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W. Gordon Collins

Leslie Gibson

Remote Sensing Unit,
University of Aston in Birmingham (U.K.)

# DERELICT AND DEGRADED LAND SURVEYS: AN EVALUATION OF THE COST EFFECTIVENESS OF AIR SURVEY METHODS

Abstract

The Remote Sensing Unit at Aston University has developed an operational system for identifying, mapping and measuring derelict land for various County Planning Authorities in the U.K.

This paper investigates the comparative usefulness and costs of carrying out regular surveys of derelict and degraded land by i) field methods and ii) air photo methods.

The substantial advantages of air survey methods are reviewed, to show that the field survey located only 87% of the sites, cost between 4.5 and 8.5 times as much, and took nearly 12 times as long as the equivalent air photo based survey.

National Surveys of Derelict Land

Historical development: Since 1964 all local authorities have been required by national government to submit returns of the amount, and to some extent the type, of derelict land found within their administrative area. The first survey was initiated by the Ministry of Housing and Local Government (M.H.L.G.) and covered England and Wales, while subsequent surveys were the concern of the Welsh Office for Wales, and the M.H.L.G. (Department of the Environment after 1971) for England.

Other, and perhaps more significant changes which have taken place concern the form of the survey and the nature of the information which was recorded. Until 1969 in Wales and until 1971 in England, the data which were required consisted of the following:

1. the amount of derelict land at the end of the survey year (including those acreages justifying treatment and landscaping).
2. the amount of derelict land treated during the survey year (including areas reclaimed or landscaped).
3. the amount of derelict land to be reclaimed in the year following that of the survey (including areas to be landscaped).

Each of the above were subdivided into only three categories: "spoil heaps", "excavations and pits" and "other forms of dereliction", and all figures were given to the nearest acre.

These 'basic category' surveys were based on a definition of derelict land as being "land so damaged by industrial or other development that it is incapable of beneficial use without treatment" (M.H.L.G. 1964).

In addition the purpose of the surveys was "to ascertain the amount of such (derelict) land which in the opinion of the local authorities justified rehabilitation and which was unlikely to be treated except by the authorities or other public bodies" MHLG (1965)

More specifically Oxenham (1969) stated that the aim of the surveys was to determine the amount of dereliction likely to rank for grant aid, although he conceded that it was essential from a technical standpoint to know the total extent of dereliction in order to plan a comprehensive programme of reclamation.

Those planning authorities and research workers most concerned with the problems of dereliction, however, whilst agreeing with the aim of the survey, felt that the government definition was too narrow. The reasons for this were that under a list of exclusions to the definition, active areas of industrial land use were not considered, and certain types of land use which to all intent and purpose seemed derelict (e.g. war-damaged land and War Office areas) were also excluded. It was felt that this led to a gross underestima-

tion of the total problem and consequently reduced the amount of available grant.

In a sample area of the West Riding of Yorkshire, for example, it was found that the total area of spoiled land which should be considered was four times that figure regarded as derelict for Ministry purposes (Bush and Collins, 1973). The Nottinghamshire and Derbyshire Sub Regional Study indicated that an area of 2,350 hectares (ha) was a more realistic estimate than the officially recognised 1,540 ha, while Monmouthshire thought the area of dereliction should be almost twice as great as that officially accepted (Notts./Derby 1969; Welsh Office 1972, respectively). Even a report on the reclamation and clearance of derelict land for the second "Countryside in 1970" conference, whilst using the Government definition for ease of data collection, agreed that the official figures indicated only the "hard core" of the dereliction and that the true amount could easily be twice as much (Study Group 12, 1965).

The significance of this dissatisfaction and the later increase in greater environmental concern, is that changes were subsequently made in both the concept of dereliction and the survey procedure adopted in its survey. Although the Welsh Office led the way in 1969 when the original survey was discontinued, the Department of the Environment (DOE) followed suit in 1971, with a survey designed to take effect from 1st April, 1974: the inaugural day of the local government reorganisation! The new survey still contains room for improvement, but this will be discussed later in the context of the West Midlands survey.

The 1974 survey of derelict land in England: In their revised and greatly extended survey, the DOE included many categories of dereliction previously excluded, and also considered active surface mineral workings and refuse tipping. More emphasis was given to the existence (or lack) of restoration conditions, and provision was made for explaining any increases in dereliction from one period to another. (Previously this latter information might be disguised by reclamation figures). The greater level of detail which was required is indicated by the fact that active surface mineral workings are subdivided into mineral classes and not merely termed "excavations and pits" as used for derelict workings. Thus the survey placed the problem of dereliction in its broader context of mineral planning, waste disposal and reclamation.

Although the amount and type of data required was more comprehensive than before, many authorities undoubtedly carried out their surveys in the manner to which they had become accustomed, utilizing ground survey methods, relying on the knowledge of staff and incorporating data held in the planning office. Others such as the West Midlands, and Merseyside Metropolitan County Councils probably realized that the staffing and financial input into the extended survey could not be much greater than for the earlier, less demanding surveys, and that the time spent in collecting the

new data should not unduly interfere with the workings of the planning departments. Consequently an efficient and speedy, but accurate survey method was required.

Past research and experience had shown that the use of aerial photographs would satisfy these requirements and it was in this context that the Remote Sensing Unit at Aston undertook to carry out the first derelict land survey for the West Midlands County Council using air survey methods.

Aerial Photography and Derelict Land Surveys: Although aerial photographs have been used for quantitative surveying for the production of maps and plans (see Belling, 1966, for example), there is little evidence to show their use in qualitative survey work. A survey by Denton (1973) which attempted to establish the degree to which aerial survey was used by local planning authorities in Great Britain, showed that 45% of those authorities which had used aerial photography in the five years preceding his survey, had done so in relation to derelict land studies and that this application was eighth out of a total of nineteen listed. The relative importance of photographs for such a use is recorded as being considerably greater in Scotland, but in all cases there is no indication as to the exact nature of the usage.

The West Midlands Derelict Land Survey

Survey classification: A first step in preparation for the survey was to decide which classification of derelict land would be used. In the light of experience gained by the Remote Sensing Unit in surveys of this nature and considering the requirements of the County Council, a suitable classification was derived after consultation between the Unit and representatives of the County Planning Department.

The data which were to be collected are as set out in Table 1 and relate mainly to site location, its area, the nature of the dereliction or active working found within the site, the nature of any vegetation cover and the type of surrounding land use. Most classes are reasonably self-explanatory but several require further explanation.

The first four sub-divisions of "Type of dereliction" are categories which relate specifically to the DOE survey classification while the remaining sub-divisions are partly included in the Department's "Other forms of dereliction". The notable exception is "Neglected waste land" which is not included by the DOE, but which is of great significance to the West Midlands County. Such land has been described by Wood (1976) and includes,

(a) areas damaged by development, either past or current which is subject to planning conditions or other arrangements providing for after treatment (including land currently being worked for minerals but having inadequate restoration conditions and accordingly land which is likely to become officially derelict at some future time).

(b) land in temporary use ancilliary to current industrial

or other recognised use

(c) land damaged by development and abandoned.

The importance of "Neglected waste land" or "waste land" to which it is subsequently referred, is discussed later.

The "Wet or dry" class of the derelict land classification refers to standing water present on sites and excludes natural and man-made drainage channels. Such "ponded water" may have resulted from breaching the water table level, particularly in excavations, or by inhibiting the natural flow of water through the soil (if present) or sub strata. Whether the site is wet or dry is most significant since it will influence the use to which a site can be subsequently put, especially if tipping is being considered.

The "Vegetation type and cover" is also significant to the reclamation and after use of sites, since such data will suggest;

(a) whether any "cosmetic treatment" is needed if the site is not to be assigned a specific use

(b) whether there is sufficient vegetation to complement any landscaping work inherent in a development scheme

(c) whether there is sufficient cover to screen any temporary but environmentally detracting activities such as waste tipping

(d) the degree of stability of spoil heaps

(e) the nature of any underlying soil i.e. whether the soil is well established, free from toxic substances, well drained etc.

The "Surrounding land use" will have a large influence in deciding the after use of a derelict site. For example, developing a site which is in a residential area, for amenity or community purposes, may well be more desirable than establishing an industrial estate. Conversely, industrial re-development in an industrial area may be more appropriate than building houses. The areal extent of the site will also be significant.

The geological sub-divisions (class 12) relate to those listed by the DOE for describing the nature of mineral workings. Sub-divisions which are not shown are not present in the West Midlands and are, therefore, not included in this particular classification. This listing could be obviously adapted, however, for surveys of other counties where other minerals are significant.

The final class of "Access points" is important in considering excavations and pits for tipping purposes.

Other data sources: Having established the classification of the data that were to be collected, and obtained the necessary photographic converage of the county, it only remained to assemble the data sources which would supplement the air photo

interpretation. These were Ordnance Survey maps of 1:10,000 or 1:10,560 scale, depending on those areas which had been mapped at the new metric scale, and the Geological Survey maps of 1:63,360 scale.

Survey method: Using the resources outlined above, the Remote Sensing Unit survey team interpreted the aerial photographs, viewing them stereoscopically using Wild ST4 stereoscopes fitted with 3x and 8x binoculars and parallel guidance mechanisms. The data were originally recorded on acetate overlays placed over alternate aerial photographs and then transferred using a Bausch and Lomb Zoom Transferscope, to a transparent base map which overlay a 1:10,000 scale O/S National Grid map.

Survey Results: In the case of the county being considered, the total extent of the air photo based survey was 902 $km^2$, and extended across all or part of 52 O/S maps at a scale of 1:10,000, each map covering 5km x 5km.

A total of 2404 derelict and degraded land sites were identified, and the details of every site were recorded (Figure 1) and mapped in black (Figure 2). In addition many other sites were identified and mapped only - initially in blue. These sites were smaller than the 0.5 ha minimum cell size set for this survey.

The area of each site was measured and the total area for the county was 7,546 ha of derelict and degraded land.

Analysis: a) Air Photo based survey and mapping

| | |
|---|---|
| Area of Survey | 902 $km^2$ |
| Number of sites recorded | 2404 sites |
| Total area of sites recorded | 7546 ha |

Cost of data extraction, measuring, mapping and recording

£ 50 per 1 $km^2$ (902 $km^2$) = £ 45,100

Average costs (excluding flying and photography)

| | |
|---|---|
| 2.7 sites per 1$km^2$ | 67 sites per 25$km^2$ |
| 8.4 ha per 1 $km^2$ | 210 ha per 25$km^2$ |

(A single 1:10,000 O/S map covers 25$km^2$)

| | |
|---|---|
| £50 per 1$km^2$ of survey area | £ 18.5 per site |
| £50 per 2.7 sites | £ 6.0 per ha |
| £50 per 8.4 ha | |

b) Average cost of flying and photography £50,000

£55 per 1$km^2$ total air cover
£21 per site surveyed
£ 7 per ha for sites surveyed

The above figures assume that the photography is to be used exclusively for the derelict and degraded land survey. In the case of the West Midlands the photography was also used for a total survey of Potential Waste Disposal Sites, and for

a wide range of data collection and mapping tasks.

It is estimated that about one fifth of the total cost of the flying programme should be charged to the derelict land survey. This will reduce the above figures as follows:-

$11 per 1km$^2$ total air cover
$4 per site
$1.5 per ha for sites surveyed

c) Field Survey Costs: A total of five 1:10,000 O/S maps, each covering 25km$^2$, (i.e. 125km$^2$ in total) were chosen as a sample, and one fifth of each map i.e. 5km$^2$ was taken to determine the cost of carrying out a similar survey. This gave a total sample area of 25km$^2$. The O/S maps were used as base maps upon which to outline the location and extent of each site. Identical information was recorded to that of the air photo based survey.

The total cost for the 25km$^2$ sample survey included wages, travel, and subsistence allowance appropriate to the work. A total of 73 sites were located which extended over an area of 224ha costing $12,950.

The sample area of 25km$^2$ contained 73 sites which together totalled an area of 224ha which had to be field surveyed.

Comparison of costs: Table 2a details the comparative costs of carrying out the surveys. The costs of the field survey are compared with two different costings of the air photo based survey: one in which the entire cost of the flying is included, the other in which one fifth of the flying costs are included.

The results of this comparison clearly indicate the economic advantages of the air photo based system for mapping derelict and degraded land. It shows that field survey methods are between 4.5 times and 8.5 times more expensive than air photo based methods.

The precise value of this cost relationship depends on the unit being considered i.e. the total area of the County being flown and surveyed, or the cost per site identified, or the cost per hectare of the sites identified, measured and mapped.

There will also be variations in the contract price of the flying and the relative cost effectiveness of the field survey team. However, the results of this study provide a real live case, and broadly demonstrate the relative financial advantages of using aerial survey methods for identifying, mapping and measuring derelict and degraded land.

There are other additional advantages, including accuracy and speed. The air photo view is total and virtually unimpeded; very few sites of any significance are hidden from view. This contrasts sharply with a field survey where a restricted viewpoint and constraints of physical access do not permit a 'total' survey to be carried out.

These problems are evident when comparing the results of the field and air photo surveys of the 25km$^2$ sample area. The results (Table 2b) show that the field survey failed to locate

11 sites extending over a total area of 27ha. The field survey located only 87% of the sites identified from the aerial photography.

In terms of speed, the time taken to field survey the 25km$^2$ was 2,237 man hours. The time taken, by air photo interpretation, to extract and map the same area (but including the 11 extra sites) was 193 man hours.

This showed that the air photo survey was 11.6 times faster than the field survey, with the proviso that the time and delays of obtaining the aerial photography did not enter into the considerations as the County Authority supplied all the material when it became available.

Another major advantage in air photo based survey is that it provides a permanent, 'true', record of the field situation: a unique land/environment data bank, fixed in time and space. By carrying out aerial photography on a regular basis, it is possible to monitor more accurately the various changes which occur. Land use is dynamic, and for effective planning it is necessary to know not only what it is, where it is, and how much of it there is, but also its rate and direction of change.

Much of the work undertaken by the Remote Sensing Unit at the University of Aston has involved monitoring change. By the use of aerial photographs as a data source it is possible to compile a classification of a particular aspect of land use. This can then be applied to photography taken many years previously. This facility for carrying out surveys 'in retrospect' is rarely available in field surveys, where the original objectives, definitions and classifications of the units being surveyed are fixed, selective, and cannot be altered to supply the data needs of a current survey.

Although this paper deals with the surveying and mapping of derelict and degraded land, and clearly demonstrates the relative advantages of aerial survey methods, much of what has been written applies equally well to many other aspects of land use surveying and mapping.

Indeed the authors conclude with the comment that the most cost-effective method of acquiring a wide range of land use/landscape/environmental data is by having aerial photography taken at regular intervals to provide a massive land/environment data bank.

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Table 1

West Midlands Derelict Land Classification

| | |
|---|---|
| 1. Site number | sites numbered consecutively per map |
| 2. Geo-code | 8 figure grid reference; road name or local feature |
| 3. Area | acres and hectares |
| 4. Type of dereliction | a Spoil heaps<br>b Excavations and pits<br>c Military and other service dereliction<br>d Disused rail land<br>e Disused sewage works and installations<br>f Disused waterways land<br>g Neglected waste land<br>h Other |
| 5. Tipping | Y - yes; N - No |
| 6. Area of demolition | Y - yes; N - No |
| 7. Used or disused | U - site in use; D - site in disuse |
| 8. Wet or dry (excluding stream, drain, river or canal) | W - water present on site<br>D - water not present on site |
| 9. Buildings on site | Y - yes; N - No |
| 10. Vegetation type and cover | Extent of cover<br>a - 0-10%; b - 10%-50%;<br>c - 50%-100%<br>Dominant vegetation type<br>t - trees; s - shrubs; g - grass |
| 11. Surrounding land use | I - industrial; R - residential;<br>O - other<br>Multiple use given where necessary |
| 12. Geology | 3 clay, shale and marl<br>4 coal<br>6 igneous rock<br>8 limestone<br>9 sand and gravel<br>10 sandstone |
| 13. Access points | Number of access points over 4m in width (Holes only). Complete access referred to as ∞ |

Table 2a

COST COMPARISON

Air Photo Survey and Field Survey (Prices in $U.S.)

| | Per km$^2$ | Per site | Per ha of site |
|---|---|---|---|
| | $ | $ | $ |
| a) API only | 50.0 | 18.5 | 6.0 |
| b) Total flying | 55.0 | 21.0 | 7.0 |
| (a + b) Total | 105.0 | 39.5 | 13.0 |
| d) Field Survey | 518.0 | 177.0 | 58.0 |
| k) Cost of Field Survey in relation to Air Photo Survey | 4.93x | 4.48x | 4.46x |
| a) API only | 50.0 | 18.5 | 6.0 |
| c) one fifth of flying | 11.0 | 4.0 | 1.5 |
| (a + c) Total | 61.0 | 22.5 | 7.5 |
| d) Field Survey | 518.0 | 177.0 | 58.0 |
| e) Cost of Field Survey in relation to Air Photo Survey | 8.49x | 7.87x | 7.7x |

Table 2b

ACCURACY COMPARISON

Air Photo Interpretation and Field Survey

| Method | Number of sites identified | Extent of sites (hectares) |
|---|---|---|
| API | 84 | 251 ha |
| Field Survey | 73 | 224 ha |
| % Accuracy of Field Survey | 87% | 89% |

| 1. Site Number | 2. Geo. Code and road name | 3. Area | 4. Type of derelic-tion | 5. Tipping | 6. Demolit-ion | 7. Used/ disused | 8. Wet/ dry | 9. Build-ings on site | 10. Vegetation | | 11. Surr-ounding land use | 12. Geology | 13. Access points |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Extent | Type | | | |
| 48 | 0975 7835 Petersbrook Road | 6.08 2.46 | J | N | N | D | D | Y | b | s | R | | |
| 49 | 0970 7860 Brookhouse Farm | 8.57 3.47 | b | N | N | D | W | N | b | s | O | 3 | 1 |
| 50 | 0950 7650 Houndsfield Lane | 20.95 8.48 | b | N | N | U | D | Y | b | s | O | 9 | 3 |

Figure 1. DERELICT LAND RECORD FORM

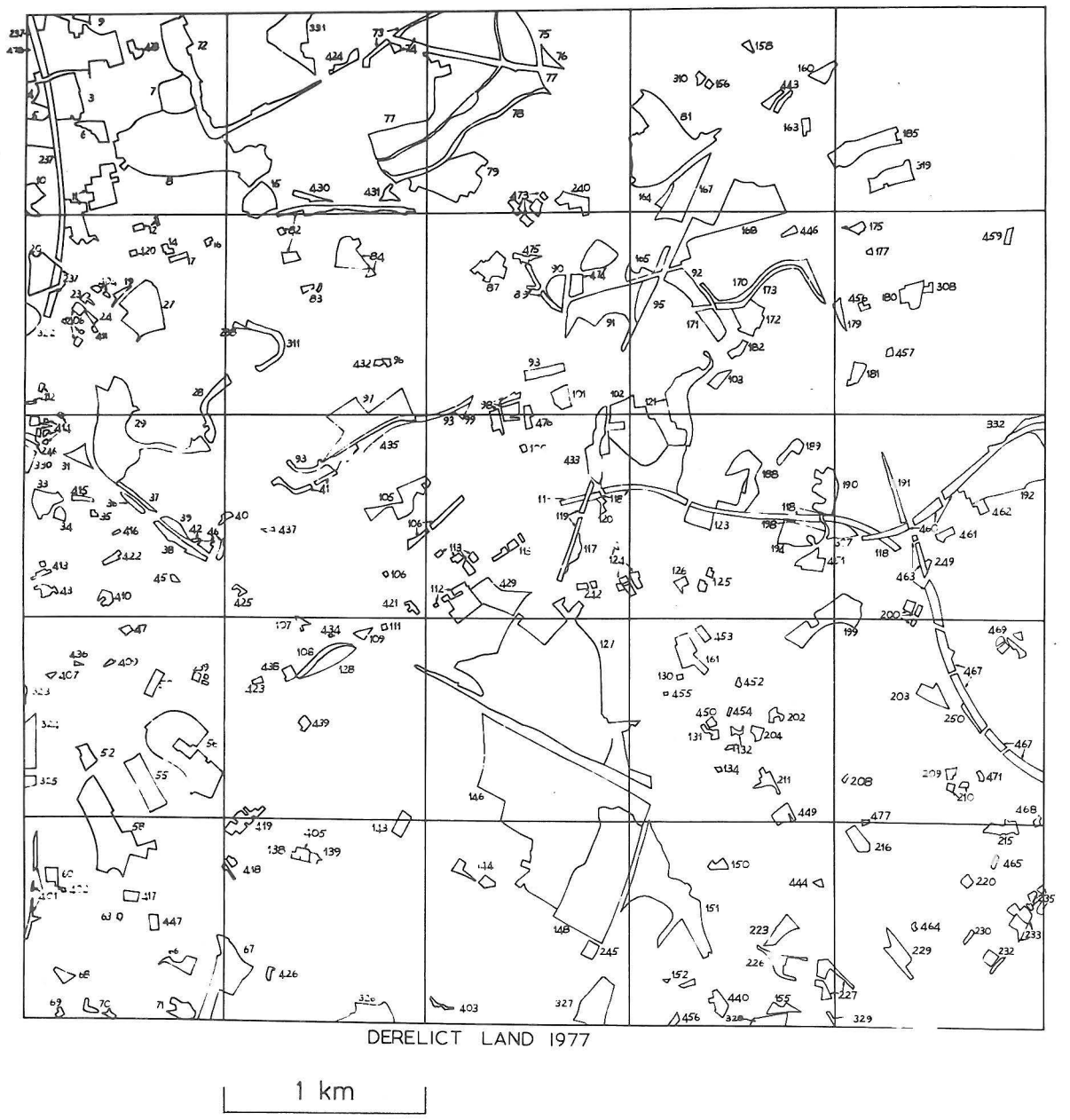


Figure 2.