Infoterra, a leader in the provision of geospatial products and services, originally purchased a Leica ADS40 Airborne Digital Sensor, like most other operators, in order to replace a conventional 9 inch film survey camera. However, the “satellite” sensor qualities of the camera have meant that Infoterra has been able to exploit the acquired imagery far more than expected.

On delivery, the Leica ADS40 was put into immediate operation acquiring data in the UK suitable for producing a colour RGB ground-orthophoto at 25 cm resolution. This was no small task because Infoterra, and its joint-venture partner, was in the process of flying the whole of England, an area of approximately 130’000 km², to build a seamless orthophoto mosaic. This is an even more daunting task when you consider the UK weather, which at best is unpredictable, even during the so-called summer months. When the sun does shine the Leica ADS40 certainly proves its worth by allowing more data to be captured during each flying day than was possible with the previous film camera technology.

Once captured, the data was very impressive, not only in terms of resolution but also in terms of image consistency and radiometric performance. The CCD array, capturing multiple datasets, has allowed Infoterra to expand its standard product portfolio beyond traditional natural colour imagery. A complete data stack is now available including colour infra-red (CIR), digital surface model (DSM), and digital terrain model (DTM). This data stack offers a wealth of information such as landcover, feature height, and slope information, which can help studies as diverse as habitat analysis and soil erosion estimation.
As the world becomes more ‘spatially aware’ there is an ever increasing demand to measure and monitor our environment, be it for climate change, biodiversity, or urban development. Such activities heighten the need for value-added products, beyond just imagery, to quantify key features present in geographic data. The depth and quality of information captured using the Leica ADS40 takes us a giant leap towards providing the required measurements.

**Landcover**

Landcover information is a crucial first step requirement as it can be used as a quantitative descriptor of the landscape, as well as a base to derive other information such as habitat maps and landuse. Traditionally, landcover information is extracted in two different ways: either automatically by classifying the “color” of a satellite image into its most appropriate class or manually by interpreting aerial photography based on color and contextual information.

The satellite method usually gives a spatially coarse measurement but has the potential to identify quite specific classes quickly. The aerial photo method can create highly detailed mapping but is very labour intensive. Infoterra, using the ADS40 and the latest image classification technology, has moved towards a best-of-both-worlds solution using the “color” or “spectral” descriptor of the 4 channels, the high resolution, and height information for context.

Object-based image classification is used to semi-automate this process whereby the imagery is segmented (separated into meaningful chunks) into areas of consistent color and texture. Each of these objects can then be assigned specifics such as color, texture and height, but also contextual information such as the difference to surrounding objects. Combining this technology along with the wide area coverage and radiometric consistency of the Leica ADS40 allows Infoterra to tackle large areas and provide a National product.

The specification of this classification was developed after reviewing numerous existing schemes both UK and European in origin (such as LCM2007, NLUD & CORINE), assessing market needs and iteratively trialling the classification technology to see what was possible and robust. A generic, thematic approach was taken while retaining the high spatial resolution of the original data. The prime reason this approach was taken is that it allows a high resolution measure of the basic landcover make-up, while being suitable for bespoke thematic upgrades to specific client requirements. The resultant product from Infoterra is LandBase™.

LandBase provides three Level 1 classes and ten Level 2 classes captured to a MMU (Minimum Mapping Unit) of 50m² allowing analysis down to individual building and tree level. Level 2 classes include: sea
& estuary, inland water, artificial surface, buildings, bare ground, herbaceous vegetation, sub-shrubs, shrubs, tall shrubs/small trees, and trees.

Urban and rural settings
In an urban setting landcover mapping can give useful insights into the make up of a city, such as sealed surfaces (surfaces sealed with concrete or paving for example) and urban density. The vegetation types identified as part of LandBase are suitable to accurately define the green space within a city which can be used for historical tracking, environmental assessments, and flood modelling. As much of the Leica ADS40 data stack as possible is included in the LandBase product to provide height information and local cover statistics. This information can be used for volumetric analysis and measures of building/tree density. Such information is routinely used for telecommunications network planning but may also be linked into diverse applications such as air quality models and human geography.

For urban areas, Infoterra has also enhanced the LandBase classification by incorporating Lidar height information, where available. This not only improves the height precision it also helps to better define buildings into regular shaped objects.

Classifying rural regions in this way opens up many new possibilities, for example woodland extent is captured in such precise detail to include individual and small groups of trees. Typically, existing woodland mapping by photo-interpretation only captures extents greater than 5’000m². Identification of shrubs gives the possibility of hedgerow extraction and in turn an estimate of a crucial habitat. Semi-natural environments, such as upland heath, have traditionally been mapped as either heather or grass dominant parcels, but can now be broken down in detail to grass, heather and bare earth components, allowing more precise extent monitoring.

Using LandBase it is possible to fulfil some very specific classification goals. For example, if a local authority or council was introducing a household composting scheme or monitoring the current collection volumes, then extracting garden area would be useful information. By using growing routines within a spatially aware ruleset, garden extents have been extracted automatically for a 25 km² test site in Leicestershire. The routine includes grasses, shrubs, and trees of small extent close to buildings, while excluding woodland, recreational, and common land.

A step beyond Landcover
By using a similar approach of applying logical rules, a more detailed 16 class habitat map of the same study area was generated automatically to include classes such as reed bed, improved amenity grassland, and scattered scrub. Such mapping is used by local authorities for monitoring purposes but this same approach could be applied to add higher levels of landcover complexity or for detailed landuse mapping.
In capturing a “snapshot in time” LandBase has been proven to aid change detection when used with historical data. Semi-automatic mapping has been carried out over Leicester and Maidstone to identify areas which have recently been built up; from new housing estates down to the level of newly tarmacked driveways. This was made possible by comparing the latest Leica ADS40 imagery and historical imagery within LandBase. Areas which have changed from vegetation to artificial surface or buildings are automatically highlighted by a classification routine. Such a method has proven even more effective than manual interpretation because of the difficulties of a seemingly easy game of spot-the-difference – we all know is never as easy as you expect. The image resolution has allowed the identification of changes to existing properties, for example building extensions, as well as new developments to be detected, and the wide area coverage has added large sample sizes giving greater statistical validity when doing cross analysis.

About the Authors:
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The Future

The quality and depth of data available from the Leica ADS40 has significantly helped Infoterra meet its goal of being able to quantify and monitor the environment/surroundings in acute detail. Also the wide area collection of the sensor gives more scope for consistent data and regular updates. Statistics at a level not previously available can allow more informed decision making for a range of areas – urban planning, environmental management, and flood modelling. As the above example shows, the real power of the Leica ADS40 and successive camera’s such as the Leica ADS80, might be in providing a time series of consistent imagery, from which detailed change detection can be undertaken – allowing a new level of precision for monitoring what is really happening to our urban and rural landscapes.

If you thought the Leica ADS40 only delivers good quality imagery, then think again about the wealth of information that imagery actually contains.

More information:
http://www.infoterra.co.uk/data_landbase.php