# LARGE-SCALE SOIL MAPS AS THE SOURCE OF SPATIAL INFORMATION CONCERNING ENVIRONMENT

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The paper presents kinds of large-scale soil maps used in Poland, the range of environmental information contained in these maps, information value of the data, some properties of physiographic objects, and the significance of this information for the creation of physiographic databases serving land development.

## 1.Introduction

The physiographic information may be obtained, besides direct measurements, methods of photogrammetry and remote sensing, also by the use of the existing maps and documentation attached to them [Koreleski 1995, 1998].

In Poland large-scale soil classification maps, soil-agricultural maps and soil-natural maps are in common use. They create a rich source of information about natural environment, useful for the needs of spatial planning, especially of rural areas.

Many existing databases and SIS are based on soil information.

Here are some examples.

The BIGLEB-Wo system (information bank about soil-plant environment) serves carrying out control studies of the environment degradation and introducing the results of this research into the database system.

The main aim of the TEMKART system is the processing of information concerning the terrain (including also natural environment features) of cartographic and non-cartographic character, coded in the network of marked fields (raster), enabling the computer preparation of thematic maps in various scales.

The PROMEL system bases on agricultural-water melioration characteristics of arable lands.

The information system of natural environment SINUS is a widening of the TEMKART system and hence all the information contained in the TEMKART database can be also found in the SINUS database.

The essential range of basic physiographic information for the needs of local planning of rural areas included in the physiographic data catalogue (PDC) may also be obtained from the soil maps and documentation. The PDC, worked out in the Dept. of Rural Areas Planning, Organisation and Protection, University of Agriculture in Cracow, comprises five thematic groups: 1.Soils (grounds), 2.Relief, 3.Climate, 4.Water conditions, 5.Protection and shaping of natural environment [Koreleski 1995]. These are as follows.

I. SOILS (GROUNDS):

Soil classes of agricultural land (8 classes of arable lands, 3 complexes of grasslands).

Soil – agricultural complexes (14 complexes of arable lands, 3 complexes of grasslands).

Soil reaction (pH in KCl) – 4 classes.

Mechanical composition of soils (according to the PTG division).

Soil stoniness in the plough horizon (4 classes).

Compressive strenght of grounds (MPa) – 4 classes.

Air – water conditions of soils (5 categories).

II. RELIEF:

Agricultural types of relief acc. to the IUNG division (11 types).

Areas with active processes: land sliding and slumping, marginal erosion, suffosion, etc.

Occurrence of agricultural benches (3 classes of height).

Occurrence of ridges and scarps (4 classes of height).

Slope gradient (5 classes).

Man – made landforms: dumps, pits, quarries, etc.

III. CLIMATE:

Mean annual air temperature period (in degree Centigrade).

Duration of vegetation period (in days) – 5 classes.

Number of days with ground frost – 5 classes.

Occurrence of temperature inversion.

Yield hazard due to hail (4 zones acc. to Kozminski).

Mean annual precipitation (in mm).

Slope aspect: south, north.

IV. WATER CONDITIONS:

Surface waters: stagnat, flowing.

Land melioration: drainage, irrigation.

Floded areas.

Depth of the occurence of ground water - 5 classes.

V. PROTECTION AND SHAPING OF NATURAL ENVIRONMENT:

Areas ecologically protected: national parks, nature reserves, landscape parks, areas of protected landscape, monuments of nature, documentation sites, ecological sites, natural-landscape complexes.
Protective zones around: animal farms, sewage purification plants, refuse dumps, health resorts, drinking water intakes, national parks, etc.
Protected forests: soil and water protection, protection of spas, protective zones for industry, etc.
Areas of intensive agricultural production, forest production.
Devastated forests.
Land use: forests, arable lands, grassland, waste lands, etc.
Polluted waters (out of classification).
Devastated grounds.
Areas with exploitation of rocks and minerals.
Areas with overrun concentration standards of: HF, $SO_2$, $No_x$ , dust, etc.l

## 2. Types of large-scale soil maps in Poland

The soil classification which was carried out on the area of the whole country in the years 1956-1965 is still being used for fiscal purposes. The eight valuation classes (I, II, IIIa, IIIb, IVa, IVb, V, VI) on arable lands and six classes on grasslands (I, II, III, IV, V, VI) have been attributed mainly with regard to the studies of soils and also local relief, climate and water conditions.

The next stage in recognition of arable lands was the natural-agricultural evaluation which distinguished fourteen soil-agricultural complexes on arable lands and three complexes on grasslands, grouping lands of similar usefulness for plants {Koreleski 1994].

This evaluation has been based on the following criteria: soil properties, morphological situation, agri-climate and water conditions. The complexes constitute thus the site types of agricultural productive areas.

The contents of soil-agricultural maps (maps of agricultural capability of soils) comprises the contours of: soil-agricultural complexes, as well as the constituting them soil units, location of the investigated soil pits, agriculturally useless soils (for afforestation), forests, built up areas, roads, inland waters and also village borders.

The soil-agricultural maps (basic scale 1:5000) and the descriptive annexes accomplished for the whole area of Poland between 1965 and 1981 give the detailed information concerning geographical environment, agricultural properties and classification register of soils.

Soil-natural maps contain, besides basic soil parameters, widened information concerning other environmental features, such as: relief, microclimate, water conditions, site types, a.s.o.

Summing up, large-scale soil classification maps and soil-agricultural maps in the scale of 1:5000 (accomplished for the whole area of Poland), as well as soil-natural maps in the scale of 1:5000, (referring to some areas of the country only), contain valuable information about natural environment, such as: physical and chemical parameters of soils, air-water conditions, soil kinds and types, soil situation in the relief, agritechnical conditions and evaluation of agricultural sites, such as soil class, soil-agricultural complex a.s.o.

**3. Range of environmental information**

Characterising the current state of knowledge regarding natural environment on large-scale soil maps one may observe that whereas the description of soil pits contain a lot of detailed data concerning edaphic conditions, and the annexes present the same information in a more synthetic and generalised way, the maps provide itemised information about their spatial allocation and differentiation.
The following parameters may be of interest for spatial planning purposes:
- soil conditions (thickness, transition of layers, mechanical composition, structure, $CaCO_3$ content, reaction, gleying, etc.)
- water conditions (air-water conditions, underground water level, river network, etc.)
- other physiographic elements (geological structure, land use, genetic type of soils, geological and textural kind of soil, sites, situation in the relief, aspect, landscape, local climate, etc.)
- agritechnical conditions (degree of soil culture, cultivation difficulties, erosion hazard, soil richness and needs for fertilisation, naural obstacles hampering land use, etc.)
- agricultural sites evaluation (soil class, soil-agricultural complex).

**4. Information value of data**

Information contained in soil maps is an important element assisting decision taking in the range of environment protection and shaping. This especially concerns the following stages of local spatial planning:
- study of conditioning and spatial management directions (natural environment inventory, functioning of environment and its threats)
- local plan project (prognosis of local plan influence on natural environment, particularly the inventory of natural elements considered in the prognosis, assessment of the impact on environment resulting from the prospective area destination)
- land management (EIA for investments especially harmful for environment and human health, for the needs of infrastructure development) [Koreleski 1998].

Information derived from maps and soil documentation is mostly used for professional reports in the range of:
- soil protection (areas of intensive farming, evaluation of soil erosion intensity, needs for antierosion procedures)
- soil (land) improvement (needs for amelioration, liming, fertilisation, land reclamation, improvement of mechanical composition)
- shaping of technical infrastructure (localisation of built up areas, road network)

- land use (land transformation, rationalisation of land use structure, proper choice of agricultural machines and tools)
- land consolidation (comparative assessment of plots)

Information value of data from large-scale soil maps and documentation has been evaluated in a two-degree system [Koreleski 1993]:

- the significance of information for the needs of a given elaboration, distinguishing:
  - information of basic meaning for solving a given problem (B)
  - information of auxiliary meaning for solving a given problem (A)
- completeness of information, distinguishing:
  - information sufficient for solving a given problem (S)
  - information insufficient for solving a given problem (I)

For example, mechanical composition of soil provides information of type B for completing projects concerning: needs for soil fertilisation and land reclamation, improvement of mechanical composition, location of built up areas and road network. Information of type A refers to projects of fertilisation and crops rationalisation, land transformation, land use improvement, proper choice of machines and tools.

Information concerning land use is of basic meaning (B) for land transformation and of auxiliary meaning (A) for the assessment of water melioration needs, liming, fertilisation and land reclamation, improvement of mechanical composition, rationalisation of land use, proper choice of machines and tillage tools.

The research shows that in such cases as: areas of intensive farming, water erosion hazard and anti-erosion protection, water melioration, land transformation, proper choice of machines and tools and comparative land assessment – physiographic information from maps and documents is sufficient (S). For such issues as: liming, fertilisation and reclamation, mechanical composition improvement, built up areas location, road network localisation, land use rationalisation and regionalisation of plant production is insufficient (I) for a full completion of projects.

It may be generally stated that environmental information from large-scale soil maps and attached documentation constitute valuable material useful for works on development of rural areas.

## 5. Chosen properties of environmental objects

Physiographic objects from large-scale soil maps may be of *discrete* character, that is be:

- zero-dimensional (points), e.g. soil pits location
- one-dimensional (lines), e.g. rivers
- two-dimensional (areas), e.g. soil contours
- three-dimensional (solids), e.g. land forms;

or *continuous,* that is appear on the whole area considered, e.g. terrain surface. The planning practice is, however, interested not so much in the surface as a whole, but rather in its fragments representing the given physical phenomena, i.e. discrete objects.

The objects are characterised by their attributes, which display values, belonging to a given field and expressed by a proper measurement scale (*nominal scale*, e.g. areas of erosion, kinds of land use; *ordinal scale*, e.g. soil classes of arable lands and grasslands, soil-agricultural complexes; *interval scale*, e.g. classes of height of benches, ridges and scarps, slope gradient; *ratio scale*, e.g. mean annual temperature, precipitation, etc.).

The data in the information system have certain features determining their quality, such as accuracy, precision, variability, being up-to-date, accessibility, completeness, credibility, etc. [Gazdzicki 1990]. Several aspects concerning the selected features are discussed below.

*Accuracy* should be, first of all, referred to parameters expressed in the interval and ratio scale. It results from the measurement accuracy (e.g. climatic parameters) and, in case of using the data from maps, depends also upon the degree of generalisation related to the scale. For instance, all the soil contours on the soil-agricultural maps in the scale of 1:5000 are drawn with the accuracy of up to 0.25 ha (exceptionally up to 0.10 ha to show small areas of poor soils among very good soils). The contours of complexes of soil units below 0.25 (0.10) ha of area are not marked on these maps.

*Being up-to-date* may be expressed by a time interval in which the attribute value changes. The feature depends on the variability of a given attribute, as well the process of bringing the data up to date, which may be done every time a change occurs (current updating) or after a great number of changes occur (periodical updating).

For example, in order to enable the full usability, which is obtained from large-scale soil maps, and the annexes for land development, this information must be adequately updated.

The author has distinguished the following needs for updating the data in the physiographic data catalogue (PDC, mentioned in the introduction):

0 – practically no need: e.g. climate and relief parameters

1 – periodical need (over 10 years): occurrence of natural obstacles in land use, like swamps, landslides

2 – moderate need (every 3-10 years): water conditions, soil erosion, tillage difficulties

3 – frequent need (every 1-3 years): soil reaction, stoneniness, fertilisation

4 – immediate need: after land reclamation and soil improvement works.

*Accessibility* is connected with the easiness and speed of data obtaining. It depends on a kind of data (maps, documentation, tabulary listing, which are afterwards undergoing technological procedures aiming at their introduction to database. In the case of cartographic materials, scanning, digitising, calibrating, etc. may be considered.

*Completeness* may be defined as a proportion of the possessed information in the given area, to information necessary for working up a problem. This issue has already been dealt with in part 4 of the paper.

## 6. Final remarks

The data contained in the large-scale soil maps and annexes provide a valuable source of spatial information in the range of natural environment. These data may be used for constructing data bases serving land development. The already mentioned PDC for spatial planning of rural areas forms the basis for monitoring, registration and information processing. This catalogue is of open character and bases on the basic data which may be of attributive, spatial and identification nature. Through the processing of this information it is possible to obtain numerous sets of natural features for the needs of organisation, rational utilisation and improvement of agricultural areas, rural settlements, taking into consideration the aspect of sustainable development of environment.

The PDC may be based on the model in raster description which allows to achieve a high degree of automation of data obtaining process from graphic documents, as well as the accumulation of a large number of data, and may be adapted for producing maps [compare: Gazdzicki 1990].

Taking into consideration possibilities of relation analysis of e.g. MapInfo program, we may say that it can also be applied for the creation of databases for land development – especially for the evaluation of spatial differentiation of the area at the introductory stage of planning procedure (studies and listing).

The PDC may be in future included into the All-Poland System of Land Information.

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