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Barbara Błach

# THE INFLUENCE OF ANTHROPOGENIC FACTORS ON THE CHANGES IN LANDSCAPE STRUCTURE

The surrounding natural environment, which evolved as a result of combined action of abiotic, biotic, natural and anthropogenic factors (Kondracki, Richling, 1983) is subject to constant changes whose monitoring and evaluation is one of the basic tasks for environmental protection. Remote sensing is a very good tool for observation of the environment and monitoring its changes.

The application of aerial photographs and satellite images allows to conduct comprehensive research on the condition of the environment, analyse its components, conduct quantitative and qualitative evaluation of changes, identify the prevalent transformation trends and make forecasts on future aspects of the environment. In the conducted research, landscape has come to be regarded as a "territorial system composed of interrelated natural or natural and anthropogenic elements and taxonomically lower ranking complexes" (Richling, 1992).

This paper basically aims to answer the question whether socio-economic changes driven by political events are reflected in the transformations of landscape structure. In order to be able to thoroughly study the changes occurring in the landscape, its basic structural units in the order of ranges were distinguished.

The research area was the Osławica catchment basin situated at the boundary of the Low Beskidy and the Bieszczady mountains in south-eastern Poland. This area is of particular interest in terms of environmental protection, since there we encounter atypical landscape changes caused either by discontinued agricultural land use or by a specific (occurring only in the countries which once formed the communist bloc) form of large-area farming.

Discontinued use of a significant portion of land of the research area caused by the resettlement action related to the specific political, ethnical and social situation of the Low Beskidy and the Bieszczady mountains was adopted as a basic anthropogenic factor generating all the later changes. Other elements in the causative sequence of events were: the changing history of the large-area farming, development of industry, forest economy and rapid development of tourism.

## CHARACTERISTICS OF ECONOMIC AND POLITICAL CHANGES

Following World War II, the then authorities, in order to counteract the increasing ethnic conflicts, took a decision to resettle the population of Ukrainian and Ruthenian origin to the north and west of Poland (the so-called "Vistula" action). As a result, in the *gmina* (local administrative unit) of Komańcza there remained only one fourth of the population living here prior to 1946. The buildings deserted by the resettled were devastated, the untilled land went into decay, the orchards ran wild, the meadows, not mowed regularly, gradually changed their vegetation composition. Forest and grey alder encroached on the areas deserted by man. In order to cultivate the unused land, in the years 1952–1956, State Farms (PGR) were organised on a large scale. The PGRs, struggling with many economic problems, were in existence for another 20 to 30 years. The political changes in Poland in the 1980s aggravated the critical situation of PGRs and, at the end of the day, led to the collapse of most of the farms. Land of the former PGRs was taken over by the State Treasury Agency for Rural Ownership which later sold it to private investors.

## STAGES OF RESEARCH

The assessment of landscape changes in the Osławica catchment basin was conducted on the basis of panchromatic aerial photographs. The study made use of photographs from 1952 supplemented by photographs from 1955 in the average scale of 1:25 000, and from 1995 in the scale 1:30 000, thus obtaining environmental data records in two temporal perspectives. During the first stage of research, based on interpretation copies made using the aerial photographs, land use maps were compiled in the scale 1:25 000 for 1952 (Fig. 1) and 1995 (Fig. 2). Land use maps as well as geological and morphometric maps constituted the basis for distinguishing landscape structural units, similar in rank to the range. Then, on the basis of the similarities between their constituent elements, individual landscape units were combined into landscape unit types. A comparison of data on the types of ranges in the years 1952 and 1995 allowed to obtain accurate information on quantitative and qualitative changes of structural landscape units of the Osławica catchment basin.

For delimiting landscape units and qualitative analysis, GIS techniques were used (ARC/Info and ERDAS IMAGINE version 8.3 operating on a Silicon Graphics work station).

## COMPILATION OF MAPS OF LANDSCAPE TYPOLOGICAL UNITS

The aforementioned aerial photographs do not permit any detailed classification of farmland. However, an analysis of basic land use categories, such

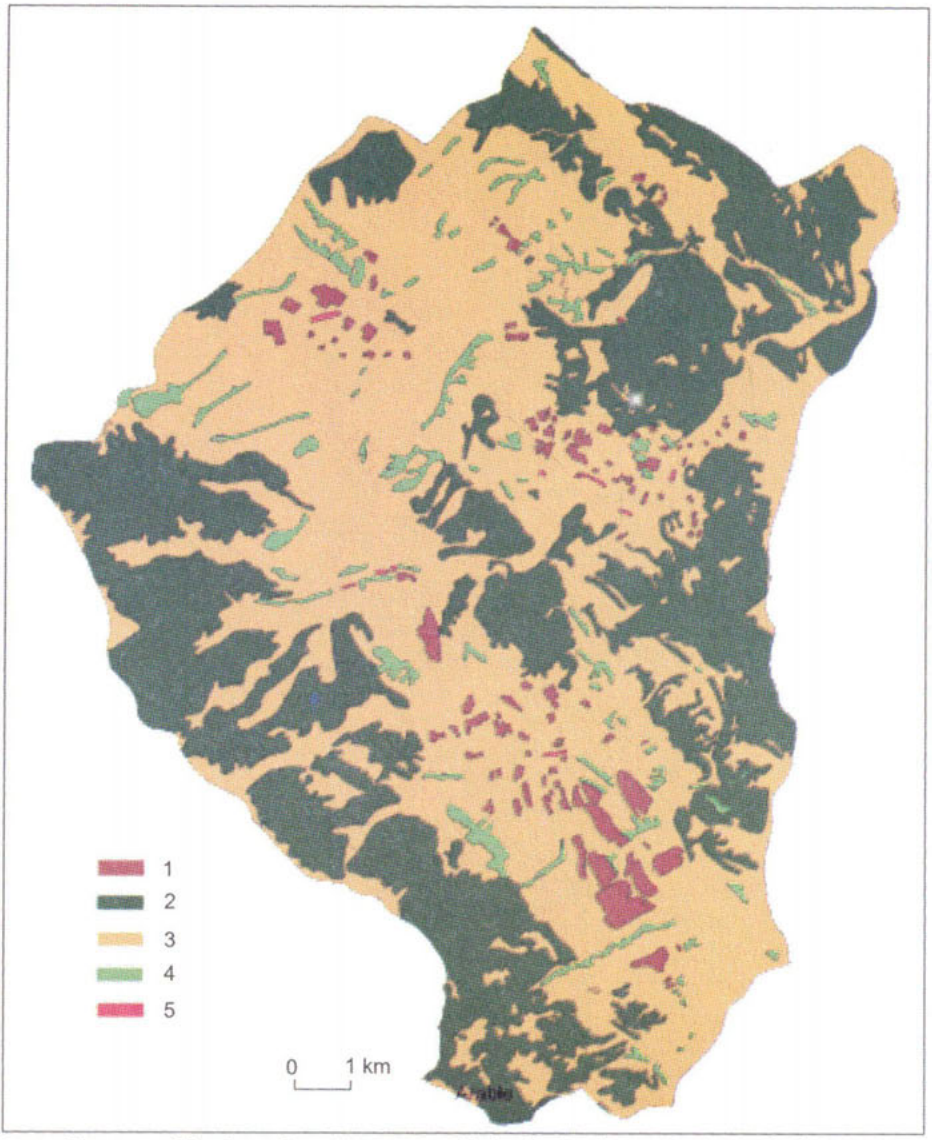


Fig. 1. The map of land use for 1952: 1 — arable land, 2 — forest, 3 — grassland, 4 — coppice vegetation accompanying watercourses, 5 — houses.

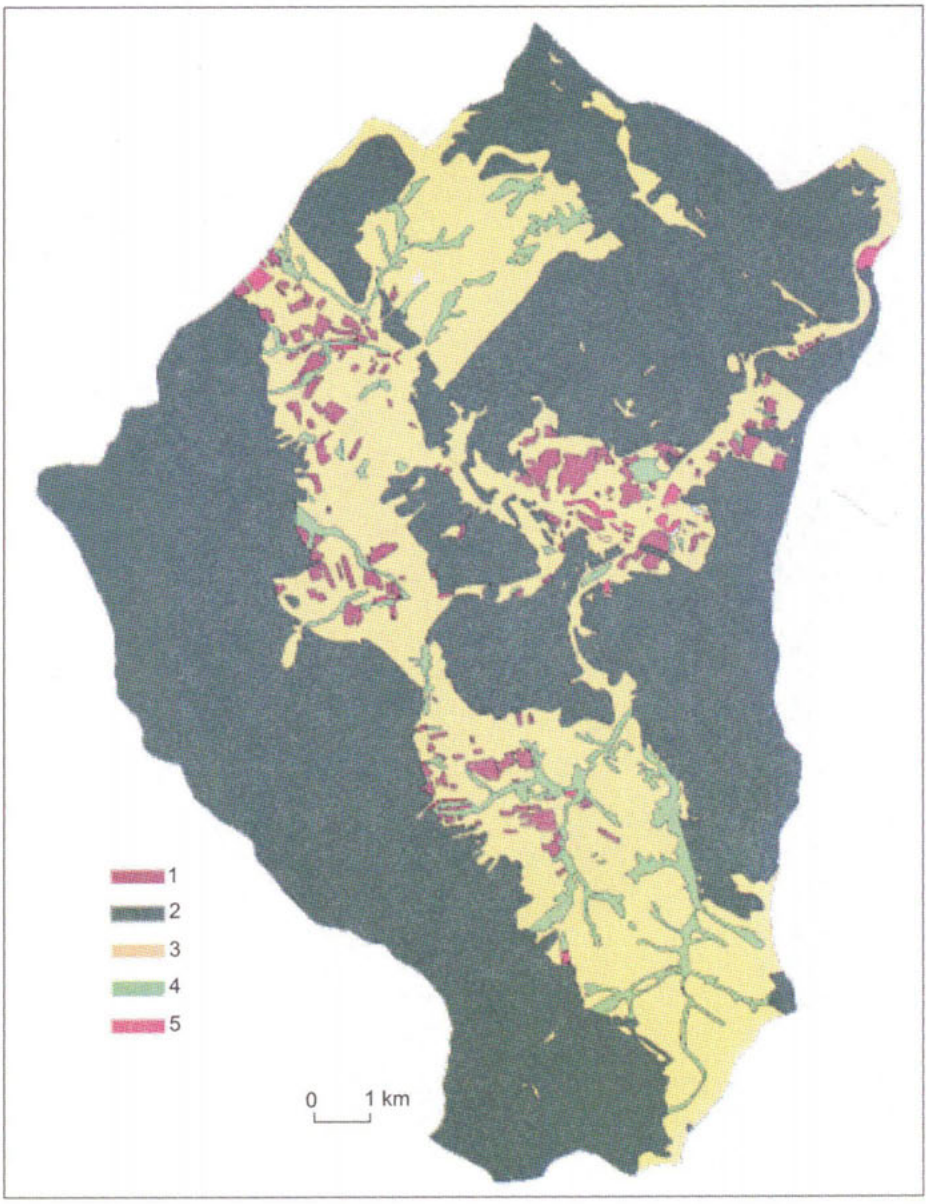


Fig. 2. The map of land use for 1995: 1 — arable land, 2 — forest, 3 — grassland, 4 — coppice vegetation accompanying watercourses, 5 — houses.

as arable land, grassland, forests and coppice vegetation accompanying watercourses allows to draw conclusions on the changes in the land management of the Osławica catchment basin.

Following the compilation of maps of those components and entering them into the ARC/Info programme, the individual strata were added. As a result, maps of spatial units of range-related rank were obtained. The number of distinguished units for 1952 was 1189, and for 1995 — 1178. As a result of generalisation, units with too small areas were eliminated and fused with larger units. 7000 square metres were regarded as a border area. Then, similar units characterised by a similar geological structure, land slope and land use were grouped together (Gil, 1979). As a result, 94 categories were obtained for 1952 and 96 landscape units for 1995.

It was decided that the above number of categories precluded the compilation of a readable map of landscape units, similar to ranges in rank. Therefore, individual units were merged into types, with land use as a determining factor, since it was land use that most affected the landscape changes.

On the researched area (Fig. 3 and 4), 24 range types were distinguished:

— range type of arable land on flat-topped mountains;
— range type of arable land on gentle slopes;
— range type of arable land on medium-gradient slopes;
— range type of arable land on inter-valley flats;
— range type of arable land in river and stream beds;
— range type of grassland on flat-topped mountains;
— range type of grassland on gentle slopes;
— range type of grassland on medium-gradient slopes;
— range type of grassland on steep slopes;
— range type of grassland on inter-valley flats;
— range type of grassland in river and stream beds;
— type of forest range on flat-topped mountains;
— type of forest range on gentle slopes;
— type of forest range on medium-gradient slopes;
— type of forest range on steep slopes;
— type of forest range on inter-valley flats;
— type of forest range in river and stream beds;
— range type of coppice vegetation accompanying watercourses on flat-topped mountains;
— range type of coppice vegetation accompanying watercourses on gentle slopes;
— range type of coppice vegetation accompanying watercourses on medium-gradient slopes;
— range type of coppice vegetation accompanying watercourses on steep slopes;
— range type of coppice vegetation accompanying watercourses on inter-valley flats;
— range type of coppice vegetation accompanying watercourses in river and stream beds;
— range type of housing in river and stream beds.

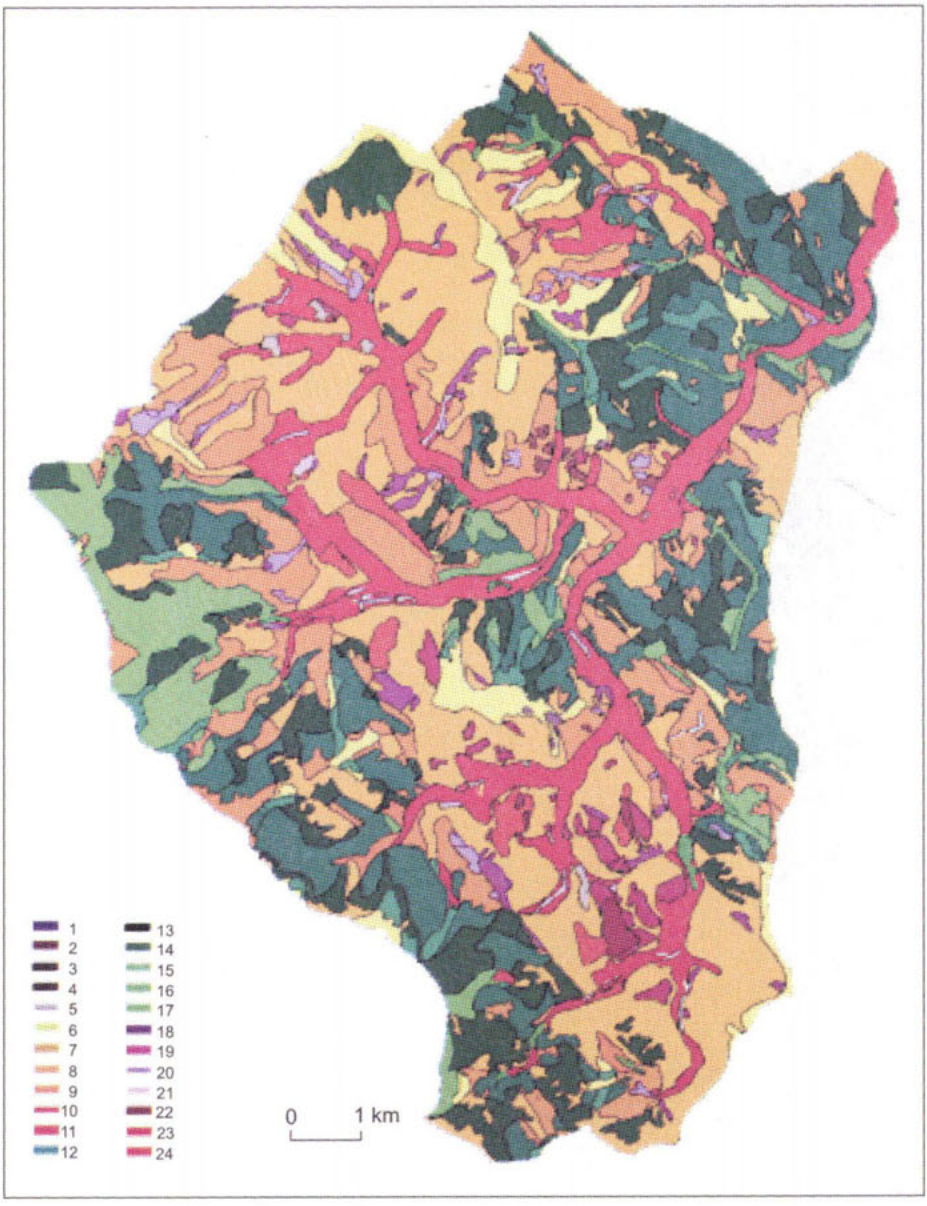


Fig. 3. The map of range types for 1952.

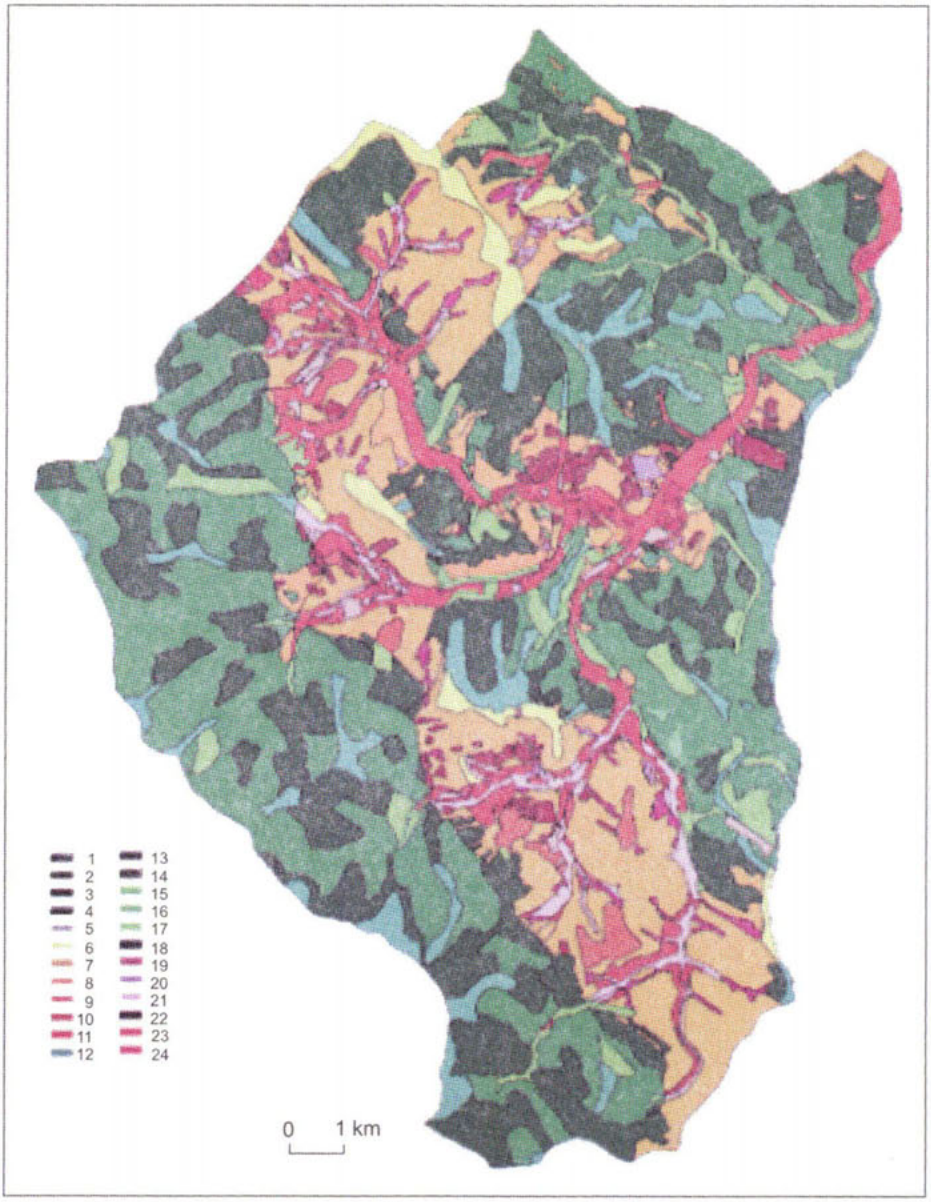


Fig. 4. The map of range types for 1995.

## COMPARATIVE ANALYSIS OF LANDSCAPE UNITS OCCURRING IN 1952 AND 1995

The landscape structure in 1952 was distinctly dominated by the forest range type occurring on gentle and medium-gradient slopes, which in all occupies 28 per cent of the catchment basin area, and the range type of grassland on medium-gradient slopes, occupying nearly 25 per cent of the basin area.

Generally, grassland range type occupied 59.27 per cent of the catchment basin area; forest range type — 35.13 per cent; range type of coppice vegetation accompanying watercourses — 2.7 per cent, and arable land — 2.89 per cent. The arable land range type primarily occurred on gentle slopes and inter-valley flats. The housing range type (built-up area) occupied barely 0.01 per cent of the analysed area. Such a low value results both from the actual situation and from generalisation, during which process small-surface housing elements situated on the border of two ranges were added to the bigger one (Fig. 3).

An analysis of the percentage distribution of individual range categories of the Osławica catchment basin in 1995 shows a clear predominance of forest ranges, occupying 62.49 per cent of the entire area under research. The range type of coppice vegetation accompanying watercourses account for 5.45 per cent, and arable land ranges occurring mainly on gentle slopes and inter-valley flats represent 2.42 per cent of the catchment basin area. The housing ranges cover 0.56 per cent of the basin area and are mainly situated in river and stream bottoms (Fig. 4).

Table 1.

Changes in the average range area by categories in the years 1952 and 1995

| Category of range type | Average range area as percentage of the entire catchment basin area | |
|---|---|---|
| | 1952 | 1995 |
| Field | 0.04 | 0.02 |
| Grassland | 1.10 | 0.08 |
| Forest | 0.09 | 0.12 |
| Coppice vegetation accompanying watercourses | 0.03 | 0.04 |
| Built-up areas | 0.01 | 0.02 |

Table 1 shows differences in the average percentage size of ranges in both analysed temporal perspectives. It indicates that the highest (over twofold) increase in the average area of ranges occurred in the housing range category, as a result of developing settlement. A considerable increase can also be observed in the forest range category and the range type of coppice vegetation accompanying watercourses, which results from dynamic afforestation processes and the proceeding succession of natural vegetation. Based on

aerial photographs, changes in the forest limit were observed. Currently, forests occupy 63 per cent of the catchment basin area, whereas in 1952 they covered only 35 per cent. A sharp fall in the average area can also be observed in the arable land category which, when related to data on the aggregate area occupied by this category of range, may testify to a considerable size reduction of arable land.

In order to render the changes in the landscape structures that occurred in individual categories of the analysed units even more accurately, in Table 2 percentage of individual range types for the years 1952 and 1995 are presented.

Based on the data listed in Table 2, it can be said that arable land ranges withdrew from flat-topped mountains and inter-valley flats. This phenomenon resulted from the liquidation of large-area fields owned by state farms (PGR), which, in 1952, occurred on inter-valley flats, in addition to ceasing land cultivation on flat-topped mountains, which was related to a relatively difficult access to those areas, frequently precluding their proper cultivation. Increase in the area of arable land ranges can be observed on gentle and medium-gradient slopes, which was a result of the development of rural areas and locating arable land in the vicinity of housing. Another observed phenomenon was a considerable fall in the area of grassland ranges which occurred in all range types. The highest decrease could be observed on gentle and medium-gradient slopes. This process was connected with planned afforestation of steep and uncultivated slopes, as well as natural vegetation succession.

The process discussed above is related to the increase in the area of forest ranges in all their types. The area of those ranges within the entire catchment basin increased by 27.81 per cent. Most frequently, forest encroached on gentle and medium-gradient slopes. A range increase tendency can be observed in river and stream beds, on flat-topped mountains, inter-valley flats and gentle slopes, while a decrease can be observed on medium-gradient slopes. The above table indicates that in the Osławica catchment basin a significant increase in the area of built-up ranges has taken place. It should also be noted that in 1952 built-up ranges accounted for only 0.01 per cent of the basin area, while in 1995 — for 0.02. This increase was caused by the development of villages of Komańcza, Radoszyce and Czystogarb and to the establishment of PGRs.

## CONCLUSIONS

The applied method of assessing landscape structure changes allowed to satisfactorily assess the qualitative and quantitative transformations, thus corroborating the introductory thesis that the prevailing factor in generating landscape changes in the Osławica catchment basin were socio-economic changes constituting the first link in a subsequent chain environment trans-

Table 2.

Differences in the area occupied by individual range types in relation to the entire catchment basin area in the year 1952 and 1995

| Range type | Percentage of the Osławica basin occupied by given range type in 1952 | Percentage of the Osławica basin occupied by given range type in 1995 | Change in per cent value in the years 1952 and 1995 |
|---|---|---|---|
| Arable land on flat-topped mountains | 0.14 | 0.01 | –0.13 |
| Arable land on gentle slopes | 1.26 | 1.43 | +0.17 |
| Arable land on medium-gradient slopes | 0.2 | 0.52 | +0.32 |
| Arable land on inter-valley flats | 1.21 | 0.35 | –0.86 |
| Arable land in river and stream beds | 0.08 | 0.11 | +0.03 |
| Grassland on flat-topped mountains | 10.59 | 5.19 | –5.4 |
| Grassland on gentle slopes | 26.32 | 15.44 | –10.88 |
| Grassland on medium-gradient slopes | 14.00 | 3.64 | –10.36 |
| Grassland on steep slopes | 1.05 | 0.37 | –0.68 |
| Grassland on intervalley flats | 1.3 | 0.45 | –0.85 |
| Grassland in river and stream beds | 6.01 | 3.9 | –2.11 |
| Forest on flat-topped mountains | 3.85 | 7.11 | +3.26 |
| Forest on gentle slopes | 12.14 | 22.66 | +10.52 |
| Forest on medium-gradient slopes | 16.5 | 29.36 | +12.86 |
| Forest on steep slopes | 2.39 | 2.59 | +0.2 |
| Forest on inter-valley flats | 0.07 | 0.17 | +0.1 |
| Forest in river and stream beds | 0.18 | 0.6 | +0.42 |
| Coppice vegetation accompanying watercourses on flat-topped mountains | 0.3 | 1.29 | +0.99 |
| Coppice vegetation accompanying watercourses on gentle slopes | 1.38 | 1.98 | +0.6 |
| Coppice vegetation accompanying watercourses on medium-gradient slopes | 0.88 | 0.33 | –0.55 |
| Coppice vegetation accompanying watercourses on inter-valley flats | 0.02 | 0.74 | +0.72 |
| Coppice vegetation accompanying watercourses in river and stream beds | 0.12 | 1.2 | +1.08 |
| Built-up areas on gentle slopes | 0.01 | 0.14 | +0.13 |
| Built-up areas on inter-valley flats | – | 0.3 | +0.3 |
| Built-up areas in river and stream bottoms | – | 0.12 | +0.12 |

formations. A comparative analysis of the development level of the *gmina* of Komańcza in the years 1952 and 1995 shows two basic tendencies. The first is the development of individual villages, increase in the number of buildings and redevelopment, or rather building activity in the areas occupied by villages

prior to 1946. Another observable tendency in the environs of Komańcza is a decrease in the area of arable land caused by low profitability of production and discontinuance of costly and labour-consuming land cultivation.

The operation of state farms generated the appearance of large-area arable fields never before encountered in the borderland of the Low Beskidy and Bieszczady mountains. A large part of these fields has been transformed into pastures and meadows or afforested. All those causes and effects of human activity have been reflected in the landscape structure changes at the range type level.