Whether you’re the owner of a small private woodland or a forestry company responsible for millions of acres, you’ll know that effective forest management and commercial decision-making relies on a detailed understanding of what tree species you have, and where they are located. The spatial and temporal resolutions of satellites offer a unique data source to understand species across even the largest forests and are now used within business as a notable alternative to more traditional methods.

In this article we explore the common challenges encountered when identifying species using traditional aerial technologies, looking at how satellite data can be used within commercially available data services to quickly, accurately and cost-effectively identify and map tree species distribution, and the benefits this can provide.
BACKGROUND

Identifying and mapping tree species distribution has always presented a challenge for forestry companies, particularly when analysis is required over a large geographical area or in areas where access is restricted. However, businesses have much to gain by improving their knowledge of species presence, relative proportions and distribution, as this knowledge can help to:

+ Estimate the commercial value of timber stock
+ Gain commercial advantage when competing for harvesting rights
+ Reduce the risk of planning and strategic decisions on forest management issues
+ Provide more accurate resource assessments
+ Allow quick identification of problems or areas at risk (such as invasive species)
+ Enable the more efficient deployment of ground teams
+ Provide a timely baseline for monitoring changes over time

It’s not just woodland owners and forestry companies who can benefit from accurate species mapping. For governments and regulators, it supports the implementation of policies governing sustainable management. For the real estate sector, it provides valuable data for land acquisitions.
ANALYSIS OF PAST & CURRENT TECHNOLOGIES

Today these images are normally captured automatically with cameras mounted to fixed-wing aircraft, helicopters or unmanned aerial vehicles (UAVs or “drones”). With high or very high resolutions down to just a few centimeters, aerial photography can be an effective way to map fine-scale landscape features, such as land surrounding rivers or individual trees. However, for larger diverse forested areas that are continuously changing, it has a number of significant limitations.

Capturing aerial images can be expensive when photographing vast forested areas. Not only that, but interpreting the data gathered is time-consuming, being done manually by highly trained interpreters. Given these time and cost considerations, the revisit rate could be as long as ten years apart.

Even with expert analysis, there is a degree of subjectivity in the interpretation of aerial photographs and the process is prone to systematic errors. Once the data has been acquired it is often difficult to analyze, particularly in areas of closed canopy and densely mixed woodland, where species can be easily missed or wrongly identified. More recently, technological improvements have enabled aerial imagery to be coupled with digital image analysis techniques, but image quality is dependent on the weather on the day of capture, and errors often occur during the collection and digitization of photographs that can limit their use.

Because of the costs, time and limitations involved in aerial imagery, although it is still used widely by forestry companies, it is broadly accepted that this technology on its own is insufficient for mapping tree species across large spatial scales. It is normally used in conjunction with field data. However, even with this data, the technical errors involved, and the low rate of data updates make it impossible to track change over time with any degree of accuracy. This makes it ineffective for making decisions, which could impact the health of valuable species or mean new commercial opportunities are delayed or missed.

Another technology used for larger scale forest analysis is, of course, Lidar. However, while it can provide detailed data on tree height to support growth and volume statistics, it doesn’t offer species classification, which limits its value in areas where multiple species are present. Like aerial photography, it’s also costly to obtain Lidar data and it therefore has similarly infrequent refresh rates - the result being that companies typically have to work with information that’s several years out of date.
THE BENEFITS OF SATELLITE DATA

Only one of the tree species mapping technologies available today offers accurate results with a high refresh rate and speed of analysis, and that’s satellite imagery.

In the past, the low resolution of the satellite imagery available fell short of commercial accuracy requirements, and the development of classification techniques for species identification was therefore limited to non-commercial contexts. Historically, there was an unwillingness to move away from traditional methods, in part due to concerns about costs and the effect of cloud coverage on image quality. What’s more, a lack of expertise also meant that many companies were simply unaware the technology existed.

The higher resolution and more freely available satellite imagery accessible today renders many of these concerns a thing of the past, now providing huge quantities of frequently updated geospatial information quickly and accurately. A wide range of satellites now offer different resolutions of imagery in both open source and commercial contexts, making it far easier for forestry companies to benefit from high-quality, affordable imagery that can be digitally interpreted by geospatial data experts for insights into tree species identification and location mapping.

Satellite data provides broad spatial coverage for a lower cost per survey than other methods, and is less weather dependent than aerial photography or Lidar. It shows you what’s going on in the entire forest, not just small parts of it, giving you a complete and accurate picture of tree species and their location. Cloud cover is no longer an issue, because satellites now have multiple optical and radar sensors that enable them to provide forestry companies with a range of sources to help reduce their previous dependency on the weather and other technical barriers.
EVEN MORE BENEFITS OF SATELLITE DATA

Satellite data has the added benefit of enabling regular revisit frequency to monitor change over time, as data can be refreshed as often as weekly or even daily. This eliminates guesswork to ensure that commercial decisions are made using accurate, up-to-date information. Importantly, it also significantly reduces the costs of data interpretation, as it can yield valuable commercial insights using machine learning algorithms rather than having to be manually scrutinized by highly skilled interpreters.

The use of satellite-derived data for species analysis or indeed aerial imagery is not seen as a replacement for field surveys. In fact, both methods should work in a complementary way. Field data is always required to calibrate and validate these data sets. Likewise, these technologies can help to add value to field surveys. The synergies of both methods lead to a more efficient system for data capturing to produce abundant and reliable information.

To summarize, the table below gives a comparison of the technology currently available.

<table>
<thead>
<tr>
<th>Method</th>
<th>Refresh</th>
<th>Speed of Analysis</th>
<th>Quality of Output</th>
<th>Cost per Survey</th>
<th>Spatial Resolution</th>
<th>Product Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite Derived Data Analytics</td>
<td>Up to weekly</td>
<td>Fast</td>
<td>High (depends on terrain/species mix)</td>
<td>Medium</td>
<td>Medium</td>
<td>Tree Height, Species</td>
</tr>
<tr>
<td>Lidar</td>
<td>1-5 years</td>
<td>Fast</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Tree Height</td>
</tr>
<tr>
<td>Aerial Image Analysis</td>
<td>1-10 years</td>
<td>Slow</td>
<td>Medium (depends on terrain/species mix)</td>
<td>Low</td>
<td>High</td>
<td>Species</td>
</tr>
<tr>
<td>Field Survey</td>
<td>1-10 years</td>
<td>Slow</td>
<td>Medium (depends on terrain/species mix)</td>
<td>Medium/High</td>
<td>Low</td>
<td>Tree Height, Species</td>
</tr>
</tbody>
</table>
THE DATA YOU NEED FOR INFORMED DECISIONS

At Rezatec, we’ve used ground data to develop a machine learning classification algorithm that automatically interprets tree species information from satellite data with maximum accuracy. This allows us to create a map of any area of interest, giving you an accurate view of the distribution and abundance of each species. We present this information in an online portal that makes the data easy to understand for any stakeholder, supporting informed business decisions and taking the risk out of commercial ventures.

Our tree species mapping service brings numerous benefits to your business, allowing you to:

+ Gain an accurate spatial understanding of an entire forest area, including coniferous and broadleaf species
+ Combine tree species information with other data - such as tree health, height and volume, soil classification and much more - for a more complete picture
+ Know where high-value species are
+ Monitor new species, species decline and other changes over time
+ Combine with other technologies, such as ground survey or Lidar data, to enhance your understanding and give you insights into what’s happening between updates

So far, we’ve mapped tree species distribution to meet a variety of requirements across an expanding list of locations around the world, including the UK, US, Europe, Canada and Australia.

Our robust methodology enables an ever-growing number of species to be classified with 80 to 90% accuracy, supporting informed commercial decisions. We can apply confidence limits for risk assessment, and we can create data suitable for a range of users.

80-90% species classification accuracy
As highlighted on the previous page, high-quality plot inventory data is an invaluable complement to satellite observation, and most forestry companies rely on field data in addition to the aerial or Lidar data obtained. However, with Rezatec’s innovative solution, the amount of field data required to maintain a high quality inventory can be significantly reduced. A standard cruise inventory density requires 1 plot per 5-10 acres, but with Rezatec’s analytics – particularly for larger properties (>50,000 acres) – we typically require calibration plots at densities of less than 1 plot per 100 acres. This reduces the survey time as well as providing an accurate, up-to-date spatial distribution to ensure the most efficient use of your resources.

**INNOVATIVE FORESTRY SOLUTION**

- Save up to 80% in operational expenditure
- Refresh rate up to weekly
- Tree species accuracy up to 90%

**FIND OUT MORE**

Contact us on +44 (0)1865 817500 or email info@rezatec.com

In the meantime, you could also learn more by reading our case studies on forested asset decision support and forest mapping in British Columbia.