Wildfires

Forewarned is forearmed

software can model how a wildfire will spread-and how to stop it happening

LEST anyone doubt the speed with which a brush fire can strike, consider how rapidly flames engulfed Mati, a seaside resort near Athens, on July 23rd. Less than 90 minutes after fire was reported, flames had reached densely populated areas. Hordes of people fled into the sea, the only refuge, to escape. At least 91 were killed.

That toll could have been avoided, says Gavriil Xanthopoulos, a wildfire expert at Greece’s Ministry of Rural Development and Food, if proper use had been made in advance of fire-simulation software. Fed with data on the area’s vegetation, building materials, paved surfaces, paths to the sea and weather patterns, such software would have suggested, he says, those places where trees and brush should have been removed, roads widened and evacuation paths built-not to mention how zoning laws could have been better devised in to face of fire risk.

Greece, Dr Xanthopoulos laments, has been slow to adopt such software. Others are not so dilatory. America’s Forest Service, for instance, uses a model developed by Esri, a geographic-information firm in Redlands, California, to assess fire risk. This model feeds on data on the distribution and types of trees, bushes and other vegetable ground cover, and on construction materials used in an area.

These data are collected mainly by satellites and aircraft, but rangers and crews of firefighters contribute detail from the ground. According to Chris Ferner, a wildland-fire technology specialist at Esri, even entering the diameters of tree trunks and the sites of-clogged culverts (which alter patterns of water flow) is grist to the software’s accuracy.

**Fire! Take aim...**

Once a piece of fire-forecasting software such as Esri’s knows how much inflammable stuff there is on the land, it can bring in data on rainfall, snowfall, sunshine, temperature and the like, to work out how this might change in the future, as well as how much moisture the vegetation holds. It can also take into account past fires and the lie of the land. A south-facing slope, for example, dries out faster (at least, in the northern hemisphere) than one facing north.

Another model, developed at the University of California, Santa Barbara, by Christina Tague, is called RHESSys. Dr Tague has loaded RHESSys with fuel- and moisture-data for roughly 800 square kilometres of wildland, most of it in California. This shows forestry officials where best to bulldoze fire breaks, cut down trees of clear scrub.

Rob Linn of Los Alamos National Laboratory, in New Mexico, who helped design yet another piece of modelling software, FIRETEC, describes this as “engineering” the behaviour of wildfires. FIRETEC is so sophisticated that it even models how the flames of a planned burn, intended to clear vegetation in a controlled way, will be fed by the wind they generate. This lets users (who include the forest services of Canada and France, as well as the United States) design precise patterns for planned burns, in order to clear surface vegetation without destroying tree canopies.

All of which is well and good for the purposes of prevention. But, if prevention fails, the question remains of whether software can then be used to forecast a fire’s spread, assisting those fighting it, and helping those threatened get out in time.

This is more challenging problem, for forecasting a fire’s behaviour requires a staggering number of calculations. FIRETEC, for example, divides the fire-threatened space under analysis into one-metre cubes called voxels, and then crunches estimates for each voxel of fuel, moisture, temperature and airflow, taking into account drag created by foliage and other objects. As a simulation progresses, the values in each voxel affect adjacent ones, thus creating feedback which produces impressive verisimilitude. Unfortunately, it does not do so quickly. FIRETEC’s simulations run more slowly than real fires burn, making it useless for real-time forecasting.

To calculate, in a useful amount of time, the spread of a fire that has already started thus requires compromise. A model called CAWFE has voxels with sides 370 metres by 370 metres by ten metres. That makes it less accurate than FIRETEC, but according to Janice Coen, of the National Centre for Atmospheric Research, in Boulder, Colorado, who is leading the development of the software, it spits out a forecast of a wildfire in just a quarter of the time that the fire takes to burn.

Such forecasts are about to get better. Using infrared images captured by aircraft, Dr Coen is training CAWFE to predict when and where a wildfire is likely to produce several infrequent but terrifying types of tendrils that reach out beyond the fire line. These include “fire whirls” (see picture), which can snap and hurl trees; pairs of counter-rotating “horizontal roll” fire vortices that form in mid-air but can collapse onto the ground; and “flame fingers” that have smitten firefighters even 100 metres from a fire’s edge.

The most extreme 1% or so of wildfires, however, are likely to remain unmodellable for some time. These include the “explosive” wildfires that ravaged central Portugal last year. On June 17th 2017 wildfires broke out around Pedrogao Grande, near Coimbra. Initially, meteorologists reckoned that these fires would advance at about 3kph, but the soaring flames soon changed direction and accelerated to six times that speed. Sixty-seven people died, nearly half of them trapped motorists.

Flames that rose roughly 100 metres into the sky during these fires generated a gale and searing “pyrocumulus” clouds, a process too complex for today’s best software to model, according to Marc Castellnou, a member of the technical commission that studied the disaster. Francisco Castro Rego, an expert on fire forecasting at the University of Lisbon, reckons that at least two more years of development will be needed to model such fires.

Fire-modelling is, however, getting better all the time. New satellites, with shortwave-infrared sensors, can detect fires as small as a backyard barbecue. Satellites and aircraft with rangefinders that use lidar, an optical version of radar, can map the height of vegetation precisely, which helps forecasting software work out whether a brush fire is likely to ignite trees. As statistics on fires accumulate, new correlations will be identified, such as how fluctuations in average temperature influence burn sizes of a given landscape. Such intelligence will be needed increasingly in the future. Predictions based of the likely effects of climate change suggest that by the middle of the century fires will burn twice as much acreage as they do today.