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Using citizen science to verify machine learning data

Forest Research

The Challenge

- Accurately estimate the number of trees felled or broken during Storm Arwen

The Benefits

- Improved confidence in the accuracy of tree-loss data
- Better planning for commercial timber production
- More information to support sustainable forest management
- A proven approach for future storms

In the aftermath of Storm Arwen, Forest Research used ArcGIS to enable people to check, edit and capture data in the field about the locations of 22 million fallen trees. This citizen-science app allowed the organisation to verify data generated via machine learning technology and build up a more accurate and comprehensive picture of the full scale of the natural disaster.

The Challenge

In November 2021, Storm Arwen swept across Scotland and Northern England causing catastrophic damage to woodlands and forests. Stunned by the scale of the destruction, foresters and land owners needed to know how many trees had fallen and exactly where, to help them recover wood safely that could be used for timber production. Fallen trees that are not harvested quickly will soon become unviable, leading to the waste of a valuable resource, increasing the release of carbon, creating a breeding ground for pests and diseases and augmenting the risks of wildfires.

The Solution

In the first instance, data engineers and data scientists at Forest Research used Sentinel Synthetic Aperture Radar (SAR), a technology that detects changes in the forest canopy cover by measuring radio waves between satellites and the ground. The organisation compared SAR readings from before and after Storm Arwen and created a model using machine learning techniques to identify areas where there had been a notable disturbance in canopy cover.

This initial dataset estimated the loss of around 8 million trees, providing the first indication of just how much devastation the storm had caused. When Forest Research published its data, however, it began to receive reports from local authorities, utilities and the general public about additional areas of tree loss. It conducted site visits to forest areas near its office in Edinburgh to see the situation on the ground, but simply didn't have the staff required to validate its tree-loss data across all of the affected areas of Scotland and Northern England. That's when citizen-science was raised as a possible solution.

Forest Research had been using solutions from Esri's ArcGIS suite for many years and was familiar with ArcGIS Hub Premium, an online data sharing platform that allows thousands of people to submit and edit data via the web or mobile apps. It realised that it could use ArcGIS Hub Premium to engage the help of people across the industry and the general public as citizen scientists to validate its tree-loss data.

Working exceptionally quickly, Forest Research set up a dedicated landing page for the initiative on ArcGIS Hub Premium and built a mobile app using ArcGIS Survey123 to enable people to view, edit and validate data using their smartphones. "We were able to spin up a citizen-science portal using ArcGIS Hub Premium in less than a day," says Tony Farndon, GIS Specialist and Development Manager at Forest Research.

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Forest Research's citizen science portal

Forest Research shared the app with the forest industry, local councils, utilities, road departments and the general public, encouraging everyone to help validate the SAR-generated data so that it could refine its model, improve its machine learning and reach a more accurate estimate for the actual number of trees felled by the storm.
Although the organisation initially had some concerns about how easy it would be for non-GIS experts to edit data in the field, the Survey123 app was widely used and delivered a large volume of quality data.

The Benefits
Improved confidence in the accuracy of tree-loss data
The citizen-science approach that Forest Research implemented using ArcGIS Hub Premium enabled it to quickly validate data across thousands of square miles of land throughout Scotland and Northern England and gauge the impact of Storm Arwen with far greater accuracy and confidence. It discovered that more than two and half times more trees had been damaged than initially estimated. "As a result of the citizen-science validation, we can now confidently estimate that 22 million trees came down in the UK on one night during Storm Arwen," Farndon says.

Better planning for commercial timber production
Forest Research was able to share accurate information about the locations of fallen trees with organisations throughout the forestry industry. Consequently, forestry and commercial logging companies could make faster, better decisions about where to focus their resources to harvest fallen trees before they began to degrade. Similarly, sawmills were able to use the data to better plan how to manage the sudden surge in demand and store the additional volume of wood that would be coming to them.

More information to support sustainable forest management
Forest Research's data is now being used to help foresters and landowners plan their ongoing clean-up activities and identify areas where action may be needed to mitigate the risks of disease and pests. The data is also being used by tree nurseries to help them understand the volume of seeds and young trees that will be needed to replant areas devastated by the storm and ensure the sustainable management of forests and woodlands.

A proven approach for future storms
The citizen-science-led initiative that Forest Research developed in the aftermath of Storm Arwen, using ArcGIS Hub Premium and ArcGIS Survey123, has given the organisation a proven approach that it can reapply in future storm events. "With climate change, events like Storm Arwen are estimated to happen more often," Farndon says. "We now have a hub, a model, a mobile data capture solution and a proven citizen-science approach that we can use to respond quickly following severe storms and gather the accurate information the forestry industry needs."

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