Time for CHANGE

Mapping what lives in the British countryside and classifying habitats to detect change involves endless hours tramping through bogs, up and down hills, and through some of our most rugged landscapes. **Paul Scholefield** describes how drones are lending a helping hand

At the centre of this activity is the Countryside Survey conducted by the Centre for Ecology & Hydrology (CEH). The work includes mapping landscapes and its ecosystems in often remote areas – from big features such as fields and woodlands to details of ditches and hedgerows.

The Survey (https://countrysidesurvey.org.uk/) is the definitive record of Britain's countryside and how it's changing over time. It helps policymakers, regulators and industry understand the natural resources that are available and how we can use them sustainably.

Producing it takes huge amounts of fieldwork. Trained surveyors drive around the countryside with tablets, trudging to hard-to-reach areas and cataloguing the major landscape features and the vegetation found there.

Aerial perspective

The work on the ground isn't going away, but the aerial perspective that drones add to fieldwork allows the author and his colleagues gain more scientific insight from it. It gives them thousands of high-resolution aerial photos that can be assembled into intricate 3D maps, providing an unprecedented wealth of information on the mosaic of different habitats that make up the countryside.

The author pictured at the 2018 Commercial UAV Show in London. Photo: GeoConnexion

Until recently, scientists relied on satellite images and photographs taken from research aircraft for the big picture on how the landscape's changing. But satellite photos can't give much detail – one pixel can represent an area of 25m² or more. Planes, meanwhile, are expensive to operate and have to be booked months in advance. Even then, bad weather can mean that, on the day they can't take off, ruining scientists' plans.

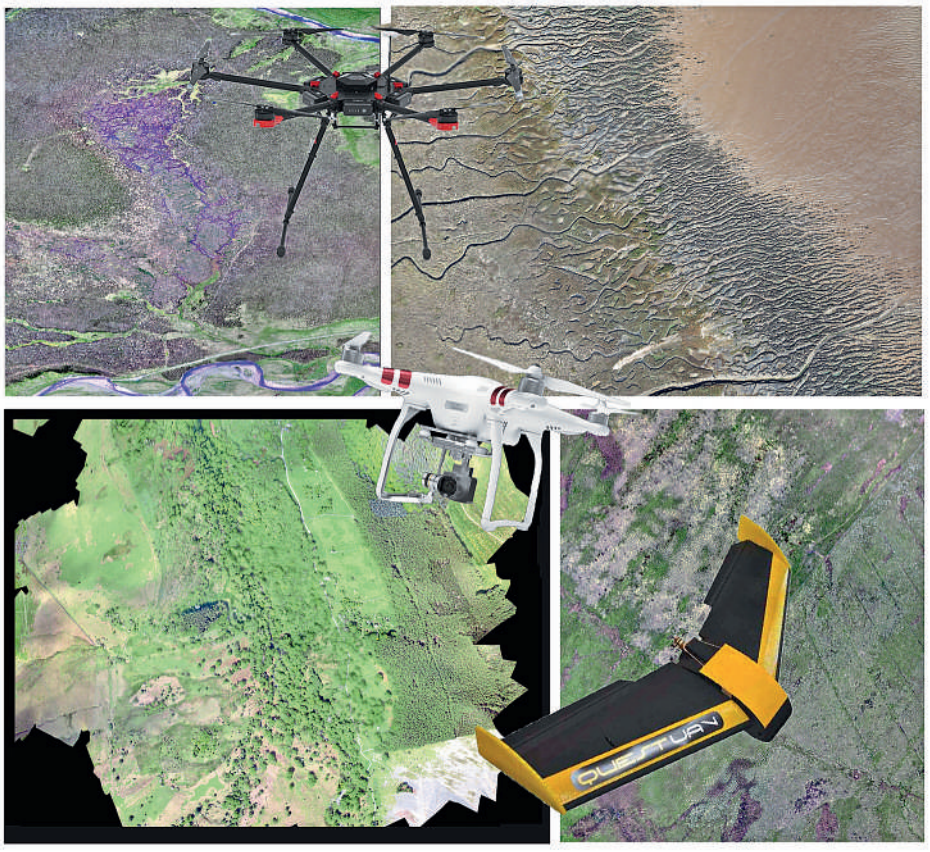
Drones, in contrast, are cheap and can be launched at short notice. With the UAV, one can just go along to the site on the same day the surveyors are there, fly the drone, and end up with a detailed 3D picture of that bit of the countryside. This eliminates any doubt over whether things have changed in the time between the work on the ground and a plane being available to fly overhead. And because they're cheap to run, drones can repeatedly visit an area to get a handle on how it's changing over time.

Off-the-shelf solution

The survey team uses an off-the-shelf fixed-wing drone, equipped with a high-resolution camera that can capture details down to centimetre-level. With this, it is possible to see which patches of heather are flowering, which channels in a salt marsh have water in them, and even individual blades of grass. It means scientists can start looking at microclimates within a landscape by, for example, identifying erosion gullies, quad bike tracks, and areas of bare mud due to overgrazing.

Such information is invaluable in understanding how a landscape changes over time – for instance, how a beautiful or scientifically valuable area is being affected by what people are doing there. Knowing this is the

Photo: Scott George Knowles / Shutterstock



Aerial images pictured above (from left clockwise): A CEH monitored catchment at Moor House-Upper Teesdale NNR; High resolution aerial imagery of the coastal zone and mudflats at Dengie NNR; Imagery collecting using a Quest 300 UAV and a gimbal mounted Panasonic Lumix LX5 that has been stitched together using Agisoft Photoscan Pro and assembled in ESRI ArcGIS 10.2; A one square kilometre mosaic of the Afon Rhaeadr Fawr area near Abergwyngregyn. UAVs pictured inset (top): The DJI Matrice 600 system can carry large sensors, hold a steady position in the sky and fly pre-programmed routes autonomously, making it ideal for creating high precision maps. Middle: The DJI Phantom 3 is a small and relatively cheap quadcopter which, like the Matrice 600, can fly pre-programmed routes and is ideal for acquiring centimetre resolution aerial imagery and 3D landscape (height) models. Lower: the QuestUAV 300 fixed-wing UAV can cover larger distances (maximum range of 100 km) than rotary platforms and is ideal for surveying relatively large areas

first step towards being able to predict its future.

The drone means the team can work to its own schedule rather than depending on the availability of a research aircraft, and gather much more aerial imagery in the process. Already, it has produced highly detailed maps of terrain ranging from uplands like Moor House-Upper Teesdale National Nature Reserve in the North Pennines, to the intricate sand dune systems at Sandscale Haws NNR in Cumbria and the saltmarshes at Dengie in Essex.

Image processing and analysis

Through waypoint programming, the UAV completes a series of passes over an area of interest; after 30 minutes it lands in a field or other open area. The team retrieves it, downloads the acquired imagery, and feeds it into a powerful computer back at the office. This spends several days stitching the images together to create a composite image the size of a tennis court (representing several square kilometres of countryside).

Using photogrammetry, canopy height models are generated for counting trees, low lying shrubs, or even sheep on hillsides. The main constraint seems to be the volume of data, and the processing time. Images are classified using a combination of data fusion techniques and machine learning to gain a more comprehensive understanding of landscape patterns.

An example of this improved understanding was evident in a survey of conducted at the Moor House NNR and where 4 sq. km. of terrain was mapped in an afternoon – an exercise that would have taken weeks on foot. Although the team already had high resolution satellite imagery and detailed information from previous ground surveys, the drones filled the middle ground between these two extremes to deliver a greatly improved picture. While surveyors see the reality of what's on the ground over a small area, drone imagery allows them to scale-up and apply their insights much more widely. That said, surveyors will always be needed to ground truth the collected data.

Looking to the future

The author and his team are now looking to acquire more drone sensors such as IR cameras and LiDAR instruments that will help scientists map the precise structure of forest canopies. Another project in its early stages is to fly drones at night to find bats by picking up their ultrasonic calls. As well as looking to extend drone flight duration, other intended work is to mount and test a lightweight hyperspectral camera for habitat classification research, and to explore the potential of machine vision for the on-board processing and classifying of imagery - a real challenge!

Even so, this is just the start of using drones to gain fresh insights into Britain's natural landscapes. In the longer term, thought is being given to crowdsourcing drone imagery. As more and more people start owning and flying their own drones, the amount of aerial imagery will grow exponentially. If scientists can get hold of this information – perhaps hosting it at a central database managed by CEH – they could assemble it into a gigantic, exquisitely detailed nation-wide map. After all, more and more tools that were once confined to professional researchers are now cheaply available to the public. This vision of citizen science from the air hints at ways the information they produce could come together to make something that helps us all.

The Centre for Ecology and Hydrology is hosting a two-day Data Fusion and Habitat Classification course in January. For more information: https://www.ceh.ac.uk/training/using-drones-map-habitats.

Dr. Paul Scholefield works in ecological modelling and spatial analytics at the Centre for Ecology & Hydrology (https://www.ceh.ac.uk) at Lancaster University. Larger versions of the drone imagery reproduced here can be found at www.gigapan.com/profiles/Fieldstitcher/gigapans