A G R I C U L T U R A L R E S E A R C H C O U N C I L

Soil Survey of England and Wales

Making 1:250,000 soil maps

by

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SUMMARY

In the current survey programme, soil maps at a scale of 1:25,000 are being prepared for 100 sq. km. areas selected to represent typical landscapes in each county. At a later stage, county, regional and national soil maps are to be prepared at a scale of 1:250,000, by interpolation. This paper describes how the later series of maps will be prepared, and their aims.

Existing information is reviewed and the principles and units to be used in compiling the maps are outlined. The three stages of the mapping procedure are then indicated. Soil associations will be the main type of mapping unit, and block diagrams will show the distribution of soil series.

The principles to be followed in defining soil associations are discussed, including the effect of scale and the need for a balance between simplicity and maximum content of information. The value of probability sampling in interpolating between areas of detailed soil study is indicated, and suggestions made for experiments to determine its value more precisely.

INTRODUCTION

In the current programme of the Soil Survey (Board Paper 1) detailed, 1:25,000, maps of selected 100 sq. km. areas are being prepared. Board Paper 19 describes the methods used. The programme provides for some 15% of the country to be covered in this way in addition to the 10% already mapped in detail at 1:63,360. The remaining 75% that will not be so mapped in the foreseeable future will be covered by reconnaissance maps at 1:250,000. Individual maps will be of single counties, groups of counties, economic planning regions or the new administrative units proposed by the Royal Commission on Local Government. In this paper these units are referred to as "regions". Each will cover several thousand to several tens of thousands of square kilometres, and later be compiled into a national map at 1:250,000.

Several 1:250,000 soil maps have been made already. They include Lancashire, Shropshire, Buckinghamshire, Hertfordshire and Dorset. The methods by which they were made have varied, and the paper draws on this experience and on experience elsewhere to outline principles and a practicable method for preparing general purpose 1:250,000 soil maps in the future.

AIMS OF 1:250,000 SOIL MAPPING

There are three aims:-

(1) To classify the soil into soil series in the previously unmapped areas, and to provide a descriptive key or legend, from which the series can be identified. The main users here will be advisory officers.

(2) To subdivide each region into a small number of areas throughout each of which a common pattern of soil confers similar land use potential. This is to cater for planners at regional level.

(3) To enable all users - in planning, advisory work and education - to generalise about the soil over large areas.

EXISTING INFORMATION

The Survey programme envisages completion of all the selected detailed maps within a county or region before commencing mapping at 1:250,000. The intention is that from these maps and from any previously published 1:63,360 soil maps a legend can be constructed for mapping the remainder of the area. To this end the 1:25,000 sheets are chosen to include all the more important types of physiography. Also available are geological maps at 1:63,360 and 1:253,440, as well as complete topographic coverage at 1:10,560, 1:25,000, 1:63,360 and 1:250,000. Other maps of land attributes give background information, and the small-scale soil map of the country proposed by Avery (Board Paper in preparation) will be of value.

Air photography of suitable scale, focal length and quality is becoming increasingly available. In many parts of the world air photo interpretation has been found very valuable for small-scale soil mapping. Its value for this purpose in this country is being studied by the two units (upland and lowland) set up in the Survey.

PRINCIPLES AND UNITS

Mapping soil at 1:250,000 differs in degree from detailed soil mapping in three respects. These are:

(1) In order to cover the much larger areas concerned in any reasonable time the map must be based on much sparser soil profile data.

(2) Mostly, reasonably homogeneous areas, i.e. of soil series cannot be delineated and series will have to be grouped according to locality rather than similarity of profile or other inherent properties.

(3) To give map users information about series, which are unmapped, the map key must enable users to distinguish between series, and show where they are most likely to occur.

To meet these needs and make the best use of the existing soil and background data, soil, geology and landscape must be associated. Thus in areas previously surveyed, soil type will be linked to geological and landscape features that can also be recognised in the unsurveyed areas, since mapping units are already chosen to coincide with changes in geology or landform or both. Landscape elements commonly recur to form readily recognisable patterns, so that if soil series are grouped according to the landscape patterns with which they are associated, their boundaries can be delineated economically either by field work or by photo interpretation. Further, by knowing how soil is related to landscape it is possible to predict soil conditions with reasonable confidence at sites whose positions in the landscape are known.

The units shown on the maps will therefore be soil-landscape associations, henceforth referred to here simply as "associations", (see note below). Each will contain a group of soil series that are contiguous: in most series will also recur in recognisable patterns and occupy characteristic parts of the landscape. Each region will be subdivided into associations largely by pattern recognition. Different associations will be distinguished where:

(1) Most component soil series differ.

(2) Soil series, though common, differ strongly in their proportions.

(3) Soil series, though again mostly common, are distributed in different ways and form different patterns.

MAPPING PROCEDURE

The aim of mapping is to delineate associations of the kind described using all the available information. Boundaries are located where patterns or groups of relationships are seen or otherwise known to give place to others. This is best done in stages (see below) that permit progressive refinement and clarification of the mapping units as knowledge of the region accumulates. Surveyors will avoid defining associations too rigidly in the early stages of survey.

Stage 1. In this stage the existing information is reviewed and collated. In particular the topographic and geological maps and air photographs are studied together with the local detailed soil maps. Where there is complete or wide coverage of suitable air photography this is laid down to form a mosaic for study. It may also be scanned systematically at this stage. Reconnaissance journeys are made to complete the surveyor's broad picture of the region.

Using this information, as many as possible of the boundaries likely to be needed to sub-divide the region are drawn approximately in their final positions. These will define areas for study in the next stage. Their precise location may be modified or they may be

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Note: In Scotland soil series are grouped into soil associations even in detailed surveys; a soil association comprises series developed in similar parent material, but varying in profile morphology mainly because of differences in hydrologic conditions.

deleted as a result of later study. However, few fresh boundaries should need to be added.

The result of this stage is a first provisional map that will serve as a sampling framework for the previously unsurveyed portion of the region.

Stage 2. The aim of this stage is to discover what kinds of soil are present within each provisional unit and how they are spatially related; i.e. to discover what constitutes each soil and landscape pattern. The distribution of soil series in the previously mapped areas is known. Elsewhere the soil distribution within each provisional unit is examined in small sample areas and along transects. These are chosen so that a few will reveal all the variety of soil that can be expected in that unit. These areas and transects are studied in detail in the field, and where possible on the air photographs, in the way described in Board Paper 19, section 3.

The result of this stage is a reasonably comprehensive description of each provisional unit. The description lists all the soil series that are characteristic of the unit and any other series that are known to be present and locally important. Each soil series is described briefly and its landscape position noted.

A block diagram is drawn for each unit to show the relations between its component parts. It will often be desirable to supplement this by sectional sketches or sample maps. A block diagram will show both the relationships between the component parts of the unit and their consistency. Where relationships are not understood, further field work is needed. If there is no recognisable pattern it is worth reconsidering the content of the unit: some alternative grouping of series could be preferable.

Concise generalised descriptions of the soil, rock, land form and cultural use of each unit are made.

Stage 3. Here the map is finished. The surveyor, unless he has already done so by the end of stage 2, decides what associations are to be shown on the map and defines them. Using the information gained in stage 2 and by further field work where necessary the provisional map is refined. This will often be done by a second systematic examination of the air photo cover. Provisional boundaries found to be unnecessary are deleted. Fresh field work will be carried out where the results of stage 2 require new units. This should happen infrequently.

GUIDELINES FOR DECISION

Making 1:250,000 soil maps in the way described will inevitably need arbitrary decisions. In some areas, patterns of landscape and soil change gradually and there is no obvious place to draw a boundary; some landscapes are more distinct than others; some are complex; in some no pattern is discernible. Precisely how these situations are treated will be left to individual surveyors. However, the following guidelines will be used:

1. Scale. The classification will be determined by scale, and each association recognised should be capable of representation to scale at 1:250,000. Occurrences must be at least 3 mm. wide on the map, i.e. 750 m. on the ground. Generally, they should be considerably wider (see section 3 below). Cartographic exaggeration will be confined to the very few small units judged particularly important or contrasting markedly with their neighbours. Otherwise the soil will be accommodated within one or other of the neighbouring

associations.

2. Simple associations. To aid identification of series, associations should be as simple as possible, and contain few series - not more than 7. Ideally these will be related simply and consistently to the visible landscape. In extreme cases a single series will cover one or more large blocks of country and be delineated separately.

3. Simple map. For regional planning purposes the map should be simple. The fewer the mapping units that will adequately reflect the variety of soil and landscape present the easier will the map be to use. However, the extremities of associations mapped in neighbouring regions should be shown (see 5 below).

Requirements 2 and 3 will often conflict; the simpler the associations are the more of them there are likely to be. The surveyor will judge the best compromise.

4. Generalisation. For purposes of generalisation it will be useful if soil series are so grouped that they are generally similar within an association. This may involve splitting some coarse patterns into parts. This must be balanced against simplicity and the relative advantages and disadvantages will be weighed. If it is not possible to group soils in this way it will be helpful to have a dominant soil type within an association.

5. Extrapolation. The 1:250,000 soil maps will eventually cover the whole of England and Wales, and from them a national map will be compiled. In order that the final compilation can be done with the minimum of further work surveyors will need to be aware of soil associations that have been, or are likely to be, used in neighbouring regions and accommodate them where appropriate, to avoid abrupt discontinuities at regional boundaries.

Even with these general guidelines there are likely to be many different and equally profitable ways of subdividing a region. The classification used will be the one which gives clearly and quickly, from material available at the time, the maximum amount of fundamental and useful information about the soil.

TEXT

The text that accompanies the map will consist mainly of the descriptions of the associations shown on the map. In the first instance, texts will be Bulletins describing the soil of a county. An outline of the contents of a County Bulletin (Berkshire) is given in BP/22. For each association there will be a short generalised account followed by detailed but concise descriptions of the component soil series. Descriptions must be sufficient to discriminate between series within the association. Wherever possible a block diagram will be included, supported if necessary by diagrammatic cross sections. Where an association has to be defined for an area with no consistent relations between soil and land form, maps of sample areas will be included.

For users needing only general information the map alone is sufficient key. Those who wish to identify the series present at particular sites or to predict the occurrence of particular series in areas mapped only at 1:250,000 will use the map together with the association descriptions. For any site of interest the map will show the association to which the site belongs. This narrows the search to one of several series, i.e. it yields a short list. The user will then consult the series descriptions, block diagram and supplementary sketches in order to identify the series concerned. The process can be used in reverse to locate sites on particular series. A format that makes these recognition aids easy to use is presented in Board Paper 22.

PROBABILITY SAMPLING

The map and its legend will be prepared by the usual, largely intuitive, methods of classification or pattern recognition. The aim is to make a useful map quickly with the available effort, and purposive sampling is therefore chosen in preference to probability sampling. It is unlikely that the resulting map can be appreciably improved with respect to boundary location at the chosen scale, the lists of series within the associations or to the block diagrams that show their interrelations. Probability sampling will be needed, however, to obtain unbiased numerical estimates of proportions of series or other categories of soil present within associations or of the values of soil properties. Rudeforth has described the advantages of probability sampling (Board Paper No. 12).

There are many ways of arranging such sampling; the most appropriate is probably to use the associations as a framework, to minimise sampling effort. An approximately equal number of sampling points should be located in each association. The profile at each point would be assigned to its series and as much other information recorded as desired.

Such sampling is likely to be expensive if reasonable levels of confidence are to be attained. For example, 1:250,000 maps of the complexity so far produced would require between 1,000 and 1,500 sampling points to be visited after mapping was complete, and further work is needed to assess how such data adds to the value of association maps. An experiment is also needed to determine if the provisional subdivision of a region (stage 1 above) can serve as a sampling framework, so that data collected during stage 2 could be used both to check and define the associations and for unbiased quantitative descriptions of them. If this could be achieved there would be a considerable economy.

Alternative sampling schemes on a regular grid are also being studied. Their advantages are the greater versatility that they confer in analysing and displaying the data, though at greater cost.

CONCLUSIONS

A method is outlined for constructing county, regional and national soil maps to a scale of 1:250,000. Improvements are likely to follow as the method is tried, and local variations will be called for to deal with special circumstances.

The paper is offered to the Board for information. Suggestions for improvement will be welcome.