EVALUATION OF THE SOIL MAP ACCURACY

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Le problème d'évaluation de la précision des cartes pedologiques n'est pas encore décidé. On propose de considérer la précision de la carte pedologique comme la probabilité moyenne de "l'identification sans fautes" de tous les contours de la carte. Cette approche suppose l'élaboration des modèles quantitatifs-qualitatifs des relations sols-paysages (les matrices des supperposition des sols-indicateurs). De la même manière on peut d'estimer et comparer les méthodes diverses de cartographie pedologique.

1 Introduction

At present Russian soil scientists are being faced with a problem of soil maps revision over agricultural regions. Requirements on quality of primary data are greater now in making the soil and land resources inventory, evaluation and monitoring. The assessment of maps' quality, however, is still among the least developed problems in the soil mapping.

2 Principal criteria for maps quality

It is common practice in general cartography [4] to assess maps using two kinds of criteria: 1) based on the map informativity (that is quantity of information the map carries)^ and 2) based on the accuracy of presentation (that is degree of correspondence between the real objects and their images in the map). The *informativity* is considered [3] as a measure of geographical differentiation: the latter may be expressed in two ways: 1) in terms of number of subdivisions adopted in the legend, and 2) in terms of number and size of units shown in the map. To estimate quality of a map a useful information is to be considered, which corresponds to the map's purpose and may be stated as a set of requirements to its content. The notion of *accuracy* includes both geometric precision and adequate presentation of geographical features. Geometric accuracy is estimated by value of errors in contours position. The main source of errors in soil maps, however, is not geometric inaccuracy, but geographical inadequacy which results from insufficient data, limitations of the classification adopted and errors in primary field observations or in their interpretation. It has been noted [1] that in the case of thematic maps based on wrong assumptions, conjectures or incomprehensive data, errors may increase up to 10 times.

3 Special features of the object of soil mapping

A distinguishing feature of the soil cover as an object of mapping is that it cannot be studied continuously: conclusions are necessarily drown from selective sampling and therefore are probabilistic in essence. The map reliability depends directly on the completeness and quality of soil sampling. This being so, an unbiassed assessment of the soil map informativity cannot be obtained without the map accuracy having been estimated. This is a fundamental difference between the soil mapping and other branches of cartography (such as general or economic cartography); in the latter case the nature of objects under study makes, for all practical purposes, the whole volume of data available for cartographer.

According to current concept of the soil cover structure [2] as applied to mapping, the soil cover is considered as a hierarchic system of soil-geographic territorial units of different levels. In such a way it is possible to arrange in order various forms of soil diversity which appears universally.

4 The approach suggested

In estimating map quality the following propositions are accepted as a starting point: 1) Accuracy and informativity of a soil map are closely interrelated. The accuracy is estimated in terms of adopted standards for useful information (stated as a set of technical requirements for the map content: object of mapping, characteristics to be mapped,sampling standards, size of modal and minimum units).

2) The focus in the map assessment is shifted from boundaries verification towards tests for geographic reliability (that is, validity and completeness of presentation). 3) The accuracy is estimated on the basis of an elaborated system of landscape indicators.

We suggested [5] to assess the soil map accuracy in terms of weighted average value of probabilitiies that all the soil units are mapped correctly. The maximum accuracy (1.0) means there are no units left out or shown incorrectly. The map may be taken as reasonably accurate if the average probability does not go below a specific level - 0.95, 0.9 or 0.8, that is if the area of units determined erroneously does not exceed 5, 10 or 20%, respectively, of the total map area.

The accuracy (P_i) is calculated for each unit using the equation: $P_i = Pa + Pb + Pc - PaPb + PaPbPc$,

where P_a, P_b and Pc indicate accuracies of information derived from primary data on soil sampling, from lithological-geomorphological indicators and obtained from aerial images interpretation.

respectively. To estimate the accuracy in this way, first of all indication tables should be constructed, showing how close the correlation is between soils and various indicators (such as topographic properties, aerial photoimages, vegetation, etc.) used as a basis for the map compilation.

The table below presents a fragment of the indication table "Soil-topography", as applied to detailed survey of soils in a region of southern forest-steppe. Columns in the table correspond to groups of soils, while topographic characteristics are arranged in horizontal rows; figures at column/row intersection express the probability that the specific soil (elementary soil area - ESA) will appear on the given topographic element. It is evident, that diagnostic significance of various categories of relief (in the soil units identification) is variable and may be expressed quantitatively. Informativity of a microrelief map as a base for soil mapping has been assessed using C.Shannon information measure equation at 0.84 bit.

Table of soil-topography correlation (a fragment)

Element of microrelief	Soils				
	Чт	Чв	Чт^{к}	Чл	Total
Flat microwatersheds	36 / 0.95		2 / 0.05		38 / 1.00
Microslope	40 / 0.53	5 / 0.07	30 / 0.40		75 / 1.00
Linear hollow	14 / 0.58	10 / 0.42			24 / 1.00
Slopes of depressions	5 / 0.29	11 / 0.65	1 / 0.06		17 / 1.00
Bottoms of depressions				9 / 1.00	9 / 1.00
Total number	95	26	33	9	163

Note: types of soils: Чт - typical chernozems, Чв - leached chernozems, Чт ^{к} - typical chernozems highly calcareous, Чл - meadow chernozem soil. Numerator indicates number of cases, denominator - probability estimate.

A working document - a cartogram showing probability of each soil unit to be identified correctly - manifests spatial variability of the potential accuracy over the mapped area. Experimental tests indicate the local correlation between and various kinds of indicators ranges from 0.5 to 0.9. On the whole the accuracy depends on the following factors: how close are relationships between elements in the landscape; whether the indicators have been chosen correctly and arranged in the proper order; how complete primary data were. Required level of accuracy may be obtained by the adjustment of the factors.

It should be taken into account that degree of accuracy depends as well on how complicated the legend is: the less numerous are its subdivisions, the easier is establishing the indicative relationships and obtaining a high degree of accuracy. The achievement however is at the cost of a decrease in informativity. Paradoxical as it seems, the conclusion only confirms the fact that the soil map accuracy cannot be considered in isolation from its informativity, the volume of necessary data (useful information) should be defined beforehand.

Taking all the above into consideration, the following algorithm can be suggested for the soil cover mapping:

1) initial "factor" base map is constructed;

2) representative key sites are chosen;

3) models of soil-landscape relationship at the key sites are developed (in a form of indication table-matrix), the correlation between various categories of soil cover and environmental indicators must be assessed quantitatively. To construct the matrix a rigid hierarchy should be developed for both soil units and landscape indicators, as well as regional inventory compiled. The soil cover is presented by soil-geographic units belonging to different levels of the soil cover structure, depending on the map scale;

4) the interrelations revealed are extrapolated in accordance with the pedological-geographic subdivision of the area;

5) the map accuracy is assessed.

References

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