

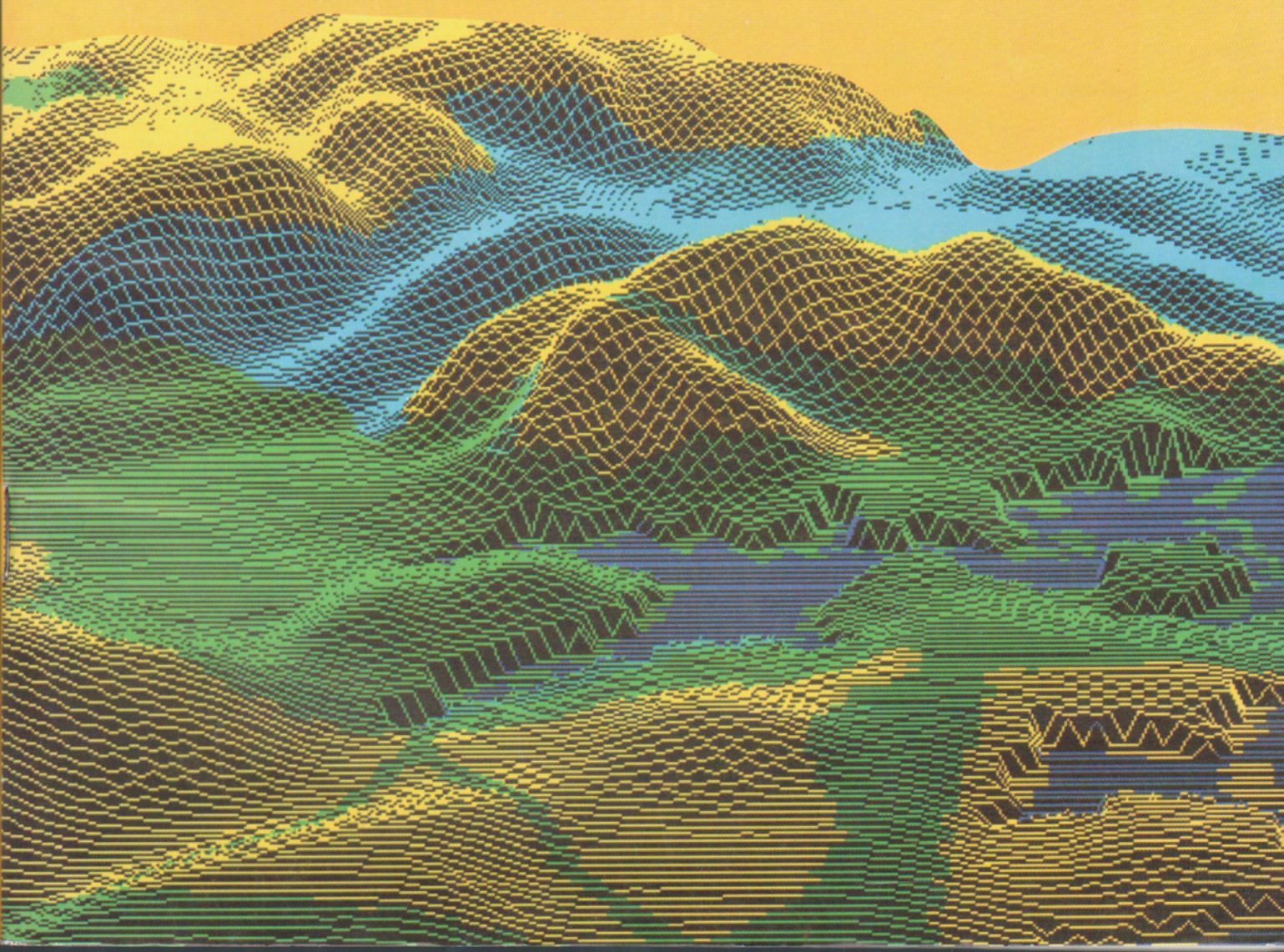
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UTILIZING THE SPOT SATELLITE DATA TO SET UP A LAND USE MAP

Vítězslav NOVÁČEK

Abstract

Land use map is one of many possibilities to make use of data provided by the SPOT satellite in order to indicate spatial distribution of individual landscape elements and components. Resulting physiognomy of the area under study is defined by natural framework as well as by spatial arrangement of products of human activities. Proper content of the land use map is a result of integrating documents and data of various origin and content (false colour composites made of SPOT satellite three spectral zones, aerial photographs, topographical maps of different scales, terrain surveys). A map which is set up in this way is of areal character with individual phenomena and functional areas being plotted in colours. The empirically found physiognomic elements of landscape use illustrate spatial structure of the landscape from environmental point of view.

Shrnutí

Využití údajů z družice SPOT pro sestavení mapy využití ploch

Mapa využití ploch ukazuje na možnosti využití obrazových dat z družice SPOT pro zjišťování prostorového rozmístění jednotlivých prvků a složek krajiny. Vedle přírodního (fyzickogeografického) pozadí je využití ploch hlavním fyziognomickým prvkem současné krajiny, přičemž výsledná fyziognomie sledovaného území je určována přírodním rámcem a prostorovým rozmístěním produktů lidské činnosti. Specifickým typům přírodní krajiny v podstatě odpovídá výběr, kombinace a prostorové rozmístění tvarově a velikostně diferencovaných areálů forem využití ploch. V průběhu historického vývoje se v zájmovém území vytvořily tři základní funkční typy, jenž jsou definovány prostorovou strukturou využití ploch: 1. technické formy, 2. zemědělské formy a 3. lesnické formy. Vlastní obsah mapy využití ploch je výsledkem integrace podkladů různého charakteru (nepravě barevná syntéza pořízená z údajů snímačů družice SPOT, letecké snímky, topografické a tematické mapy různých měřítek, osevní plány a přirozeně i vlastní terénní šetření). Tímto způsobem zkonstruovaná mapa využití ploch má areálový charakter, kde jednotlivé objekty a funkční areály jsou barevně znázorněny. Takto vyčleněné fyziognomické prvky využívání krajiny charakterizují prostorovou strukturu krajiny z environmentálního hlediska.

Key words: false colour composite, interpretation of satellite imagery, environment, land use mapping

1. Introduction

The term "land use" is normally used to express external manifestation of utilizing geographical environment for economic activities of human society. Actual forms and methods of the land use are usually a compromise between natural properties of the given area and technical potentials, knowledge and capabilities of the man in the specific historical epoch. The actual information on spatial arrangement of individual components of landscape cover are considerably important for the whole range of decision-making processes which are necessary for general transformation of economy in the Czech Republic. At these decision-making processes, necessity of preserving the landscape complexes has to be taken to account, whose organization is near to natural environment optimum status. If the threshold status has been exceeded, we speak of devastated areas whose original natural status can be restored only with difficulties.

Character of actual land use situation in the given region is best illustrated by data obtained from satellite carriers such as LANDSAT or SPOT, which are being processed and interpreted with consequent plotting into the map. On the basis of the hitherto experience and acquired knowledge it can be stated that the remote sensing methods are a.o. very efficient at monitoring and evaluation of lands, i.e. at studying and characterization of spatial distribution of individual landscape elements and components. Apart from the existing natural (physico-geographical) background the land use forms one of the major physiognomic elements of contemporary landscape. Thus, the land use map can provide unambiguous and irreplaceable information about fundamental functional differentiation of the area under study.

When resolving the issue of landscape spatial structure organization it is useful to start with definition of a scheme of its description which would facilitate classification of the landscape sphere into a hierarchic system.

This means that it would be useful to set up a classification scheme of several stages which would correspond to different distinguishing standard. At present, we can meet with a whole range of land use and land cover classification systems which are rather similar as to their typological units. A classification scheme which was worked out by the EU Committee for the project "CORINE-Land Cover" has been considerably spread lately.

Two basic interpretation methods can be used at monitoring and evaluation of land use by remote sensing, which depend on the character of the used image information. If there are image data at our disposal, which have been recorded on floppy disc carriers, it is useful to process the information by means of computer interpretation methods employing a corresponding software. However, if we only have the image information in the form of a photograph (false colour composite), we should rather prefer a visual-analogous method of interpretation.

2. Methods to process and set up the map

A major task at creating the thematic land use map consists in allocation of proper thematic content to actually existing areas, i.e. in defining the way of use for each individual area including its taxonomic classification. The given issue is well suited for very successful utilization of satellite data which are being processed into the form of false colour composites for visual interpretation. A properly set-up false colour composite makes it possible in the case of visual interpretation to assess the reality under study in a much more effective and complex way including a possibility of analyzing its spatial structure. This procedure is close to geographical approach to the landscape, representing a.o. a consistent method of how to use multispectral data. Proper implementation of the thematic land use map included imagery material which was obtained from the SPOT satellite on 2 May, 1990. Source data were acquired from the joint Czechoslovak-French remote sensing pilot project in two types: a false colour composite illustrated the area under study at the scale of 1:100 000 (see the colour twin sheet in the middle of the journal), visualized digital data at the original scale of 1:375 000 were at our disposal in all three SPOT satellite carrier spectral zones (channel 1: 500-590 nm, channel 2: 610-680 nm, channel 3: 790-890 nm). Positive copies were magnified to the scale of the resulting thematic map, i.e. 1:50 000 for each of the spectral intervals by means of a specific photographic procedure. Basic map of the Czech Republic, sheet 34-22 Hodonín (scale 1:50 000) was used as a basis. However, due to excessive generalization, this map put some limitations on optimum use of information gained from the given area, which had been obtained in the course of relatively detailed terrain surveys, study of archive materials and evaluation of additional aerial and cosmic materials.

Basis for the thematic land use map created in this way was plotting of information obtained through false colour composite into the cartographical fundamental document, the decisive guide at delineating the boundaries being changes in colours of individual areas as well as all line elements indicated in the false colour composite inclusive the recognizable river network and water area images. The detected areas of individual objects were further precised by visual interpretation of individual black-and-white photographs of relevant spectral zones, with visual interpretation of large-scale aerial photographs being used in some cases, too. The first stage of setting-up the thematic land use map did not include any further support information of non-distance origin. The areas thus illustrated realistic situation in land use, documenting planary structure of the landscape to the date of scanning. Comparison of the areas with the basic map revealed a whole range of imperfect data, particularly in the illustration of areas with forest covers. Discrepancies were also found in the plotting of residential units namely those of urban types, in the course of road network (newly built roads are not plotted at all) as well as in the course of riparian line of water areas and streams (e.g. very distinct changes in meander shapes of the River Dyje near Strážnice).

In addition to the above information for correction, precision and actualization of the map, the illustration of land use areas provides new information not included in common maps. This relates in particular to the possibility of defining limits for forest species composition types and classification of agricultural lands by existing methods of their cultivation. After definition and plotting of land use areas for individual species, which was to certain extent a very labourious and time-consuming stage of creating the map by means of the above method, the next step consisted in filling the network of areas with thematic information which would characterize actual use of the given area. This information was evaluated on the basis of visual interpretation of false colour composite. The number of mutually different forms of land use that can be interpreted from FCC synthesis on the basis of empirical experience depends on resolution capacity of the synthesis by means of the scale, which also defines conditions for classification itself and consequently extent of the land use map legend. Three following basic categories of land use forms (see enclosure no. 3) were interpreted at the given scale of 1: 50 000 and defined for the land use map:

- 1 Technical forms of land use
- 2 Agricultural forms of land use
- 3 Forest forms of land use.

The first category included following forms of land use, which were detected within the space demarcated by the map sheet 34-22 Hodonín: built-up dwelling areas, built-up production areas, built-up recreational areas, areas with open-cast mines of mineral raw ma-

terials (sand pits, clay pits, open-cast quarries), devastated areas, spoil heaps, landfills, areas used for military purposes, roads, railways, field airports, water areas and water streams. The second category of agricultural land use forms includes arable land, meadows and perennial grass stands (in some cases with shrub vegetation), vineyards, fruit orchards, vegetable-growing areas, gardens and small land tenures. The third category of forest land use forms classifies: coniferous forests, mixed forests, deciduous forests and clearings.

Nevertheless, some of the above mentioned land use forms could not be defined unambiguously and were classified only on the basis of visual interpretation of false colour composite recorded by individual spectral channels of the SPOT satellite, this being caused by proper spectral manifestation of some objects whose spectral properties were practically identical (e.g. permanent grass stands were plotted in a practically identical way as arable land covered with perennial fodder plants or in the case of newly established vineyards or fruit tree orchards the spectral interpretation was similar to that of bare land, etc.). This was due to the date of remote sensing (beginning of May) and to the course of vegetation development in the given year. This was the reason for us to strictly verify success of FCC visual classification, and this is also why extensive material was obtained mainly from individual agricultural plants in the form of detailed rotation plans and personal discussions with individual agronomists from agricultural establishments. Methods of direct terrain survey were used in cases when false colour composite objects which are difficult to classify were defined directly in the terrain on the spot. Documents of the District Authorities in Hodonín were used at assessing some specific land use forms such as at defining open-cast mineral mines, waste landfills etc.

A thematic land use map made like this is of areal character where individual monitored categories and functional areas are colour-plotted. Choice of means to delineate the individual land use categories in the given conception respects recommendations of the technical committee for land use mapping at the International Geographical Union (IGU).

3. Discussion and conclusions

The area demarcated by the map sheet 34-22 Hodonín occupies an area of approximately 440 square km (territory of the Slovak Republic not being included) with nearly two thirds of the territory being occupied by agricultural land use forms (five major forms have been identified on the basis of false colour composites). Forest forms of land use occupy hardly one third of the given area with four major forms indicated. Most numerous representation is that of the technical land use forms

which do not represent large areas but their representation includes fifteen major forms in total. In some cases, the false colour composite synthesis facilitates interpretation of other land use forms, but their plotting in the map is no more realistic taking into account legibility, good arrangement and interpretation capacity of the map. The land use map which has been set up on the basis of the above procedure makes it possible to operatively up-date content of the map to the date of remote sensing or on the basis of annual up-dating provided that necessary supporting data are available. Advantage of a map which has been set up in this way consist in the fact that localized informations provided are independent of the static geodetical information system which relates to administration units. If a chronological series of these maps has been created, we can start assessing of dynamics of changes of some phenomena and processes in the landscape, differentiating and prognosing the areas also from the viewpoint of some aspects in their time and spatial development.

In addition, the land use map can provide the very valuable information about actual situation of the landscape sphere. Its application can be seen at all places of legal area-planning decision-making and at all places where the maps can serve a suitable basis for decision-making processes of administration bodies such as authorities of regional area development and environment protection at district councils. The land use maps belong to fundamental information layers at generating data files for geographical information systems (GIS). GIS creation and their up-dating by means of strictly made interpretation of remote sensing materials appears to be considerably effective both from the time point of view and in terms of financial funding. The above described method of land use map generation, which consists in visual interpretation of false colour composites appears useful particularly in cases when corresponding technical facilities for digital processing of image information are not available (ie. the whole system chain - from obtaining digital satellite data through to graphical output by means of large-size colour laser printer). The above mentioned procedure of land use thematic map generation has been based on human factor and makes full use of empirical experience of interpreter at assessing false colour composites. The used material gained by means of SPOT satellite scanners provides relatively acceptable results at the used map scale of 1:50 000. If other satellite records are to be used such as Landsat TM data or at interpretation of aerial multispectral photographs, some adjustments and corrections must be made since the Landsat TM data are of a much wider spectral engagement and false colour composites made of them facilitate more precise and more reliable interpretation of land use forms under study.

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Explanations to the map - Appendix No. 3

TECHNICAL FORMS OF LAND USE:

- | | |
|---------------------------------|-----------------------------------|
| 1 - built-up dwelling areas | 9 - waste dumps |
| 2 - built-up production areas | 10- waste landfills |
| 3 - built-up recreational areas | 11- military-affected areas |
| 4 - sand pits | 12- roads |
| 5 - clay pits | 13- railways |
| 6 - open-cast quarries | 14- field airports |
| 7 - devastated areas | 15- water areas and water streams |
| 8 - undermined areas | |

AGRICULTURAL FORMS OF LAND USE:

- | | |
|--|--|
| 16- arable lands | 19- fruit-tree orchards |
| 17- meadows and perennial grass stands | 20- vegetable-growing areas, gardens, small land tenures |
| 18- vineyards | |

FOREST FORMS OF LAND USE:

- | | |
|------------------------|-----------------------|
| 21- coniferous forests | 23- deciduous forests |
| 22- mixed forests | 24- clearings. |

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Reviewer

Doc. RNDr. Alois HYNEK, CSc.



Village Petrov: Folk wine cellar-architectural monument from 18th and 19th century.

Photo: K.Kirchner, V.Nováček








Aerial view of the district town of Hodonín (southern border).





Photo: V.Nováček

LEGEND:

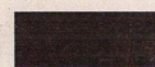



Man made and urbanized landscape

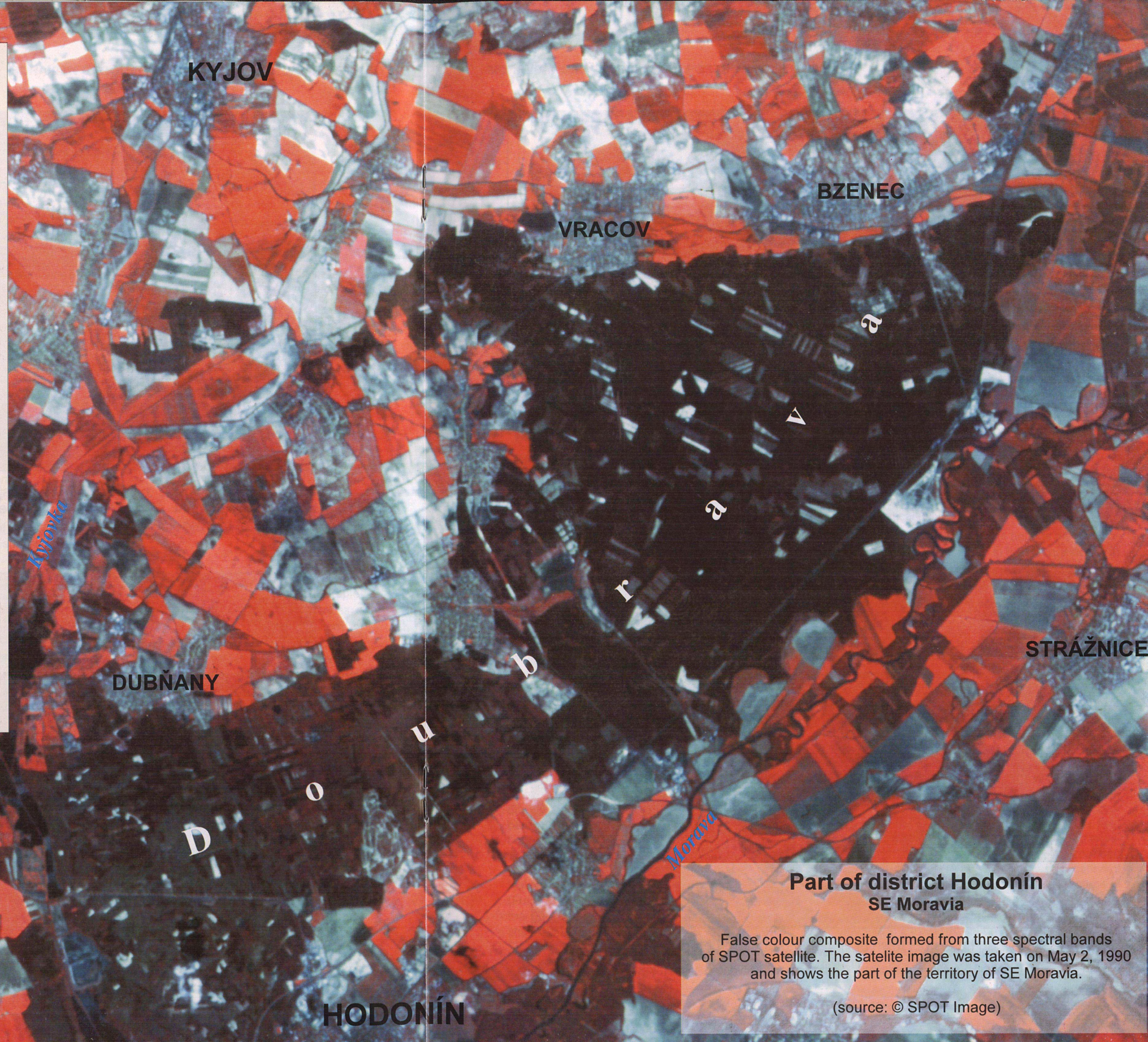
-  residential and productional built-up areas
-  sands-pit
-  waste dump
-  military - affected area
-  water areas

Agricultural landscape

-  arable land covered with vegetation
-  arable land without vegetation
-  meadows and sustained grass growths
-  vineyards

Forest landscape

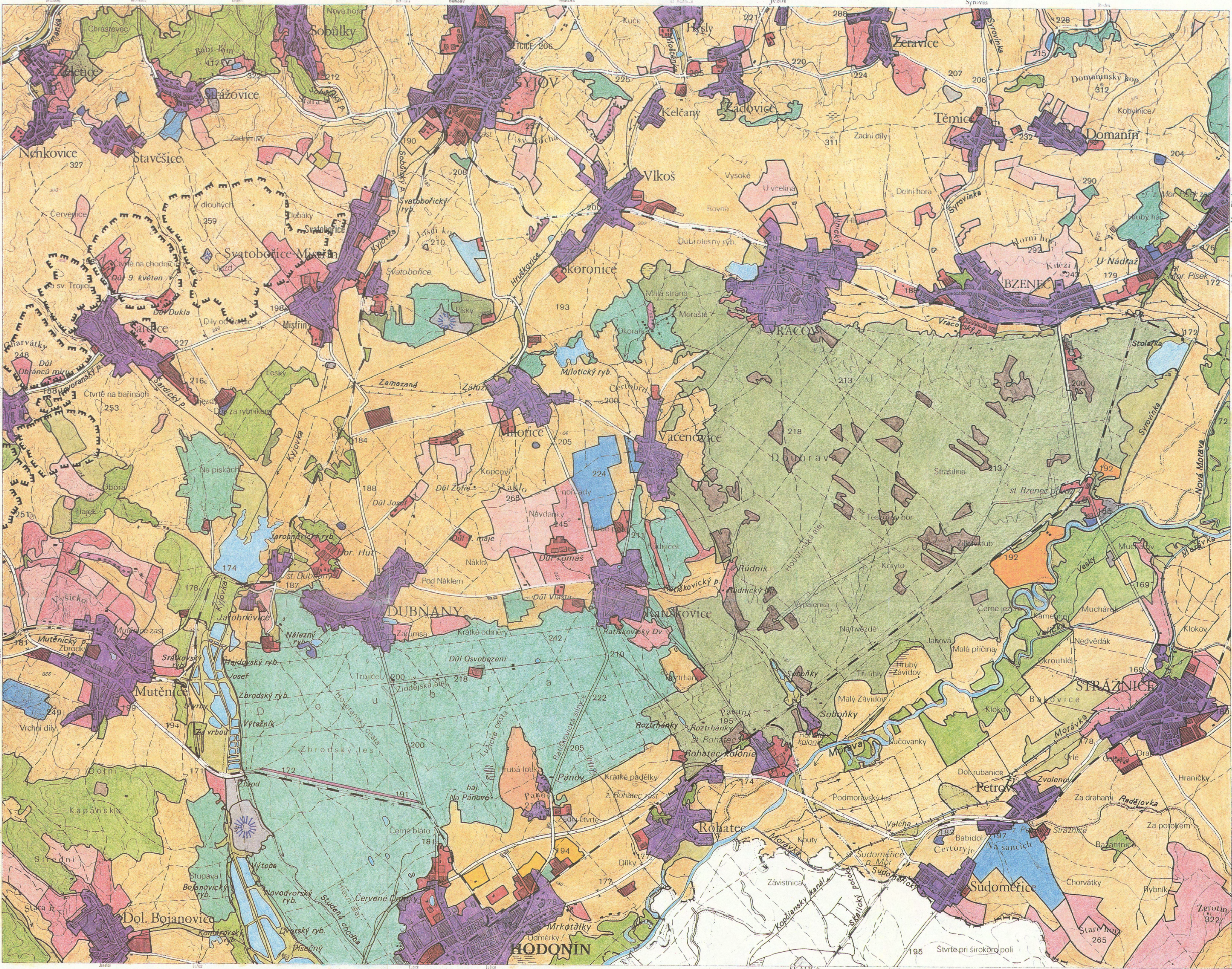
-  coniferous forests
-  mixed forests
-  deciduous forests
-  clearings



Part of district Hodonín SE Moravia

False colour composite formed from three spectral bands of SPOT satellite. The satellite image was taken on May 2, 1990 and shows the part of the territory of SE Moravia.

(source: © SPOT Image)



LEGENDA:

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24

TECHNICKÉ FORMY VYUŽITÍ PLOCH:

1 - zastavěné plochy obytné; 2 - zastavěné plochy výrobní; 3 - zastavěné plochy rekreační; 4 - pískovny; 5 - hlinišť; 6 - povrchové lomy; 7 - devastované plochy; 8 - poddolovaná území; 9 - výsypky; 10 - odpadní skládky; 11 - militární ovlivněné území; 12 - silnice; 13 - železnice; 14 - polní letiště; 15 - vodní plochy a vodní toky.

ZEMĚDĚLSKÉ FORMY VYUŽITÍ PLOCH:

16 - orná půda; 17 - louky a trvalé travní porosty; 18 - vinohrady; 19 - sady; 20 - zelinářské plochy, zahrady, drobná dráža.

LESNICKÉ FORMY VYUŽITÍ PLOCH:

21 - jehličnaté lesy; 22 - smíšené lesy; 23 - listnaté lesy; 24 - mýtiny.

SOUBOR GEOGRAFICKÝCH MAP ŽIVOTNÍHO PROSTŘEDÍ
VYUŽITÍ PLOCH

List 34-22 Hodonín, měřítko 1:50 000. Stav květen 1990. Zpracováno v rámci projektu E 5.5 "Inventarizace, evidence a evaluace ekosystémů České republiky". Odpovědní řešitelé podprojektu "Evidence stavu a geografické hodnocení biotopů České republiky": ing. Jan Lacin, CSc., RNDr. Vítězslav Nováček, CSc.

Autor listu: RNDr. Vítězslav Nováček, CSc.

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Tisk: GEODÉZIE BRNO a.s., 1993

Vydáno péčí Ústavu geoniky AV ČR, pobočka Brno

1:50 000

