

AGRICULTURAL RESEARCH COUNCIL

Soil Survey of England and Wales

Making 1:25,000 Soil Maps

by

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SUMMARY

The Soil Survey of England and Wales has embarked on a programme of surveying and publication of maps at a scale of 1:25,000.

Preparatory work needed before field work starts, and the use of air photographs is described. Reconnaissance and soil identification follow, and the technique of surveying is outlined. Brief details are given of tools, methods of recording and the pattern, density and depth of soil sampling. Sampling for supporting laboratory analysis is described followed by accounts of the preparation of the map key, text and illustrations, and the soil map itself.

The paper has been prepared to introduce several of the new maps, to be published shortly.

INTRODUCTION

In 1966 a new principle was introduced into the mapping of the soils of England and Wales, whereby selected 38 sq. mile areas in each county are being surveyed and maps published at a scale of 1:25,000. The areas correspond to those of the Ordnance Survey 10 km. x 10 km. 1:25,000 map series. They are chosen to be representative geomorphologically, and to aid the compilation of county, regional and national soil maps, and the priority given to each is assessed in terms of its interest to agricultural and other users.

Major objectives of the new programme are that information about soil distribution shall reach users quickly, and that a national soil map should be available within 20-25 years. To achieve these, effort equivalent to 12-18 Scientific Officer-months is allocated to each sheet.

A programme of map sheets has been drawn up (Board Paper No. 11) and is now being reviewed in the light of two years' experience. The revised programme is described in a separate paper (Board Paper No. 18). The present paper describes how the maps are made, and embodies the recommendations of a meeting of senior officers in January, 1969. The purpose of the paper is to record the present state of practice in mapping for the benefit of the Soil Survey Research Board; a more extended version is in preparation for new entrants to the Survey.

PLANNING

The following stages are recognized in planning the survey of a 1:25,000 soil map.

1. Preparatory work and air photo interpretation
2. Field reconnaissance
3. Soil identification and legend construction
4. Surveying
5. Soil sampling and laboratory analysis
6. Preparation of final map key
7. Preparation of text and diagrams
8. Preparation of the Soil Map

1. PREPARATORY WORK

The object of this is to accumulate and study prior publications and maps. Useful documents are earlier soil surveys, geological and land-use maps and aerial photographs. Two-page information sheets are prepared, one giving a geological sketch map, and the other a brief digest of existing knowledge of soils, land-use, air photograph coverage, etc.

Contact is made with M.A.F.F. staff, the local branches of the C.L.A. and N.F.U. are approached, and letters are prepared for later circulation to landowners and farmers, on a parish basis, asking for permission to enter land.

The contribution made by air photograph interpretation to soil survey in Britain varies according to quality of material and type of country as well as skill of interpreter and equipment available.

Sources of air photographs at present in use include existing cover and those flown specially for the Survey. Existing cover is held in the Air Photo Library of the Ministry of Housing and Local Government, by commercial air photo companies and by some local authorities. Cover flown for the Survey is ordered by the surveyor some time prior to starting work. The order is placed through, and with the advice of, the two Airphoto Units of the Survey, one for the uplands at Leeds and the other for the lowlands at Cambridge.

Although some existing photographs have been of value, frequently the quality and scale are far from ideal and coverage is incomplete. With specially flown material it is possible to obtain better quality photographs, at the required scale, flown at times of the year when tonal patterns are most likely to be distinguished.

In upland areas where soils are often related to vegetation it has been shown that a time saving in the field work of up to 40 per cent may be obtained by previous interpretation of photography. A similar advantage has been gained in eastern England where prominent tonal patterns are often related to soil differences. Elsewhere in the lowlands, however, particularly in grassland areas, less has been achieved and it is hoped that newer types of photography, e.g. in colour and false colour, may reveal more of the soil patterns.

2. FIELD RECONNAISSANCE

The object of the preliminary reconnaissance is to make a general field study of the area in order to identify soil parent materials and to establish the relationships between soils and landform, and between land use and soil type. The existing knowledge of local farmers and N.A.A.S. advisory staff can be of value at this stage and visits to key farms with advisers are a first step in public relations as well as familiarisation with the district.

Parent materials are described in existing exposures and occasional pits, a geomorphological sketch map is prepared and transects and areas chosen to represent each landscape unit and soil. Possible correlations with soils elsewhere are reviewed. From the knowledge obtained in stages 1 and 2 the surveyor is then able to start detailed study of the soils.

3. SOIL IDENTIFICATION AND LEGEND CONSTRUCTION

The object here is to identify all the major soils for a descriptive mapping legend which serves as a basis for the later routine survey. This is perhaps the most important stage as it determines the quality and significance of the survey as a whole. The time spent depends on the range of soils encountered, the surveyor's familiarity with these soils, and the complexity of the pattern; these in turn regulate the size

of sample area necessary to cover the full range of soils.

The soils are identified in borings and pits in selected transects (i.e. strips of country about 1 km. wide) or in sample blocks of land chosen by air photo interpretation and field reconnaissance. The average total area needed for these observations is 5-10 sq. km. and within this borings are made at an intensity of about 50/sq. km. Data is recorded on cards or in notebooks and tape recorders are also in use in one region. Borehole inspection is immediately followed by description of the soils in pits from which a few reference soil samples may also be taken for confirmation of texture, etc. (BP/16).

For reasons given above this procedure may occupy a significantly different proportion of the whole survey time in different areas but in most cases should be complete in 8 weeks of field work.

From the data accumulated a mapping legend is drawn up which provides a key to the symbols to be used in the subsequent survey, and describes the characters by which the units are recognised. It also relates the mapping units to land form and to air photograph patterns, where these exist, and indicates the nature of the boundaries between units. As well as primary series mapping units it includes obvious phases such as those related to land use or land form, and may also propose complex units, although refinement of such units is only possible in the later stages of survey.

The preparation of a descriptive mapping legend before survey proceeds further is most essential where field survey is by recently recruited staff. The use of arbitrary, numerical or letter, symbols is also recommended as a means of avoiding premature correlation, although preliminary correlation should be a part of constructing the legend to ensure that criteria used for defining units are in line with those used in mapping units already established elsewhere.

4. SURVEYING

In this stage, boundaries are drawn between areas of the map corresponding to the mapping units listed in the legend. The legend is also made more precise by closer definition and separation of the units, particularly of any phases needed. Units are also grouped as complexes if, as survey advances, it becomes clear that series cannot be separated at the recommended density of observations.

The screw auger is an adequate tool for verifying most soil characteristics used in defining mapping units. Where such features as structure and horizon boundaries need to be examined soil pits are necessary and some surveyors use a combination of shallow pit and auger hole, although this is not a suitable method in arable crops. A larger diameter Dutch auger is to be tried as an alternative. 3 ft. (90 cm.) borings and pits are generally thought to be adequate for most purposes but rather deeper holes may be necessary to prove contacts of drift with solid substrata, and in peat borings are made deep enough to establish the thickness.

Records of observations are made in the field on 1:10,560 O.S. map sheets which are durable and provide plenty of space. Quartered sheets are used and are photo-copied as soon as they are completed, and a copy sent to Headquarters. Methods and detail of recording vary at

this stage, depending on the experience of the surveyor. In order to provide a check on interpretation of the legend and to gain experience in describing soils, inexperienced staff should record descriptions in notebook or on profile cards (BP/13, C.5). Otherwise symbols and notes on the map sheets may only need augmenting with additional notes where new units or further definition of mapping units is necessary. Detail of recording greatly influences rate of progress, full recording of data is perhaps 30 per cent slower than brief though systematic and informative symbols on field sheets (20-25 per day as against 30-35 per day). At some centres records are made on cards to test methods of data retrieval.

Density of borings is related to time available and rate of progress but also dictates the minimum area mapped. The average boring intensity is 45/sq. km. in view of the time scale allowed for completion of 1:25,000 sheets, i.e. 7-8 months, although with very detailed recording of data this may take as long as 10-12 months.

A range of 30-60/sq. km. allows for variation in the homogeneity of soil cover, the first figure relating to areas of simple topography and geology and the second being more appropriate to intricate or small areas of soil down to 2 hectares, the proposed minimum separation.

Borings and pits are located to confirm the surveyor's intuitive placing of soil boundaries where they can be expected to coincide with changes in parent material, slope, aspect and other environmental factors which may also be indicated by air photograph tonal patterns. Where clues to soil distribution are few, observations tend to be on a grid pattern, the density varying according to the local conditions referred to above.

Apart from locating boundaries between mapping units it is necessary to assess the range of variability within major mapping units, some of which may be accounted for by mapping phases. Where this is not possible symbols or notes are used to assess later the proportion of other kinds of soil included within the mapping unit as well as to indicate the range covered by each of the diagnostic properties used in defining the unit.

Some surveys have been conducted on a strict grid basis or on a random stratified selection; in conjunction with systematic recording of data this provides the means of expressing soil characteristics numerically better and of stating variability on a statistically sound basis. However, where the grid is an open one (1 km. spacing or more), the location of soil boundaries is very dependent on their appearance and accurate interpretation on air photographs, by no means assured in Lowland Britain. On the other hand, a dense grid (100 m. spacing) allows field boundaries to be located accurately in the field and at the same time supplies the data necessary for variability testing. This technique is very time consuming, however. Work is in hand to assess how these methods can be integrated with or be used as an alternative to the present system.

5. SOIL SAMPLING AND LABORATORY ANALYSIS

Representative profiles are dug by hand or Proline auger, described, and sampled for laboratory analysis. This is done after the soils have been identified, a legend prepared, and a reasonable assessment made of their distribution, i.e. towards the end of field survey. Whole horizons are sampled, i.e. sample intervals are the same as horizons. Samples are taken from one profile of each soil series or phase covering more than 1 per cent (1 sq. km.) of the map sheet. Undisturbed samples are also taken as

needed, for micromorphological and soil physical measurements, either by small portable corer or from the larger Proline cores.

Samples for analysis are sent to the Headquarters laboratory, with typed copies of the soil profile and site description, including the grid reference. Field identification is confirmed by analyses of particle size distribution, organic carbon, calcium carbonate equivalent, dithionite extractable iron, and pyrophosphate extractable iron, aluminium and carbon. Determinations are also made of loss-on-ignition and pH (in water and 0.01 M CaCl_2), and of cation-exchange capacity on selected samples.

Variability studies, with statistically adequate sampling, may also be made of soil chemical properties, as a research project in certain cases (BP/16).

The Survey's soil moisture unit at Derby measures the moisture release characteristics of undisturbed samples from selected soil series. Determinations are made on triplicate core samples from each horizon of four representative profiles in each series.

6. PREPARATION OF FINAL MAP KEY

This key summarizes the data obtained in the survey, it classifies the taxonomic units and identifies the mapping units to be shown on the final soil map. The procedure involves the final comparison and correlation of the units with existing ones where possible and the setting-up of new unit names otherwise.

The key provides the means of circulating information about the completed survey to other staff to aid correlation and is the framework for the written account. Apart from selection of final symbols for new units the key should at this stage be in the form to be used on the published map. From this point the map and key are passed to the cartographers who implement stage 8. Recommendations are also made for the colours to be used when hand colouring the black and white published maps.

7. PREPARATION OF TEXT AND ILLUSTRATIONS

The text accompanying each map reviews briefly the physical geography, climatic environment, geology and geomorphology of the area. The soils are then described in detail, in general terms as well as representative profiles. The results of laboratory analyses are given with each profile for which they are available. The overall objective is to characterize every relatively homogenous tract of land sufficiently to allow accurate assessment of its fundamental nature and practical usefulness.

In certain areas, the text also includes a brief assessment of the agricultural capability of the different soils, prepared by a local panel of experts under the guidance of the National Agricultural Advisory Service. This supplementary account is accompanied by a second map at a scale of 1:25,000 showing the distribution of land in the different classes of agricultural capability recognized in the scheme used by the Survey. In some cases, a third 1:25,000 map derived from the soil map, is prepared to show the distribution of other single soil factors, for example soil drainage classes.

Block diagrams have played an increasingly important role in illustrating the texts of Soil Survey publications. The 1:25,000 map sheets included in the Survey's mapping programme are chosen to represent geomorphological landscapes typical of areas in each county. They therefore represent one or more recurrent patterns of soil distribution or soil associations. These landscape units are recognized during the survey, and block diagrams prepared to illustrate them in the publication accompanying the map.

The technique at present used for this is to prepare a three-dimensional model with thin layers of polystyrene, using O.S. topographical data from the base map. After contours have been rounded off with plaster the soil distribution is marked with boundary lines and symbols, and the model photographed. An improved mechanical technique for making a diagram directly from a topographical map is being studied.

8. PREPARATION OF THE SOIL MAP

A map showing boundaries to appear on the published 1:25,000 scale map is prepared by the surveyor from the 1:10,560 scale field sheets, and a clean copy sent, with the field sheets to the Cartographic department. It is accompanied by a legend explaining the mapping units, for printing on the map sheet. Care is taken at this stage to see that boundaries crossing sheet edges coincide on adjacent sheets.

In the Cartographic department copies of the 10,560 are redrawn, soil symbols added, and the sheets photographed. Reduced copies are then photographed on a stabilized film at a scale of 1:25,000.

The reduced copies are then traced and fair drawn on sheets of "Permatrace", a stable, transparent material with a blue printed impression of Ordnance Survey topography. Soil symbols, produced on strips of transparent film by a photo lettering machine are positioned to the permatrace map using wax adhesive. The fair drawing stage is completed by the construction of the key for the map. Photo-copies are returned to the surveyor for checking.

The completed soil map, with legend, is then sent to the Ordnance Survey for printing. Proof copies and the published map are usually available within six months of fair drawing.