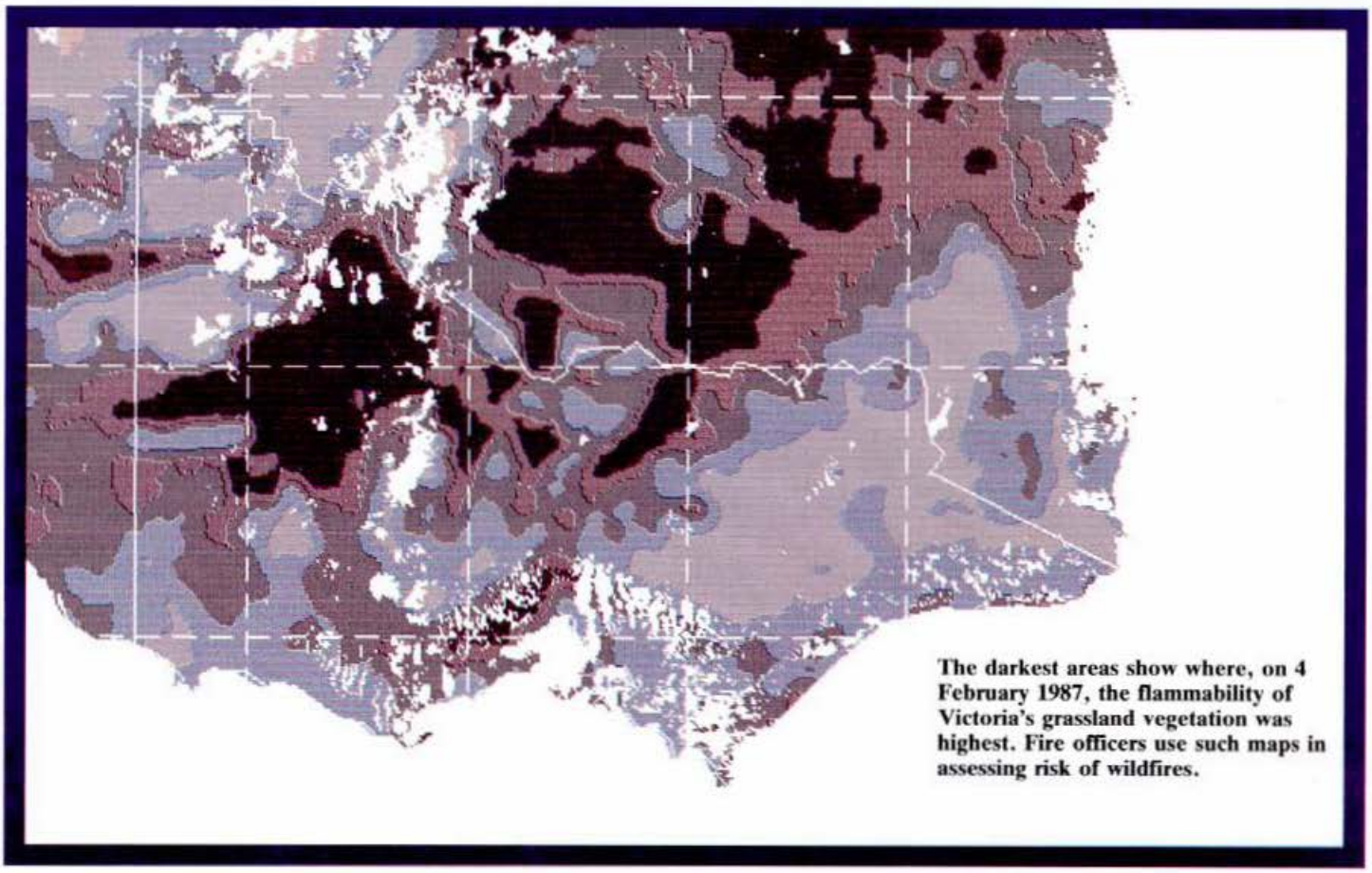
Fire risk ratings by satellite



The darkest areas show where, on 4 February 1987, the flammability of Victoria's grassland vegetation was highest. Fire officers use such maps in assessing risk of wildfires.

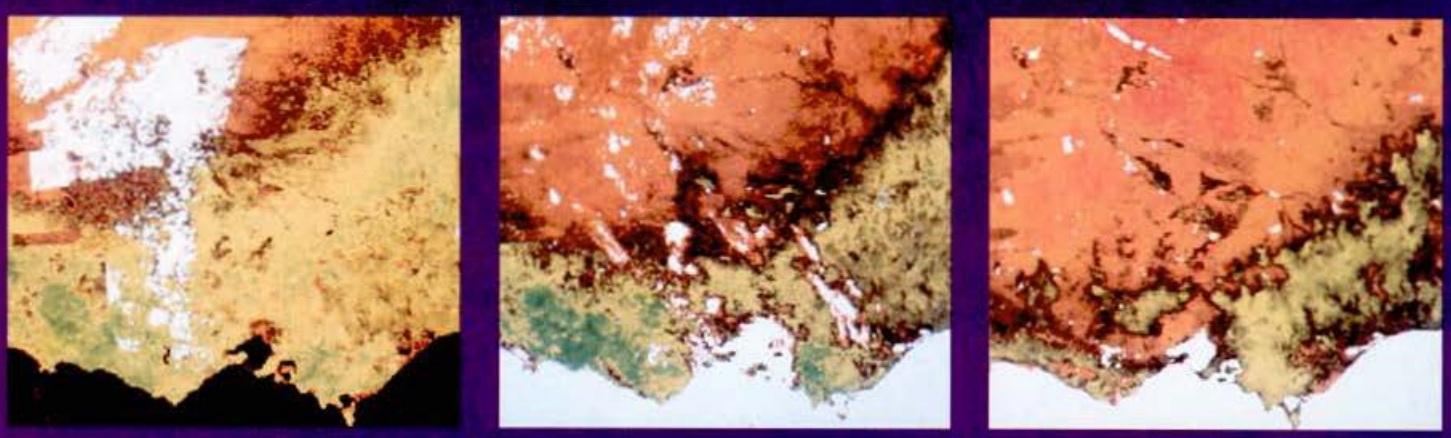
As summer's withering sun turns the paddocks brown, Victorian Country Fire Authority staff will be using polar-orbiting satellites to rapidly inform them how dry the State's grasslands have become.

Together with the state of the weather, this information allows them to gauge the current risk of fire accurately in each of the State's six regional fire districts.

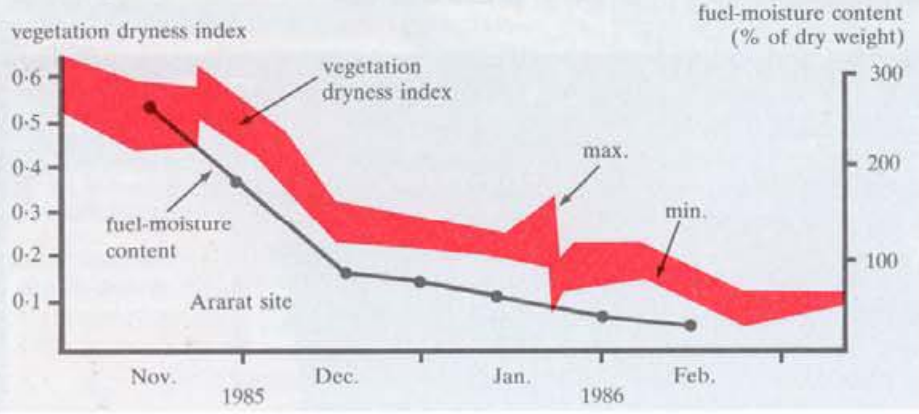
Whereas deep-rooted forest vegetation can take months to steadily dry out, leaves of grass — green and moist early in summer — can wither and senesce in a matter of weeks. Grass rapidly turns into tinder. An observer on the ground can only make measurements over a relatively small area of how flammable the countryside's tinder-box has become.

With a wide-ranging and up-to-date satellite appraisal to hand, the Country Fire Authority (C.F.A.), which is responsible for control of fires in grassland areas of the State, can more confidently declare periods

The browning of the countryside — three satellite images of south-eastern Australia during the 1986/87 summer. Colour enhancement allows the progressive drying out of vegetation to be clearly seen. With further processing, a map of fuel-moisture content (like the one above) could be produced.



Watching the country dry off



As summer progresses, the grass senesces and its moisture content steadily declines. At the Ararat site, the drop in experimentally determined values is matched by the satellite-observed vegetation dryness index.

of fire danger and days of 'total fire ban'.

The satellite system of dryness-monitoring relies on a steady stream of images received at the CSIRO Division of Atmospheric Research at Aspendale, an outer suburb of Melbourne, from the American NOAA–9 and NOAA–10 meteorological satellites. Computers process the images nearly as fast as they are received ('on the fly' as they say), and from them colour maps of vegetation moisture content are produced.

The technique of measuring fuel dryness this way was derived by pooling the expertise of researchers from the C.F.A. — who had been exploring the potential of satellite monitoring for a number of years — and the Division of Atmospheric Research. The collaborators evaluated the method during last summer and, with its usefulness now confirmed, the C.F.A. will be using it routinely, in conjunction with standard fuel-monitoring techniques, during this summer's fire season.

Dryness index

The eyes of the system are the advanced very-high-resolution radiometers, or AVHRRs, installed on the NOAA satellites. These instruments look down from a 90-minute orbit that carries them in north–south paths 800 km above Victoria four times a day (twice during daylight hours).

The AVHRRs scan the scene below in one near-infrared and three visible channels with a resolution of about 1 km. Although this provides a coarser picture than other satellites such as Landsat can achieve, the researchers have shown it is more than adequate to register how brown a paddock has become. More importantly, NOAA satellites can provide a picture every day (cloud permitting), whereas Landsat returns but every 18 days.

To work out how much the vegetation has dried out, the researchers get the CSIDA image-analysis system (see *Ecos* 41, page 9) to compare the brightness of AVHRR's channel 1 (580–680 nm) with that of channel 2 (730–1100 nm). The greater the difference between them, the drier (browner) is the vegetation.

However, the difference is also affected by the amount of vegetation cover — a bare paddock is very brown, but that doesn't mean it's highly flammable. To allow for this factor, the researchers assumed that the ground cover reached a maximum in November (the end of the growing season) and stayed more-or-less constant throughout the summer.

What the satellites see can be linked to the flammability of the vegetation using these experimental results.

In practice, this means that they continually looked to see how much green-ness a certain area had lost compared with its state in November. This gave an effective 'dryness' index, which they could present as certain colours on a State-wide map of Victoria. To calibrate the dryness index, the researchers did lots of ground sampling during the summer of 1985/86. At four locations where various pastures and crops grew, they clipped samples that were weighed, dried, and reweighed.

In this way, the moisture content of the vegetation could be calculated and compared with the dryness index. The graph (below) shows the result.

The experience of C.F.A. officers told them that a fuel-moisture content of 0–25% (of dry weight) corresponded to extreme flammability; 25–50%, very high flammability; 50–100% high flammability; 100–200%, medium flammability; and more than 200%, low fire potential. The final colour maps, one of which is reproduced on page 19, portray these categories.

Since the calibration was carried out on agricultural areas, the flammability ratings only apply accurately to them. In effect, this means most regions of the State except for forests.

As mentioned earlier, forests dry out much more slowly than shallow-rooted grasses and crops. Moreover, their flammability relates more to the fine-fuel fraction (the litter layer) than to actual water content of the crown.

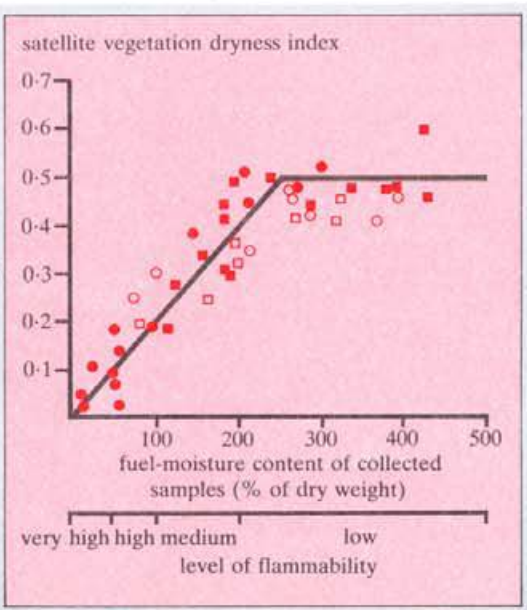
It's therefore much more difficult to relate forest flammability to what a satellite perceives. Nevertheless, the CSIRO scientists believe it's worth giving it a go. Together with the National Bushfire Research Unit, they are attempting to derive forest dryness from readings of the near-infrared channel of the AVHRR instruments taken at night. They believe they can extract data on forest temperature and humidity this way, which indirectly connect with canopy dryness.

Andrew Bell

Calibrating what the satellites see

'ground truth' sites, all with full vegetation cover, at various times

- ● Ararat — 60% pasture; 40% cereals
- ■ Lilydale — 60% pasture; 40% market gardens, orchards, vineyards
- ○ Yallourn — 50% pasture; 50% trees
- □ Loy Yang — 85% pasture; 15% trees



More about the topic

Fuel-moisture content of vegetation from AVHRR — an operational fire-potential monitoring system. J. Barber and G.W. Paltridge. *Proceedings, 1st Australian AVHRR Conference, Perth, October 1986*, 184–93.