridge

Downslope movements must realistically be assessed in terms or their combined effect and they are often considered together in assessing rates of movement. Rates of movement for gelifluction alone are strongly dependent on moisture, and its importance in periglacial environments be ascribed two primary factors: saturation or the soil due to restricted drainage promoted by a seasonally frozen water table, and moisture provided by thawing snow and ice, along winter.

Fig. 3: Colluvial cones in Gafer

The overriding importance of soil moisture with the influence of vegetation and slope angle in controlling rates of gelifluction. Here the less steep, but better vegetated slopes which tended to retain experienced faster rates of movement than steeper but less well vegetated and drier slopes. Free drainage in gravels and sands on the one hand and the cohesive properties of clays on the other, means that soils dominated by silt-sized particles are most susceptible to gelifluction.[12]

[12] Summerfield.S.Global Geomorphology. New York, pp 299.

3. Conclusions

Nivation and cryofraction phenomena are the main ones, which are reflected through the active movement of avalanches and stone streams and the massive collapse of the blocks and fragmented materials.
The morphological features of the mountainous range are consequence of the interdependence of the geological, geomorphological, climatic, vegetational and pedological characteristics.
Due to specific conditions of the microclimate of the territory, which is characterized by the prevalence of thermal inversion phenomenon, periglacial processes are developed in a fragmentary form at absolute altitude above 1700 m.
During the Pleistocene epoch, cryogenic phenomena have significantly influenced to the modeling of the middle and low segments of the slopes.

4. Recommendations

The researches that need to be carried out in order to identify traces of shapes created by periglacial processes should be coordinated between disciplines and various scientific fields, such as pedological, plant and climatological fields. A detailed analysis of climatic features will present an important impact, under the conditions of periglacial relief formation. In some cases, the periglacial landforms should be provided with the status of protection, including them in the managed areas of the Republic of Albania. In future studies, such measures should be taken with respect to the morphometrical elements, such as length, width and depth of them, as well the classification of their dimensions, based on the level of topographic conditions development, presence of tectonic faults and lithological composition as well. As part of the natural heritage, artificial protection should be provided to the nivation hollows through vegetation coverage, which in the future can be used as a natural pasture, such experience has started to be widely practiced in the nordic countries and the British Islands. The protection of periglacial landforms should also include the rehabilitation of quality, species diversity values, habitats, biological communities.

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[2]. Institute of Hidro-Meteorology. Collective authors. Meteorological and hydrological data for the Shpat and Polis mountainous range stations for the period 1960-1990. Hydrometeorological Institute Tirana 2018
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