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COMPLEX PHYSICO-GEOGRAPHICAL RESEARCH IN CZECHOSLOVAKIA: ITS PRINCIPLES, PROBLEMS AND PRACTICAL UTILIZATION

In the past Czechoslovak geography dealt above all with the study of the individual components of the natural environment. Attempts at comprehensive evaluation of the natural environment and the delimitation of natural landscapes were very rare in Czechoslovakia and not detailed enough (e. g. F. Kolářek, 1924, 1934, J. Král, 1930). This fact reflects itself even in the new Atlas of the Czechoslovak Socialist Republic (1966) where the very complex physico-geographical maps are missing. But in recent years the necessity of comprehensive study of the natural environment of Czechoslovakia became evident from the point of view, both of the development of the theory of geography as a science and of the needs of practice. That is why Czechoslovak geographers approached the comprehensive study and delimitation of the types of natural landscapes in Czechoslovakia in 1965. In this paper I am going to give concise information about the principles, problems and practical utilization of the results of that research.

I.

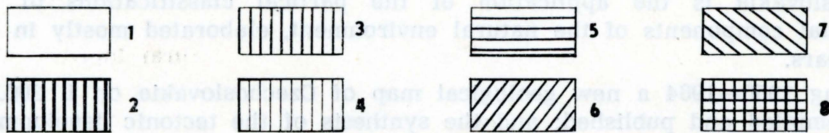
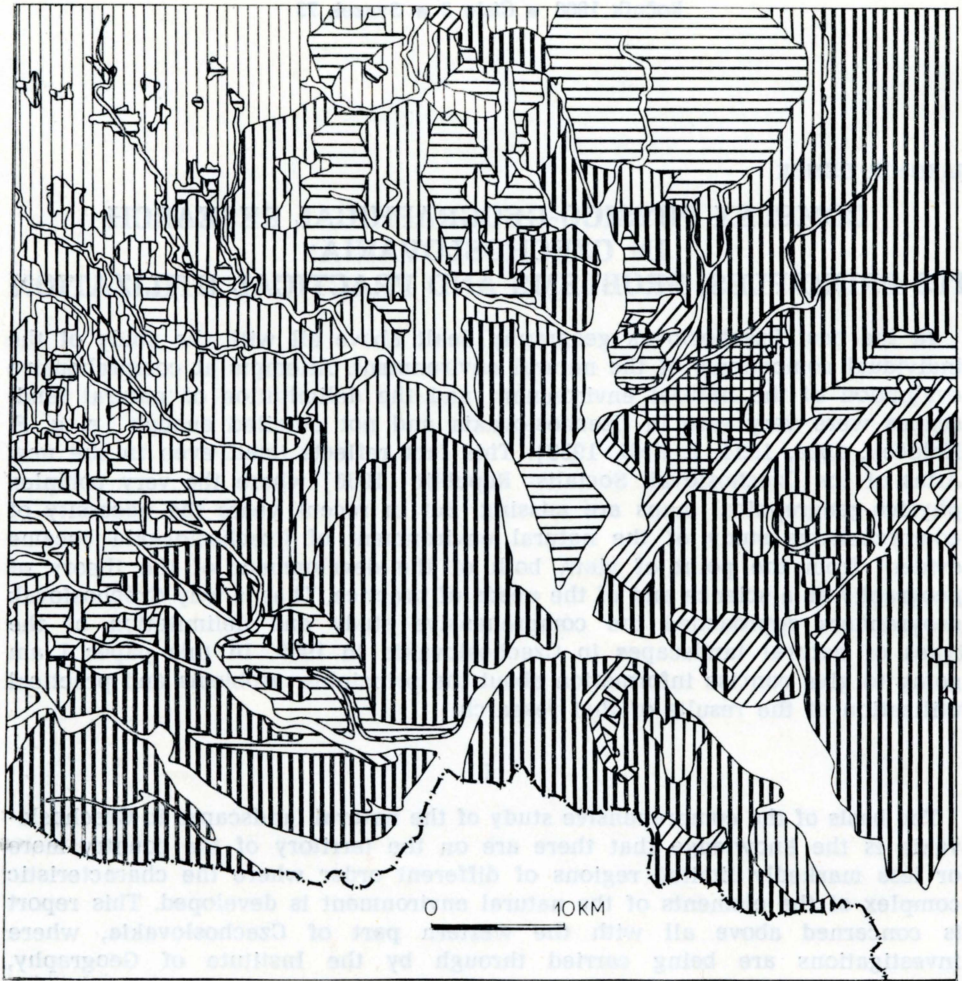
The basis of the comprehensive study of the natural landscapes in Czechoslovakia is the knowledge that there are on the territory of the country more or less markedly limited regions of different order where the characteristic complex of the elements of the natural environment is developed. This report is concerned above all with the western part of Czechoslovakia, where investigations are being carried through by the Institute of Geography, Czechoslovak Academy of Sciences, in Brno.

The basis for the definition and delimitation of the natural landscapes of Czechoslovakia is the application of the partial classifications of the individual components of the natural environment, elaborated mostly in the past years.

During 1950—1964 a new geological map of Czechoslovakia on 1:200.000 was compiled and published; and the synthesis of the tectonic development of the territory of the country (Tectonic Development of Czechoslovakia, 1960) was carried out.

The team of geomorphologists of the Institute of Geography, Czechoslovak Academy of Sciences, Brno, compiled the "General Geomorphological Map of the Western Part of Czechoslovakia" on the scale of 1:500.000 (J. Demek et al., 1965), in which the relief types were delimited for the first time on

this scale. By the relief type the authors of the map understand a more or less distinctly bordered territory displaying the same surface forms, the same



1. Example of the map of soil types of the central part of Czechoslovakia. Reduced from the original on 1:200,000 compiled by D. Sekaninová [1967].

Explanations: 1. Gley and semi-gley alluvial soils; 2. chernozems true and degraded; 3. lowland burozems predominantly on loess; 4. brown forest soils; 5. podzols of uplands and lowlands; 6. true and degraded humus-carbonate soils; 7. true and degraded rendzins; 8. saline and salt soils.

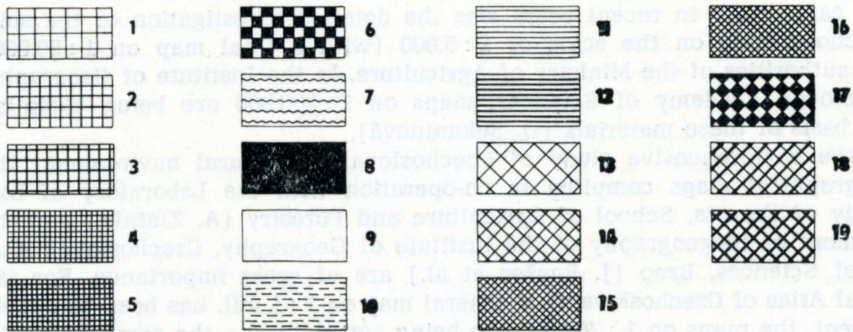
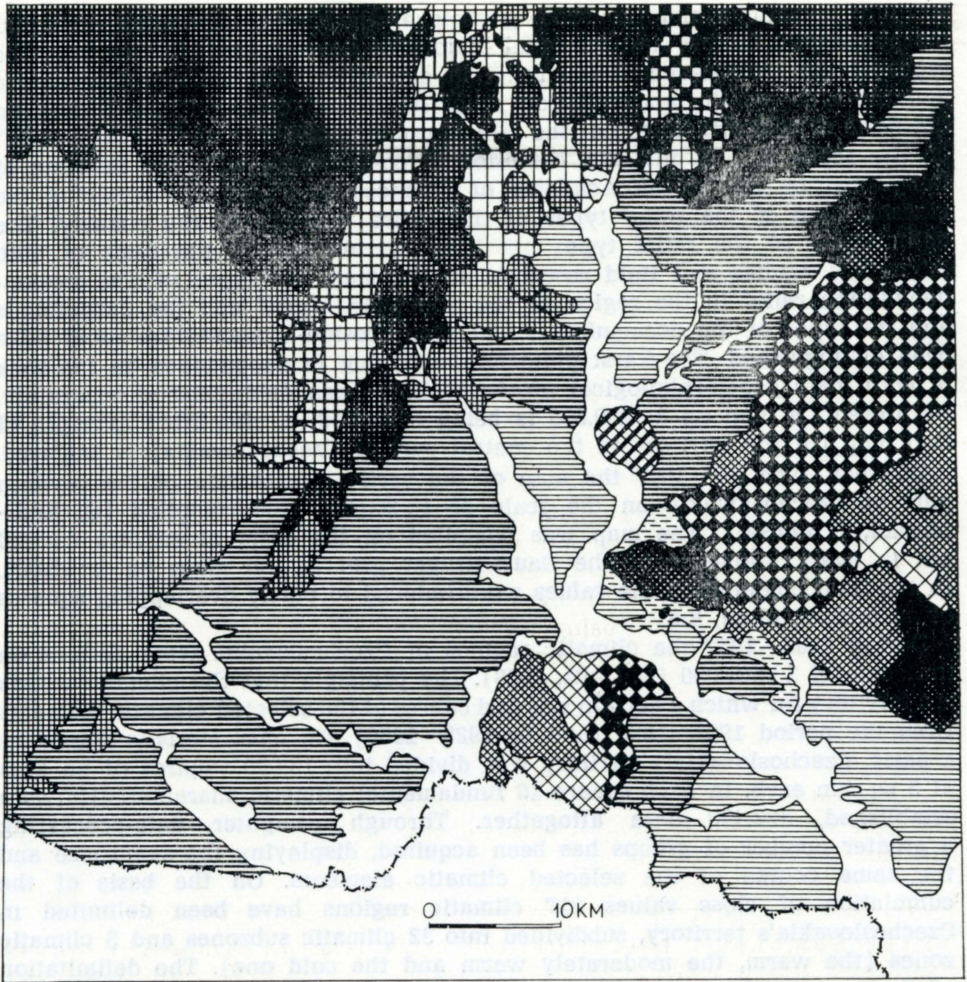
absolute elevations and the same genesis of the relief, depending on equal morphogenetic factors and on equal history of development. In the map, the types of the erosion-denudation relief in dependence on the morphostructure and the types of the accumulation relief have been distinguished. It was on the basis of this principle that the "Geomorphological Map of Czechoslovakia" on the scale of 1:1 mil. was compiled in co-operation with the Institute of Geography of the Slovak Academy of Sciences in Bratislava, involving the classification of the relief types of the entire territory of the country. The delimitation of the relief types has been carried out on the basis of both laboratory studies and field research. In the map, the types of the erosion-denudation relief in the region of the Bohemian Massif and the Carpathians and the types of the accumulation and even erosion-accumulation relief have been distinguished. The karst plateaus developing in dependence on the rock in both main geomorphological provinces have been distinguished separately. At present, a map on 1:200.000 is being compiled. A simplified example of that map (of the territory in the central part of Czechoslovakia) is enclosed.

Between 1965 and 1967 the map of the vertical dissection of the western part of Czechoslovakia on the scale of 1:200.000 was compiled (O. Kudrnovská, J. Kousal). The map was compiled on the basis of surveys carried out in every kilometre of the Gauss-Krüger grid in the maps on 1:25.000. In the final compilation the values were reduced to partly overlapping squares of an area of 16 sq. km.

During 1966—1967 the climatic regions of Czechoslovakia were defined on the scale of 1:500.000 (E. Quitt, 1968). The principle that the climatic region is a territory for which a certain size and course of the selected climatic elements from the period 1901—1950 (and or 1923—1950) are characteristic served as a basis. Czechoslovakia's territory was divided into 16.000 squares of an area of 9 sq. km each. In each square 16 fundamental climatic characteristics were established, 122.400 data altogether. Through computer data-processing a greater number of groups has been acquired, displaying the same size and the same course of the selected climatic elements. On the basis of the cumulation of close values 217 climatic regions have been delimited in Czechoslovakia's territory, subdivided into 32 climatic subzones and 3 climatic zones (the warm, the moderately warm and the cold one). The delimitation of the zones and subzones in the map on 1:500.000 is exact enough for the definition of the physico-geographical regions on the scale of 1:200.000.

Also carried out in recent years was the detailed investigation of the soils in Czechoslovakia on the scale of 1:5.000 (with a final map on 1:50.000) by the authorities of the Ministry of Agriculture. In the Institute of Geography, Czechoslovak Academy of Sciences, maps on 1:200.000 are being compiled on the basis of these materials (D. Sekaninová).

For the comprehensive study of Czechoslovakia's natural environment the biogeographical maps compiled in co-operation with the Laboratory of Biocenology of Forests, School of Agriculture and Forestry (A. Zlatník) and the Department of Biogeography of the Institute of Geography, Czechoslovak Academy of Sciences, Brno (J. Raušer et al.) are of great importance. For the National Atlas of Czechoslovakia a general map on 1:1 mil. has been compiled. At present, the maps on 1:200.000 are being completed on the same principle. The fundamental units of these maps are the biogeocenoses in Sukachev's conception (ecosystems — A. G. Tansky), i. e. complex of organisms (plants



2. Example of the map of relief types of the central part of Czechoslovakia. Reduced from the original on 1:200,000 compiled by T. C z u d e k and J. D e m e k (1967).

and animals) and their environment. In Czechoslovakia's territory two large biogeographic provinces have been distinguished, the Bohemian Highlands and the Carpathians. Within the scope of those provinces nine biogeographical tiers have been defined, called after the typical timber species (1 oak tier, 2 beech-oak tier, 3 oak-beech tier, 4a beech tier, 4b beech-coniferous tier, 5 fir-beech tier, 6 spruce-beech-fir tier, 7 spruce tier, 8 dwarf-pine tier, 9 alpine tier). The tiers have been divided, in dependence on soil properties, into four rows (acidophilous, normal, with good humification, alkaline) with characteristic biogeocenoses. The biogeocenoses have been reconstructed according to the stage before the interference of Man (i. e. perhaps in the Subatlantic Period), when about 90 % of the territory of the country was covered with forests. The biogeographical maps representing whole communities in their dependence on the conditions of the environment differ by their geographical conception from vegetation-sociological maps (e. g. geobotanical ones), based on differently conceived phytocenological systems. A simplified example of this map of the territory in the central part of Czechoslovakia is enclosed.

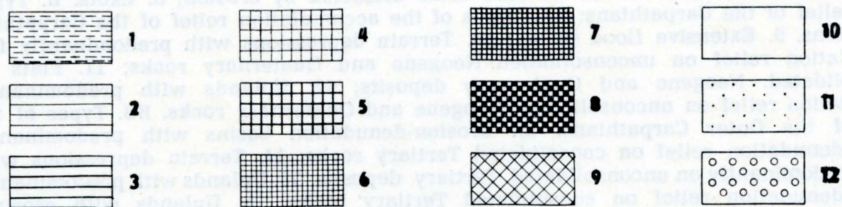
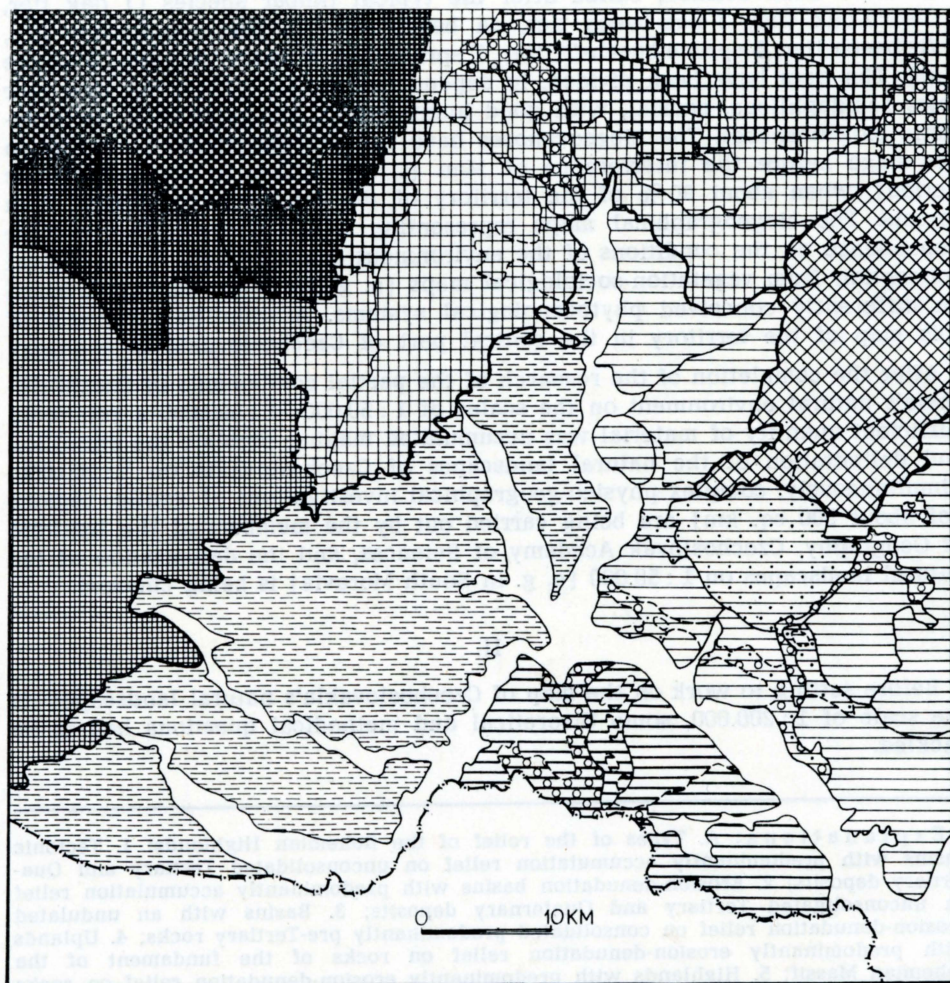
After the completion of the research of the partial components of Czechoslovakia's natural environment on the scales of 1 : 50.000—1 : 500.000 a relatively sufficient quantity of material was accumulated making possible the definition and delimitation of the natural landscapes of Czechoslovakia on 1 : 200.000. Simultaneously, complex physico-geographical investigations of smaller regions (of about 500 sq. km) are being carried out by the members of the Institute of Geography, Czechoslovak Academy of Sciences, and the delimitation of the natural landscapes on 1 : 50.000 (e. g. in South Moravia) is being checked.

II.

Before setting to work on the map of Czechoslovakia's natural landscapes on the scale of 1 : 200.000, some theoretical and methodical questions had to be tackled.

Explanations: A. Types of the relief of the Bohemian Highlands: 1. Tectonic basins with predominantly accumulation relief on unconsolidated Tertiary and Quaternary deposits; 2. Erosion-denudation basins with predominantly accumulation relief on unconsolidated Tertiary and Quaternary deposits; 3. Basins with an undulated erosion-denudation relief on consolidated predominantly pre-Tertiary rocks; 4. Uplands with predominantly erosion-denudation relief on rocks of the fundament of the Bohemian Massif; 5. Highlands with predominantly erosion-denudation relief on rocks of the fundament of the Bohemian Massif; 6. Highlands with predominantly erosion-denudation relief on rocks of the fundament of the Bohemian Massif with karst phenomena; 7. Dissected relief of the tectonic dome dissected by erosion; 8. Exots. B. Types of the relief of the Carpathians: BA. Types of the accumulation relief of the Carpathian Depressions. 9. Extensive flood plains; 10. Terrain depressions with predominantly flat accumulation relief on unconsolidated Neogene and Quaternary rocks; 11. Flats on unconsolidated Neogene and Quaternary deposits; 12. Uplands with predominantly accumulation relief on unconsolidated Neogene and Quaternary rocks. BB. Types of the relief of the Outer Carpathians. 13. Erosion-denudation basins with predominantly erosion-denudation relief on consolidated Tertiary rocks; 14. Terrain depressions with relief predominantly on unconsolidated Tertiary deposits; 15. Uplands with predominantly erosion-denudation relief on consolidated Tertiary rocks; 16. Uplands with erosion-accumulation relief on predominantly unconsolidated Tertiary rocks; 17. Highlands with erosion-denudation relief on consolidated Tertiary rocks; 18. Exots on unconsolidated Tertiary rocks. 19. Exots on Mesozoic limestones with karst phenomena.

First there was the problem of which elements of the physico-geographical environment should be taken into consideration in the definition and delimitation of the natural landscapes. The optimum number of considered



3. Example of map of biogeographical regions of the central part of Czechoslovakia. Reduced from the original on 1:200.000 compiled by J. Raušer (1966).

elements had to be established with respect 1. to the comprehensive evaluation and 2. to the avoidance of developing a too detailed mosaic of landscape types. In the detailed studies on the scale of 1 : 25.000 carried out in South Moravia, the following factors were taken into consideration:

1. the morphography and morphometry of the territory (vertical dissection, shape of the territory, i. e. flood plain, upland, etc.);
2. the morphostructure (appurtenance to structural-geological units, lithological composition);
3. geomorphology (genesis of the relief of the territory; relief type);
4. climate — macroclimate and mesoclimate;
5. hydrography — mainly shallow ground waters, inundated regions;
6. soils — especially soil types;
7. biogeography — primary and secondary biogeocenoses;

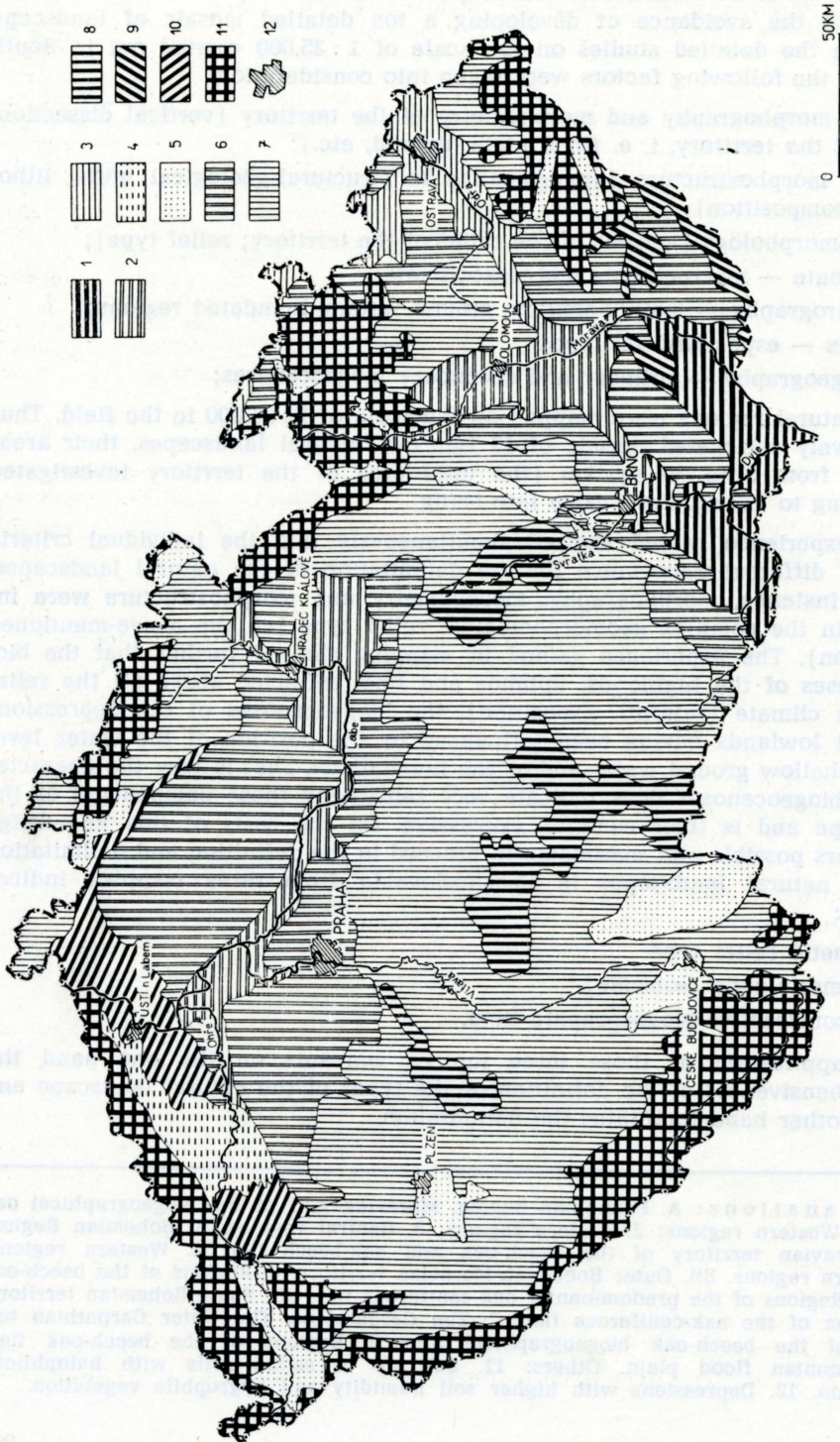
The natural regions were mapped on the scale of 1 : 25.000 in the field. Thus a relatively variegated mosaic of 16 types of natural landscapes, their areas ranging from 3 to 70 sq. km (the total area of the territory investigated amounting to 427 sq. km), came into being.

The experience gained showed simultaneously that the individual criteria were of different importance for the delimitation of the natural landscapes. So for instance, morphography, morphometry and morphostructure were included in the complex geomorphological relief type (cf. the above-mentioned definition). The experience gained in mapping showed further that the biogeocenoses of the highlands, uplands and flats reflected above all the relief and the climate (rainfall, exposition), the biogeocenoses of the depressions and flat lowlands having been influenced by the position of the water level of the shallow ground water and/or the inundations. That is why the character of the biogeocenoses does indicate very sensitively those components of the landscape and is their complex expression. On the basis of this knowledge it appears possible and reasonable to proceed in the definition and delimitation of the natural landscapes in Czechoslovakia from three complex indices such as:

1. genetic relief type
2. climatic zone (subzone)
3. reconstructive biogeographic tiers.

The application of those three indices warrants on the one hand the comprehensiveness of the definition of the types of the natural landscape and on the other hand facilitates the delimitation.

K Explanations: A. Pannonian Region. Moravian golf of the biogeographical oak tier: 1. Western regions; 2. Eastern regions; 3. Central regions. B. Bohemian Region: BA. Moravian territory of the beech-oak and oak-beech tier. 4. Western regions; 5. Eastern regions. BB. Outer Bohemian-Moravian territory. 6. Regions of the beech-oak tier; 7. Regions of the predominantly oak-coniferous tier. BC. South-Bohemian territory. 8. Region of the oak-coniferous tier. C. The Carpathians. The Outer Carpathian territory of the beech-oak biogeographical tier: 9. Regions of the beech-oak tier; 10. Pannonian flood plain. Others: 11. Salt up to saline soils with halophilous vegetation. 12. Depressions with higher soil humidity and hygrophile vegetation.



4. Schematic map of natural landscapes in the western part of Czechoslovakia. Compiled by J. Demek with collaboration of E. Quitt (climate) and J. Raušer (biogeography).

Explanations: 1. Warm lowlands of the Carpathians in the oak biogeographical tier; 2. Warm lowlands of the Bohemian Highlands and the Carpathians in the predominantly oak-beech biogeographical tier; 3. Moderately warm lowlands of the Bohemian Highlands and the Carpathians in the oak-beech and even oak-coniferous biogeographical tiers; 4. Warm basins of the Bohemian Highlands in the predominantly beech-oak biogeographical tiers; 5. Moderately warm furrows and basins of the Bohemian Highlands and the Carpathians in the predominantly beech-oak and even fir-beech biogeographical tiers; 6. Moderately warm uplands and even highlands of the Bohemian Highlands and the Carpathians in the predominantly beech-oak and even oak-beech biogeographical tiers; 7. Moderately warm and even cold uplands up to highlands of the Bohemian Highlands and the Carpathian in the predominantly oak-coniferous and even fir-beech biogeographical tiers; 8. Cold dissected highlands of the Bohemian Highlands in the predominantly fir-beech biogeographical tier; 9. Moderately warm mountain ranges of the Carpathians in the oak-beech and even beech biogeographical tiers; 10. Moderately warm up to cold mountain ranges of the Bohemian Highlands (predominantly of volcanic origin) in the beech and even oak-coniferous biogeographical tiers; 11. Cold mountain ranges of the Bohemian Highlands and the Carpathians in the fir-beech and even spruce biogeographical tiers; 12. Larger towns.

The second question concerns the leading factor in the definition and delimitation of the natural landscape. Czechoslovakia is a relatively dissected country in the physico-geographical conditions of which the vertical zonality manifests itself above all. That is why we maintain that the first leading factor in the definition of the landscape should be the modelling of the relief, especially the morphographic and morphometric appearance of the relief (lowland, upland, highland, mountains, high-mountains). This character of the relief defines even the other elements (the climate, the soils, the biogeocenoses) in connection with the altitude above sea level and the relative dissection of the relief. Only in places where the relief rises slowly without more distinct geomorphological borders (plateaus of the Bohemian Highlands) two other factors become decisive, especially the biogeographical tier. We consider this process justified also for the reason that the observer sees first the forms of the relief and then the vegetation cover completing the character of the landscape.

The third problem is that of the borders. The geomorphological borders are usually marked (for instance fault or structural scarps, river valleys, etc.) and they can be defined in the map with a relatively sufficient accuracy. But even these borders have sometimes the shape of a narrow strip (zone), being some tens of metres wide. Of somewhat other character are the climatic and biogeographic borders. Especially the climatic borders are usually established by interpolation on the basis of the relatively thin network of the stations with respect to the relief, etc. That is why the accuracy of those borders can vary even within some kilometres. The border of the reconstructive biogeographical tiers too is being established on the basis of interpolation between the preserved remnants. Czechoslovakia, in its prevailing part, is a territory settled for a long time and the borders of the original biogeocenoses were considerably wiped of by the interference of Man. Hence, even the accuracy of the border can vary. It is evident that especially on accumulation flats in the lowlands or on the plateaus of the Bohemian Highlands one border can be composed of sections of various types (e. g. partly according to geomorphological criteria and partly according to biogeographical ones). Practical experience with the delimitation on natural land-

scapes in the western part of Czechoslovakia has finally shown considerable conformity between the relief types and the biogeographical tiers.

The fourth question concerns the method used in defining and delimiting the natural landscapes. In our case we have chosen a two-mode process. In the first phase the maps of the three above-mentioned complex indices (relief types, climatic zones (subzones) and biogeographical tiers) are successively placed one on the other. In this way the overlaps and differences can be established. The "cores" of the natural landscapes are being delimited where there is the highest homogeneity of all elements and where the dynamic relations between the components of the landscape defining its character are developed most typically. But in many cases the conformity is so evident that the natural landscapes and their borders can be delimited even on the basis of this method. The method mentioned is sometimes rejected (e. g. A. G. Isachenko, 1965, p. 296). But our experience has shown that the application of that method permits the objective idea of the distribution of the "cores" of the natural landscapes and the acceleration of the process of their delimitation. In the second phase the characteristics of the natural landscapes and their borders are established and defined with more precision in laboratories by means of partial maps, aerial photos or directly by field mapping.

III.

On the basis of the above-mentioned principles the delimitation of the types of the natural landscapes in the Western part of Czechoslovakia was approached (cf. the maps enclosed).

The differences in the physico-geographical environment led first to the distinction of two large provinces in Czechoslovakia's territory. In the west, it is the old Hercynian complex mountain range (the Bohemian Highlands) and in the east the Tertiary overthrust mountain range (the Carpathians). Within the scope of both the provinces, landscape systems were distinguished above all on the basis of geomorphological criteria (the relief types). They are e. g. systems of lowlands, basins, uplands, highlands, mountains, etc. The systems are then subdivided on the basis of climatic and biogeographical criteria. The areas of the natural landscapes have been defined in the basic map of 1:200,000. In the legend the natural landscapes have been characterized verbally, e. g. the dissected upland of the Bohemian Highlands with prevailing erosion-denudation forms of the moderately warm climatic zone (subzone 7) in the fir-beech biogeographical tier. As can be seen from the enclosed schematic map, the types of the natural landscape recur in various parts of the country in dependence on equal combinations of the individual physico-geographical factors. The area of the individual landscapes is changeable. In the map on 1:200,000 the size of the individual natural landscapes ranges from several sq. km up to some tens of sq. km.

On the basis of the map of natural landscapes a map of physico-geographical regions has been compiled. The physico-geographical region corresponds to the natural landscape in the typological division. But in higher units regions attached to each other spatially are put (joined) together into subsystems and systems. The physico-geographical regions occur therefore in the territory of Czechoslovakia but once and have local names (e. g. Odra Highland, Basin of Plumlov, etc.).

IV.

Czechoslovakia is a country where the original natural conditions were considerably influenced and modified due to the long-lasting settlement and economic activities of Man. Especially the original biogeocenoses were modified into secondary biogeocenoses in the largest part of the territory of the State. The changes evoked by Man are in many cases at variance with the action of natural factors. In some regions this development regressively influences unfavourably the economic activities of Man (e. g. accelerated soil erosion). The reconstruction of the types of natural landscapes and their delimitation in the map on 1:200,000 together with the definition of the complex of processes acting in them is therefore of considerable practical significance.

Modern agriculture on large areas of unified fields requires an all-round analysis of the natural factors of the area in question. For instance, the oak biogeographical tier is a suitable area for the cultivation of thermophile plants (vine, tobacco) and the main production area of maize (J. Raušer, 1967, p. 227). But the areas most suitable for maize growing are the accumulation flats and flat uplands of the oak tier often covered with loess and with characteristic mesoclimatic conditions.

The scale of mapping 1:200,000 is advantageous for practice due to the possibility of representation, on the one hand, of a relatively great number of details, and on the other hand being synoptical enough even when used in regional planning. In the densely settled territory of Central Europe an important problem is the arrangement of the landscape in such a way that it is both aesthetic and capable to the greatest extent of meeting the economic demands of the society. For this "architecture of the landscape" the maps supply a lot of material. They can also serve as basis in the prognosis of the development of the landscape.

The maps are also of considerable importance for use in schools and education. One especially important aspect is the education to landscape conservation.

Nevertheless, practice will certainly influence the further development of comprehensive physico-geographical research as well as the mapping of natural landscapes and the delimitation of physico-geographical regions in Czechoslovakia.

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R é s u m é

KOMPLEXNÍ FYZICKOGEOGRAFICKÝ VÝZKUM V ČESKOSLOVENSKU: PRINCIPY, PROBLÉMY A PRAKTICKÉ VYUŽITÍ

V článku určeném především pro informaci zahraničních geografů se autor zabývá současnými problémy komplexního fyzickogeografického výzkumu naší republiky, zejména ve vztahu k výzkumům v západní části ČSSR, prováděným Geografickým ústavem ČSAV v Brně. V minulosti byla komplexnímu výzkumu přírodních podmínek u nás věnována poměrně malá pozornost. Odráží se to např. i v novém Atlasu ČSSR, kde chybějí právě komplexní fyzickogeografické mapy.

Práce je rozdělena na čtyři části. První část obsahuje údaje o hodnocení jednotlivých složek fyzickogeografického prostředí v ČSSR a jejich komplexů. Základem výzkumu je poznatek, že na státním území objektivně existují více nebo méně výrazně ohraničené oblasti různého řádu, v kterých je vyvinut svérázný komplex prvků fyzickogeografického prostředí. Podkladem pro definování těchto fyzickogeografických komplexů a vymezení jejich plošného rozšíření v Československu je využití dílčích klasifikací jednotlivých složek přírodního prostředí, jež byly převážně zpracovány v posledních letech. Jsou to:

1. Geologické mapy Československa 1 : 200 000 a syntéza tektonického vývoje státního území (Tectonic Development of Czechoslovakia, 1960).
2. Přehledná geomorfologická mapa západní části ČSSR 1 : 500 000 (J. Demek et al., 1965) a Geomorfologická mapa ČSSR 1 : 1 mil. v Atlasu ČSSR (1966).
3. Mapa výškové členitosti západní části ČSSR 1 : 200 000 (O. Kudrnovská, J. Kousal, 1967).
4. Mapa klimatických regionů západní části ČSSR 1 : 500 000 (E. Quitt, 1968).
5. Půdní mapy ČSSR 1 : 50 000 zpracované orgány Ministerstva zemědělství.
6. Biogeografické mapy západní části ČSSR 1 : 200 000 zpracované pod vedením A. Zlatníka a J. Raušera s kolektivem spolupracovníků.

Zpracováním těchto map se nahromadilo poměrně značné množství analytického materiálu, který umožňuje stanovení fyzickogeografických komplexů a jejich prostorového vymezení na území ČSSR.

V druhé části se autor zabývá některými teoretickými problémy, jež bylo třeba řešit v souvislosti s vymežováním přírodních krajin na našem státním území. Byly to zejména tyto problémy:

1. problém optimálního počtu prvků, které je třeba brát v úvahu při vymežování přírodních krajin v měřítku 1 : 200 000; autor soudí, že je možné vycházet při definování a vymežování přírodních krajin ze tří komplexních ukazatelů, a to: a) genetického typu reliéfu, b) klimatické zóny (podzóny), c) rekonstrukčních biogeografických (vegetačních) stupňů; použití těchto tří ukazatelů zajišťuje jednak komplexnost definování typů přírodní krajiny a jednak usnadňuje jejich vymezení;

2. problém vedoucího činitele při definování a vymezení přírodních krajin; autor soudí, že vzhledem k přírodním poměrům Československa musí být prvním kritériem reliéf a teprve v druhé řadě klima a biogeografický stupeň;
3. problém hranic přírodních krajin; autor dochází k závěru, že největší přesnost mají hranice geomorfologické, menší biogeografické a nejmenší klimatické;
4. problém metodického postupu při definování a vymezení přírodních krajin; autor doporučuje dvoustupňový postup, a to nejprve vymezení „jader“ přírodních krajin překrýváním map výše uvedených tří komplexních ukazatelů a potom upřesnění hranic podle terénního výzkumu, leteckých snímků a map dílčích prvků.

Ve třetí části autor pojednává o konkrétních výsledcích dosavadních studií (srov. mapy v příloze).

Čtvrtá část je pak věnována praktickému významu komplexního studia přírodních podmínek ČSSR. Autor zdůvodňuje vhodnost zvoleného měřítko 1 : 200 000 jak pro teoretické výzkumy, tak i pro využití v praxi. Hlavní význam využití výzkumů v praxi spatřuje ve výzkumu vývoje a ochrany krajiny, zemědělství, rajónového plánování a tvorbě životního prostředí v Československu. Soudí, že výsledky výzkumů budou využity i v kulturním životě, zejména ve školství.