Abstract: Outline of the contents: The southern border of Cracow runs in the border zone between the Carpathians and the Sub-Carpathian Basins. The convergence of the anthropogenic and natural border affects the functioning of that area. As a result of the mapping, five parallel landscape belts were designated in the area in question. It was established that the degree of anthropogenic changes was strongest in the valley bottom while it decreased towards the south. The natural transformations are chiefly linked with the natural succession (meadows, ponds) and with relief-forming processes (landslides). Semi-natural landscape is represented by small erosion-denudation slope valleys.

Key words: the Cracow Gate, the Wieliczka Foothills, structure of the environment, environmental transformations

Introduction

The peripheral zone of a large city is an area of dynamic transformations of the natural environment that result from the interaction between the strongly transformed urban areas and poorly transformed rural farmland-forest areas. The development of the Cracow agglomeration involves intensification of housing areas and creation of municipal infrastructure, which results in the changes of water and microclimatic conditions, and of plant communities.

According to K. Kasprzak and B. Raszka (2001) the development of a city under Polish conditions is often of elemental and planless character, and the borders of management types do not coincide with natural borders in the environment. The preservation of the semi-natural environment of the peripheral areas of a city is of great importance for the improvement of living standard within an agglomeration. The city functions
as a natural system which requires external supply sources, hence its peripheral zones fulfill the role of migration corridors for the resources (Szulczewska, Kaftan 1996).

The southern border of the Cracow agglomeration runs in the vicinity of a high-ranking taxonomic regional border between the Subcarpathian Basins (the Cracow Gate and the Sandomierz Basin) and the Outer West Carpathians (the Wieliczka Foothills). In the existing regional divisions e.g. the geomorphological one by M. Klimaszewski (1972), the physical-geographical by Z. Czepe and K. German (1979); J. Kondracki (1998), K. German (2003) there are considerable controversies in designating a detailed course of the border, chiefly on account of the existence of a transitional zone built of folded Miocene silty and sandy rocks, marked by a landscape similar to that of low foothills. The convergence of the physiognomical and administrative border of the city and of the regional natural border should influence the dynamics of the environment of the area in question and should involve numerous transformations of its condition.

The aim and method of the studies

The aim of the paper was to study the structure and to acknowledge present-day environmental transformations in the above mentioned border zone. Using the method by Z. Czepe and K. German (1978) a physical-geographical mapping of uroczysko units was carried out, summer 2001, in a sector of the border zone between Kurdwanów in the north and Podstolice and Ochojno in the south (Fig. 1). A record was made in applying a questionnaire method, taking account of the effects of the main natural and anthropogenic transformations. Transformations of the relief, soils, water conditions and of plants were recorded. On the basis of the performed mapping, 385 individual “uroczysko” units were typified and afterwards 32 individual “teren” units were designated. Taking into account landscape similarity (on the basis of perceivable elements of the natural environment), the neighbouring individual units were linked by separating 5 parallel belts (Zapała, 2002).

The structure and environmental transformation

The most frequent occurrence of the “uroczysko” units in the relevant area are to be found on slopes of moderate (10-20°) and gentle inclinations (below 10°). They co-dominate both in the respect of the number and of the surface (Tab. 1). The fragments of steep slopes (above 20°) are few in the northern part of the area (associated only with deep erosion cuts) and more numerous in the southern part (linked with structural features of the substratum). A terraced valley is only displayed by the Wilga between the humps of Golkowice-Grabówki and Ochojno-Podstolice. The broad, non-terraced valley of Kurdwanów, was formed by proglacial waters as a marginal glacial terrace (Starkel, 1972). Considerable environmental transformations by man have brought about the necessity to separate anthropogenic uroczysko units. These include large cuttings associated with the construction of a motorway and of fortress roads, fortifications, and of ponds. The fortifications of the outer ring...
Fig. 1. Environmental structure of the border zone between the Carpathians and the Sub-Carpathian Basins south of Cracow

Ryc. 1. Struktura środowiska strefy granicznej pomiędzy Karpatami a Kotlinami Podkarpaczkimi na pd od Krakowa


of the Fortress Cracow came into being over 1874-1902 (Bogdanowski, 1978). Elements of the system are 3 large forts (Rajsko, Kosocice, Barycz), field-work and a network of front-line roads (linking the neighbouring forts in the ring) and access roads (linking individual forts with their background). The breeding ponds are nowadays unused. Some of them had disappeared as a result of mining works in the salt mine of Barycz (Pociask-Karteczka, 1995).

As a result of investigations 5 landscape belts were distinguished, which reflect a gradual passage from the basin bottom up to the middle foothills; 

1. The basin floor on the unfolded Miocene deposits (the valley of Kurdwanów) characterized by a low differentiation and a high dissimilarity of the environmental structure relative to the remaining belts. Absolute and relative heights are lowest. There dominate convex landforms. The “uroczysko” units cover large areas. There are only 5 types of “uroczysko” units (including characteristic types of “uroczysko” units of a flat watershed and of a broad valley floor transformed glacifluvially) and 1 type of “teren” unit. The anthropogenic transformation of the area is high (Tab. 2)
and is associated with housing building of high intensity, transformation of water conditions (drainage of the valley floor, channeling of stream beds), transformation of soil conditions (muck soils or muck-like soils originated as a result of drying up of black earths), relief transformations (levelling of the former limestone quarry at Kurdwanów, motorway excavation). Semi-natural elements are the meadows in the southern part of the belt. The lower part of the slope of Rajsco-Kosocice is shaped by natural processes. Such a character is revealed by the forest-meadow border and a few alluvial cones at the outlet of major valleys.

2. Humps on the folded Miocene deposits characterized by a high diversification of environmental structure (28 types of uroczysko units and 3 types of terrain). There prevail, both in number and in surface, uroczysko types of gently and medium inclined slopes, though they are not dominants. The ravines are usually deeply incised and their bottoms display lateral erosion. Slope uroczysko units of gentle inclination occur in the lower part of the catena and form a characteristic accumulation profile. The humps reach considerable absolute and relative heights (Rajsko 349.5 m a.s.l.). On account of poorly permeable substratum, gley soils are to be found in the valley bottoms. Characteristic of the area are sudden flows of small streams resulting during frequent torrential rains. The anthropogenic transformations within the belt are heavy but are usually of point or linear character (along the roads). Within the belt the most numerous are uroczysko types of anthropogenic origin. These are the “uroczysko” units of fortifications, artificially planted with ash, horse-chestnut and robinia. The existing ponds are not used and represent various stages of plant succession, some of them nearly totally filled with a cover of vegetation. The effect of man’s pressure is represented by spontaneous fairly intense single-family housing, especially along the road Swoszowice-Barycz and by the former front-line road between the forts Kosocice and Rajsco. In many cases the houses are not built according to the construction rules e.g. those built above the upper stretches of ravines. Concave landforms happen to be used as refuse dumps. The new concentrations of single-family housing to be found on the northern slope of Rajsco constitute an element of the city’s expansion. The vegetation preserved

<table>
<thead>
<tr>
<th>No of belt</th>
<th>Polynhemeronchia</th>
<th>Relief changes</th>
<th>Changes of water conditions</th>
<th>Soil changes</th>
<th>Deforestation</th>
<th>Afforestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>64.8</td>
<td>77.7</td>
<td>91.1</td>
<td>93.1</td>
<td>8.4</td>
<td>4.3</td>
</tr>
<tr>
<td>2</td>
<td>19.2</td>
<td>30.9</td>
<td>6.2</td>
<td>27.5</td>
<td>37.4</td>
<td>18.5</td>
</tr>
<tr>
<td>3</td>
<td>2.5</td>
<td>29.7</td>
<td>7.1</td>
<td>50.3</td>
<td>40.7</td>
<td>5.2</td>
</tr>
<tr>
<td>4</td>
<td>3.4</td>
<td>13.7</td>
<td>0.8</td>
<td>22.9</td>
<td>43.7</td>
<td>14.9</td>
</tr>
<tr>
<td>5</td>
<td>1.2</td>
<td>14.6</td>
<td>2.9</td>
<td>9.7</td>
<td>58.5</td>
<td>16.5</td>
</tr>
<tr>
<td>Total</td>
<td>17.4</td>
<td>30.3</td>
<td>15.2</td>
<td>33.3</td>
<td>38.7</td>
<td>14.7</td>
</tr>
</tbody>
</table>
in this area fulfills recreational function.

3. The direct foreland of the flysch escarpment displays the character of a narrow, discontinuous belt forming a kind of a pediment stretching outwards of the flysch escarpment. Surface dominant of the area is constituted by “uroczysko” units of mid-slope flats. Relative heights in that belt are relatively small. The area is fairly heavily built up, which is due to its location above the layer of thermal inversion. Anthropogenic changes reveal a high degree there, especially in the Malinówka valley in the vicinity of Barycz. As a result of salt mining by underground leaching many concave landforms of subsidence basins have come into being. Part of them is filled with brine, part is used by a municipal waste landfill. There is no forest isolation belt to separate the landfill from Soboniowice. In a few places traces of turf digging were observed. The lack of sewage treatment plants is a cause of heavy pollution of streams already in their heads, so more that in most cases these are outflows of subsoil waters. A semi-natural process at work in the area investigated is the forest succession encroaching on the fallow-lying fields in the lower portions of the slopes. The species to be observed in such a community are birch, alder and the thorny bushes of blackthorn and hawthorn.

4. The low Foothills on flysch rocks are characterized by a considerable mosaic of “uroczysko” units with a high contribution of steep north-facing slopes. The zone of the flysch escarpment is marked by the occurrence of numerous short, consequent, small valleys of erosion-denudation character and of landslides. There are no flat-bottomed accumulation valleys. Characteristic types of the “uroczysko” units in that belt are also floodplains, river channels and meadow terraces of the Wilga. The valley displays an aregional character since the terraced river valleys are not a peculiar feature of the low foothills. Areas of the meadow terrace are used as pastures, more rarely as arable land, or for building. There are a few concrete fords in the Wilga valley. They narrow the river bed, causing destruction of the edge of the meadow terrace during inundations. The anthropogenic changes are of point character. There are a few non-used ponds. Their establishing in the narrow valleys have stimulated the development of landslides on relatively steep slopes. A large landslide on the Grabówki hillslope had come into being in the 1980s as a result of mining works in the salt mine of Barycz. Nowadays its headwall is under the influence of forest succession while below it a few swamped lakes can be observed.

5. The middle foothills on flysch rocks characterized by a considerable diversification of environmental structure, chiefly at the level of the types of terrain (3 types of slopes in 2 levels). Slope “uroczysko” units on flysch rocks constitute a clear dominant with steep slopes to be found in the lower portion of the catena. The upper portions are dissected and there are large surfaces of gentle and moderate inclinations. There are no gullies and gullies with boggy bottom and the existing slope valleys are marked by high slope in the long profile. The dominant form of land use is agriculture. There are no major forest patches. Compact buildings areas are to be found solely on ridges while on the slopes they are scattered. The changes observed are in large measure of natural or semi-natural character (landslides, windblows). One of the landslide tip is being used as a sports ground.
Conclusions

Despite the predominance of open spaces there is lack of acreage of high natural value (protected areas). The existing green areas fulfill chiefly recreational functions and are also used as ecological corridors making it possible to transport natural resources into the urban ecosystem.

The degree of anthropogenic changes decreases to the south (Tab. 2). The most transformed is landscape belt 1, which wholly lies within the administrative boundaries of Cracow. The transformations observed are of surface character. Nearly all geocomplexes are marked by transformations of water and soil conditions. This fits in with the degree of polyhermobia according to M. Pietrzak (1998). The influence of the city in the “uroczysko” units of hills built of the folded Miocene rocks bears a historical stamp (fortifications, overgrowing ponds) and corresponds with the degree of euhermobia (Pietrzak, 1998). Belts 3, 4, 5 are characterized by a relatively similar degree of anthropogenic changes, typical of rural-urban areas – mesohermobia (Pietrzak, 1998). The dominant type of changes is deforestation.

The highest degree of anthropogenic transformation is to be observed on flats and on gentle slopes which, on account on their accessibility, are used by settlement. The main element of changes in major valleys is agricultural drainage. The least degree of man-induced changes is characteristic of geocomplex types of steep slopes and of erosion-denudation valleys (Tab. 3). Small valleys function as oases of semi-natural landscape, which are marked by a high landscape diversity.

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Struktura i współczesne przemiany środowiska strefy granicznej między Bramą Krakowską a Pogórzem Karpackim na południe od Krakowa

Streszczenie


– proces ekspansji lasu (głównie brzoza i olsza) w niższych partiach stoków w związku ze zmianą typu gospodarki i porzucaniem nierentownych pól uprawnych,
– dziczenie opuszczonych sadów,
– proces zarastania nieużytkowanych gospodarczo stawów,
– wzmożoną erozję krawędzi strukturalnych w obszarach silnie wylesionych,
– modelowanie stoków w wyniku procesów osuwiskowych.

Zaobserwowano także następujące tendencje zmian powstałe w wyniku działalności człowieka:

– duże zanieczyszczenie potoków w związku z brakiem oczyszczalni i uwalnianiem ścieków bytowych wprost na pola,
– przemiany związane z budową autostradowej obwodnicy miasta (osuszenie gruntów, przemiany gleb, zmiany w użytkowaniu ziemi, przekształcenia rzeźby),
– przemiany związane z intensyfikacją zabudowy mieszkalnej (wzrost zaśmiecenia obszaru, uruchamianie osuwisk, przemiany rzeźby i stosunków wodnych),
– przemiany związane z działalnością przemysłową (szkody pogórnicze),
– przemiany związane z działalnością rolniczą (budowa nowych dróg polnych, dojazdowych, zakładanie stawów rybnych, powstawanie gleb hortisoli),
– przemiany związane z działalnością fortyfikacyjną (holwegi, nasypy, drogi rokadowe i dojazdowe, specyficzna roślinność).

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