

SOIL SURVEY IN BRITAIN

The first suggestion for a systematic collection of information on British soils appears to be that made by a committee of the Royal Society in 1665 in furtherance of a project for "Histories of Nature and Arts":

"The several kinds of soyls of England, being supposed to be, either Sandy, Gravelly, Stoney, Clayie, Chalky, Light-mould, Heathy, Marish, Boggy, Fenny or Cold weeping ground; information is desired, what kind of soyls your Country doth most abound with, and how each of them is prepared when employed for Arable?"

However, little seems to have been done to collect the information. Robert Plot, in his Natural Histories of Oxfordshire and Staffordshire written some years later, makes no reference to the project and says he undertook these works for his own pleasure.

Previous to Plot, little was said about soils in the various histories and perambulations (e.g. Lambarde's Perambulation of Kent, 1576), although Barnaby Googe inserted occasional notes on English soils into his translation of Heresbach's Four Books of Husbandry (1577). At this time much of the printed soil lore is a direct translation from Virgil's Georgics. A paraphrase of one of Virgil's soil tests as given by Googe reads very like the present day "spit and rub" field method of **estimating soil texture**:

"a clod (is) sprinkled with water, if in working with the hand it be clammy and cleaving, and sticketh to the fingers like pitch, when it is handled ... and breaketh not in falling to the ground, this sheweth a natural fatness and richness to be in it."
(Georgics, II, 249-50; Heresbach-Googe, f.18r).

Dropping a clod is still a common way of observing soil structure (Clarke, 1957, p.72). Gervase Markham in The English Husbandman (1613) is the first to print a soil classification and to indicate where the various soils are to be found. The classification is a simple one: there are four main soil types, black clay, white clay, red sand and white sand; all other soils are compounded from these. He also gives a modification of the handling test in which the soil, after wetting, is dried before a hot fire. W. Folkingham (1610) divides all soils into "vulgar or pretious", the former being of agricultural importance, the latter of value for minerals.

Otherwise he follows the common arrangement into clay, mould, moor, sand, etc. He also realized that the subsoil was important and recommends its examination.

Evelyn in his Philosophical Discourse of Earth (1675) quotes Virgil with approval, expands the handling test and discusses the effect of colour of soil on its properties. He quotes Kircher (1665) as giving the number of soils (terrae) as 479,001,600, but remarks that, in fact, only some eight or nine are described. Kircher was actually considering not only agricultural soils, but medicinal and industrial earths as well, and to arrive at this vast number he combined the various kinds of consistence (9) with colours (8) and taste (6) to obtain factorial 12 (12!). The eight or nine agricultural soils correspond in part to those described by Virgil.

Evelyn touches very lightly on the subsoil and says little about its possible effect on aeration and drainage. However, he was probably the first to employ a microscope for the examination of soil. Robert Plot in his Natural History of Oxfordshire (1686, p.52) showed that he appreciated the importance of both subsoil and topsoil, but gives very little information on the soils of Oxfordshire or of Staffordshire in his later work. He remarks that "more possibly might have been added ... and not a little instructive to the farmers of the country, but I found most of them froward and to flight my enquiries; let them therefore thank themselves if I am not so obliging." He therefore concentrated on earths that were more useful in trades.

The committee of the Royal Society made no proposals for recording the soil information on maps, but in 1683 Dr. Martin Lister presented the Society with "An Ingenious proposal for a new sort of Maps of Countries, etc." which included both soils and rocks. It is not certain that he meant soils in our modern sense for he is careful to define earth as "such a mixture as we usually find upon the surface of the ground, which hath ever in it, besides, such Sands and Clays as either the Soyle naturally produces a great part of the rotten parts of Plants and Animals". It was left to the writers of the General Views on Agriculture, commissioned at the end of the 18th century by

the Board of Agriculture, to make the first attempt to produce soil maps and to provide many reasonably detailed descriptions of the soils of the counties according to the older nomenclature. Some of these maps give a good representation of the distribution of soil types in terms of sands, loams, clays etc., others appear to have reflected land use rather than soil differences, whereas some would today be termed geomorphological maps.

A comment by one writer is of interest: "When I began to inspect the land it was my intention to represent by a map, the mixture and connexions of different soils, but having upon experiment frequently found that one and the same parish produced four or five different soils, nothing but a particular survey could have answered the purposes of delineation ..." (Stone, 1794). This may be compared with the remark by the writer on Hertfordshire: "These soils have been indiscriminately scattered by the hand of nature all over the face of the county ..." (Walker, 1785). Arthur Young, however, was not deterred by this scatter and produced for his "View of the Agriculture of Hertfordshire" a soil map which shows the broad pattern of soil distribution: the soils of the Chiltern plateau, the loams and gravels of the Lea Valley, the clay soils of the eastern, chalky boulder clay area, and of the London clay in the south, finally the thin chalky soils in the north-eastern corner of the county (Young, 1804). Perhaps the most outstanding of the various writers of the county surveys was Charles Vancouver, an American by birth, who contributed accounts of Cambridgeshire, Essex, Sussex, Devon and Hampshire, all containing soil maps.

Few of the earlier Scottish reports contained soil descriptions and at least one reporter was at pains, like some of his English colleagues, to point out that "few things are more difficult than to give such a description of soils, as to convey any accurate ideas to those for whom it was intended" (Anderson, 1794). Several of the later editions and revisions contained soil maps, but some were content simply to indicate arable, pasture and heath.

No further attempts at surveying soils seems to have been made until the turn of the 19th century when D.A. Gilchrist and his colleagues at Reading published their investigations on the soils of Dorset.

Unfortunately, in this work and all the subsequent studies up to 1926, it was assumed that the correlation between soils and geology was good enough for the solid or drift maps of the Geological Survey to serve as the foundation of the soil map (e.g. Gilchrist *et al.* 1899; Hall and Russell, 1911; Newman, 1912; Robinson, 1916-17).

Although several of these writers appreciated the importance of subsoil characters, soil drainage, and climate, and one attempted to use the U.S. soil series system of classification (Rigg, 1916), none appears to have appreciated the possibility of using soil morphology as an aid to mapping soils. The soil profile phase did not begin until 1920 following a visit to the United States by W.G. Ogg (Ogg, 1920).

In 1919 a soil survey subcommittee of the Development Commission, with co-opted members, reviewed the need for a soil survey of Britain and the possibility of making soil maps. Suggestions were in the main directed to the improvement of geological maps and one distinguished soil scientist went so far as to suggest that pedology would be best treated as a branch of geology. However, after both Ogg and Robinson visited the United States, where great strides had been made in preparing soil maps, and when Russian soil literature became accessible, it became clear that any soil survey should be undertaken by an independent body. There appears to have been unwillingness on the official side to set up a properly organized survey, but a beginning was made by appointing assistants, whose work would primarily be soil mapping, to the chemists at various advisory centres. In view of the general interest shown in this question a Soil Survey Conference was instituted in 1926 and the first meeting held at Harper Adams Agricultural College. A demonstration of mapping on a soil profile basis was given by G. Newlands and W. Dow and the first of the modern soil series maps was that of the Harper Adams farm. Further meetings of the Soil Survey Conference and its Mapping Committee soon established a standard system of soil description and methods for recording the soil series and types on the maps.

G.W. Robinson and his colleagues began the systematic mapping of Welsh soils in 1925, at first mainly on a geological and texture basis, but in 1927-8 the U.S. system of series and types was adopted, using the profile as the unit of classification. Elsewhere mapping was on a more limited scale, but by 1930 surveys were also being done in South-east

England and Oxfordshire, and in the advisory provinces of Bristol, Harper Adams, and Cardiff. Mapping had also begun in the Lothians and Aberdeenshire.

As there was no central organization a small Soils Correlation Committee was appointed in 1930 to visit the areas in which mapping was being done to correlate the work and, as far as possible, to ensure uniformity in methods, nomenclature and classification. The Committee's first tour was to various English centres in 1930, a second to Scotland in 1932 and a third, again to England and Wales, in 1935. The Committee contributed much to the progress of soil surveying and, together with the annual Field Meetings, which brought the surveyors together, helped to standardize techniques. A feature of the early Field Meetings was the mapping of the same area independently by different surveyors. This exercise always led to much discussion but gave the surveyors confidence in their methods because different surveyors produced substantially similar maps.

In 1936 the Soils Correlation Committee was replaced by the Soil Survey Executive Committee with more authority but essentially similar functions. In 1939 the Soil Survey of England and Wales was formally recognized and the late Prof. G.W. Robinson appointed Director. The surveyors were then directly under his supervision, but continued to work from their own centres. At that time the full-time staff consisted of 6 surveyors, two in Wales and one each at Harper Adams, Reading, Long Ashton and Wye.

In Scotland, after the Macaulay Institute for Soil Research was started in 1930, the bulk of soil mapping was done from Aberdeen, but some was continued in the West of Scotland College area.

The reorganization of the agricultural advisory services in 1946 resulted in the headquarters of the Soil Survey of England and Wales being transferred to Rothamsted. The Scottish Survey remained as a department of the Macaulay Institute. Both Surveys have since expanded and there are now 12 surveyors in Scotland and 21 in England and Wales. Owing to lack of accommodation at Rothamsted only three surveyors are stationed there, the remainder being based mainly at the regional centres of the N.A.A.S. (Newcastle, Leeds, Ormskirk, Derby, Wolverhampton, Cambridge, Bristol, Reading, Wye, Starcross and Cardiff).

The earlier workers assumed a fairly close connexion between geology (solid or drift) and the superjacent soils; although this must always be true to some extent, because the rock material has been converted into soil, the geological map may not bring out the features of the rocks in which the pedologist is interested. This was strongly emphasized in the early proposals for a soil survey, when most of the soil chemists wished for improvements in the drift maps which it was thought could be the basis for soil maps. However, factors other than geology are also concerned in the formation and use of soils: climate, relief, vegetation and time. Soil under natural conditions is the resultant of the actions and interactions of all these factors on a parent material, and in a country like Britain cultivation over many centuries introduces a factor which often considerably modifies the connexion with geology, and may well confuse the picture.

The unit used in the present method of characterizing soils for mapping is the soil profile, the vertical section of the soil from the surface down to what can be considered the parent material or, in some cases, to an arbitrary depth. When a profile is exposed there is usually some visible stratification, although it may be slight. The layers that can be distinguished are called horizons. Among the properties described for each horizon are: texture, colour, structure, consistence, secondary chemicals (e.g. carbonates, iron oxides) and faunal activity, all of which can be fairly readily determined in the field visually, by handling, or with the aid of simple reagents such as dilute acid or pH indicators. Other data relevant to the profile, such as the degree of apparent leaching and parent material, are also recorded. Soils having the same general profile characters and formed on the same or similar parent material belong to the same soil series.

Whenever possible in large scale mapping (e.g. at 6 in. to 1 mile) the soil series is the mapping Unit. For special purposes, including experimental farms, maps have been made at the scale of 25 in. to 1 mile when more detail can be shown. The earlier detailed soil surveys in Britain were made at the scale of 6 in. to 1 mile; recently there has been a change to mapping at $2\frac{1}{2}$ in. to 1 mile to increase the rate of survey. Because of rapid variations in relief, which is frequently associated with changes in soil drainage, or in parent material

such as alternating beds of sand and clay, it is often necessary to use larger mapping units, complexes or associations, particularly when a reconnaissance survey is being made at a small scale. Soil series, complexes and associations are usually given locality names.

In reconnaissance mapping the series that can be recognised are, if necessary, grouped into convenient units, these being decided by their occurrence in the field. Thus the area of a given parent material may have an undulating relief giving rise to an alternation of well drained and poorly drained soils, or the parent material may vary rather regularly with relief, when the mapping unit will be the land form which would contain a known variety of parent materials and the corresponding soils.

The soil series are naturally of local importance, though several square miles may be covered by one series, but it is possible, in the light of Russian and other work, to group them in larger classification units, known in Britain as Major Soil Groups. Some of the names used are of foreign origin, e.g. podzol and podzolic soils, or are translations, e.g. brown earth from Braunerde (German). The realization that climatic zones and vegetation zones can be correlated with larger units of this nature enabled Dokuchaiev in 1900 to publish a soil map of the world which was quite a remarkable piece of interpretation from the existing information

When a soil surveyor starts work in a new area he will familiarize himself with the terrain, land use and agricultural and forestry practices. This he does while making traverses, digging small pits, making borings and examining any sections visible. At the same time he notes correlations of soil with relief or vegetation and even with agricultural practices (e.g. shape of fields) which may point to important soil differences. Such correlations speed up the rate of mapping later. Having decided on what appear to be the main soil series or mapping units, the surveyor starts detailed mapping using a 6 in. to 1 mile map as base map. The lines followed during survey will be determined by whatever connexion has been found between soils and other circumstances, of which relief is one of the most important. In

flat land, such as the Fens, the work is slower and more tedious, as many inspections are needed. Soil boundaries are rarely sharp, but as soil differences are found the positions of the changes are marked on the map and are eventually used in delimiting the series.

The soil maps as published (1 in. to 1 mile) show soil series or other suitable units which, in the legend, are arranged according to major soil groups and sometimes also according to their parent materials. This information, together with an indication of the drainage status of the soils (free, imperfect, poor, very poor) enables the soil conditions in a given area to be pictured from an inspection of the soil map.

Soil maps, on a soil series basis, have been made in many parts of Britain, although only about 20 per cent of the country has been mapped in detail. The largest single area is in North Wales and reflects Robinson's activity and influence. In Scotland the North-east has now been completely mapped. Elsewhere large blocks of country have been mapped in southern Scotland, covering Ayrshire, Roxburgh, Berwickshire and parts of the Lothians. In England much of Lancashire has now been surveyed, parts of Yorkshire, Northumberland, Hertfordshire, Cambridge, Shropshire, Somerset. Smaller surveys have been done in Romney Marsh and the W. Sussex coastal belt.

An explanation of the 1 in. maps is published in the form of a memoir, which describes both the environment and the soils, and includes sections on agriculture, forestry and other forms of land use.

As the soil series takes account of the surface and of the sub-soil to some depth, the soil maps, although produced within an agricultural setting, are of much more general use than the older ones that recorded surface texture only.

The value of a soil survey was appreciated early in connexion with specialized crops such as fruit, and districts surveyed included the Vale of Evesham, parts of Hereford, Worcester, Berkshire (the Vale of the White Horse) Kent and Hampshire. In the earlier of these surveys no soil map was made but careful identification of soil series made it possible to observe "to what extent the growth, character and fruiting habits of trees growing in the area can be correlated with soil factors"

(Wallace et al. 1931). Such surveys gave much help in advisory work and pin-pointed many of the problems involved in fruit-growing. The provision of soil maps in the later surveys (e.g. Wright & Ward, 1929; Osmond et al. 1949; Kay, 1934, 1939) enabled the distribution of problem soils to be seen at a glance and greatly enhanced the value of the work. Such surveys showed the practical importance of soil mapping, but others were made in areas where their application was less immediate. G.W. Robinson, with his assistants and students, mapped large areas in N. Wales, the results being published briefly in the Welsh Journal of Agriculture. Recently much of this work has been revised and published by the Soil Survey of England and Wales.

W.M. Davies and his colleagues extended their mapping to cover the Wem district of Shropshire. In Scotland much of the surveying between 1930 and 1939 was done on forest land with a view to establishing correlation between tree species and growth and soil type, but a large area of agricultural land in central Aberdeenshire was also mapped. During the War the development of the newer ideas on town and country planning led to demands for more reconnaissance surveys, and much work was done in the Central Valley of Scotland and in the West Midlands and the Bristol area of England. Requests for soil maps for planning purposes are still frequent and prove very valuable in retaining land for agricultural purposes. The maps have also found their use in the planning of industrial development, e.g. the winning of glass sand, where it so happens that the quality of the sand is determined largely by pedological processes.

Soil survey in Britain originated from the demands of agricultural advisory work and many of the earlier surveys were made by the soil chemists and their assistants. The connexion is still maintained through the Survey's Regional offices and the chemists and surveyors work closely together. The Survey has made soil maps of all the Experimental Husbandry Farms as well as the farms of most research centres and agricultural institutes. It thus provides the basic information on the soil which will enable correlations to be made between experiments at different places where the soil itself is the dominant factor.

Perhaps the most general use of any soil survey is that it places on permanent record in map form the distribution of the various kinds of soils classified according to current ideas. There is no doubt that others than the surveyor often have a more intimate and detailed knowledge of the soils of a restricted area, but that knowledge is uncoordinated and unsystematized, and, of more importance, it is not generally available. Much more detailed study of the different soil series is still required before generalizations about their individual behaviour can be made, but the provision of soil maps should facilitate such generalizations.

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