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GEOMORPHOLOGICAL CONDITIONINGS OF THE ECONOMIC DEVELOPMENT OF THE NOWY ŻMIGRÓD GMINA

Abstract: The natural environment is of essential impact on the economic development of a region. An analysis of all the elements of the natural environment in the course of preparing local physical management plans is necessary for a regular shaping the gmina's space. In view of considerable conditionings of the relief in economic development in the Polish Carpathians it deserves a special attention. The article presents an analysis of present-day impact and its influence on the district economy taking the following possibilities into consideration; the development of farming, settlement and the extension of road infrastructure. Geomorphological limitations and barriers in the management of mountain areas were presented. Land evaluation of the district was carried out with an attention paid to areas of varying degrees of economic development possibilities conditioned by the relief.

Key words: relief, human economy, gmina, spatial planning

Introduction

The issue of the relationships between the natural environment and man functioning in it have been discussed in many publications. Among other elaborations one should mention the papers by: A. Bogucka (1968) and by L. Starkel (1972, 1990) on the interrelationship between the economy and environmental conditions in the Polish Carpathians. Also the paper by J. Lach (1975) reveals mechanisms of changes in the natural environment of the Low Beskid Mts. as evoked by man's economic activities. Among the papers trying to determine barriers and limitations in human activities conditioned by the relief there is also one by J. Fatyga (1991) relating to the territory of the Sudeten Mts. Whereas, the issue in the Carpathians was shown in the paper by K. German and Cz. Guzik (2001). These papers became a basis for the distinction of natural barriers and hazards for the economic growth. Environmental limitations and

barriers in the management of mountain areas were also dealt with by S. Jagła (1981) and K. Kopeć (2000).

The aim of the paper is an analysis of the effect of relief on the management of areas in the Nowy Żmigród gmina and the resulting designation of barriers and hazards for the selected elements of man's economy such as land use, possibilities of building and of establishing transport routes. The aim of the paper is also land evaluation from the viewpoint of morphological conditionings for the economic growth of the relevant area. The investigations were carried out on the basis of geomorphological mapping on topographical maps of 1:10,000. A number of thematic maps were made for the area of the gmina such as: a map of slopes angles, geomorphological maps, a land use map, a map of geomorphological conditionings of the economy and a morphodynamic map at a scale of 1:25,000 a map of chief elements of the relief, as well as a map of local road network at a scale of 1:50,000. The most important of them are presented in the article. Furthermore, calculations were carried out of the density of roads and of cuttings by valleys. Taking into account the morphological criteria land evaluation was carried out by distinguishing five types of areas varying in predispositions for the economic development of the relevant gmina.

Location of the research area

The research area is the Nowy Żmigród gmina (18 units), that covers the area of 10,372.79 ha. As far as the administrative division is concerned the gmina belongs to the Jasło district, the Podkarpacka Province (Fig. 1).

According to L. Starkel's division (2001) into physical-geographical regions the gmina of Nowy Żmigród is situated within the two regions: the Low Beskid Mts. and the Jasło-Sanok Depression, which is limited from south the Beskid Escarpment. The southern part of the district belonging to the Low Beskid Mts. is at the same time situated in the subregions of the Magura Wątkowska Ridge, in the Dukla Beskid Mts. and in the Desznica-Myscowa Depression. Whereas, the northern part of the district situated in the Jasło-Sanok Depression belongs to the subregions of the Osiek Basin, the Żmigród Valley, the Faliszówka Plateau and of the Pachanowa Hump.

Relief characteristics

The southern Beskid part of the gmina reaches a height of 714 m a.s.l. Fragments of the inner-mountain (650-700 m a.s.l.) and of the foothill planation surfaces (500-550 m a.s.l.) are preserved in the axes of the ridges. That part of the gmina is built of both thick-bedded, resistant sandstones of the Magura nappe (the ridge of the Wątkowska Magura Mt.) as well as deposits of the Krosno sandstone-shaly layers and of sandstone layers of the Silesian unit to be found within the Desznica-Myscowa depression and in the Dukla Beskid Mts.

Author's observations and field measurements as well as calculations of the cuttings by valleys contributed to a more detailed characteristic of the relief of the gmina. The area of the southern part of the gmina is marked by straight slopes,



Fig. 1. Location of the research area

Ryc 1. Położenie obszaru badań

their inclination on average 10-20°, in places 30° and by valley cuttings amounting to 0.6-2.1 km/sq. km.

The very high index of cuttings by valleys, typical of north-facing slopes, is represented by deep V-shaped valleys forming the whole valley systems while the south-facing slopes are much less dissected. Typical valleys here are tielkes and basins.

The Jasło-Sanok Depression, in the northern part of the gmina represents an erosion-denudation subsidence. It constitutes a course of flat basins located at heights of 270-340 m a.s.l. divided by flat, low and medium foothills at heights of 350-500 m a.s.l. They lie within an oblong tectonic depression filled by steep-folded and little resistant Krosno layers with patchy outcrops of menilite layers and Ciężkowice sandstone, so conspicuous in the lesser diversification of the relief. Slope inclinations there rarely exceed 6°, only on slopes of low humps they reach 10° (Fig. 2). The network of valleys in the area is rare and reaches 0.7 km/sq. km. (Fig.3). Inclinations within the Jasło Foothills achieve 10-20° while in the lower parts of the slopes they decrease to 6-10°. The valley cuttings there amounts to 2.1 km/sq. km.

The area of the gmina is dissected by the Wisłoka and its left-bank tributaries of the Ryj and the Skalnik in the Beskid part and by the Niegłoszcz and the Iwiełka

in the foothill part. Within the Wisłoka valley there are alternate widenings and narrowings conditioned by bedrock resistance. In the gorge-like sections the width of the valley is as low as 130-170 m while in the Jasło-Sanok Depression its width increases to 900 m (Mytarz) and even as much as 1,700 m north of Nowy Żmigród. Four terrace levels can be separated in the Wisłoka valley. The floodplain, its relative height 3.0-3.5 m, covers a relatively narrow zone adjacent to the river bed. Its width in the Beskid part of the gmina is 100-300 m at a maximum, 250-300 m in the Osiek Basin and the Żmigród Valley. The meadow terrace achieves 4-5 m south of Kąty and 7-7.5 m in the neighbourhood of Nowy Żmigród. The width of the terrace within the Osiek Plain oscillates between 400 m in the southern part and 1,400 m in the northern part. Out of the two oldest terrace levels the well-preserved is the Vistulian level, some 13 m above the Wisłoka channel. It occurs in the form of shelves in the Beskid part, whereas in the Żmigród Valley the level runs in the form of a patch from Nowy Żmigród to the north along the right river bank.

The role of relief in economic growth of the gmina

The relief predetermines directions of economic development, decides upon the settlement and transport network and affects the chances of using natural resources. As relief diversification increases new conditions come into being, which predispose or limit possibilities of management in particular areas. Below barriers and possibilities created by topographic features of the gmina for land use, settlement expansion and for road infrastructure are discussed.

The farming land use is directly associated with height above sea level, slope angle, slope exposure and the degree of its dissection. The above-mentioned elements of the relief can constitute a real barrier in arable farming since as the height above sea level and slope angle increase with an accompanying growth of skeletal soils, arable farming become less and less effective or impossible to be continued (Tab. 1). Height above sea level sets a limit for agro-forestral boundary and the boundary of the usefulness of mountain habitats for agricultural use. The boundary is set at the lowest by J. Fatyga (1991) who appoint it at 700 m a.s.l. This value was also adopted for the gmina of Nowy Żmigród. Because relative heights in the gmina rarely exceed 700 m a.s.l., hence that element of the relief does not seem to limit the possibilities of farming use of land. The greatest possibilities for the development of agriculture are to be found within the Jasło-Sanok Depression and on the Jasło Foothills. Absolute heights there reach 360-400 m a.s.l.

Slope angle is the most important factor responsible for agricultural usefulness of mountain areas (Fig.2) as it constitutes a barrier from the economic and technical point of view, due to hardships in the use of tractor plough, and in transport (Kopeć 2000). Furthermore, with increasing slope angle erosion intensifies, which in consequence leads to the lowering of the amount and quality of crops. The increase in skeletal soils with slope angle also constitutes a limitation for arable farming. Following the papers by S. Jagła (1981) and Cz. Guzik (1992) were adopted the following limiting values of slope angles in the gmina of Nowy Żmigród; arable farming – 12°, meadow

Tab. 1. Barriers constraining economic development in the gmina of Nowy Żmigród

Tab. 1. Bariery ograniczające zagospodarowanie w gminie Nowy Żmigród wynikające z rzeźby

Farmland barriers	Settlement and infrastructure barriers
<ul style="list-style-type: none"> – Heights > 700 m a.s.l – Slope angles > 12° – Narrow and sharp ridges – Dome-like and knoll ridges – Conical ridges – V-shaped valleys, dingles and tielkes – Trough-like valleys > 6° – Plains of wet meadow terraces liable to flooding – Floodplains – Present-day alluvial cones – Landslide headwalls and tongues – Escarpments of terraces and of alluvial cones – Other erosional escarpments (together with anthropogenic ones) – Natural or artificial cuttings of valley sides and of slopes – Landslide-creeping surfaces – Valley heads 	<ul style="list-style-type: none"> – Narrow and sharp ridges – Dome-like, knoll, and conical ridges – Slopes and hillsides > 10° – Plains of flood terraces and the alluvial cones associated with them – Plains of wet meadow terraces – Lateral V-shaped valleys and dingles – Tielkes with an uneven and muddy bottom – Trough-like valleys > 6° – Valley heads – Terrace escarpments – Other erosional escarpments (together with anthropogenic ones)

and pastures – 20°, forests >20°. While taking into account the slope inclination (Fig.2) the most predisposed areas for arable farming in the gmina are; slopes of the Magura Wątkowska Mt. to a height of 450-500 m a.s.l. and the southern slopes of the ridge of G. Skały with angles 6-15° except for the slopes in the outlet section of the Ryja stream. Favourable conditions for arable farming are also found in the middle parts of of the ridge in the Desznica-Myscowa Depression, slope angles 6-10° as well as the southern slope of the ridge G. Bucznik, with inclinations of 6-10°. The best conditions for intensive arable farming occur in the Jasło-Sanok Depression.

Furthermore slope dissection in the gmina constitute another barrier in economic growth due to difficulties in property integration and limited access to the fields (Fig. 3). According to author's calculations of valley dissections, the highest fragmentation in the Beskid part of the gmina is most conspicuous for north-facing slopes, their dissection amounts to 1.8-2.1 km/sq. km. The Beskid Escarpment is characterized by valley cutting equal to 2.4 km/sq. km. A considerable fragmentation (2.0-2.1 km/sq. km) is also marked on slopes of the Faliszówka Plateau and the Pochorówka Hump in the northern part of the gmina.

Relief also influences a chance possibility of building roads, houses and it affects a shape of settlement units. The extension of settlements and of transport infrastruc-

ture is dependent on slope inclination, occurrence of landslide hazard, inundations and on unfavourable microclimatic conditions in inner-mountain basins and poorly ventilated valleys (Tab. 1). The location in a valley bottom, despite the vicinity of water is unfavourable on account of floods or undercutting of river banks. The Holocene terraces are marked by water-loggedness due to shallow occurrence of around water table. Moreover, the valley floors are adversely affected by mesoclimate through stagnating masses of cold air (Starkel 1972).

Houses encroaching steep slopes of high inclination and a dense network of field roads in the gmina amounting to 5.4 km/sq. km on average (according to author's calculations) bring about remarkable transformations of slope surfaces, thus creating additional hazard to their stability.

Despite a high hazard landslide areas are easily settled owing to the abundance of water and low slope angles within landslide forms. Besides, the location of landslides, confined by a steep headwall, affects local circulation of the air (Margielewski 2000). However, the risk of renewing landslides and of further recession of landslide edges in humid years, with an additional burden of houses is very high. A considerable slope inclination is an essential barrier for the development of settlement, as to the probability of appearance of new landslides and of creeping surfaces, slopes inclined more than 10° should not be built up. Relief also influences possibilities of building roads and foundations and affects the shape of settlement units.

In the case of the gmina these are slopes in the range of the Dukla Beskid Mts., slopes descending to deep V-shaped valleys and areas in close proximity to the edges of river terraces. The extension of settlement and of road network is also impeded by erosional edges. High edges confining buildings, which as a result of sliding down of higher portions of slopes, are undercut and the material frequently getting into the buildings can be observed in the valleys of Beskid tributaries of the Wisłoka (the Ryj and the Skalnik).

The favourable conditions for the development of settlement occur on higher terraces, on foothills within the slopes of lesser inclination (5-15°) (Fig. 2). The places predisposed to the growth of settlement in the gmina are; a broad meadow terrace of the Wisłoka, higher terraces of the Wisłoka especially in the Osiek Basin and in the Żmigród Valley, the higher-raised fragments of flattenings in the Ryj and the Skalnik valleys, flattenings of the near-valley level preserved on the northern slopes of the Low Beskid Mts. except for the escarpment of the Dukla Beskid Mts., flattenings of the near-valley level on ridges and humps in the Osiek Basin and on the Jasło Foothills at a height of 340-390 m a.s.l.

Land quality evaluation in the gmina

On the basis of the main elements of relief (Fig. 3) and of the map of inclinations (Fig. 2) land quality evaluation was carried out in order to distinguish particular areas of the Nowy Żmigród gmina with different capacities for the economic development. Designated were areas which constitute a barrier, areas predisposed for the growth of certain economic functions, areas where economic activities can be impeded as well

as areas favourable from the viewpoint of man's activity in the mountains (Fig. 4). Five areas were separated with features of relief or landforms deciding upon a specific destination of land (Tab. 1).

- I. Area with unfavourable conditions for building, road construction, arable farming, green farming, recommended for reforestation; slopes above 20°, absolute heights above 700 m a.s.l., headwater areas, narrow and sharp ridges, cupola-like, dome and conical ridges, V-shaped valleys, dells.
- II. Area with unfavourable conditions for building, road construction and arable farming, favourable for green cultivation; inclinations 12-20°, basin-like valleys with slopes 12-20°.
- III. Area with unfavourable conditions for building, road construction and arable farming, favourable for green cultivation or reforestation; plains of meadow terraces, wet or threatened by flooding, floodplains, present-day alluvial fans, tielkes, landslide scars and tongues, edges of terraces and alluvial cones, erosional cuttings of slopes.
- IV. Area impeding building and road construction but favourable for arable farming; slopes 10-12°, trough-like valleys, slopes 6-12°, broad and rounded ridges.
- V. Area favourable to building, road construction and arable farming; slopes below 10°, trough-like valleys below 6°, plains of medium and high terraces, plains of alluvial cones linked with medium and high terraces, plains of meadow terraces with favourable water conditions.

Land quality evaluation shows considerable differences in geomorphological conditionings for economic development of the gmina.

The southern part of the gmina is characterized by mosaic patterns with varied conditions for its development. In addition, they cover smaller surfaces. Frequently within one slope all the distinguished land evaluation areas can be found (the Wątkowska Magura Mt.). Such great differences of relief impact over a relatively small area bring about considerable difficulties in the management of all the area. In consequence, some fragments of the slope surface, despite their favourable relief conditionings, must be excluded from man's activities on account of limited access or of their localization within areas with unfavourable effects for the economy. The highest fragmentation of areas separated in the process of land quality evaluation is to be found in the whole range of the Dukla Beskid Mts., it is also there that the highest share of surfaces with unfavourable conditions for human activities occurs (Type I, II, and III). The northern and north-eastern slopes of that ridge entirely eliminate them from the management. High limitations in the management of the areas are to be also observed on the slopes of the Wątkowska Magura Mt., Mount Trzeci Kopiec and of Mount Kolanin. Moreover, difficulties can be found on the slopes of Mount Kamień.

Areas predisposed for the chosen fields of economy in the gmina (land use, building, road network) are to be found mainly in the northern part of the area.

The favourable conditions of that part of the area are also affected by such agents as small height differences, low slope angles, broad meadow terraces of the Wisłoka and

fertile soils of the basins originated on thick accumulation material. The Jasło-Sanok Depression is characterized by lesser differentiation in conditions for the economy of conditions and of lesser share of areas with unfavourable conditions.

The Osiek Basin and the Żmigród Valley are marked by a domination of two types of areas (type III and V), which form large and coherent complexes (Fig. 4).

Assessment of the management in the Nowy Żmigród gmina

A comparison of the present structure of land use in the gmina of Nowy Żmigród and of spatial distribution of areas with varying predispositions for the development of the economy in that area makes it possible to express opinion that the spatial economy in the gmina, taking relief into consideration, is very near to the desired one. The accordance of the present state of the gmina's management with conditions of its economic development resulting from relief relates to the mode of land use with such barriers taken into consideration as; height above sea level, slope inclinations and the degree of terrain dissection as well as constraints caused by settlement surface fragmentation. Some risk for the economy, especially on large surfaces (the acreage) of arable lands, is caused by the impact of morphogenetic processes such as rainwash, linear erosion and mass movements. They influence the effectiveness of arable farming and agrotechnical and technical measures which facilitate arable farming in the relevant area. When taking a land use structure of the gmina into account it is possible to judge that there are relatively small surfaces that require the introduction of essential changes in management. The changes are constrained to a stabilization of landforms and surfaces modeled by gravitational processes. Floodplains should be reforested as well as steep slopes of deep V-shaped valleys, erosional escarpments and escarpments of river terraces e.g. the escarpment at Nowy Żmigród, the edge of a higher terrace west of Mytarka and the escarpment at Skalnik. Wet areas should be turned into meadows and pastures or reforested e.g. valleys within the Jasło-Sanok Depression. Stabilization is required of the escarpment of landslide headwall Podgóry, south-east of Nowy Żmigród, at the foot of which farm buildings are situated.

On account of buildings concentrated along valley bottoms and a small number of hamlets the problem with irregular location of farm buildings is also smaller than expected in the mountainous areas. Some difficulties are caused by buildings located too close to escarpments, both above the cuttings as well as at their base. Such a location buildings leads to sliding down of parts of buildings situated on the escarpments and to burying the buildings at their foot. Therefore of space management require introduction of some location limitations for the settlement in the Ryja and the Skalnik valleys. Houses and farm buildings, especially those located in the perilously close vicinity to the receded slope escarpments are principally endangered by mass movements. The processes of land sliding are also threatening the escarpment of the Wisłoka terrace on which Nowy Żmigród itself is located. In the Beskid valleys the irregular location of buildings is linked with a small distance from the river bed. There is a need of constraining dwelling housing on areas inundated during floods. Farmsteads situated there, built within the valleys of the Carpathian streams, impede the flow

of surface waters they are endangered by inundation and their users are threatened by high material losses. Along the Beskid stretch of the Wisłoka valley, at the hamlet Kąty Wola, Zarszyn and Zagrody the dwelling houses encroach floodplain of the river and on the escarpment between the inundation and meadow terraces. In the case of road construction special attention should be paid to roads led through the floodplain at Kąty Podgóry and Kąty Wygoda as well as to a road situated too close to the terrace escarpment (Kąty Podpagórek, Kąty Wygoda). In the Ryj valley an asphalt road is endangered in a few places by destruction as a result of lateral erosion of the river.

Conclusions

The limitations and barriers for the economy of the Nowy Żmigród gmina include; high slope angles of 15 to 30° in the southern part of the gmina (they are responsible for the share of skeleton soils and the intensification of erosion processes), considerable dissection of slopes, narrow ridges, valley floors (unfavourable microclimate) and considerable relative heights (up to 300 m). The northern part is marked by lesser relative heights (30-100 m), small slope angles below 15°, broad hilltops and fertile alluvial soils creating favourable conditions especially for arable farming.

The basic management problems resulting from the relief in the gmina include; dwelling houses located in too close vicinity from watercourses and of all sorts of natural and anthropogenic escarpments, unstable and liable to denudation processes. That phenomenon is fairly frequent in all the Beskid valleys and in the upper reach of the Niegłoszcza valley in the northern part of the gmina. Widespread, too, is the location of houses and buildings on floodplains of the Wisłoka and at the foot of landslide slopes.

Such practices involve frequently irreversible and catastrophic consequences. Unfortunately, in the hitherto practice of the management of mountain regions the limitations and barriers resulting from geomorphological conditions are in too small degree taken into consideration. Therefore, the most urgent tasks for the spatial economy should include managing the space according to conditions of the natural environment, the exclusion from the building up of potentially inundation and landslide areas, biological consolidation of catchment basins and, if such need arises, a change in the structure of land use.

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Geomorfologiczne uwarunkowania rozwoju gospodarczego gminy Nowy Żmigród

Streszczenie

Autorka prezentuje ograniczenia i bariery, jakie stwarza ukształtowanie powierzchni na gospodarkę człowieka w gminie Nowy Żmigród, ze szczególnym uwzględnieniem użytkowania ziemi, możliwość przeprowadzenia ciągów komunikacyjnych oraz zabudowy. Rzeźba gminy cechuje się znacznym zróżnicowaniem w związku z tym warunki dla rozwoju w poszczególnych jej częściach są inne. W ocenie warunków wzięto pod uwagę typy rzeźby, związany z nim układ grzbietów i obniżeń, zróżnicowanie nachyleń, kształt stoków oraz stopień ich rozczłonkowania. Dla zabudowy i infrastruktury oszacowano odległość od koryt rzecznych i podnóży stoków oraz występowanie form osuwiskowych. Na podstawie opracowań kartograficznych dokonano bonitacji obszaru gminy pod kątem ww. możliwości inwestycyjnych. Analiza obecnej struktury użytkowania ziemi oraz przestrzennego rozmieszczenia wyznaczonych w bonitacji obszarów pozwoliła na określenie jakości gospodarki przestrzennej w gminie, która jest zbliżona do prawidłowej. Wskazano na stosunkowo nieliczne obszary o koniecznej zmianie użytkowania (ustabilizowanie krawędzi, obszarów osuwiskowych) oraz podkreślono potrzebę ograniczenia zabudowy i infrastruktury blisko licznych krawędzi, koryt potoków i podnóży stoków. Jednocześnie uwypuklono rolę geomorfologii w planowaniu przestrzennym obszarów wiejskich oraz rolę planowania miejscowego jako narzędzia prawidłowej gospodarki.

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