

THE USE OF PHOTO INTERPRETATION FOR DETAILED SOIL MAPPING

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Abstract To evaluate photo interpretation for soil mapping at the scale 1 : 10,560 a photo-analysis was carried out, followed by normal field mapping, the object being a comparison of the resultant maps. The region involved consists of dissected sediments, considerably affected by solifluction. Two field sheets were chosen, covering a total of 3100 hectares, epitomising conditions found in the London syncline. The final map from photo analysis was a fusion of a slope map with a map of land use, parcelling and other cultural features likely to serve as a guide to the soil pattern.

The greatest divergence was found (1) where soil boundaries occurred with no visible landscape change, (2) where interpretation boundaries occurred without a soil change, and (3) where a soil boundary was wrongly delineated owing to rounded solifluction features. The least divergence was found on the Thames alluvium and floodplain terrace. Depositional land forms appear to be more favourable to photo interpretation than an erosional landscape. Solifluction terrain is difficult due to its gentle slopes and rounded forms, particularly in areas of unconsolidated sediments. Excepting possibly areas of uniform and clearly defined physical characteristics, with an intensive agriculture, soil mapping at 1 : 10,560 is too detailed to benefit from photo interpretation.

Résumé Afin de pouvoir apprécier la valeur de l'interprétation photographique dans des levés pédologiques au 1 : 10.560, il a été effectué une analyse photographique suivie par une prospection conventionnelle sur le terrain. On a comparé ensuite les deux cartes en résultant. La région en question consiste de sédiments disséqués et considérablement affectés par la solifluction. Il fut choisi deux secteurs d'une superficie totale de 3100 hectares, réunissant les diverses conditions rencontrées dans le synclinal de Londres. La carte définitive d'analyse photographique consistait en la fusion d'une carte des pentes avec une autre d'utilisation des terres, de parcellement et d'autres phénomènes agricoles susceptibles de différencier les sols. On a observé les divergences maxima 1) lorsque les limites pédologiques ne se manifestaient pas sous forme de changement appréciable de paysage, 2) lorsque les limites d'interprétation ne correspondaient à aucun changement pédologique, et 3) lorsque les limites n'occupaient pas leur place correcte en raison de configurations arrondies de solifluction. Quant aux divergences minima, elles apparurent dans les terrasses alluviales et la plaine d'inondation de la Tamise. Il semble ainsi que les paysages de dépôts conviennent mieux à l'interprétation photographique que ceux d'érosion. Les terrains de solifluction présentent des difficultés à cause de leurs pentes douces et de leurs formes arrondies, tout particulier dans les secteurs à sédiments non consolidés. Sauf dans les régions à caractéristiques uniformes et clairement définies et à agriculture intense, la cartographie des sols au 1 : 10.560 est trop détaillée pour bénéficier de l'interprétation photographique.

Zusammenfassung Um den Wert der Photo-Interpretation für die Bodenkartierung im Masstabe 1 : 10.560 beurteilen zu können, wurde eine Photo-Analyse mit nachfolgender, normaler Geländearbeit ausgeführt, um die beiden resultierenden Karten mit einander vergleichen zu können. Die betreffende Region besteht aus durch Erosion zerfurchten Sedimenten welche starkem Gekrieche unterworfen sind. Zwei Kartenblätter wurden gewählt, ein Gebiet von 3100 ha. umfassend, welches die Verhältnisse im Londoner Becken versinnbildlicht. Die endgültige Karte der Photo-Analyse war eine Verschmelzung einer Geländeformkarte mit einer Karte der Landnutzung, Parzellierung und anderer Kultur-Erscheinungen, welche wahrscheinlich einen Hinweis auf das Bodenmuster liefern könnten.

Die grösste Divergenz wurde gefunden 1) wo Bodengrenzen ohne sichtliche Veränderung des Landschaftsbildes auftraten; 2) wo interpretierte Grenzen ohne Änderung der Boden-

beschaffenheit auftraten; 3) wo eine Bodengrenze fehlerhaft kartiert worden war, u.zw. infolge der Rundformen des Gekrieche. Die geringste Divergenz zeigte sich im Thames-Alluvium und auf der Terrasse des Überschwemmungsgebietes. Es scheinen somit Absatz-Landformen für die Photo-Interpretation geeigneter zu sein, als Erosionsformen. Gelände mit Gekrieche ist infolge seiner sanften Hänge und rundlichen Formen schwierig zu bearbeiten, u.zw. besonders in Gebieten nicht-verfestiger Sedimente. Mit der möglichen Ausnahme von physisch deutlich gekennzeichneten Gebieten mit intensivem Landwirtschaft, ist der Masstab 1 : 10.560 für die Bodenkartierung zu gross, um aus der Photo-Interpretation Nutzen ziehen zu können.

It has been commonly accepted that photo interpretation for soil mapping on a large map scale, for instance 1 : 15,000 or more, is impracticable or uneconomic. The object of this work was to test the practicability of photo interpretation as an aid to soil mapping at 1 : 10,560, carrying out first a photo interpretation of a test area followed by a normal soil survey without reference to the photo interpretation, and then comparing the results. Two sheets were chosen, covering a total of 3,100 hectares (12 square miles) which together reflect the geology, geomorphology and land use of a large part of the London Basin. The rocks consist of Eocene clays overlying chalk: the region is much dissected and the land forms comprise plateau and river terrace surfaces which have been considerably affected by Pleistocene solifluction.

Two maps for each sheet area were prepared by interpretation of the air photographs, showing respectively physiographic and relevant cultural data, and two further maps were then constructed to show coincidence of boundaries between these and the soil map. The map of relevant cultural data portrays those elements of the cultural landscape which may provide clues to the soil pattern: these include types of land use; intensity of agricultural use; parcelling – that is, the distribution of enclosures according to shape and size; and the distribution of excavations for clay, chalk and gravel, which are often distinguishable separately. The soil survey was carried out as part of the routine work of the Soil Survey of England and Wales.

The area of Sheet 1 comprises relatively high land near the headwaters of minor streams. The physiographical interpretation is presented as a map of land forms (FIG. 1). The duplicated consequent drainage pattern parallel to the strike, and the pinnate pattern of subsequent streams, are immediately apparent. The divisions comprise 1. broad interfluvial summits, usually cambered into a slight convexity, 2. gully bottoms, 3a. intermediate slopes, with 3b. steeper bluffs in places, 4. the level land of the major valley in the south east, and 5. the steep slopes bounding this valley to the north. The cultural interpretation of Sheet 1 (FIG. 2) reveals a division into predominantly arable and predominantly grass, the former being further sub-divided into areas with large fields (with one zone of rectangular field pattern), and areas with smaller, less regular fields. Heath is divided according to tone, with a further minor type – heath with trees.

To what extent are soil boundaries reflected by the photo interpretation? FIG. 3 shows the physiographical photo interpretation and soils coincidence map for Sheet 1. Similarities between soil and slope boundaries are recognis-

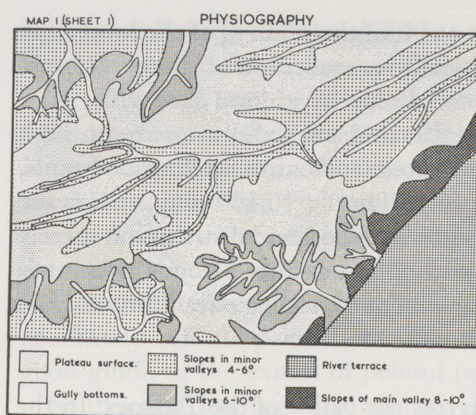


FIG. 1.

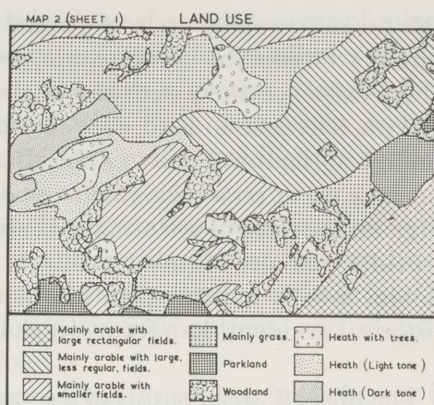


FIG. 2.

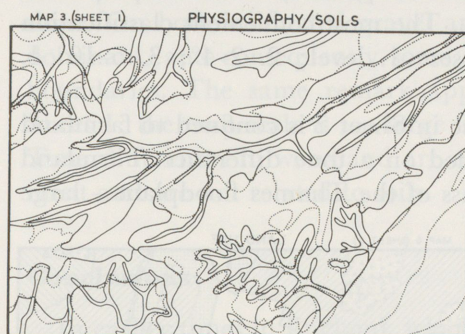


FIG. 3.

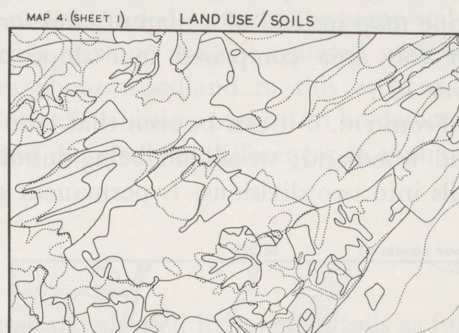


FIG. 4.

able, the greatest coincidence occurring at the highest and lowest levels – bounding the main valley floor and the highest terrace surface. Between these areas of good agreement the many slope boundaries vary in their approximation to soil boundaries. In the north west the steeper bluffs mark an outcrop of Ypresian clay, bearing a distinctive soil type, whose boundaries coincide well with slope boundaries. The land use boundaries reflect the soils to an even smaller extent (FIG. 4). Heathland tone differences are unrelated to soils, being the result of human interference such as burning. The boundaries of farming patterns are the most useful, though they do not agree well with soil boundaries. There is a close coincidence between the boundary of the two main arable divisions and a soil boundary.

What are the reasons for these divergences? The chief factor is Pleistocene solifluction: by this process, material on certain slopes has moved from higher outcrops. Thus, for example, a soil on a Cuisian plateau surface may continue down adjacent slopes, although these slopes are due to the presence of an outcrop of Ypresian clay. Only where there is no solifluction deposit does the soil typical of Ypresian clay appear, and such places may not be distinguished by a change of slope. Other important soil variations which are not reflected by a change in slope occur on a plateau surface: here different soil parent mate-

rials are outcropping on level ground as a result of the planing of the landscape during a Pleistocene erosion cycle, giving rise to a succession of three soil types whose existence and extent can be determined only by ground survey.

With reference to land use – woods, heaths and parkland are rare on high quality agricultural soils *i.e.* level land with deep loamy welldrained soils, but may occur on a wide range of poorer soils. The 1 : 10,560 map scale is too large for the recognition of a distribution pattern. Woodland distribution merely provides evidence of varying value in support of that deduced from agriculture. Heaths usually indicate poor land, but their boundaries here result more from historical accident than from soil change.

The Sheet 2 area consists of a section across the valley of the Thames. In the physiographical interpretation (FIG. 5) the large areas of even slopes and the lack of geomorphological definition, at this map scale, led us to prepare a slope map instead of a map of land forms. The most convenient classification for this area comprised four slope classes: 1. level; 2. 2–4°; 3. 5–10° 4. over 10°.

From FIG. 6 it can be seen that land use in Sheet 2 is confined to farmland and woodland; woodland being subdivided on a tone difference. Farmland falls into two divisions, 1. permanent grass of the Thames floodplain – large

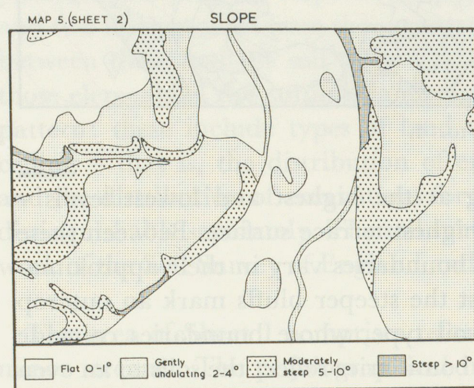


FIG. 5.

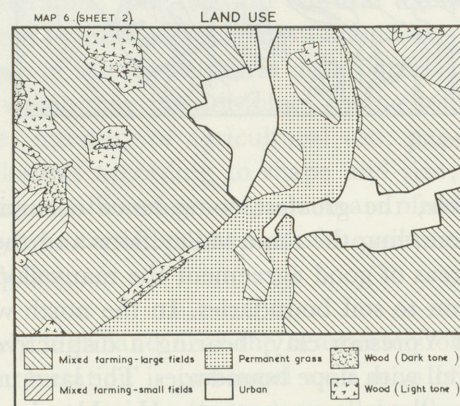


FIG. 6.

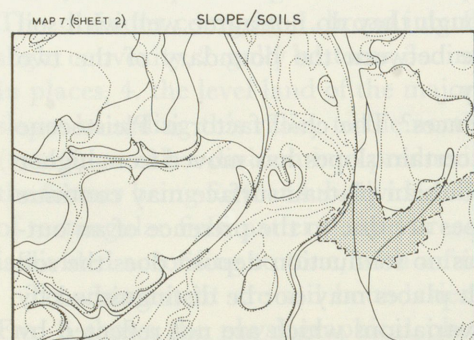


FIG. 7.

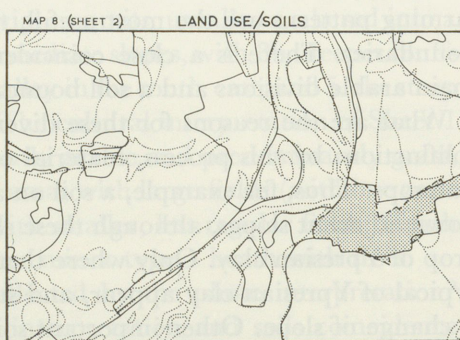


FIG. 8.

fields with boundaries along ditches and side channels; and 2. areas of mixed farming, comprising a. areas with large fields with straight boundaries of wire fences or small well-kept hedges, and b. areas with a greater proportion of grass, having smaller irregular fields, often with thick overgrown hedges. Numerous pits occur in the Sheet 2 area, and were used as evidence to support boundaries inferred by physiographic and/or cultural changes.

FIG. 7 shows the physiographical photo interpretation map together with the soil map. A close resemblance between the distribution of slope and soils is apparent in places, but some boundaries are not correlated. Land use (FIG. 8) accurately reflects part of the Thames floodplain soils pattern, and is also a good guide to the extent of pelosol pseudogleys.

Solifluction has been an operative factor in this area also, but whereas in Sheet 1 solid geological materials were involved, in Sheet 2 the main effect of solifluction has been the degradation of river terraces into a continuous gentle slope. On both soliflucted gravel and non-degraded terraces the same soil is dominant, and consequently some breaks of slope are not equated with soil boundaries. The same remark applies about woodland in this area as in Sheet 1; the map scale is too large for any distribution pattern to be detected. Tone differences in woodland are mostly the result of differences in management and are not related to soils.

Conclusions

In earlier times in England, when each parish used its range of soils as fully as techniques allowed, it is likely that the landscape reflected soil conditions far more completely than today. From the 18th century onwards the growth of industry, the migration of labour to the towns, the competition from agriculture in the new lands overseas, and the gradual increase in prosperity, have all contributed to the complexity of the rural landscape. In the 18th and 19th centuries many large houses were built in this part of England, surrounded by parks in which trees were sited, land was laid down to grass and in some places even hills and valleys were made; purely for aesthetic reasons and with little regard to soil conditions. Many woods have also been planted for game preserves, in long rectangular shapes suitable for conducting pheasant shoots – again with little regard for soil type. It is clear that an intimate knowledge of the physical and cultural characteristics of this landscape is necessary, including its economic history. Economic development is important; for example, in an economically less advanced country with a higher rural population density, the land use pattern would probably more clearly reflect the physical conditions, and tone differences would occur in a more regular fashion.

Where either solid or superficial geology result in the juxtaposition of marked differences in slope or land use, the interpretation can be made in terms of soil information. Where, however, land forms are not marked or land use is mixed, interpretation for use in soil mapping is much less conclusive. On the whole, greater accuracy was achieved in fluvial rather than in erosional

terrain. Patterns were much more distinctive in recent alluvial and floodplain terrace areas than elsewhere.

In general, however, the cartographic scale is too large: the discontinuity of the various features of the landscape – its diverse geology and land use – makes its basic character apparent only at a smaller scale.

Discussion

Ing. PASCAUD (France): What was the scale of the photographs used and what was the density of observations in the conventional soil survey? *Answer:* The scale was 1 : 12,000; the density of field observations varied between 1 boring per 2 to 4 acres.

MR. TOMLINSON (Canada) asked what was the ratio between time spent on photo interpretation and time spent in the field. *Answer:* Photo interpretation took only about 14 hours of office work.

Mr. P. JONGEN (France) remarked that in Africa south of the Sahara photo interpretation on scales 1 : 10,000 to 1 : 20,000 is made before the field work is carried out, so that a more rational choice of field observations may be made. After the field work has been carried out, the photo interpretation makes it possible to draw the soil boundaries with a greater precision. In this system the density of field observations is 3 observations per 10 ha for maps on scale 1:10,000 and 1 to 2 observations per 10 ha for maps on scale 1:20,000.

Mr. L. F. CURTIS (U.K.) commented that before detailed mapping begins it is usually necessary to carry out a reconnaissance survey. In a reconnaissance survey of North Kelsey and South Kelsey, Lincolnshire, it was found that photo interpretation greatly aided the work. Thus photo interpretation may be useful in the early stages of a detailed survey. Mr. JARVIS replied that he is now changing over to more reconnaissance mapping.

Mr. R. WEBSTER (U.K.) noted that Mr. JARVIS finds air photo interpretation more difficult in erosional than in depositional landscapes. The soil boundaries in erosional landscapes are frequently more diffuse, and not only because of solifluction. Bearing this in mind, does the speaker think that it is possible to predict, reasonably confidently, the nature and sense of change in soil conditions in terrain of this type, even though it is not possible to draw boundaries with certainty? Mr. JARVIS answered that, owing to the diverse nature of the superficial deposits, he has found it difficult to do so.

Dr. R. M. S. PERRIN (U.K.) wished to emphasize the danger of using land use for soil predictions. The presence of a factory taking some particular crop, such as peas or sugar beets, often distorts the pattern over a large area. Would the author or Dr. VINK care to comment further? Mr. JARVIS remarked that land use is dependent on so many factors in England, that it is not a reliable guide to soil conditions. Dr. VINK (W.G. chairman) remarked that land use is certainly a guide to soil conditions, but that the actual land use boundaries always diverge from the soil boundaries. Therefore he uses land use as an "element of interpretation", but wherever possible in combination with one or more elements of a morphological nature.