ACTA UNIVERSITATIS CAROLINAE
2003 GEOGRAPHICA, No. 1, PAG. 21–29

# Anthropogenic transformation of the relief in Euroregion Glacensis

MIROSŁAW BOGACKI, PIOTR WAŁDYKOWSKI

Warsaw University, Faculty of Geography and Regional Studies,
Department of Geomorphology, Poland

## Abstract

The authors' intention was to discuss the negative impact of non-natural factors on the relief of the Stołowe Mountains, which endangers the inimitable beauty and educational values of the range's inanimate nature. Decisions taken within the administrative boundaries of the Euroregion may influence those factors. The final conclusions are based on the findings from the research in contemporary morphological processes conducted in the years 1998–2000 by the staff of the Department of Geomorphology of Warsaw University's Faculty of Geography and Regional Studies in the Stołowe Mountains National Park, and from a study conducted during the preparation of the Park's protection scheme in the years 1995–1999.

**Key words:** Euroregion Glacensis, Stołowe Mountains, anthropogenic transformation, natural conservation

Euroregion Glacensis (formally created on 05. 12. 1996) is made up of 69 Czech and 23 Polish municipalities and covers an area of 8,351 km$^2$ (in Poland – 1,902 km$^2$). The Euroregion has the function of a European administrative unit, and is primarily aimed to facilitiate cooperation in the border regions of European countries in the sphere of environmental protection, regional development, spatial planning, social issues and the development of technical infrastructure.

In terms of natural characteristics, Euroregion Glacensis comprises mountainous areas with highly diversified landscapes, typified by a mosaic of geological structure and morphological patterns which influence the formation of individual features of the region's natural environment.

The distinctive elements of this mosaic include the Stołowe Mountains (*Góry Stołowe*) on the Polish side and their continuation on the Czech side, the Broumovsko Plateau (*Broumovska Vrchovina*). The range crosses again the Polish border at the point where its boundary is marked by a cluster of rock forms turned into a natural reserve, bearing the name of Dwarves' Rocks (*Głazy Krasnoludków*).


The massif's reach is similar to that of Upper Cretaceous horizontaly laid rocky layers of sandstones interspersed with layers of marls. These formations represent age layers corresponding to the Middle Cretaceous period (from Cenomanian to Upper Turonian), with directly underlying Permian (Zechstein) sediments (Jerzykiewicz, 1968; Radwański, 1975; Pulinowa, 1989).

Owing to the natural assets of this mountain range, which are unique on both the Polish and European scale, the area came under protection. In 1993, the Stołowe Mountains National Park (*PNGS) was set up in Poland, and 1991 saw the establishment of the Broumovsko Protected Area Park in the Czech Republic. On both sides of the border, the major protected elements include the unique platy-type relief along with picturesque rock formations (e.g. Great Fissure Mount (*Szczeliniec Wielki*), Errand Rocks (*Błędne Skały*), Teplicko-Adršpašskie Rocks, Rock Towns on Mount Ostaš). The occurrence of rock formations coincides with outcrop zones of Middle and Upper Turonian sandstones.

On the Polish side of the border, nature protection in these areas dates back to 1938, when the first nature reserve, the Great Batorów Peatland, was created. Other reserves were not established until after World War II; the Great Fissure Mount and the Errand Rocks reserves were created in 1957. In 1981, the Stołowe Mountains Landscape Park

*PNGS – Stołowe Mountains National Park

was created; it originally covered about 75.1 per cent of the current surface area of PNGS (6,339.25 hectares). The reason behind the creation of the landscape park, and later the Stołowe Mountains National Park, was to ensure means of protection primarily for inanimate nature.

Based on the observations conducted in the protected area of PNGS it can be said that the Park's relief is most heavily influenced by currently performed forest works involving tree stand renewal. These works are necessitated by inappropriate forest management in the past, when indigenous deciduous and mixed forest, including beech and fir trees (Zoll, 1958), was replaced with single-species, single-layer spruce coniferous forest; it now covers about 83.1 per cent of the Park's wooded area. The 1994 damage assessment of the Stołowe Mountains forest (PNGS core materials) revealed that heavily damaged trees account for 8 per cent of the entire wooded area (Borecki, Lubczyński, Miścicki, Nowakowska, Wójcik, 1995).

In those regions where there is a need to conduct works in the degraded forest stands, the relief is seriously endangered. Based on the observations from the years 1995–2000, forest works consisting in felling parts of the forest and transporting timber down the slopes were the major factors causing slope erosion. Furrows that are created during the rolling of logs have considerably disturbed the slope drainage system. Removing the vegetation cover that sustains the substratum by pulling out tree roots and creating log-rolling furrows has initiated the concentrated water flow in the furrows and increased slopewash, particularly its linear type. The degradation influence of forest works also affected unsurfaced roads, where furrows developed that forced a specific direction of the flow of precipitation and snowmelt water (see photo). The shallow nature of the rock mantle, particularly above the zone of rock sandstone edges, might lead to the destruction of relief in the most precious parts of the Stołowe Mountains. The most intense destruction of forest litter and rock mantle reached the bedrock. The observations of changes in log-rolling furrows in the period between July 1998 and August 1999 (Wałdykowski, 2000) confirmed their development in an annual climatic cycle. Such forms could be extended up to approximately 0.5 metre per annum. Furthermore, it seems that the system of the drainage of slopes where logs are rolled has been permanently changed, since a large part of the flow of precipitation and snowmelt water repeated the pattern of log rolling furrows, which were not overgrown by vegetation but developed continually. Ruts along roads and furrows caused by the rolling of logs on the road surface, created by vehicles used in the process of forest works (trucks, tractors, etc.) proved equally durable. Ruts and accompanying road depressions occurred in all places where forest works were conducted. The surfaces of some forest roads which coincide with tourist routes, have been degraded to a degree that distinctly impairs tourist traffic (see photo 1).

Tourist traffic, frequently presented in literature as one of key anthropopressure factors, has only a local role owing to the concentration of major traffic in two areas: in Great Fissure Mount and in Errand Rocks. Destruction caused by pedestrian traffic is mainly due to treading. This process, similarly to forest works, fostered the development of natural processes of linear and dispersed slopewash. It should be emphasized that pedestrian traffic in the Stołowe Mountains is not limited to paths earmarked for hikers, but overlaps with a pattern of various types of roads, including roads used during

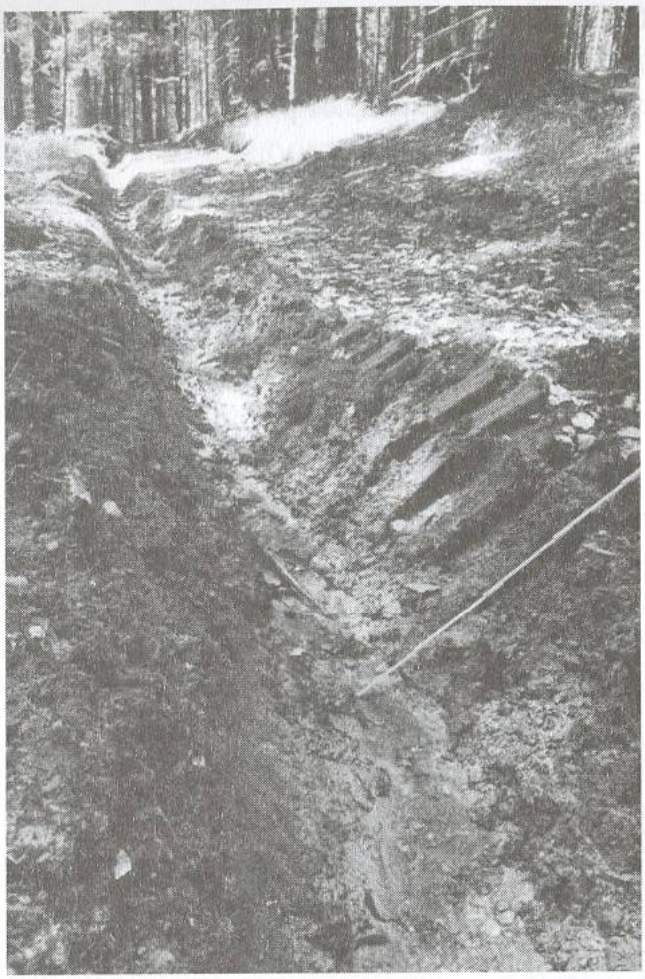


*Photo 1* Furrow caused by tractor wheels on the forest road surface, deepened by linear drainage

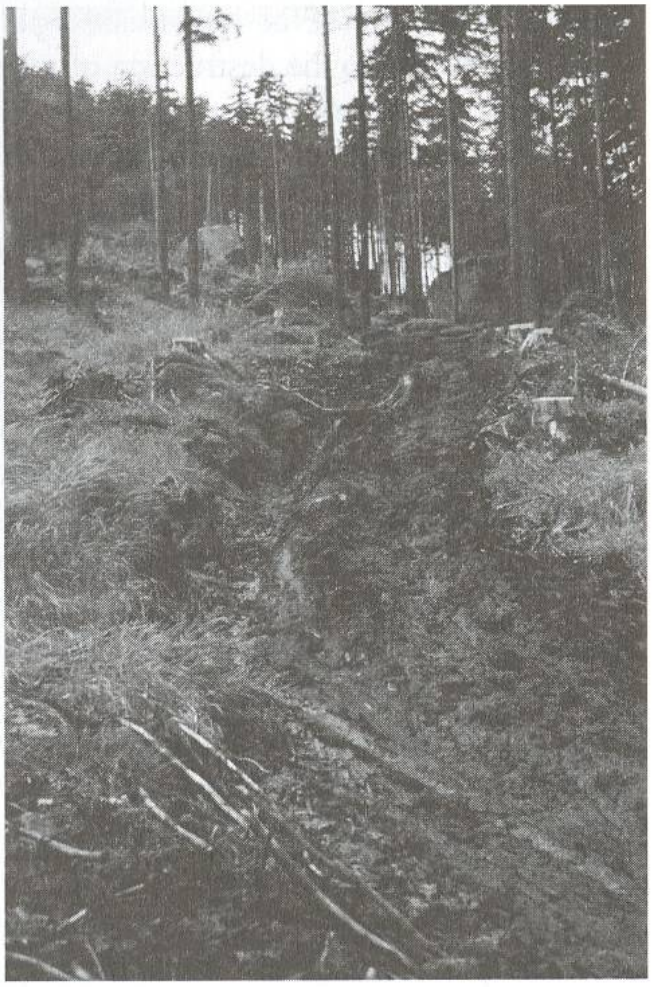


*Photo 2* Fresh, deep log-rolling furrow on the northern slope of Great Fissured Mount (July 1998)

*Photo 3* Linear drainage during the spring thawing period in the bottom of a log-rolling furrow after six months since its emergence (March 1999)

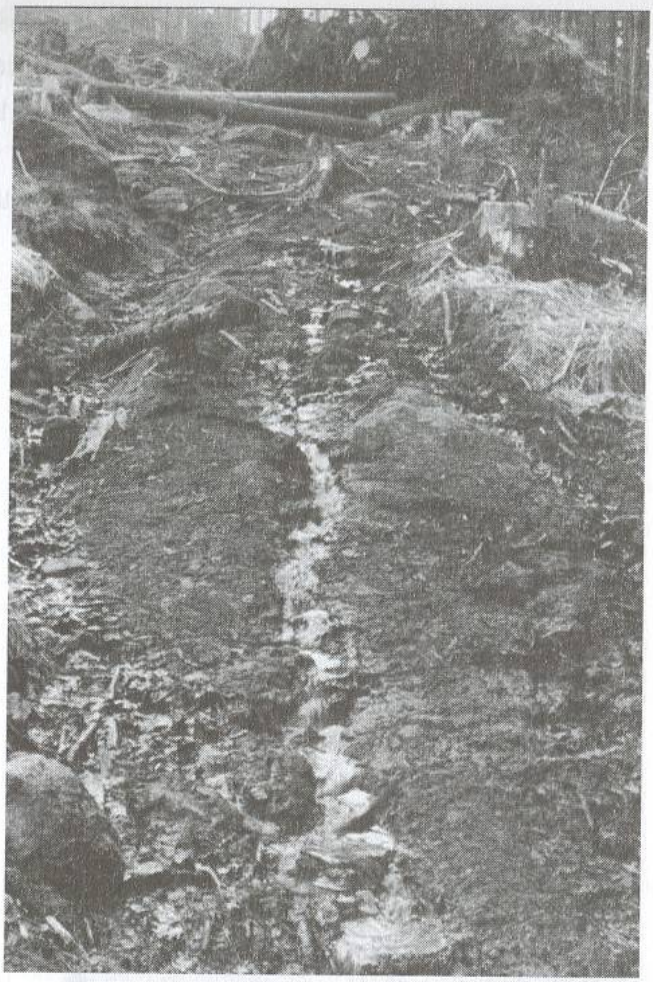


*Photo 4* Damage to the morphological edge near the Radków Scarp [Próg Radkowa] caused by tree felling

forest works. On roads with soft surfaces, which are used during such works, the morphogenetic role of hikers is also visible. They usually leave traces of their boots in the soft soil which, following rainfall, would turn into pools of mud, hindering passage along the trail. As a result, people would frequently opt for alternative passage off the marked tourist trail, which means an uncontrolled destruction of the substratum (Wałdykowski, 2000).

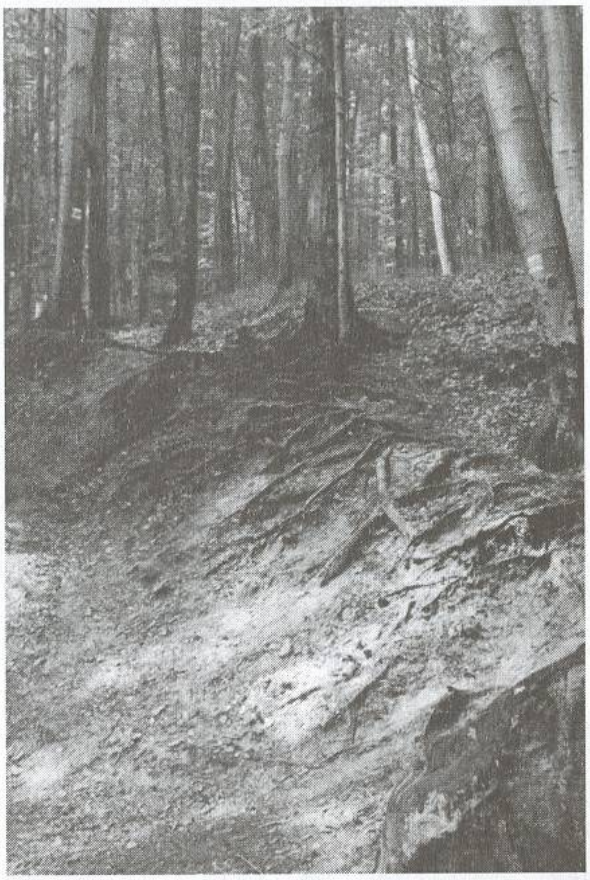
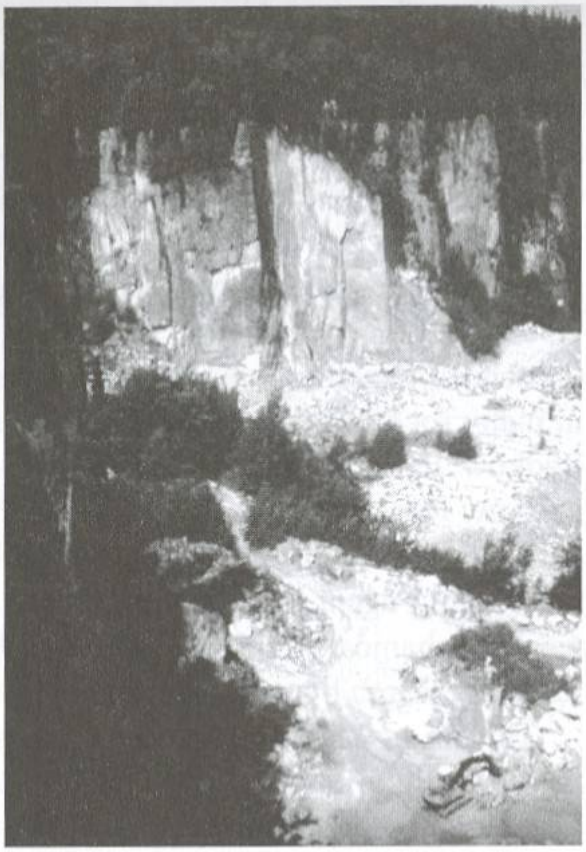


*Photo 5* Treading signs by pedestrian tourist traffic, along the yellow tourist trail below the Pośna Gate

The active quarry of Middle Turonian sandstone can be seen as a certain contradiction existing within the Park. This is a spectacular example of man's most detrimental influence on the relief. The quarry, situated in the north-eastern edge of the Stołowe Mountains, consists of two workings, lying in a distance of about 300 metres, with walls reaching a height of 62 metres (see photo 6). This facility is not only detrimental to nature; it also significantly disturbs the natural water circulation in the fissured mountain complex. Continued blasting works lead to artificial seismic activity – microshocks – which pose a clear danger to the unparalleled rocks forms and sandstone walls – the key protected assets of the Stołowe Mountains National Park. Lack of shock monitoring precludes any accurate estimation of their influence. The effects of shocks, however, can be seen in the form of artificially generated gravitational mass movements, such as: falling of rock grain, boulders, stone avalanches, stonefalls, etc. The so-called mining area, that is the zone of possible dispersion of rock crumbs while conducting blasting works, is about 1.95 $km^2$, whereas the area of direct mining covers approximately 0.4 $km^2$ (Zgorzelski, 1999). It can be said, therefore, that the activity of the quarry can be viewed as an artificial source providing large quantities of material, ranging from sandstone rubble to sand and dusty fractions in the lower situated parts

*Photo 6* Sandstone quarry in the north-eastern edge of the Stołowe Mountains near Radków.



of the Park. The supply of smaller fractions is manifested in the form of alluvial cones below the quarry and rock walls, which makes those zones anthropogenic aggradation areas (Wałdykowski, 2000). Currently, the site of the quarry is separated from the Park's area and is treated as an enclave governed solely by Polish mining law. Its influence on the neighbourhood by far exceeds the enclave's area, which questions the existence of such a facility within the national park. According to different observations from the years 1995–2000 and the mapping of contemporary morphological processes (Zgorzelski, 1999; Wałdykowski, 2000), the quarry poses a serous danger particularly for the relief of the north-eastern edge of the Stołowe Mountains, which may influence other parts of the range in a manner that is impossible to assess.

Another serious threat facing both the biotic environment and sandstone rocks is the air with increased humidity, containing carbon dioxide. This is true in particular for the north-eastern edge where, as a result of weaker heating, colder thermal conditions prevail, as compared to the southern part of the massif. Thus, weaker horizontal air change fosters the gathering of pollutants, particularly amidst rock formations and other hollows in the ground. In this natural phenomenon, the indirect influence of man on the relief can be seen in the presence of air pollutants which, affecting the surface of rocks, especially those built on the basis of carbonates, lead to their destruction – aided by water in this process. According to Lewińska and Czerwieniec (1991), higher sulphur dioxide concentrations occur in the hilltop areas, which can be explained by the inflow of gas pollutants from further regions (industrial and power centres in Germany and the Czech Republic) and convective upward movement of pollutants in warmer seasons from the valleys hosting localities surrounding the Table Mountains (Kudowa Zdrój, Duszniki Zdrój, etc.) and from local industrial plants (situated in such towns

as Broumov, Nachod, Hronov in the Czech Republic). Currently, owing to the lack of ongoing monitoring of ambient air pollutant concentration, the authors do not have accurate data on the presence of $SO_2$ in the Park's environment. Atmospheric pollutants were measured in February 1996, by analysing snow water samples (Wicik, 1996 – PNGS materials). It turned out that the prevailing pH of snowmelt water oscillated between the value of 3.6–4.5, locally reaching 2.9–3.5. Converted into ambient air pollutant concentration per square metre, this would correspond to the value of about 1.35 g $SO_4/m^2$/per annum. Although there is no research model for assessing the influence of such pollution on the relief, the impact of acid rainfall water can be seen in many rock formations, particularly in the north-eastern edge of the massif (e.g. the Radków Edge [*Krawędź Radkowska*] – from Rock Mushrooms [*Skalne Grzyby*] to Radków Rocks [*Radkowskie Skały*]). The degradation is manifested in the form of the exfoliation of sandstone surfaces, development of pitted microstructures, slackness of the binding agent between grains and the crushing of rock surfaces as a result of a weak mechanical factor (Zgorzelski, 1999, Wałdykowski 2000). This problem calls for further research by experts from various disciplines of natural sciences.

To sum up, anthropogenic transformations of the relief in the Stołowe Mountains massif are the major factor affecting the transformation of the natural environment. They initiate natural processes, which subsequently either destroy or build up on the individual relief subsystems. Of all the discussed factors, forest works involving the felling and transport of trees down the slopes and roads most strongly affect the relief on the Polish side of the border. Transformations having a similar impact are caused by the sandstone quarry, the range of which, however, is local, at least in relation to the entire mountain range. Other factors, such as tourist traffic or air pollutants such as sulphur compounds influence the relief more slowly. We can but hope that forest works conducted on the Polish side of the border are a momentary phenomenon, caused solely by the need to renew the forest stands. The authors hope to draw the attention of decision-makers to the detrimental effect such protective actions can have on the unique platy-type relief of the Stołowe Mountains massif.

## References


BORECKI, T., LUBCZYŃSKI, L., MIŚCICKI S., NOWAKOWSKA, J., WÓJCIK, R., (1995): Stan drzewostanów parków narodowych, [Condition of Forest Stands in National Parks], Biblioteka Monitoringu Środowiska PIOŚ, Warszawa.

JERZYKIEWICZ, T. (1968): Sedymentacja górnych piaskowców ciosowych niecki śródsudeckiej (górna kreda) [Sedimentation of Upper Sandstones of the Middle Sudeten Basin (Upper Chalk)], Geologia sudetica 4: 409–462.

KONDRACKI, J. (1994): Geografia Polski mezoregiony fizycznogeograficzne [Geography of Poland – Physiogeographic Mesoregions], PWN Warszawa.

LEWIŃSKA, J., CZERWIENIEC, M. (1991): Wstępne wyniki oceny zanieczyszczenia powietrza w wybranych rejonach Sudetów [Air Pollution Assessment in Selected Sudeten Areas – Initial Findings], Acta Univ. Vrat. 1213, Prace Inst. Geogr., seria A, 5, 27/2: 154–157.

PNGS core materials, a collection of findings from the research conducted in the years 1995–1998 by a team headed by M. Zgorzelski in connection with the development of the protection plan for the Table Mountains National Park.

PULINOWA, M. Z. (1989): Rzeźba Gór Stołowych [Relief of the Stołowe Mountains], Prace Naukowe Uniw. Śląskiego, Seria Geografia nr 1008, Katowice.

RADWAŃSKI, S., 1975, Kreda Sudetów Środkowych w świetle wyników nowych otworów wiertniczych [The Middle Sudeten Chalk in Light of New Boreholes ], Biuletyn Inst. Geol. 287/24: 2–56.

WAŁDYKOWSKI, P. (2000): "Współczesne procesy morfologiczne w Górach Stołowych" [Contemporary Morphological Processes in the Stołowe Mountains], MA dissertation written at the Department of Geomorphology of the Faculty of Geography and Regional Studies at Warsaw University and supervised by M. Korotaj-Kokoszczyńska, PhD, Warszawa.

ZGORZELSKI, M. (ed.) (1999): Góry Stołowe [The Stołowe Mountains], Wyd. Akademickie Dialog, Warszawa.

ZOLL, T. (1958): Podstawowe zagadnienia zagospodarowania lasów górskich w Sudetach [Basic Issues Related to the Management of Mountain Forests in the Sudeten], Sylwan 102/5–6: 9–33.