B08.3

Using aerial imagery to join up the rural environment

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Abstract

The recent emergence of 'off-the-shelf' countrywide datasets of digital aerial photography has opened up the use of aerial imagery to a wide number of organisations to whom aerial photography used to be an expensive luxury. Until recently, users commissioned photography for their own use only which resulted in expensive data, poor market development, a patchwork of data at different scales, dates and formats. Combined with developments in compression technologies, integration within GISs and the developments of desktop machines, aerial imagery has become a very real solution for organisations wishing to truly understand the environment they are seeking to manage.

1.0 Introduction

This paper will emphasise how aerial imagery has improved decision making and helped provide solutions to a myriad of difficulties of working within the rural environment, from redefining working practices and methodologies caused by foot and mouth, to providing information on areas where no physical boundary features are mapped. By integrating the imagery with other geospatial data either from within the same organisation, or in partnership with others working within the same field, the tool becomes especially powerful. By using case studies of organisations already using imagery, this paper will show how innovations in data supply can provide practical solutions for those working within the rural environment.

2.0 Data capture and new partnerships

Getmapping is making firm progress in its aim of achieving the first ever, complete continuous digital vertical aerial photographic survey of the whole of the UK. This current dataset, the Millennium Map, is a seamless digital mosaic of over 197,000 sq km of the UK (see coverage achieved to date below). The data has been
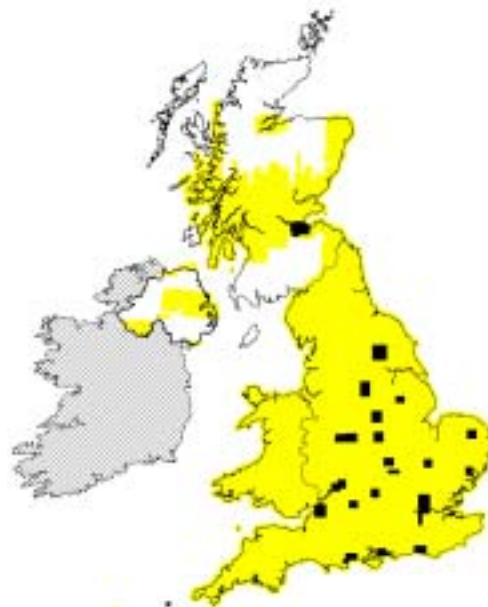
Figure 1: Flying coverage 1999-2002 Shaded area indicates areas flown. Black area show cities captured at high resolution

captured at a nominal scale of 1:10,000 and scanned at 1200 dpi to give a resolution of 25 cm on the ground. To date (August 2002), the whole of England and Wales has been captured, together with over 50% of both Scotland and Northern Ireland. To complement the base 25 cm data, Getmapping has flown over thirty cities at high resolution (10cm) resulting in a highly detailed and information rich dataset which makes it possible to view details such as street furniture, road markings and exact tree locations, features not visible using traditional mapping. The images below illustrate the same house in York taken at the two different scales.

Figure 2: Image of York: 25 cm data, captured in 1999

This image is an extract from the Millennium Map™ which is © Getmapping plc

Figure 3: Image of York: – 10 cm data, captured in 2002

This image is an extract from the Millennium Map™ which is © Getmapping plc

Getmapping has signed an agreement with Intermap Technologies of Canada who are creating a high precision Digital Surface Model (DSM) and a Digital Terrain Model (DTM) of much of the UK. Utilising wide area airborne radar imagery, Intermap has already started to collect the data. The first DEMs were ready for distribution in April 2002 and the whole of England and Wales by the Autumn of 2002.

This country has never had such a high precision height dataset as this before. Getmapping will be responsible for the distribution of this data in UK and the combination of this and the Imagery datasets provides an enormous source of information to professionals working in the rural environment, particularly when used in further combination with Ordnance Survey large scale mapping. The accuracy of the data is perfectly suited to many different applications such as flood plain analysis, site assessment, marine and coastal erosion studies and line of site surveys for wireless telecommunications networks.

Another exciting development is the creation of an Historic series of Imagery. Created from the 1946-49 RAF coverage of the UK this dataset is proving to be of tremendous value to anyone interested in possible contamination or understanding of the developments which have taken place since this date.

Finally, by using 3D modelling techniques, users can now simply and effectively have user defined fly throughs of models where the imagery has been draped over the DSM. This technique can use the historic imagery or the modern day equivalent. This provides extremely realistic modelling and environmental impact assessments.

SPECIFICATIONS

3.0 Digital National Imagery

Date flown:	3/99 – present
Scale:	1:10,000 nominal (1:20,000 nominal in Scottish Highlands)
	1:5,000 nominal for high resolution areas of towns and cities
Standard Resolution:	0.25m (0.50m in Scotland or 0.10m high resolution)
Standard size (metres):	1 km x 1 km
Standard size (pixels):	4000 x 4000
Other resolutions:	0.10m (where available), 0.50m, 1m, 2m, and10m
Other sizes (metres):	5 km, 10 km
XY Control:	OS Land-Line® or MasterMap® or OSNI Large Scale Mapping in N. Ireland
Z Control:	OS Profile™ or OSNI DTM in N. Ireland
Ortho RMSE	+/- 2m
Projection:	Transverse Mercator
:	Airy (Modified Airy in N. Ireland)
Datum:	OSGB 1936 (Ireland 65 in N. Ireland)
Standard format:	Jpeg (max quality)
Other formats:	ECW, SID, TIF (limited areas)
GIS formats:	MapInfo TAB, ESRI world, ERMapper ERS

Figure 4. Example of digital imagery in North Wales 4
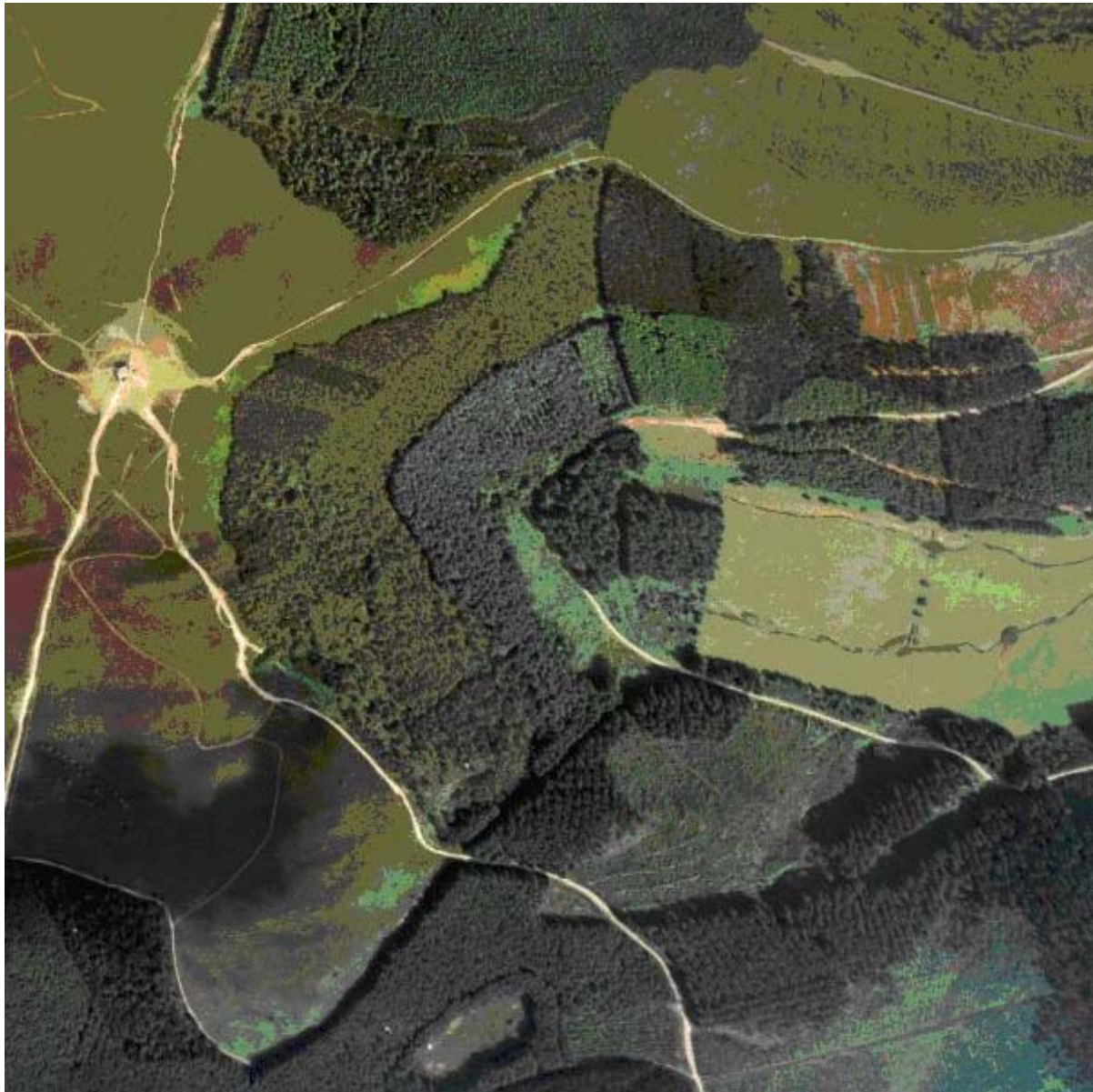
This image is an extract from the Millennium Map™ which is © Getmapping plc

3.1 NEXTMap

Product	Product Description	Horizontal Accuracy	Vertical Accuracy	Projection
DSM	Digital Surface Model (GTF) (Southern England and Wales)	2.5m RMSE	50cm RMSE	OSGB Newlyn Datum
DTM	Digital Terrain Model (DTF) (Southern England and Wales)	2.5m RMSE	60cm RMSE	OSGB Newlyn Datum
DSM	Digital Surface Model (GT1)	2.5m RMSE	1m RMSE	OSGB Newlyn Datum
DTM	Digital Terrain Model (DT1)	2.5m RMSE	1.5m RMSE	OSGB Newlyn Datum

Figure 5 Example of a shaded relief Digital Surface Model, part of Wales

This image is an extract from Next Map™ which is © InterMap Inc

4.0 Emerging Applications

The Forestry Commission

Aerial photographs show considerably more information than conventional maps, especially in rural areas. The imagery reveals precise changes in vegetation, crops and other land use. The Forestry Commission is using aerial imagery in several ways. Firstly it is being used simply as a backdrop to the woodland, allowing visualisation of boundaries, forest roads and other features. This is particularly important in rural areas where the Ordnance Survey vector mapping may show no topographical detail and also where the wood is small (less than 2 Hectares). Secondly the imagery is proving extremely useful in identifying tree types.

In addition, Getmapping is flying new photography over a large part of the Forestry Commission's holdings. This new photography is useful to monitor the state of the woods in terms of windburn, disease, maturity and general condition. At the same time Getmapping is processing the imagery and including it in the national dataset as updated information which is then supplied to all users as part of the DNI.

The Forestry Commission is interested in a complete Great Britain coverage in which the imagery will be used to assess the suitability of new planning applications which are increasingly being applied for by Local Authorities for the planting of Community Woodlands. Instead of sending a field inspector to the site it is far more efficient to inspect the aerial photography and in most cases decisions can be made as to the suitability of the application without a site visit. The Forestry Commission also intend to use the photography to assist in the general management of its forests and woodlands.

The data will be stored on a Forest Enterprise's AGI award winning GIS. This system is in use throughout 30 district offices to provide quick access to digital maps and associated data. The aerial imagery gives an immediate check on the accuracy of mapped data, reducing the need to visit sites to undertake surveys, with low timber prices, the use of aerial imagery helps in further reducing survey costs.

The Forestry Commission is also interested in testing high resolution 10cm aerial data. It is believed that this scale of imagery can be used to assess the planting density of young plantations, thereby again avoiding the costly expense of sending staff into the field for assessment.

The Woodland Trust

The Woodland Trust is UK's leading conservation charity dedicated to preserving UK's woodland heritage. They have taken DNI data at 25 cm resolutions for use in monitoring and maintaining their many woodland sites spread across the whole of the UK.

The Trust is interested in utilising the photography still further on its own Intranet site for its 'Significant Trees' project. This will allow its members, and the public, to download images of any part of the country in order to locate individual trees to be included in the developing national database of tree information. Previously this work has been attempted using generalised mapping but as the mapping does not identify individual trees the members found it difficult to accurately locate them. The imagery gets over this problem.

The Trust is also considering using the imagery at 2m resolution as general background mapping on its internet site to more easily allow the general public to identify the heritage woodlands in their neighbourhood.

Local Authorities and National Parks

Many Local Authorities are now using the digital imagery to semi-automatically define the land use within their boundaries. As development land becomes more scarce, this information will become increasingly important. It will also be useful in the future to identify new areas for woodland planting.

For many years Local Authorities have specially commissioned aerial photography of their areas for a multitude of general monitoring and planning applications. Recently they have been taking the digital imagery as the power of the desk top PC has increased in performance and decreased in price. One specific application is the identification of individual trees which are subject to tree preservation orders. In the past

the location of these trees has been created using Ordnance Survey large scale mapping but again individual trees are not shown on the maps. This has led to trees being located in the wrong place and even in the wrong property, at best causing confusion and at worst leading to trees being felled when they should have been protected.

Historically, a number of National Parks have commissioned aerial photography for use in land cover monitoring. The availability of a maintained and regularly updated dataset through Digital National Imagery is proving invaluable for applications such as landscape characterisation exercises. By using imagery in bio-diversity layers within a GIS, decision on policy and land management can become much clearer.

By using different epochs of imagery, land use change, such as s footpath erosion or growth vegetation can be monitored effectively. Imagery is being utilised in a number of new and interesting ways by the National Parks. There are some useful applications regarding planning such as enforcement. For example, the photography can show clearly the extents of caravan sites on the National Park, so over development can be immediately spotted. Caravan sights have restrictions upon their numbers so the imagery can be used as proof of sighting at a particular time and place. Other applications for the National Parks include their Unitary Development Plans, where it is intended to use the aerial photography as a background in the settlement proposal maps rather than the traditional Ordnance Survey map.

The National Assembly for Wales Transportation Department
The Transport Directorate of the Welsh Assembly Government uses its own bespoke GIS system for the maintenance and planning of the road system. Called WHIS (Welsh Highways Information System), the system holds details of the trunk roads and associated land parcels. NAWTD has the responsibility to maintain all the roads in Wales. They have acquired DNI for the whole of Wales and are using it for the maintenance and planning of roads, and to assess the trees which are adjacent to the highways. Often these trees overhang the road and need to be lopped whilst in other areas the falling leaves of the deciduous trees can cause slippery and dangerous road surfaces.

The imagery is particularly useful in identifying small parcels of land severed by road development. This is important for land disposals and is also useful when assessing planning applications for areas that run alongside the trunk network. The imagery is also used to assess the effects of any noise reduction schemes which often involve the roadside planting of trees.

The National Assembly for Wales Agriculture Department
The Agriculture Department of the National Assembly for Wales acquired DNI for the whole of Wales as part of a project by the Agriculture Department to make digital data available for the IACS system, which processes applications by farmers for European aid. The Department uses the database, which records field boundaries throughout Wales, to prepare an annual return to the European Union to monitor the agriculture of land eligible for set-aside and grant aid. Print outs of farmers holdings are given to each farmer during individual interviews and imagery is proving to be a very successful way of agreeing on boundaries.

The imagery is also being incorporated into NAWAD's bespoke GIS, WENDI - Welsh Environmental Data Interface. WENDI is used for monitoring and evaluating agri-environmental land-based schemes, and imagery provides a powerful tool in helping to analyse the rural environment.

The Countryside Council for Wales and Countryside Agency
Digital National Imagery is being used by the Countryside Council for Wales (CCW) to support a number of different activities. These include Tir Gofal, the all Wales agri-environment scheme promoting agriculture that protects the environment and maintains the fabric of the countryside. Tir Gofal is a partnership project between CCW and the National Assembly. The project has been facilitated by both organisations having access to imagery for the whole of Wales.

CCW is also using the imagery to help classify land access. Under the new Countryside and Rights of Way Act, the CCW must publish maps showing open country and registered common land. Aerial imagery will

also be used for identifying and notifying the boundaries of SSSI's (Sites of Special Scientific Interest) and other protected sites and to support general case studies and planning enquiries.

The Countryside Agency is preparing maps of all open country and registered common land in England under the provision of the Countryside and Rights of Way Act.   The mapping study is largely desk-based, using existing data sets to compile the maps of access land. Validation of the maps is carried out using aerial photography supported by any necessary field visits. DNI will help to enable validation through an accurate assessment of the extent of boundaries and features not shown on OS maps. [1]

Environment Agency Wales
The Environment Agency Wales has provided access to DNI to nearly 900 users, 150 of whom have access to ArcView GIS. It will be used primarily for land use assessment and for flood plain definition, which is particularly important in a planning situation. The Agency supply flood plain information to different bodies such as Local Authorities, DEFRA and the National Assembly for Wales, as well as commercial organisations such as insurance companies. The aerial imagery is particularly useful for highlighting flood banks and other natural features not found on traditional maps. The Agency also intends to use it for conservation studies and environmental impact assessments.

The Environment Agency has recently purchased the NextMap DEM for England and Wales. In Wales, it can be used in conjunction with DNI to provide a highly accurate real world view of the lie of the land. The accuracy of the data is perfectly suited to many different applications such as flood plain analysis, site assessment and marine and coastal erosion studies.

NEXTMap Applications

The project will collect over 200,000 sq Kms of elevation and radar image data for Britain. All data will be processed and stored as a seamless database. The entire project is to be completed by January 2003. Selected areas will be completed with different specifications. The elevation calculation for all areas is to be made at a 5 metre spacing on the ground. For England, an area from the south east up to the Midlands, covering many urban regions, including the London Basin, will be collected as a DSM with a vertical accuracy of 50cm. The DSM for the rest of Britain will be collected with a vertical accuracy of 1m.

The DSM typically includes vegetation and cultural artifacts and is used to create the DTM by electronically removing these features. In other words, the DTM is a representation of the ground or 'bald earth' without trees or buildings. The DTM for the South East will have a vertical accuracy of 50cm or better. For the remainder of the dataset, the derived DTM will be 1.5m vertical accuracy with a data point every 5m. In areas of heavy forest cover, where a clear view of the ground is not always possible the DTM will be the 'best estimate' of the actual terrain surface.

The Digital Surface Model of NEXTMap can be used to assess the maturity of any woodland but is also important for microwave propagation modelling for the siting of new mobile communication transmitters. It will also be of importance in the planning of woodlands in the vicinity of airfields where the future penetration of a new woodland into the final approach airspace may be critical from a safety point of view.

The 'bald earth' Digital Terrain Model allows for organisations such as the Environment Agency to accurately define flood plains. This information may well be of importance to the siting of new woodlands.

5.0 Historic Imagery
In addition, Getmapping has reached agreement with English Heritage to scan and rectify the 1946-1949 RAF photography of the UK. This will be rectified and fitted to the Ordnance Survey mapping as is the current imagery, allowing for a direct comparison between the two epochs.

Figure 6 Example of 1946 RAF Historic Aerial Imagery, Parliament Square, London

6.0 Conclusions

Aerial photography and especially rectified digital imagery has come a long way in recent years, mainly due to the progress made in delivering greater and greater power to the desk top PC. The data is now extremely affordable and many new applications are being discovered by a wide range of users.

Aerial imagery is the natural dataset for organisations that need to monitor or manage land, particularly in a rural environment. It provides a real world view – WYSIWYG – What You See Is What You Get! It depicts a multitude of features not shown on traditional maps:

- Trees

- Fences

- 'The natural state or quality of the environment of an area'

- Small outbuildings and sheds

- Gateways

- Land use and habitats

- Embankments

- Where vehicles park

- Street furniture

- Size of a hedgerow

- Vegetation types

- Coastline structures

- 'Unmade or unofficial' footpaths/access paths

Datasets such as DNI, which are regularly updated and maintained have a far higher currency that traditional mapping; they can be more easily interpreted than traditional mapping and are a snapshot of a place in time. This allows for greater certainty in policy making and planning in the rural environment. DNI has proved to be especially effective in Wales. For the first time the Welsh agencies have had access to highly detailed and seamless aerial imagery of the whole country provided in a digital format for display on computers and matched to existing Ordnance Survey digital map data. The licensing of DNI data of a common geographical area reduces the price for all licensees, ensuring that not only is the data accessable, it is also affordable. The five yearly reflys of the whole of the UK will provide users with an archive of the country through different epochs. This will prove invaluable in understanding land use and management of the countryside.

Another exciting development is the NEXTMap digital height model which is offering highly accurate height information in a variety of formats. When the imagery is laid on the top of the height model an extremely powerful information source in terms of a three dimensional model can be accessed. Combining this with large-scale Ordnance Survey mapping data provides the ultimate geographic information system.

7.0 References:
[1]. http://www.countryside.gov.uk

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