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# EVALUATION OF THE PHOTOINTERPRETATION METHOD FOR DELIMITATION OF GEOCOMPLEXES IN THE BESKID MOUNTAINS

Information on geographic environment is registered by aerial photography or satellite imagery in the form of three parameters which are at the same time photointerpretation identification features, that is, photostructure, phototexture, and phototone. Combination of these three features creates on the surface of a photographic or a satellite image homogeneous areas, called territorial photomorphic units (Olędzki 1986). Homogeneity of fragments of the satellite image and therefore a well-defined, piece-wise constant relation among the pattern, texture and phototone finds its counterpart in the homogeneity of the Earth's surface area photographed. The aim of this article is to determine the nature of relation between the photomorphic units discriminated on the basis of satellite image and the pattern of geocomplexes existing on the Earth's surface.

Geocomplexes, which are homogeneous and enclosed fragments of geosphere, are determinated by specialists in a variety of ways. Boundaries, most often of zone nature, in spite of their proclaimed objective existence, are rarely determined in a unique way. In delimitation of geocomplexes decisive role is played by the so-called main components, which should be chosen by way of an integrative analysis of environment (Richling 1982). Satellite images and aerial photography present Earth's surface in a comprehensive manner, that is, account for all the existing relations among the components of geographic environment, and simultaneously generalize this presentation, hence deleting the least essential information, thereby permitting a determination of certain territorial units. In the present paper an effort is made to demonstrate that the distinguished photomorphic units rank as landscape units.

The area subject to this particular analysis is located within two physico-geographical macroregions: Middle Beskid Plateau and Middle Beskid Mts. (Fig. 1). It is geologically built of folded series of sandstones, slates and flysch marls. Slopes are covered with brown soils, while ridges and heights with thin, skeletal soils, and river valleys with alluvial warp (E. Gil 1979; L. Starkel 1978). Altitudes, which attain

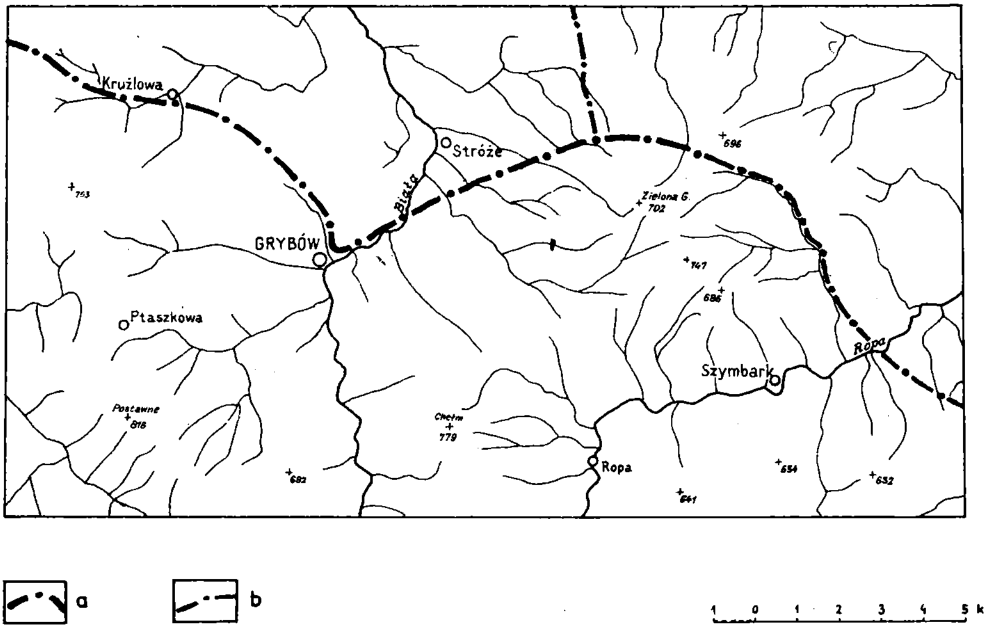



Fig. 1. Subdivision into physicogeographical regions after J. Kondracki; a: boundaries of macroregions; b: boundaries of mesoregions

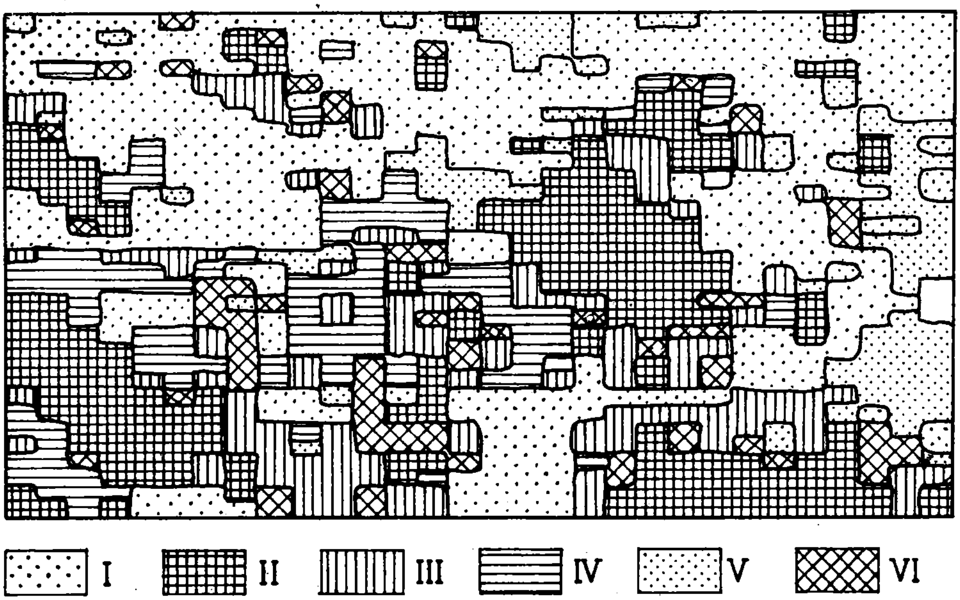



Fig. 2. Subdivision into photomorphic units;
a: unit I; b: unit II; c: unit III; d: unit IV; e: unit V;, f: unit VI

800—1,000 meters in Low Beskid and 300—750 meters within the Plateau, imply climatic and plant cover stratification. Within the plateau zone plant association called *Tillio-carpinetum* occurs, while in the low and medium height mountains appropriate association is *Fagetum Carpaticum* (J. Staszkiewicz 1973). Plant cover is strictly related to the existing micro- and meso-climatic conditions. Within the Carpathian Foothills two micro-climatic zones are distinguished: inversion-bound lows, and warm, over--inversion slopes, and there is also the third, colder, zone in the Beskids, shaped by the advection of air masses (B. Obrębska-Starklowa 1973).

The material which served as a basis for a sub-division into photomorphic units was a fragment of colour composition of the Landsat scene taken on the scale of 1:300 000. Interpretation and analysis of three fundamental photointerpretation identification features, i.e. phototone, photostructure and phototexture, permitted a determination of six photomorphic units, which are characterized, according to their definition, by homogeneity of the satellite image (see Fig. 2). Within each of the classes distinguished a detailed analysis of components of mountainous geosystems was made (involving, respectively, geology, Earth surface sculpture including forms of landscape, absolute and relative altitudes, slope's inclination, waters, soils and land use) in order to study their kind, character and stability within photomorphic units. General geographic characteristics of the units distinguished are presented in Table 1 and Figure 3.

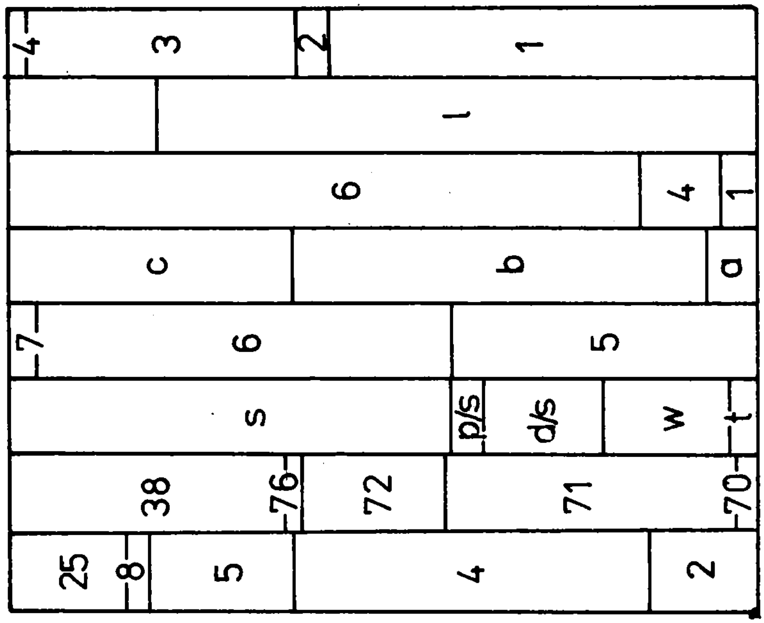
The analysis of diagrams (Fig. 3) indicates a high differentiation of the geographic environment components among photomorphic units and their relatively high homogeneity within particular classes. Differentiating factors are: sculpture, and especially gradients and altitudes, as well as land and water use. Geological structure and soil structure do not differ significantly among the units obtained. This, therefore, proves that the photomorphic units distinguished are of landscape nature. In order to more completely demonstrate this conclusion the division of this part of Poland thereby obtained was compared with landscape types determined by M. Baumgart-Kotarba (1978). This publication distinguishes 6 types of areas: Beskid type, valley bottom type, low plateau type and 3 other foothills types: A, B and C. The three plateau types proposed have numerous common features and importantly overlap in many areas thereby forming a mixed type, which leads to eventual conclusion as to introduction of one, differentiated plateau type. Comparison of these types with the photomorphic units obtained indicates that convergence of boundaries and surface magnitudes is very high. Coefficients of frequency and occurrence of connection (A. Richling 1982), calculated for every element of geographic environment and for every photomorphic unit, permitted a statistical study into relations between chosen geocomplex components and satellite images. The analysis of these coefficients confirms the previously formulated conclusion that differentiation of the pattern of the satellite

Geographic characteristics of photomorphic units (frequency indicator)

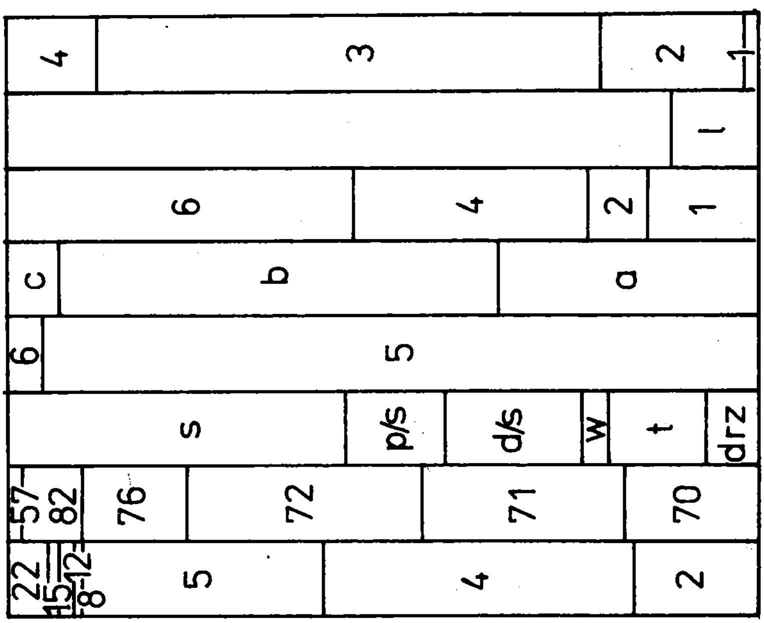
Table 1

| Aspect \ Unit | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| Geological structure | Rocky, of flysch type, 72% | Rocky, of flysch type, 66%<br>Rocky, sedimentary diagenised, 25%<br>Landslides, 5% | Rocky, of flysch type, 81%<br>Sandy-silt, 13%<br>Landslides, 2% | Rocky, of flysch type, 76%<br>Sandy alluvial warp, 11% | Rocky, of flysch type, 61%<br>Sandy alluvial warp, 11%<br>Landslides, 2% | Rocky, of flysch type, 80% |
| Soils | Brown and podzol made out of flysch, 60% | Skeletal, 15%<br>Silt, 10%<br>Brown and podzolic out of flysch, 60% | Skeletal, 15%<br>Silt, 10%<br>Brown and podzolic out of flysch, 74% | Silt, 9%<br>Brown and podzolic out of flysch, 82% | Silt, 13%<br>Brown and podzolic out of flysch, 52% and out of sedimentary clastic rocks, 33% | Skeletal, 7%<br>Brown and podzolic out of flysch, 87% |
| Landscape | All forms present<br>River valleys, 7% | Hilltops, 17%<br>Slopes, 60% | River valleys 19%<br>Slopes cut with valleys, 24%<br>Slopes, 43% | Terrace, 25%<br>Slopes cut with valleys, 21% | Terrace, 25%<br>Slope bases, 24% | Slopes, 53% |
| Absolute altitudes in mts above the sea level | 300—500, 94% | 300—500, 41%<br>500—700, 56%<br>700—1000, 3% | 300—500, 81%<br>500—700, 16% | 300—500, 94% | 300—500, 100% | 300—500, 69%<br>500—700, 28%<br>700—1000, 3% |
| Slope's inclination, in degrees | 5—10°, 58%<br>below 5°, 35% | 5—10°, 55%<br>10—20°, 38% | below 5°, 15%<br>5—10°, 60%<br>10—20°, 19% | below 5°, 26%<br>5—10°, 66% | below 5°, 51%<br>5—10°, 49% | 5—10°, 67%<br>10—20°, 25% |
| Forest cover | | Forests, 79% | Forests, 31% | | | Forests, 43% |

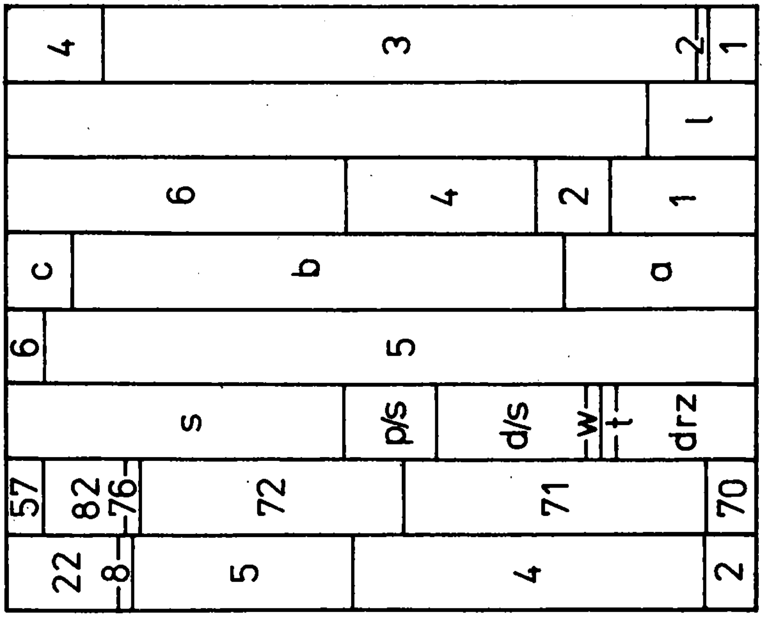
Photomorphic unit II



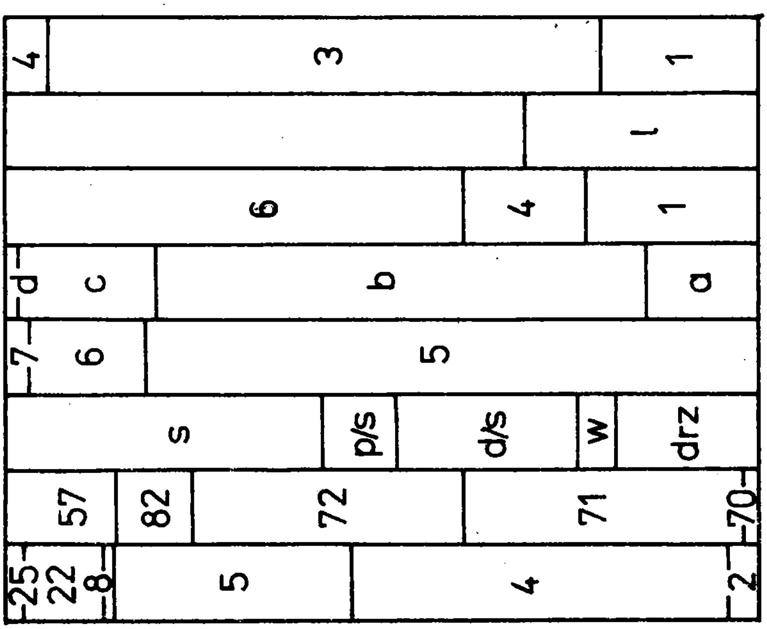

Photomorphic unit I



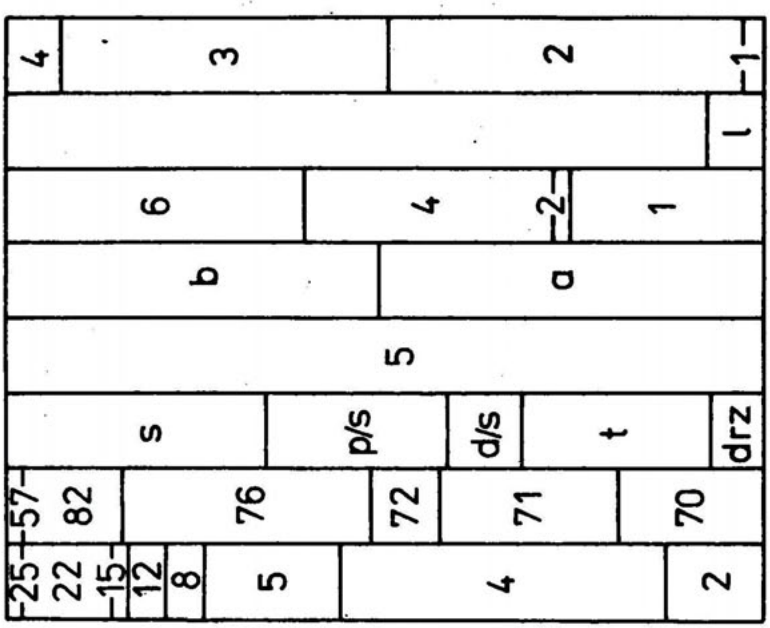
Photomorphic unit IV




Photomorphic unit III



Photomorphic unit V




Photomorphic unit VI

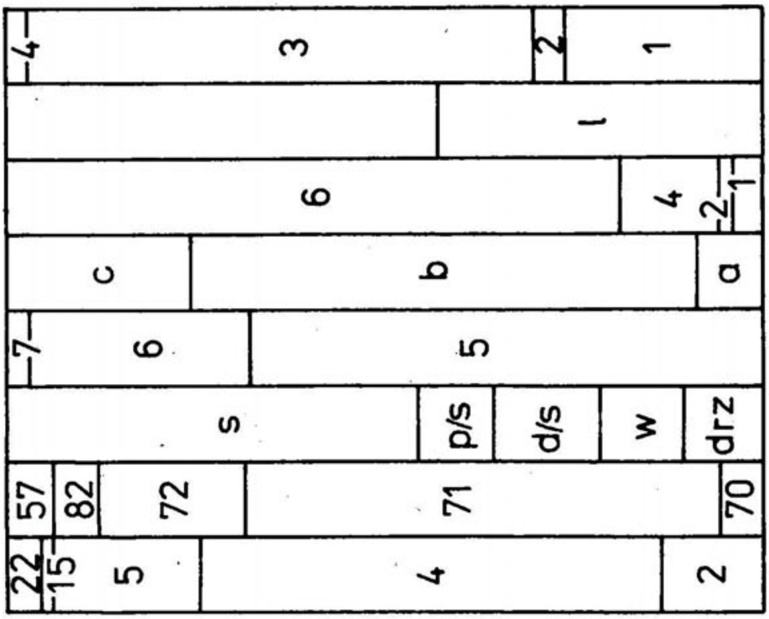


Fig. 3. (a, b, c, d, e, f). Share of particular components of geographical environment in the particular photomorphic units (in percent)

a: unit I; b: unit II; c: unit III; d: unit IV; e: unit V; f: unit VI

Geology: 2 — mountainous area of rocky sedimentary homogeneous grounds, strongly diagenised; 4 — area of rocky grounds of flysch type with domination of sandstones; 5 — rocky grounds of flysch type with domination of slate; 8 — rocky shale grounds; 12 — sand and gravel grounds of upper terraces; 15 — loamy and dusty grounds on high gravel mounds; 22 — sandy and silty grounds of lower terraces; 25 — area of slope downflows (landslides)

Soils: 70 — dusty soils
71 — clayey loamy soils } soils made out of sedimentary flysch rocks
76 — dusty soils made out of sedimentary, non-cemented elastic rocks
82 — light, medium and heavy alluvial warp soils
57 — skeletal soils

Landscape forms: drz — river valleys; t — flooded terrace; w — hilltops; d/s — valleys on the slopes; p/s — slope bases; s — slopes

Absolute altitudes: 5 — 300—500 mts above the sea level; 6 — 500—700 mts; 7 — 700—1000 mts

Slope's inclination: a — below 5°; b — 5—10°; c — 10—20°; d — 20—30°

Waters (first level of groundwater): 1 — 0—2 mts; 2 — 2—5 mts; 4 — 5—10 mts; 6 — below 10 mts

Landscape types according to M. Baumgart-Kotarba (1978): 1 — Beskid type; 2 — low foothills type; 3 — foothills type; 4 — valley bottoms type

image corresponds to differentiation of landscape and the photomorphic units distinguished are ranking as landscape types. Thus an attempt at their typology was undertaken (see Table 2).

It is striking that the valley bottom type does not appear in this classiffication in a unique and distinct way, and that, according to this particular study, this type is located in the same units as the plateau type. In order to avoid that, in future analyses, one of the spectral images made in close infrared should be added to usual colour composition, since it is this image that shows surface waters and areas with higher humidity by assigning them very dark phototone and amorphic pattern of the image.

The analysis of the coefficients of frequency and occurrence of this connection made it possible to determine geographic pattern of the obtained and delineated photomorphic units. Calculation of the connection degree, on the other hand, determines how strongly the particular classes are related to geographical components. For this purpose, use was made of the multidimensional connection indicator of K. Pearson and A. Chuprov (see, e.g. T. D. Alexandrova 1979) (Table 3). Values of this multidimensional indicator range from 0 to 1. T. D. Alexandrova, on the basis of experiences

Table 2

Typology of photomorphic units

| Unit number | Photointerpretative features: | | | Type of area |
|---|---|---|---|---|
| | Pattern | Texture | Colour | |
| I | Fine-grained | Dispersed | Light red | Foothills B Valley bottom |
| II | Amorphic | Spotty | Brown | Beskid |
| III | Fine-grained | Spotty | Dark-red | Foothills C |
| IV | Fine-grained | Dispersed | Dark-red | Transitory Foothills and valley bottoms |
| V | Fine-grained | Dispersed | Blue | Low Foothills C |
| VI | Fine-grained | Dispersed | Brown | Transitory Foothills |

Table 3

Values of the multidimensional relation indicator for dependences between the photomorphic units and the chosen components of geographical environment

| Elements of geographical environment | Values of the indicator |
|---|---|
| Geological structure | 0.34 |
| Soils | 0.54 |
| Sculpture: | |
| landcsape shapes | 0.42 |
| absolute altitudes | 0.50 |
| Slope's inclination | 0.41 |
| Water | 0.36 |
| Landscape types | 0.56 |

gained, states that values of the connection indicator are as a rule lower by 0.1—0.3 than the corresponding values of the correlation coefficient. That is why already at the values of the indicator reaching 0.4—0.5 a strict relation between the features analysed can be concluded. The work reported demonstrates that such a close relation appears between the photomorphic units and all the elements of geographic environment excluding geology (indicator value 0.34) and groundwater level (0.36); the latter, as already mentioned, should rather be studied via the infrared imagery. It is significant that the strongest connection exists between the photomorphic classes and landscape types. Images of the Earth's surface, made from a certain altitude and registering not only all elements on the surface, but also relations existing among them, are therefore in a way comprehensive "maps" of the areas considered. Pattern, texture and phototone of an image make it possible to distinguish photomorphic units, which, as was demonstrated, are closely related to typological units, with the level of a unit distinguished depending on the scale of the initial teledetection material.

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