Focus on: Technology

Over the following pages we take a look at the latest technological advances in the forest. Although the real work may happen on the ground, there is no doubt that these technological advancements are helping to get to the root of most forestry challenges.

Right: Aeriel view of Dunning Glen.

Far right: Example windblow survey.

Below: Ground preparation, restock and species surveys are also possible.

GOSHAWK FOREST MAPPING LTD

TREES are the most vertically gifted of any crop and trying to get a good view of what's happening to the wider crop when our eyes are situated at a measly 2 metres above the ground is challenging. Aerial photography in forestry isn't new. Of course you would prefer to look at more trees in less time from the business end, where the foliage is, the top! Previously the only options to allow this were expensive and only justifiable on very large sites.

No longer! The technology to allow you an aerial perspective is sitting there on the shelf of your local camera store! In the time it takes to finish a forestry degree, drone technology has gone from unreachable and complicated to affordable, reliable and user friendly with apps to enhance the usefulness of the technology and websites to help process the resulting data.

Drones are the next step in forest management. The only question is, how do we incorporate it into everyday forestry? Last May, I left my position as a forest manager and set up Goshawk Forest Mapping to answer this exact question. I went to my local photography store and bought myself a DJI Phantom 4. Most drones now are a camera first and a drone second so for those of you who care to know, the Phantom 4 is capable of taking a 12.4MP photo and 4k quality video. Is it the most expensive drone available? No. Can you see what's happening in your forest in incredible detail from above? Yes!

Over the past 18 months, I have worked using my drone to help forest managers to gain a new perspective of their woods. I've returned data or pictures for forest plans, sales, grant claims, windblow insurance claims and much more. I have purposely used only technology that is easily available to the average person.

Mapping technology allows us to produce a georeferenced aerial image of an area as small as a spot of windblow to as large as a whole forest. 360° photographs are a really quick way to look around a forest as you would if you were floating 120 metres in the air. Taking video as you're just having a look around can allow you to explore your forest as if from the eye of a bird at your desk later. You can even turn a drone into a flying GPS!

You can sit in the comfort of your office and wait for Goshawk to deliver the footage you need. Or if you would prefer to do it yourself, join our PfCO courses available from 3ic in conjunction with Goshawk. We'll not only get you qualified to fly a drone for commercial purposes, we'll also get you competent to use a flying camera in forestry for commercial purposes. Bring on the revolution.

www.goshawkphoto.co.uk/

GEOSLAM

WITH deforestation and environmental issues challenging profitability in the forestry industry, pressure is on the sector to develop a more detailed picture of what is really going on in our woodland areas. Petri Nygrén, business development director at GeoSLAM, explains how mobile LiDAR (light detection and ranging) technology is enabling surveyors to get a view from above and below the canopy.

Forestry surveys have always been difficult to capture, with thick vegetation and unmarked paths, as well as uneven terrain and severe weather causing headaches for surveyors. When working in harsh forest environments, laser scanning technology is crucial for quickly and efficiently monitoring the landscape to detect otherwise unforeseen problems.

Using pulsed light from a laser, LiDAR systems generate a 3D map of the target area that can accurately represent surface features down to millimetre level. Mobile mapping systems utilise LiDAR to scan difficult-to-reach areas, either on foot, from a vehicle, or from the air. Now more than ever, experts are able to gather critical biomass information to the most accurate degree possible.

The use of LiDAR technology with fixed-wing aircraft and UAVs has advanced considerably since I began working on some of the first aerial flights in Finland in 1992. The technology available to businesses enables a far greater understanding of densely wooded areas.

These advancements are not just down to modern UAVs being able to carry a greater payload, but also in the mapping systems themselves. Modern airborne laser scanning (ALS) systems are capable of collecting hundreds of thousands of points per second, providing detailed information from the forest canopy down to the forest floor.

Businesses in the forestry sector have been somewhat hesitant to adopt the latest geospatial technology. The industry has long been using low-point-density, wide-area airborne laser scanning to measure tree height. However, the developments in technology now allow airborne laser scanning to take place at lower altitudes with much higher point density, enabling a more detailed and accurate understanding of the project area. For example, LiDAR can be used to detect tree species, specific trunk attributes and the number of branches on an individual tree. This precise information can provide the basis for even more detailed feature mapping, which can determine the health of areas of woodland and more species-specific attributes.

Left: GeoSLAM's ZEB-REVO laser scanner.

Below centre: A LiDAR scan from within the Eden Project.

Below inset: The ROBIN mobile mapping system, mounted on a vehicle and scanning a section of jungle.

For commercial use, UAVs are better suited to smaller projects otherwise unprofitable with manned helicopter or light aircraft. While manned aerial surveys will remain crucial for larger-scale surveys of vast areas of forest, for the majority of business applications they are not cost-effective.

Flexible mobile mapping systems offer numerous advantages, including the ability to be handheld or mounted on vehicles or backpacks. Students from Maynooth University's computer science department, based in Ireland, use the ROBIN mobile mapping system, primarily with UAVs as well as light aircraft and helicopters, for a range of projects from urban mapping and forestry to environmental and coastal mapping. These projects have led to the creation of a multi-sensor pod, enabling surveyors to quickly and easily move the mapping system between modes of transport.

These various setups enable users to easily capture high-quality data of dense woodland. In the past a static terrestrial laser scanner (TLS) would have been used to gain a 3D view from within the forest; surveyors can now explore dense forests on the move.

One interesting use of this technology took place at the Eden Project in Cornwall with the University of Leicester. After setting out to develop a technique to estimate biomass and carbon more efficiently, researchers from the university found the mobility and speed of GeoSLAM's ZEB-REVO to be the perfect solution. Rather than taking hundreds of time-consuming static scans, the surveying team was able to capture all angles of the artificial tropical forest environment by simply walking in a loop around the area.

The collected point cloud data was converted into 3D volume-based plots to derive above-ground biomass and carbon densities for multiple types of tropical forest. A comprehensive dataset was created, containing information for any type of forest, which scientists can use to make calculations with minimal effort or expertise.

Proactive researchers like those at the University of Leicester are leading the way in developing groundbreaking insights into our forests, enabling a glimpse of future commercial uses for LiDAR technology.

Another exiting study is enabling researchers to measure advanced features of woodland, such as trunk growth. GeoSLAM has recently worked with academics at the Australian National University and Australia's Commonwealth Scientific and Industrial Research Organisation to monitor the growth of some 44,000 rare, endangered and symbolic trees dating up to 100 years within the National Arboretum, Canberra (NAC).

Surveying five tree species spotted gum, ironbark, Camden white gum, silver birch and a Himalayan pine, monitoring is conducted once a year in August and September, when the silver birch trees have lost their leaves to reveal the stem branch structure in clear detail. The resulting 3D images enable researchers to view the development of trees from different angles, as well as monitoring how trees change in terms of stem and branch structure, trunk girth and height of canopy.

LiDAR technology will continue to grow, becoming more portable and affordable, enabling forest workers and surveyors to carry out more detailed inspections in reduced time frames across larger areas of woodland. This innovative research will ensure that the forestry sector can continue to adapt to the ever-changing forest environment. With cheap timber imports and environmental challenges posing a threat to the UK's forestry industry, the use of mapping systems can help businesses and research bodies to further our understanding of complex woodland areas and ensure a profitable future for the sector.

www.geoslam.com

BLUESKY NATIONAL TREE MAP

THE Bluesky National Tree Map (NTM) identifies the location of more than 280 million trees nationwide, detailing their height and canopy cover. The data was created using innovative algorithms and image-processing techniques in combination with the most up-to-date and detailed aerial photography and height data. A team of experienced professionals completed an exhaustive QA process to ensure the quality and accuracy of the data.

In addition to the three vector map layers – Crown Polygons, Idealised Crowns and Height Points, the NTM also includes an attribute table including unique identification for each crown feature, height attributes and area calculations. The data is available in a range of geographical information system (GIS) formats with flexible annual licencing.

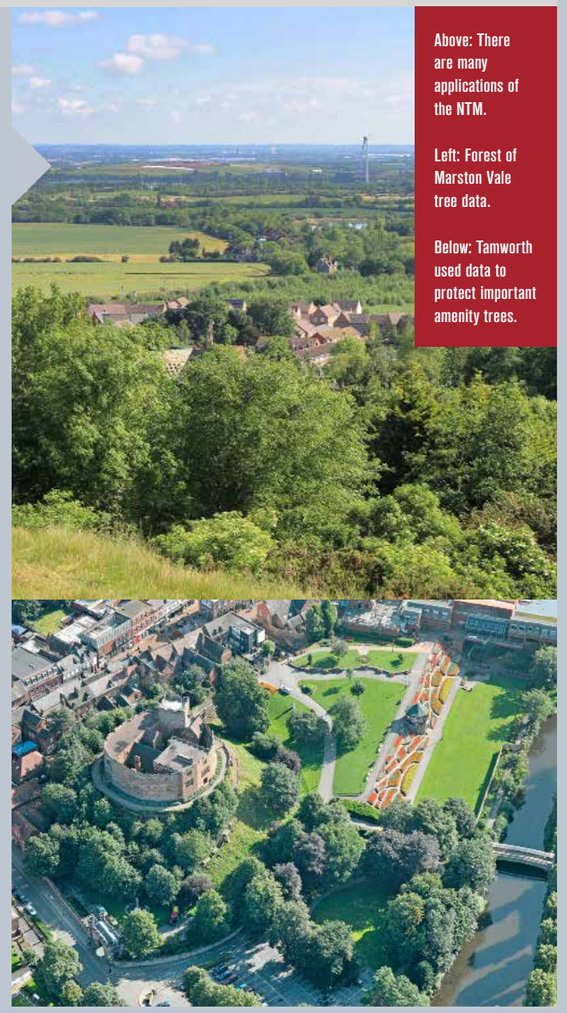
Applications of the NTM include subsidence risk assessment by insurance companies, propagation modelling for telecommunication infrastructure planning, network resilience assessment for utility companies and carbon reduction planning for environmental projects, as well as general asset management. Existing users of the data are already reporting significant improvements in day-to-day planning and operational efficiency.

For example, Tamworth Borough Council uses the data to help protect important amenity trees. An eight-time gold-winner of the national Heart of England in Bloom competition, the Bluesky NTM is helping it to identify, manage and protect trees, including those subject to tree preservation orders and other planning constraints. The tree map data is accessed via the authority's GIS and is available to all staff via its Web mapping service (WMS).

The Bluesky tree data was also used as part of a recent Progress and Impacts Study by one of England's original community forest projects and the largest environmental regeneration project in Bedfordshire; the Forest of Marston Vale.

As a result, it was concluded that tree cover had already increased to 15 per cent, half of the overall target, with woodland cover up to 11 per cent. Based on this 'forest cover' data, the study was then able to evidence that every £1 spent in creating The Forest to date had returned £11 in benefits to the area through improvements in employment, health and wellbeing, air quality, recreation, enhanced landscape, property values and, in due course, timber supply.

"While our own data and Forestry Commission data had their merits, neither was as accurate, comprehensive or as up to date as the Bluesky tree map," commented James Russell, Forest Director of the Forest of Marston Vale. "The use of the Bluesky data not only gives us critical data to assess our progress, but it also allows us to evaluate and quantify the benefits of this increased 'forest cover' to the local community."



Above: There are many applications of the NTM.

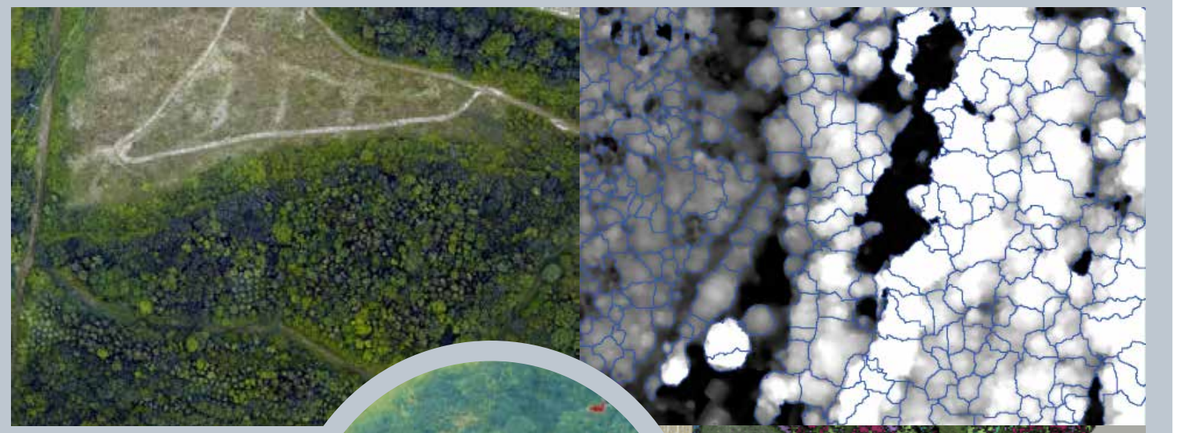
Left: Forest of Marston Vale tree data.

Below: Tamworth used data to protect important amenity trees.

Other real-world applications of the Bluesky tree map data include use by Dudley Metropolitan Borough Council to help ascertain numbers for a borough-wide inventory of trees; by Exeter University and the Met Office to create the first high-resolution maps of allergenic plants and trees; and by Daventry District Council to prepare for a new grounds maintenance contract.

Bluesky National Tree Map is currently available for England and Wales, with work already underway to create coverage for Scotland.

www.bluesky-world.com/



2EXCEL GEO

2EXCEL geo leverage their capabilities in airborne data collection, processing and analysis to generate a series of products specifically developed for effective tree management.

The process typically starts with the bespoke collection of airborne imagery (true-colour and hyperspectral) from our manned platform for the specific area of interest, although external data sources (including UAVs and satellites) can also be used where appropriate.

Following some automated data processing and engagement with end users to understand specific requirements, a selection of useful products can subsequently be created.

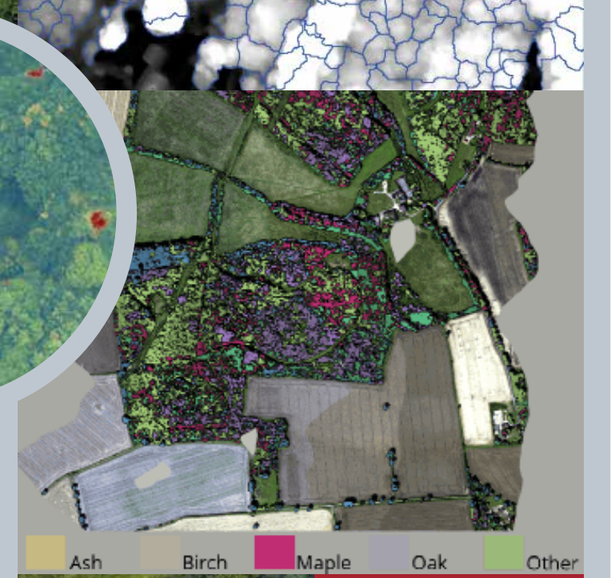
Forestry products typically start with the generation of an individual tree map. This process utilises digital surface models (derived from true-colour imagery) and allows each tree to be assessed separately for a variety of characteristics, such as tree height and canopy extent. This product can be delivered in a variety of formats; the most useful of these is typically a polygon representing the canopy extent which can be ingested into any GIS-based system.

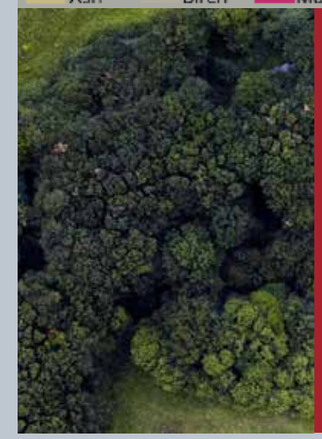
The highly detailed nature of the hyperspectral imagery acquired by 2Excel geo also facilitates a detailed assessment of tree health and condition. Hyperspectral imagery provides information about the reflectance of tree canopies in over 400 image bands across the visible and infrared regions of the electromagnetic spectrum. This allows for a much more detailed assessment of the physiological condition of trees. A comprehensive understanding of the interaction of sunlight with forest canopies allows the hyperspectral imagery to be exploited for a series of tree health-related products. These can be tailored to specific disease symptoms or general indictors of poor health such as deadwood, dieback and discolouration.

In addition to tree health assessment, hyperspectral imagery can also inform the distinction between different tree species. 2Excel geo have developed a methodology which applies machine learning techniques to the hyperspectral imagery to identify tree species of interest. When combined with tree health assessments, tree species mapping can also inform causal agents of decline and facilitate disease spread modelling and prediction.

One of the key aspects of incorporating these products into effective forest management is continued communication with the end user. Each forest manager or tree officer will have their own priorities and current systems of working. Understanding these can ultimately improve product integration and real-world application.

www.2excelgeo.com/





Top left: Airborne true-colour imagery for a mixed deciduous woodland.

Top right: Tree crown segments overlain on Digital Surface Model.

Centre inset: Hyperspectral imagery applied to assess decline (red regions demonstrate areas of poor health).

Above: Dominant tree species map for a UK woodland.

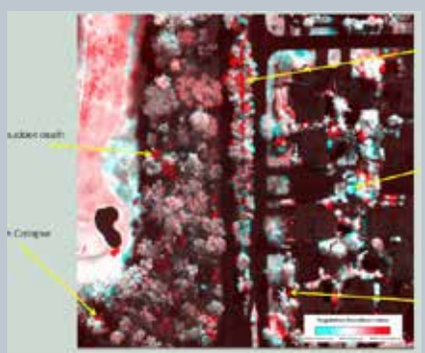
Left: RGB image of woodland.

ARBORFLIGHT

ARBORFLIGHT, specialists in tree and vegetation survey and management, have brought to the UK market the ability to perform airborne tree and vegetation analysis.

Utilising fixed-wing aeroplanes or an unmanned aircraft system (UAS – aka drone. CAA PfCO Cert UAS7235), we are able to attach hyperspectral and multispectral cameras to determine the height, canopy cover, GPS location, clearance distance from infrastructure and health condition of trees and vegetation. This information can then be put into a GIS system or our own tree management software, Arbortrack Web. From here, the data can be reported on and further analysed, along with the ability to issue resulting remedial work to contractors and manage budgets.

Where a tree is hazardous due to disease, decay or structural weakness, and shows signs of such, the occupier of the land on which it stands is normally liable under UK law for any personal injury or damage that it causes. FMs have a liability of risk which needs to be managed. Budget constraints can be a real issue for managers of large, widespread estates. Sites are often spread across the country and carrying out ground surveys requires an army of tree surveyors. This often means that tree management becomes a 'reactive' affair, with defects often reported by site engineers, other site visitors and neighbours, after a tree has fallen and damaged assets.



In comparison to a typical ground survey which can analyse just 200 trees per day, ArborFlight can typically survey more than 20,000 trees per day.

It is estimated that around 2.38 per cent of trees surveyed require immediate remediation work. This is where our services come in, with our ability to survey large areas of trees and vegetation very quickly, in order to pinpoint any dead and dying trees or trees that are showing signs of stress. We can then direct ground surveyors to the exact problem trees.

www.arborflight.co.uk

EZYTREEV; PERFECTLY 'CULTIVATED'

EZYTREEV, market-leading tree software in arboriculture, also has a lot to offer foresters. It's been developed by ra Information Systems, based in Chesterfield.

The company started life in 1988 as a small family firm, writing bespoke software, mainly for local authorities. ezytreev was then created in 1992 as a specialist tree management system, based around mapping and with industry-specific features, after it was identified that there was nothing on the market that fitted the bill.

ezytreev has since grown from having six clients in 1998 to well over one hundred in 2018, and with each new client has come new features and functionality, with developers and users combining their ideas to continually improve it.

After 30 years in the IT industry, ra has a breadth of expertise across the organisation, with the scale to deliver continual product development and excellent customer support. This includes four developers working on ezytreev full-time, as well as a help-desk team of six technicians. They also have staff with considerable tree management experience, assisting users and influencing development.

ezytreev itself has moved on considerably over the years and is now cloud-based and accessible from both Web and conventional interfaces. Surveying used to mainly be done using expensive and heavy toughened tablets and laptops, with data synced once you were back at the office. Nowadays the ezytreev app can be used on any Android, Apple iOS or Windows 10 device, and using SmartSync data transfer allows the whole inventory and all maps to be locally available to the surveyor at all times, as well as benefiting from a live link to the main system whenever 4G or WiFi is available... so the best of both worlds!

ezytreev users range from local authorities, consultants and contractors, universities and zoos, to housing associations and other large landowners. But the flexibility and range of features the system offers make it well suited to anyone managing large numbers of trees and the work carried out to them, whether in an urban or forestry setting.

Key forestry-related features include:

- Intuitive map-based app with customizable menus for surveying quickly and simply on any tablet.
- Sites can be separated into woodlands, plantations, compartments, groups and individual trees if required.
- Inspect, report and instruct work at any of these levels.
- For each compartment/group etc, record and automatically calculate area, species percentage breakdown, species actual count, overall density, timber height and age range make-up.
- User configurable in-built risk and valuation calculators.
- Versatile polygon drawing options, including drawing any shape with your fingertip or stylus.
- Manage the works ordering process, including by quotes or bill of quantities, with automatic job ticket and map generation.
- Distribute jobs to multiple teams and allow them to view and update scheduled work live in the field.

www.ra-is.co.uk/ezytreev/