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Mapping the extent of waterlogged crop using satellite imagery

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Satellite image data from the LANDSAT Thematic Mapper (TM) have been used to map waterlogged crop in Western Australia’s Upper Great Southern.

Accurate maps of the occurrence of waterlogging were produced for a 27,000 ha study area.

Before this work there was no practical ground-based method to assess the extent of waterlogging, and scientists and farmers could only guess the value of crop losses.

The results showed that satellite imagery can be useful for catchment planning and management of individual farms.

Satellite imagery

The Landsat TM satellite collects data over the whole State every 16 days with a ground resolution of 30 m by 30 m (1 pixel). This is an area of about 0.1 ha. Data collected by the satellite has two great advantages: low-cost broadscale coverage, and routine collection which allows for future monitoring.

The satellite’s digital detectors record spectral energy in a particular waveband as numbers; these numbers can be converted to colours to produce images.

In addition to visible light, digital detectors can record information which is invisible to the naked eye in the infrared and thermal wave­lengths. The LANDSAT TM sensor records in seven channels or bands; three visible, three infrared and one thermal.

The number and the location of the detectors is important when choosing a scanner to collect spectral data. Early work indicated that water­logged crop could not be accurately identified on aerial photographs which record in the visible part of the spectrum; the colours could not be consistently associated with crop known to be waterlogged. However, vegetation reflects strongly in the infrared portion of the spectrum and this spectral region provided the best discrimination between waterlogged and non-waterlogged crop.

The study

To test the value of remotely sensed data, several sites were selected on which crop condition was known. Spectral data from these areas was statistically analysed to determine if the waterlogged crop could be separated from non-waterlogged crop. If the analysis showed that there was good discrimination of waterlogging, then a reliable map could be produced from the image data.

In 1987, the first year of the study, an aircraft was used to collect high quality spectral data from a small test site in the Yornaning district. An accurate mapping of waterlogging was produced from this data (see inset photo on facing page).

Following this success, TM satellite image data (see photo above) were used over a much larger area in 1988. The study area is about 27,000 ha and includes about 90 per cent of the East Yornaning Catchment. This area was chosen because it contains all the major land­forms common in the Upper Great Southern. About 30 per cent of the catchment was sown to cereal crop, mainly wheat.
Figure 1. Two dimensional ordination of spectral data from 32 wheat training sites.

Analysis of the spectral data shows the overall distribution of 32 sites. Although there is variation between sites, the waterlogged and non-waterlogged sites are clearly separated.

BELOW: Aerial photo and classification map (inset) from the 1987 study of the 45 ha test site (outlined in white) in the Yornaning district. The yellow in the inset photo represents waterlogged crop, the other colours represent other crop conditions.
A classification map of waterlogged crop in the Yor­
naning Catchment. The thin white lines are paddock
boundaries, the thick white lines are roads. The area shown
is about 1,200 ha.

Code:
C = crop; P = pasture
Green = Non-waterlogged
crop
Brown = Waterlogged crop -
standing crop; some yield
possible
Blue = Waterlogged crop -
severe depression of growth,
weedy understorey; minimum
yield
Black = Not classified -
includes bush, most pasture
and rock outcrops

AN ON-FARM EXAMPLE

The waterlogging study provides an example
of how satellite data can be useful for manage­
ment at the farm and catchment level.

The photo on this page shows the classification
map of a sample area of the Yornaning catch­
ment; paddock boundaries and roads are in
white. At this scale the information is relevant
for farm planning.

The map can help farmers locate areas which
are suited to interceptor drains. It may also
help to identify paddocks or portions of
paddocks which are unsuitable for cropping.

Landforms in this catchment consist of small
gravely hilltops (Norrine) giving way to long
gentle slopes with some rocky outcrops
(Noombling). Together, these two units make
up about 86 per cent of the landforms common
in the Upper Great Southern. The paddocks
marked 'C' in the photo were sown to crop;
paddocks marked 'P' were under pasture. The
colours in the classification map represent the
various crop conditions.

Paddocks 1 and 2 were waterlogged through­
out most of the growing season and poor yields
resulted in substantial financial losses to the
farmer. Both paddocks have small areas of
good crop (green) located on the higher
ground. Below the high ground the land slopes
to a saline waterway along the southern
boundary fence. The slopes were badly water­
logged, the most severe being the blue area in
paddock 1.

Paddock 4 has a gradual north-west fall to the
same waterway. This paddock was water­
logged throughout (brown), with only a few
isolated patches of non-waterlogged crop
(green).

Because of the sloping nature of these pad­
docks, the effect of the waterlogging on grain
yield could have been minimized by installing
reverse bank interceptor drains.

Because of the large area being covered and the
limited time to collect ground information on
waterlogging in a growing season, local
farmers were asked to help identify suitable
training sites within the study area. Their
cooperation was a significant contribution to
the success of the project. Forty-four sites (27
waterlogged and 17 non-waterlogged) were
identified in wheat crops, 32 sites were used
for analysis and 12 kept kept for verification.
After statistical analysis (Figure 1), the satellite
data were used to produce a classification map
of ground conditions.

The accuracy of the satellite mapping was
extremely good when compared with ground
information. Waterlogged pixels were correctly
identified on all verification sites; the error on
area estimates was less than 10 per cent.

The map showed that about 32 per cent of the
area sown to crop was moderately to severely
affected by waterlogging. A further 3 per cent
was severely affected, causing crop failure.
Based on these figures, the financial losses for
the farmers caused by waterlogging were
estimated to be $1.1 million in 1988 (see ‘The
extent and cost of waterlogging’ on page 44).

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