GEOSCIENCE AUSTRALIA

September 2002 **ISSUE** 26

ACRESUPDATE

News for the Australian remote sensing industry

ACRES

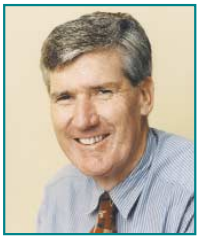
FEATURES

Extra antenna expands Australia's data acquisition capabilities

GEOSCIENCE AUSTRALIA
SPATIAL INFORMATION FOR THE NATION

contents

Cover: Data Acquisition Facility at Alice Springs, now with two X-Band antennas. Photo by Shaun Evans.



MANAGER'S MESSAGE

The National Mapping Division of Geoscience Australia, including ACRES, is on the move! We will be moving about December to Symonston where the remainder of Geoscience Australia is already located. The building is a major state-of-the-art facility located on the south-eastern fringe of Canberra. The move for ACRES will be much less complex than our last move in 1997, as our newer equipment is more robust and 'removalist-friendly'. We will of course be taking steps to ensure that our service levels to you will not be impaired during the move.

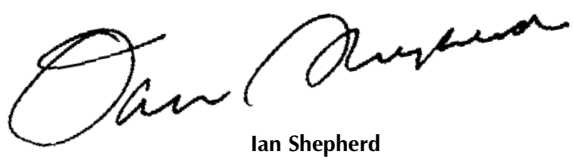
You will read in this edition of *ACRES Update* a number of contributions from users of our data. We are always very pleased to be able to report on the ways in which our data is being applied and the benefits that flow to the community. I thank these authors for their energy and commitment.

A brief update on the Landsat Data Continuity Mission (LDCM) is also included in this edition. In June, it was a milestone for me to be able to meet the two contractors for the first phase of the LDCM project, Resource 21 and DigitalGlobe. I hope that ongoing discussions will ensure that our continuing need for an Australian archive of Landsat data, and the availability of near real time data, can be accommodated in their business plans.

As usual, our staff are very busy as a number of major development projects come on-stream. Some are very visible, such as the "antenna farm" we now have at Alice Springs, and the online data we have available on our web site. Others such as new reception management software are largely invisible, but just as important to the quality of the service that we provide.

The forthcoming 11th Conference of the Remote Sensing and Photogrammetry Association of Australasia in Brisbane is shaping up to be a very interesting event. Among our presentations will be papers discussing the opportunities to further automate the delivery of our services, and the current geometric quality of our products, which now provide pixel-to-pixel registration of time series products.

Enjoy our *ACRES Update*, and, as always, we would appreciate your feedback!



Ian Shepherd

MONITORING PASTURES FROM SPACE

By Richard Stovold
Senior Research Officer
Department of Land Administration
Satellite Remote Sensing Services
Floreat, Western Australia

Farmers are the first to benefit from a time and labour saving project using satellite-based maps to manage feed for stock by estimating the amount of new growth on their properties.

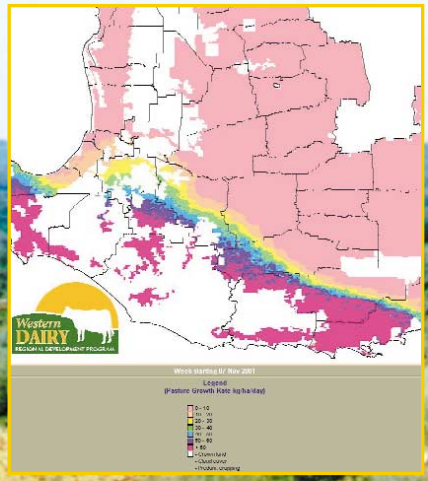
The development of two satellite-based measurement tools in a collaborative project between the Department of Land Administration (DOLA), CSIRO Livestock Industries and Agriculture Western Australia is the latest achievement in a seven year search to find an effective way of measuring the growth rate and amount of feed on offer in pastures for farmers.

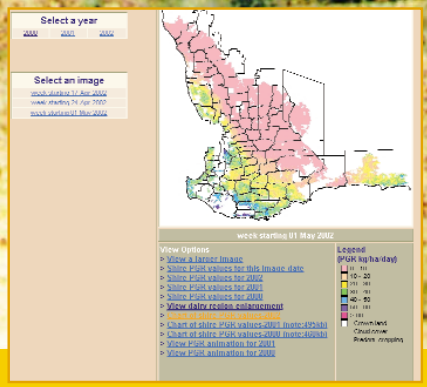
Farmers in south-west Western Australia have been participating in research projects for the past couple of years as models and applications have been fine tuned to find the most regular and timely delivery methods for information about the amount of food on offer in farmers' properties and the growth rate of their pastures.

This information is now available via the Internet thanks to two new satellite based measurement tools called Pasture Growth Rate (PGR) and Food on Offer (FOO).

PGR provides farmers and decision makers with timely estimates of regional pasture growth rates for the south western corner of Western Australia.

To provide this new service, DOLA's Satellite Remote Sensing Services (SRSS) group are accessing 1km NOAA AVHRR data from the Western Australian Satellite Technology and Applications Consortium (WASTAC) archive in Perth and processing it into fortnightly Normalised Difference Vegetation Index (NDVI) composites. NDVI is a measure of the greenness of pastures. These NDVI composites are then combined with weekly climatic data, supplied by the Bureau of Meteorology, to estimate pasture growth rates within Local Government Areas.

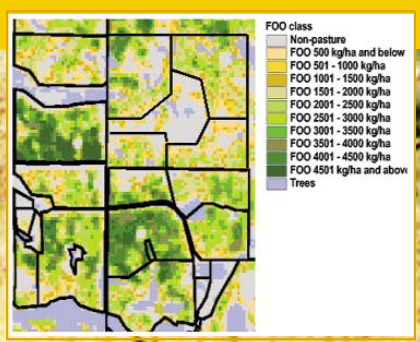




▲ An enlarged PGR map of dairy areas in south-west Western Australia on 7 November 2001.

▲ Map of south-west Western Australia showing pasture growth rate in kilogram per hectare per day on 1 May 2002.

▼ A FOO index map in kilograms per hectare at paddock scale derived from satellite imagery.



CSIRO Livestock Industries is further developing and testing the PGR model in conjunction with Agriculture Western Australia which is supplying field validation information over the last five seasons.

FOO uses Landsat or SPOT data at 30 and 20 metre resolution and gives near real time estimates of the amount of biomass available to livestock within individual farm paddocks and across the entire farm, district or region. FOO is a measure of the amount of biomass available to livestock. The estimation of FOO is based on empirical relationships between ground and satellite data to give seasonal response patterns.

How is it being delivered?

Each week throughout the pasture-growing season, the PGR files are posted to CSIRO's website at **www.pgr.csiro.au.** A weekly mean PGR value per Local Government Area is also posted to the website for the farmer to assess.

This provision of pasture information has assisted farmers to interpret the spatial and temporal variation of biomass and growth rates in paddocks. Using the PGR and FOO tools, the land manager is able to better manage fertiliser use, target grazing to improve fine wool production and achieve more efficient feed conservation.

The FOO and PGR information also has important applications for agribusiness, regional shires, banking and finance sectors. Potential uses include rural strategic planning, insurance, land valuation and assessment and futures forecasting.

The pasture monitoring program is currently being extended and verified across high winter rainfall areas of southern Australia. Further improvements of PGR products are expected with the use of the new MODIS 250 metre resolution data.

Further information is available from these websites:
www.pgr.csiro.au
www.agric.wa.gov.au

POSTER No 6

Poster No 6 features a multispectral Advanced Land Imager (ALI) image acquired on 12 January 2002 over part of the Coleambally Irrigation Area (CIA) in New South Wales. It shows ALI bands 7 (2.08–2.35 µm), 5 prime (1.2–1.3 µm) and 1 prime (0.433–0.453 µm), displayed through the red, green and blue colour guns. The image was provided by CSIRO through its role as a Principal Investigator with NASA's experimental Earth Observing-1 satellite mission. Geoscience Australia acquires EO-1 mission data on behalf of NASA.

The Murrumbidgee River, and the associated remnant forest, can be seen across the north of this image. The Coleambally Main Canal runs from the top right area down to the bottom left with various channels branching west through the agricultural area. The Tombullen Storage Dam, the large dark blue area adjacent to the Sturt Highway, is used to regulate flows to the Main Canal. Due to the positioning of ALI's 37.5 km wide swath, relative to Hyperion, the entire CIA is not covered by ALI. The contrast between the CIA to the west and the rain-fed agricultural area to the east is most pronounced in summer.

REMOTE SENSING RESEARCH AT COLEAMBALLY IRRIGATION AREA

With over 500 farms covering about 95 000 hectares, the Coleambally Irrigation Area (CIA) in southern New South Wales is one of Australia's largest irrigated land settlement schemes. Its urban centre, Coleambally, was purpose-built by the local Murrumbidgee Shire Council in the 1960s to service the progressive agricultural district.

CIA presented as an ideal community for a CSIRO project team to validate remote sensing data from NASA's New Millennium experimental Earth Observing-1 (EO-1) satellite and report on the data's suitability as a tool to improve agricultural management.

The project is one of six being carried out by CSIRO as a member of the Science Validation Team for EO-1 to test the capabilities of the Hyperion and Advanced Land Imager (ALI) sensors. These two instruments have 30m spatial resolution, like the Enhanced Thematic Mapper (ETM) sensor on board Landsat 7. As EO-1 acquires data one minute after Landsat 7, it is possible to make comparisons between ETM, Hyperion and ALI.

"This opportunity to validate EO-1 data at the CIA came along at the right time as there was already a Cooperative Research Centre for Sustainable Rice Production (Rice CRC) project which was assessing the information content of ETM data for the rice-based irrigation industry. And it was also at the right place because the CIA was in between two of the other CSIRO Science Validation sites which were being characterised by airborne hyperspectral HyMap data," said Dr Tim McVicar, CSIRO Land and Water.

The "Coly-Chain" is the network that links landholders with satellites. Scientific researchers and engineers are in the middle of the chain. Members of the chain are Landholders, Coleambally Irrigation Co-operative Limited, Rice CRC (including scientists from NSW Department of Agriculture and Charles Sturt University), CSIRO, TRW (the USA based space engineering company that built the Hyperion sensor), NASA EO-1 Project Office and finally the satellites EO-1 and Landsat 7.

The project is using a time series of Hyperion and ALI images acquired over the CIA during the 2000-2001 and 2001-2002 southern hemisphere summer growing seasons, along with associated ETM images and a high resolution digital aerial photograph mosaic. Five different varieties of rice are grown in the area during summer, along with corn, soybeans and sorghum.

The Hyperion data was collected by NASA, processed by TRW and provided to CSIRO through its membership of the EO-1 Science Validation Team. ACRES has been acquiring EO-1 data since November 2000 and supplying it to NASA.

"The CIA was perfect for the validation exercise as it falls within two Landsat scenes. This meant the project would have the benefit of an eight day repeat cycle for the acquisition of both Landsat and EO-1 imagery," said Dr Jupp, Science Leader of CSIRO's Earth Observation Centre. "Water usage and crops are well managed in the CIA. Fields are large, up to 70 hectares, and well maintained, which also meant they were ideal for instrument validation."

Team members collected a range of field data to provide ground validation of the remotely sensed data. One of the main tasks carried out during the project was extensive coincident ground sampling during the growing season to validate the spectral signatures received from Hyperion.

"Hyperspectral sensors eliminate some of the spectral limitations associated with data from other commercial sensors because they provide, in a sense, continuous spectral coverage. Until now, these sensors have been limited to airborne systems, which generate additional problems with increased data processing, making it hard to monitor large areas, as well as problems with repeatability, making it difficult or costly to acquire time series imagery."
David Jupp, CSIRO

The team set up a GPS network of ground control points that were used to register the satellite data and also for positional accuracy assessment of critical GIS data.

"When establishing the GPS network, we found that existing digital vector data did not meet the National Mapping Council of Australia's standard. Establishing our own network provided a highly accurate base to register the time-series of remotely sensed data. So now the remote sensing data is more spatially accurate than institutionally provided digital vector data for CIA," said CSIRO scientist, Dr Tim McVicar.

The team used a high-resolution mosaic image to establish field and rice bay boundaries. These boundaries were then given unique identifiers so they could be linked to the land use / management database established by the team in consultation with landholders who were happy to be involved in the International Remote Sensing Project.

Information about crop type, variety and management practices is linked to individual paddocks within the GIS. Thirty landholders have agreed to provide the research team with access to records of their daily management operations. The landholders at CIA realise that today's research may be the basis for tomorrow's operational system, so they are willing and excited to be involved in the project.

"We took ground-based measurements for validation of atmospheric correction algorithms and to characterise the many different landcovers, crop, soil, stubble, and standing water from the flood irrigated rice," explained Canberra based CSIRO Land and Water scientist, Tom Van Niel.

"Borrowing a real-time Differential GPS from other members of the Rice CRC (specifically NSW Department of Agriculture at Yanco) and using an ASD Spectral Radiometer, we were able to view the spectra, or surface reflectance, on a laptop in real time. This enabled us to ensure that everything was working OK as the satellites acquired data coincident with our ground data collection. If the battery died while the satellite was passing over, this would have been a problem, a really big problem. At the CIA you've got to wait another eight days, and that day may be cloudy, so we built redundancy into the power supply system," said Tim McVicar.

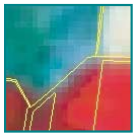


Figure 1 ▲

On 12 January 2002, CSIRO scientists, Bisun Datt, CSIRO Earth Observation Centre, (seated) and Tim McVicar (right) take ground-level measurements as ETM, Hyperion, ALI and HyMap data are recorded remotely. Bisun collects and checks ASD data on a lap-top computer positioned in the front 'dive-tub', while Tim records the real-time differential GPS position. The boom holds the fibre-optic head of the ASD at a constant angle two metres away from the quad.

While cloud-free conditions were experienced, it was very windy, resulting in variable amounts of dust influencing atmospheric scattering. A CIMEL instrument was used to better characterise atmospheric conditions at the CIA. This instrument measures: (a) atmospheric column optical depth at seven wavelengths from 0.34 µm to 1.02 µm; (b) column water vapour using a channel at 0.936 µm; and (c) sky radiance distribution at four wavelengths. The CIMEL was operated by Ross Mitchell, CSIRO Earth Observation Centre.

Photo by Tom Van Niel, CSIRO

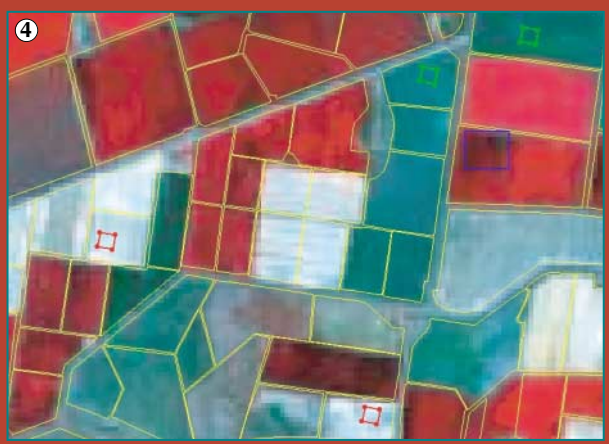


Figure 2 ▼

Schematic of the grid sampling method used at two soil sites and two stubble sites. For 25 locations at each of the four sites, five ASD spectra were measured, each a result of 15 internally averaged ASD measurements. In the figure below, 'O' stands for ASD Optimisation and 'P' is where Spectralon Panel readings were taken. Orange and green markers used throughout the 2001-2002 summer growing season to identify the site corner and mid points can also be seen in front of the quad-bike in Figure 1.

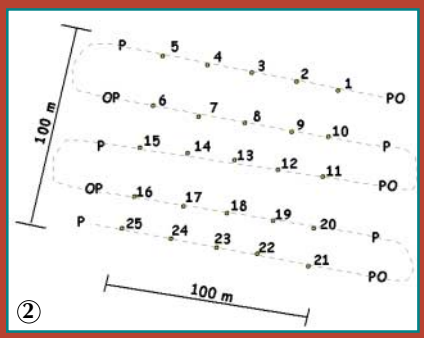


Figure 3 ▲

ASD measurements of standing water taken on 27 December 2001 in an area of flood irrigated rice where the rice crop suffered establishment problems. Tom Van Niel (left) is operating the ASD (ensuring he did not trip thus giving the ASD a bonus wash!) while Tim McVicar is recording the GPS position.

Photo by Susan Campbell, CSIRO Earth Observation Centre.

Figure 5 ▼

This image shows the location of the 25 ASD measurements for the site named 'Stubble Two' (the south most stubble site in Figure 4) overlaid on 25m Hyperion data. The Hyperion data has been re-sampled from its original 30m resolution to 25m resolution, to allow direct comparisons with the ACRES 25m 'Map-Orientated' ETM product.

Of the 155 stable Hyperion channels, this display uses channels similar to ETM, as seen in Figure 4. ALI_MS data has also been re-sampled to a 25m grid. Other data types can be spatially averaged to the 25m grid as follows: HyMap (5m to 25m); ETM_Pan (12.5m to 25m); and ALI_PAN (10m to 5m then 25m).

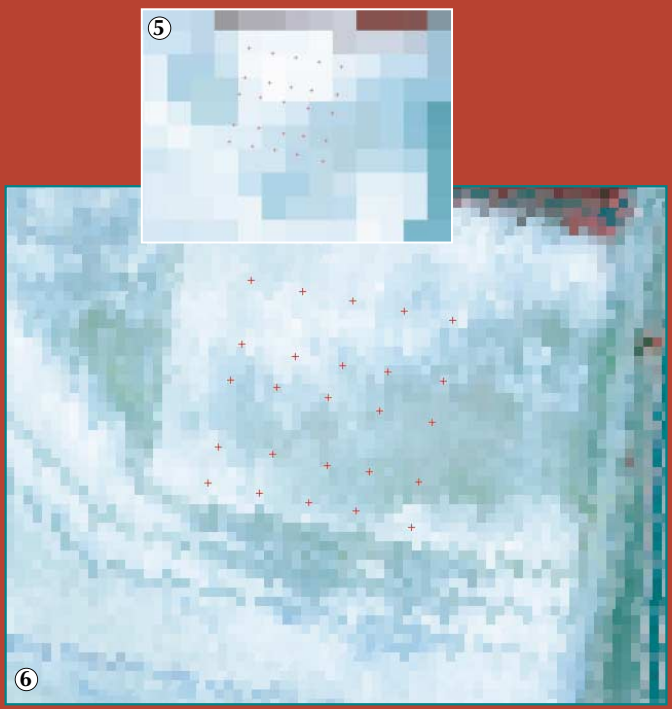


Figure 6 ▲

This image shows the same 25 ASD measurement sites for 'Stubble Two' overlaid on the 5m resolution HyMap data. Of the 128 HyMap channels, those displayed are again similar to the ETM bands shown in Figure 4. The spatial averaging of the patterns in the 5m HyMap data (Figure 6) can be matched to those in the 25m Hyperion (Figure 5). Figures 5 and 6 cover approximately the same area on the farm. The grid of ASD sites (represented by the red crosses) is identical in both Figures.

Figure 4 ◄

This ETM image acquired on 12 January 2002 shows locations of the two soil sites (green squares) and two stubble sites (red squares) shown in Figure 2. The standing water seen in Figure 3 is marked by the blue polygon in Figure 2. This display uses ETM channels 4, 3, 2 through RGB colour guns respectively. The varying shades of red are different summer crops – rice, corn, soy and sorghum. They are planted at different dates, and rice is flood irrigated, whereas the other crops are planted on rows and irrigation is applied down furrows separating the rows. Yellow strings are the field boundaries, digitised from hi-resolution (1:50,000 or 2m pixel resolution) digital air photos.

Results and findings for the future

The team is now geometrically and atmospherically correcting the time series of remotely sensed data in order to link it with ground-based measurements.

"The CIA project demonstrates successful integration of a time series of hyperspectral imagery to relevant land use and other spatial data," said Dr Jupp.

"The Coleambally agricultural database will allow for the characterisation of several types of crops through an entire growing season. This analysis will be very important for Hyperion instrument validation.

"We aim to assess the accuracy of information derived from remote sensing that either landholders or irrigation companies can use in the management of the agricultural system. This requires careful and skilled analysis of the remotely sensed data, which includes developing methods to overcome the idiosyncratic characteristics associated with each and every dataset," said Tim.

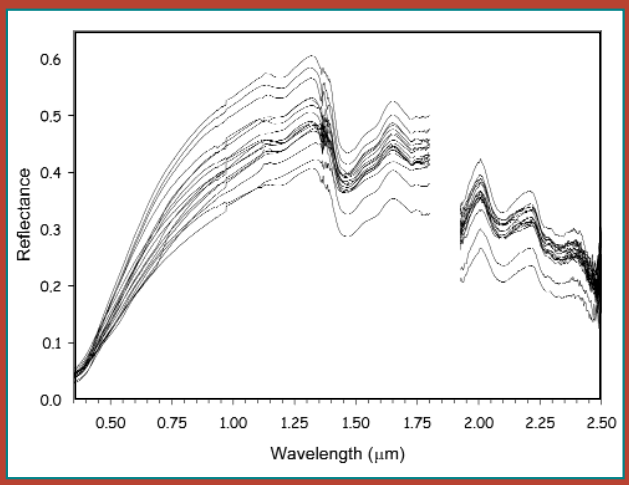
"The GIS database developed at the CIA will enable accurate geo-location of spectra. Ground spectral measurements will be crucial in atmospheric testing, plant samples will enable physiological characterisation, and land use information will be important for describing variation within the remote spectra" he said.

There are many agricultural questions to be asked of the time series of EO-1 and ETM data developed at the CIA. For example, does hyperspectral satellite data allow crop yields to be estimated more accurately and earlier in the growing season than using broadband satellite data like ETM or ALI?

"We have not yet answered these questions," said Dr McVicar, "but by collaborating with landholders, other scientists in the RICE CRC, TRW and NASA, we have developed a dataset that can be used to answer them. Our aim is to assess the data from the user's viewpoint, that is, specifying the information, and to what confidence that information can be derived from the remotely sensed data in a repeatable manner."

Figure 7 ▼

Crossplot of wavelength (x-axis) versus ASD measured reflectance (y-axis) at the same stubble site showing the natural variability in point measurements of ground level reflectance. Noisy ASD data in the range of 1.8-1.925 µm is not shown.



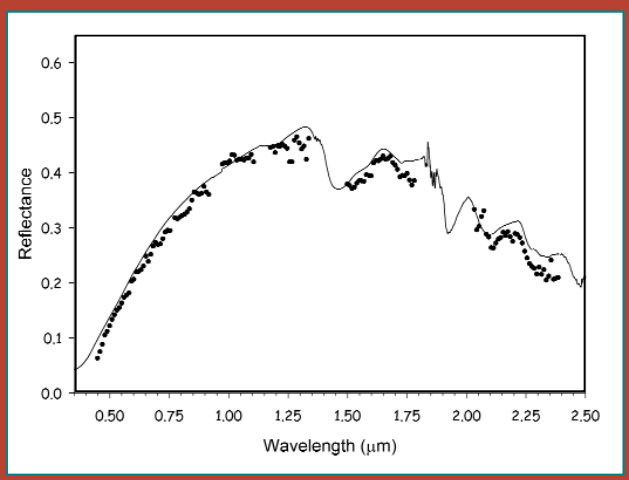


Figure 8 ▲

Results showing the atmospherically corrected Hyperion data (circles) and ASD ground truth measurement (line) plotted against wavelength. Both measures where spatially averaged. The Hyperion radiance image was atmospherically corrected to an at-surface reflectance image using the atmospheric correction package FLAASH, available as an add-on to ENVI-IDL. Only the 155 stable Hyperion channels are shown.

SATELLITE IMAGERY HELPS TO CLASSIFY AUSTRALIA'S ESTUARIES

Almost 1 000 estuaries nestle or stretch along Australia's 70 000 kilometre long coastline. Most of Australia's population is concentrated near one of them, however half of the estuaries can be considered "Near Pristine".

Estuaries are often used for dumping, sand or water extraction, and construction of marinas, ports and canal estates. They are dredged, filled in and artificially drained. Wetlands associated with them are often destroyed.

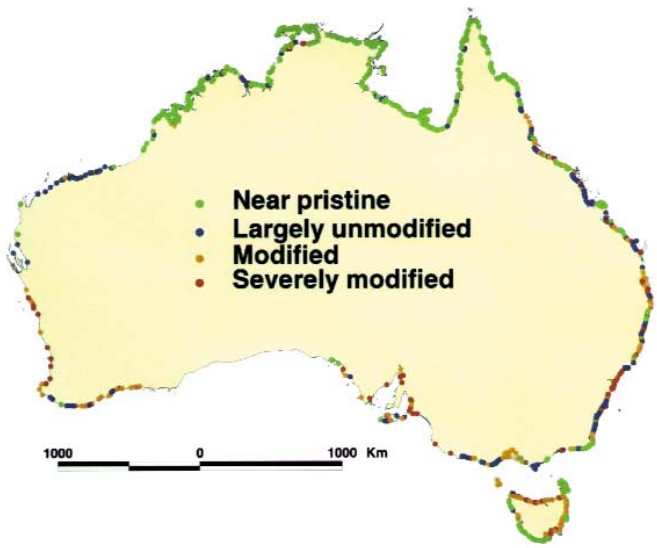
The simplest defination of an estuary is a semi-enclosed body of water where salt from the open sea mixes with fresh water draining from the land. Estuaries can be categorised based on whether they are dominantly affected by river flows, tidal or wave action. Thus, there are three basic types of estuaries: river, tide and wave.

A "Near Pristine" estuary has a high proportion of natural vegetation in the catchment, minimal disturbance from land use, low impact from human interaction and minimal impacts from pests or weeds. They provide habitat for native plants and animals, which is important for the conservation of biodiversity, and their environments support commercial, traditional and recreational fisheries and tourism.

Most of Australia's near pristine estuaries are located away from population centres in northern Australia and western Tasmania. However, important near pristine estuaries are also found around some developed areas within National Parks and State Forests.

Scientists from Geoscience Australia and the National Land and Water Resource Audit (NLWRA) have used Landsat satellite imagery to develop an online database revealing the state of Australia's estuaries. This information is being used to manage these important environments.

This project involved collecting the physical dimensions of 909 of Australia's estuaries and coastal waterways and interpreting the sedimentary environments for some 405 of Australia's modified estuaries and coastal waterways. Sediments provide substrates for habitats, so they are useful in assessing potential habitat abundance and distribution.



▲ Image showing the condition of estuaries around Australia's coastline from Heap, A. etal. 2001 "Australian Estuaries & Coastal Waterways: A Geoscience Perspective for Improved and Integrated Resource Management"

A Report to the National Land & Water Resources Audit Theme 7: Ecosystem Health

The data collected provides the most comprehensive geoscience inventory for estuaries and coastal waterways ever produced in Australia. The work includes a national assessment of sedimentary environments, including mangroves, salt marshes, salt flats and intertidal flats. These are key habitats for State of Environment Reporting, and the inventory should form a comprehensive baseline for their monitoring and management at a regional scale.

Geometry mapping

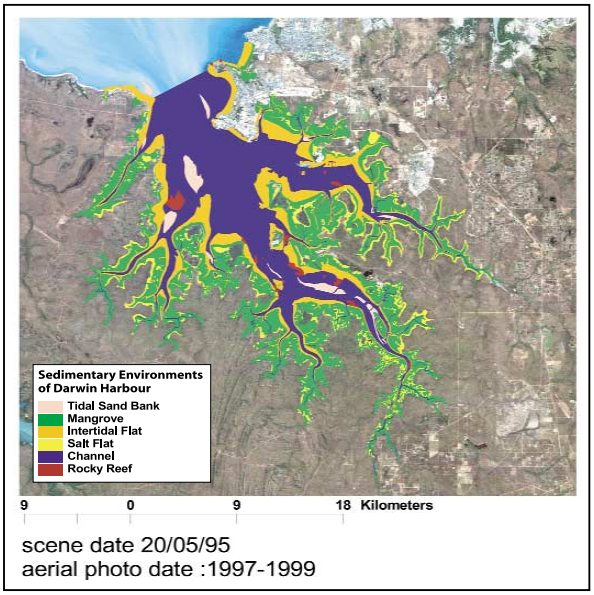
Geometric indices of estauries were derived from measurements taken from Landsat TM satellite imagery, which allows rapid appraisal of geographical features in a consistent manner. Images were processed for the enhancement of estuarine features. Hardcopies of the Landsat TM scenes, in combination with reference materials (air photos, topographic maps), were then used to interpret and define the geometric indices.

Up to six geometric indices were collected for each estuary: estuarine water area (km^2); perimeter of shoreline (km); total length of the estuary to the tidal limit (km); entrance width (km); entrance channel length (km); and maximum basin width (km).

The geometric indices were compiled to meet the needs of the estuarine modellers, and to provide a simple, standard spatial data set for a large number of Australia's estuaries and coastal waterways, for which no data currently exist. The geometric data represent part of the geoscience component of the NLWRA database.

The data will be applied in the modelling of marine exchange (tidal prism), fluvial flushing time (residence time), water and sediment quality, and for the quantification of shoreline and estuarine habitat.

Classifications for 974 of Australia's estuaries and coastal waterways are provided in the OZESTUARIES database at **www.ozestuaries.org**



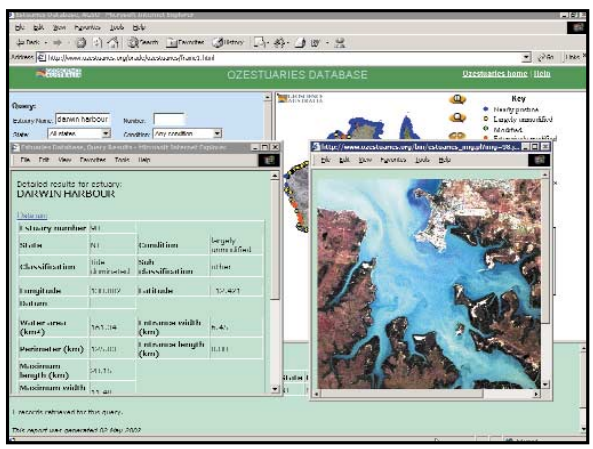
scene date 20/05/95
aerial photo date :1997-1999

Mapping of Sedimentary Environments

The spatial distribution of sedimentary environments was mapped for 405 of the estuaries and coastal waterways classified by the NLWRA as modified in some way.

Mapping geomorphic and sedimentary environments in coastal systems permits a quantitative assessment of the variability in habitats between systems, and can be used to indicate significant deviation from a pristine state. Eight estuarine environments were chosen that were easily identified and are found across all coastal system types in Australia. These were: barrier and back barrier, central basin, fluvial bayhead delta, flood and ebb tide delta, intertidal flat, mangrove, salt flats, salt marshes and tidal sand banks.

Aerial photographs ranging in scale from 1:5 000 to 1:80 000 were used for interpretation. Boundaries were mapped onto hard copies of 1:15 000 to 1:50 000 scale Landsat TM images and digitally captured into a GIS.



An example of coastal waterway mapping

Darwin Harbour (left) is situated on the north coast of the Northern Territory and opens into Clarence Strait. Annual rainfall over the 1 990 square kilometre catchment is strongly seasonal at around 1535 mm, most of which falls during the summer monsoon from December to March.

The harbour has been modified by humans and contains residential, industrial, aquaculture and port activities. The surrounding catchment is partially cleared of native vegetation for grazing and horticulture.

Darwin Harbour is a tide-dominated estuary characterised by a series of northwest-trending drowned river valleys cut into the underlying bedrock. The main channels of the harbour are funnel-shaped and taper landward from the mouth.

The channels are fringed by extensive areas of intertidal habitats. These features are typical of tide-dominated estuaries in Australia with large spring tidal ranges (greater than 4 m). Moreover, the tidal range in the upper parts of funnel-shaped tide-dominated estuaries can be significantly amplified, resulting in elevated water levels and strong tidal currents inside the estuary.

There are six key sedimentary environments identified in the Darwin Harbour estuary pictured at left. Regionally, this suite of habitats is typical of tide-dominated estuaries in the Northern Territory, because the high tidal range mangroves and saltmarsh/salt flats dominate the Harbour.

These regions are generally low-energy environments, and are thus potential sinks for fine particles (often associated with pollutants) from the catchment and offshore sources.

Strong tidal currents have created large, elongated tidal sand banks in the wide main channels of the harbour.

EXTRA ANTENNA EXPANDS AUSTRALIA'S DATA ACQUISITION CAPABILITIES

Australia's capability to acquire data from earth observing satellites has been greatly enhanced with the addition of a five metre X-Band antenna at Geoscience Australia's Data Acquisition Facility near Alice Springs.

"With two antennae now operating, we have a dual downlink capability which means we can acquire data from two satellites simultaneously," said ACRES Manager, Ian Shepherd.

"The new five metre antenna will ensure that we can meet the increasing demand from customers for acquisitions from the growing range of satellite sensors, as there will be fewer satellite timing conflicts.

"The new antenna also gives us the opportunity to undertake a much-needed refurbishment of the existing nine metre antenna, without the loss of data," said Ian.

"Both the antennas are able to acquire X-band data at two different frequencies, giving a total capacity of four simultaneous streams of X-band data. This provides maximum flexibility for data reception in the future."

Photos by Shaun Evans show installation of the new antenna.

ALL SYSTEMS GO FOR NEW NOAA ANTENNA

Early reports on the new NOAA antenna recently installed at Geoscience Australia's Data Acquisition Facility near Alice Springs are that the quality of data being received is excellent and the system is meeting all expectations.

The new antenna is part of a dedicated, stand alone system that receives, captures and distributes High Resolution Picture Terminal (HRPT) data from the National Oceanic and Atmospheric Administration (NOAA) satellites. It is jointly funded by Geoscience Australia and the Bureau of Meteorology (BoM).

Installation of the 2.4 metre antenna, built by Environmental Systems and Services (Melbourne), completes the project to provide Geoscience Australia customers with a reliable system of reception, processing and distribution for NOAA datasets.

The sensors on board NOAA satellites collect global data on a daily basis for a variety of land, ocean, and atmospheric applications, including forest fire detection, vegetation analysis, weather analysis and forecasting, climate research and prediction, global sea surface temperature measurements, ocean dynamics research and search and rescue.

The new antenna receives data from the NOAA 12, 15 and 16 satellites. This data is transmitted to Canberra for processing and then sent to the BoM server in Melbourne.

BoM uses the HRPT data for the generation of vegetation indexes and sea-surface temperature maps. These datasets are also archived for use in future climate studies.

"Until the new antenna was installed, the nine metre dish at Alice Springs was used to receive NOAA HRPT data. While it was able to provide good data, scheduling conflicts meant that we couldn't respond to all requests from customers for specific data. This dedicated antenna is now operating well and already fulfilling customers needs," said Systems Engineer, Ian Gesch, who was part of the team involved with installation of the additional antenna at Alice Springs.

The new stand-alone system near Alice Springs provides BoM with a back-up to similar systems located in Melbourne, Darwin, Perth and Casey Station in Antarctica.

Photo of new NOAA antenna above by Shaun Evans.

LANDSAT 7 MOSAIC A FEATURE OF COMMONWEALTH PLACE

The Landsat 7 mosaic of Australia produced by the Australian Greenhouse Office and distributed by Geoscience Australia is now a prominent feature in a new public arena opened to the public on 22 July. Located between Old Parliament House and Lake Burley Griffin in Canberra, the stunning four-metre high mosaic is arousing considerable curiosity and increasing awareness of satellite imagery for all visitors to Commonwealth Place.

Developed by the National Capital Authority, Commonwealth Place provides an open, grassed area for the community to attend and enjoy concerts, gatherings, rallies and celebrations in the national capital city. Visitors can see the Landsat 7 mosaic as they explore a sandstone walkway leading off the main arena. The four-metre high reproduction of the Landsat 7 mosaic of Australia is divided into nine vertical slivers, reproduced on toughened glass with a light source behind it to accentuate its colourful diversity.

Photo showing slivers of the Landsat 7 mosaic, the major feature of the sandstone walkway at Commonwealth Place, provided by the National Capital Authority.

LANDSAT PRODUCTS MORE ACCESSIBLE AND COST EFFECTIVE

Geoscience Australia's product range for Landsat data has further expanded with the availability of double and triple scenes. And more good news is that the price of full scene ortho-corrected products has decreased. In terms of price and product packaging, these developments make ACRES Landsat data more accessible to industry.

The new products have been made possible by a number of factors including:

- changes to the processing system for ACRES products;
- the Ground Control Points (GCP) Project which is making it more efficient to generate ortho-corrected products; and
- the Commonwealth Policy on Spatial Data Access and Pricing.

The introduction of double and triple scenes for Landsat data was a result of recent enhancements made to Geoscience Australia's processing system. These products now make Geoscience Australia's huge Landsat TM and ETM+ archive even more accessible and cost effective. For example, the price per square km for a path oriented triple scene is nearly 40 percent less than for a path oriented full scene. In addition, the new larger product size means extra savings for customers as there is less need to mosaic data.

The price of a full scene ortho-corrected product has been reduced by $360 to a level similar to the old system-corrected Map Image price. This is a result of the efficiencies gained in generating ortho-corrected products, made possible by Geoscience Australia's investment in the GCP project. On page 17 an article describes this project, including the increased accuracy now being achieved with ACRES ortho-corrected products and the associated decrease in production time.

The new Commonwealth Policy on Spatial Data Access and Pricing requires Landsat products, as a whole, to be sold at a price that recovers their full cost of distribution. With this in mind, the price of a full scene Path Image product has increased by $100. Prices of map oriented smaller scenes have also increased very slightly. However, it is important to note that Landsat products are still sold well below their full cost of distribution.

Other points of interest about the new pricing structure for Landsat products include:

- path image and map image prices are now the same (for the same scene size), in recognition of similar production efforts;
- the price differential between a path image full scene and an ortho-corrected full scene has fallen from $760 to $300; and
- the Map Image price for MSS products has been reduced to $595, so that Path Image and Map Image MSS prices are now similar.

PLANS FOR FUTURE LANDSAT DATA CONTINUE TO TAKE SHAPE

DigitalGlobe and Resource 21 look to be the front-runners to provide future Landsat data to the US archive and the rest of the world. This follows their selection by NASA/USGS to undertake the Formulation Phase of the Landsat Data Continuity Mission (LDCM) procurement process.

As reported in *ACRES Update* Issue 25, the Formulation Phase is designed to give NASA/USGS visibility of the proposed systems. This will ensure that the data specifications can be met, the data policy can be implemented, and the risks are acceptable. The Formulation Phase will be completed by the end of 2002.

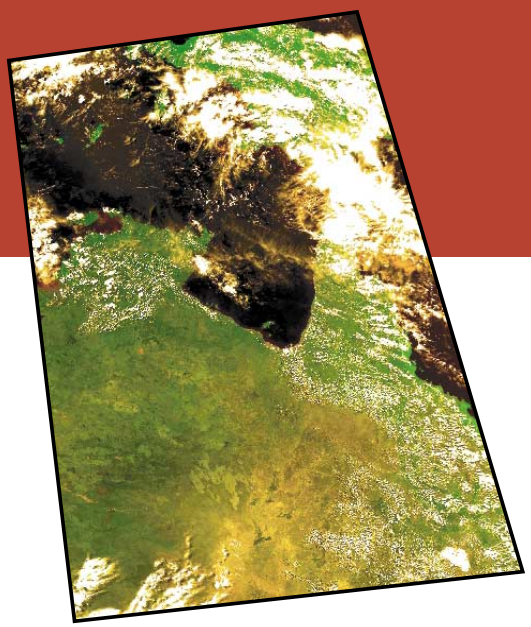
During June, presentations by both DigitalGlobe and Resource 21 were made to the International Ground Stations in Denver, Colorado. Both companies expressed their desire to comply with the LDCM Data Policy and to make LDCM data available to International Ground Stations. How this can be achieved will be the topic of further detailed discussions. Due to commercial competition, details of the models being developed will not be disclosed until the tender is finalised and assessed. However it appears that both companies are considering models that provide Landsat data as a subset of a commercial data set with higher spatial resolution, acquired by one or more satellites.

There is still uncertainty about including thermal bands in the final data specification. This is due to the high cost of building the required sensors. If users in Australia can demonstrate important applications of thermal data then this should be made known, as it may influence the final decision.

Ian Shepherd, Manager, ACRES

DEDICATED NOAA ANTENNA WIDENS RANGE OF AVHRR PRODUCTS

The first test image shows the eastern portion of Australia and was received from NOAA-16 on 17 April at 2.49pm AEST.



Since the new National Oceanic and Atmospheric Administration (NOAA) antenna at ACRES Data Acquisition Facility near Alice Springs began operating in April 2002, every NOAA pass has been available to Australian users. This is a significant advance on the previous situation where the single nine-metre antenna at the Alice Springs facility had to service all requests for remote sensing data.

The new antenna is now Australia's primary source of NOAA imagery over Australia. ACRES now offers an increased range of NOAA AVHRR products as a result of its ability to acquire both daytime and night-time passes from NOAA's 12, 15 and 16 satellites.

Until April, users could only download data from NOAA-16 daytime passes from the ACRES website. You will find more details about the new range of products on Geoscience Australia's NOAA download page at acs.auslig.gov.au/noaa_data. Night-time passes are clearly identified by the black and white Quick Look image using the thermal band 4.

An additional enhancement to ACRES NOAA AVHRR products is the provision of more detailed information in the metadata files which are also available for download.

NOAA AVHRR data has been available free online since January 2002. Due to the high disk space requirements to store processed data however, NOAA AVHRR products are only available for free download for seven days after acquisition.

DISTRIBUTORS ACHIEVE EXCELLENCE IN SALES

Four companies were presented with ACRES Distributor Awards for 2000-2001 during ACRES annual Distributors' Meeting in December 2001. The awards are determined on the basis of excellence in overall sales for the year.

GEOIMAGE
www.geoimage.com.au

For the second year running, the Gold Award went to GEOIMAGE Pty Ltd.

"GEOIMAGE is happy to receive the award once again. The ACRES Distributor model is a well established example of how the private and public sectors can work together in building a broader and stronger spatial information industry," said GEOIMAGE General Manager, Max Bye.

Satellite Remote Sensing Services, Department of Land Administration Western Australia, received the Bronze Award, for the second year in succession.

Also backing up for the Bronze Award was Resource Industry Associates.

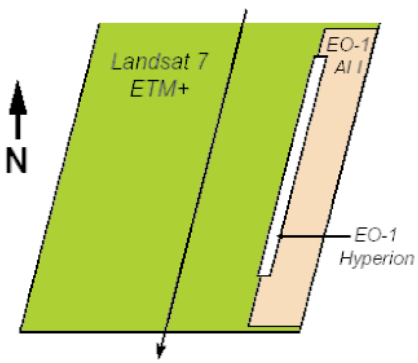
Landcare Research NZ received the award for Excellence in Sales Growth for ACRES data.

DATA FROM EXTENDED EO-1 MISSION

The E0-1 mission was initially planned as an experimental mission due to finish at the end of 2001. However, due to continued demand for its data, the satellite operators have extended the mission on an operational basis, most likely until the end of September this year. At the time of writing, it was still unclear whether the mission would be extended any further.

The Hyperion sensor on board the satellite is the first hyperspectral sensor on an Earth observation satellite. It covers the complete spectral range from 0.4 to 2.5 µm in 220 bands. Such comprehensive spectral resolution permits very detailed classification and identification of land cover.

Hyperion Swath Width: 7.6 km



NADIR Poiting

Sensor specifications

The E0-1 satellite follows the same orbit as Landsat 7 with a sixty second delay. Unlike Landsat 7 however, EO-1 can be pointed sideways (even into adjacent Landsat paths) so that customers can define the centre of their acquisition. It's worth noting that for the one acquisition, the centre of a Hyperion swath is different to the centre of an ALI swath, as shown above.

The Advanced Land Imager (ALI) was designed to demonstrate improved Landsat spatial and spectral resolution with substantial mass, volume, and cost savings. Its proven performance has the potential to reduce the cost and size of future Landsat-type instruments by up to five times. Details of the two sensors are in the table below.

Hyperion and ALI products

Products derived from the Hyperion and ALI sensors on board the EO-1 satellite were available from Geoscience Australia earlier this year through a special bulk purchase arrangement with the United States Geological Survey (USGS). Dr David Jupp from CSIRO Earth Observation Centre was instrumental in coordinating the requests for data from Australian users so that a bulk order could be placed.

Geoscience Australia was able to negotiate a special price for these products not just because of the bulk order, but also because of our commitment to the EO-1 program through downlinking worldwide data at the TERSS ground station in Hobart. This cost saving was passed on in full to customers.

This initial bulk purchase involved acquisitions for a limited time until March 2002. Subsequently, the EO-1 mission was extended to at least September this year, and Geoscience Australia has been able to negotiate special (but different) conditions for the continued supply of EO-1 products to Australian customers. The special arrangement gives Australian customers the additional benefit of receiving more than three acquisitions over their area of interest until it is successfully acquired within a specified level of cloud cover.

All other prices and conditions are described at **http://eo1.usgs.gov.** Please contact ACRES Satellite Operation Services if you are interested in placing an order for EO-1 data or require any technical contacts.

Hyperion and ALI instruments

Parameter	Hyperion	ALI
Swath width (km)	7.7	37
Product Length (km)	42	42
Spatial resolution (metres)	30	30
Processing Level	Level 1 (radiometrically corrected only)	Level 1 (radiometrically corrected only)
Format	HDF CEOS	HDF CEOS
Approx file sizes	~200Mb	~300Mb
Media	CD/DVD	CD/DVD
Spectral range (µm)	0.4 – 2.5	0.4 – 2.5
Spectral resolution (nm)	10	Variable
Spectral coverage	Continuous	Discrete
Pan band resolution (metres)	N/A	10
Total number of bands	220	10

GET MORE ON DVD

A selection of ACRES products is now available on DVD, catering for those products that are too large to be written to one CD. The advantage of DVDs is that they have a storage capacity of approximately 4.7 Gb compared to a CD which has a capacity of about 650 Mb.

Sensor	CD	DVD
Landsat	Full scene or less	Full scene or more
SPOT	All sizes	N/A
RADARSAT	All beam modes and processing levels that will fit on one CD	RAW and SLC
ERS	All processing levels	N/A
JERS	All processing levels	N/A
AGO Data	Single scenes	Tiles

The introduction of DVD coincides with the withdrawal of Exabyte and DAT as media options. These older tape media are no longer in demand for reasons associated with their shorter shelf life and the increased time taken to find files. The release of DVD also coincides with the release of Landsat imagery covering larger areas and the soon-to-be-released MODIS archived product.

The table above shows the availability of CD and DVD for various products. Customers have a choice of CD or DVD when purchasing Landsat full scenes or RADARSAT products with RAW and SLC processing.

The actual type of DVD produced by ACRES will be DVD-R(G) in Universal Disc Format (UDF). This type of DVD is the one most compatible with the majority of DVD readers.

CONFERENCE CALENDAR

5 August - 11 October 2002
various locations, Australia

National Series of GeoInsight Seminars/Workshops for the Emergency Management Community and Spatial Information Industry.

Tel: +61 2 6254 3911
Email: geoinsight@technik.com.au
Web: www.geoinsight.net.au

2 - 6 September 2002
Brisbane, Australia

11th Remote Sensing and Photogrammetry Conference

Tel: +61 2 6257 3299
Fax: +61 2 6257 3256
Email: 11arspc@ausconvservices.com.au
Web: www.geosp.uq.edu.au/11arspc/default.htm

16 - 19 September 2002
Sydney, Australia

9th International Oil Spill Conference (SPILLCON) 2002

Tel: +61 3 9417 0888
Email: spillcon@meetingplanners.com.au
Web: www.spillcon.com

25 - 30 November 2002
Adelaide, Australia

AURISA 2002 and the 3rd Trans Tasman Surveyors Conference

Tel: +61 8 8363 4399
Email: efuture@hartleymgt.com.au
Web: www.hartleymgt.com.au/efuture

LOW PRICED LANDSAT 7 SINGLE SCENES FROM THE Y2K MOSAIC

A sample from a single ortho-corrected scene from the Y2K Mosaic showing the Fitzroy River as it snakes inland toward Rockhampton along the Queensland coast.

An extended range of off-the-shelf ortho-corrected Landsat 7 products covering Australia is now available at a reduced price.

All the individual scenes used to create the Australian Greenhouse Y2K Mosaic are now available as ortho-corrected single scenes, for less than the cost of an equivalent standard ACRES Landsat product.

The individual scenes are the result of work done last year by the Australian Greenhouse Office (AGO) as part of the National Carbon Accounting System which is using satellite data to examine the link between greenhouse gases and land cover across Australia over a 20 year period. As part of this work, the AGO took delivery of 369 path-oriented, system-corrected, ACRES Landsat 7 images and facilitated production of an ortho-corrected Year 2000 Mosaic. The images forming the Mosaic were acquired between July 1999 and September 2000.

Each single scene from the Mosaic retails for $1080, which is half the regular retail price for a standard ACRES ortho-corrected single scene.

Although the larger tiles from the Mosaic have been available for some time, the release of the single scenes will allow more customers to access the Y2K imagery.

More details about the single scenes and tiles from the Y2K Mosaic are available through the ACRES Products and Services Index page at: **www.auslig.gov.au/acres/prod_ser/**

ORTHO-CORRECTED PRODUCTS SHOW IMPROVED LOCATIONAL ACCURACY

The initial results from the accuracy assessment of ortho-corrected products generated from Supplemental Control Points (SCPs) confirm expectations of sub pixel registration of Landsat TM and ETM+ products.

The SCPs are produced from image chips of fully controlled, full length Landsat 7 passes of Australia. Each SCP image chip is approximately one km square in size and contains image data from all Landsat 7 bands. The panchromatic band of the SCP chip is used in the generation of Landsat ETM+ and SPOT panchromatic and multispectral products, while Landsat TM products are generated from the multispectral bands of the SCP chip.

The early results also indicate that users can generally expect pixel to pixel geometric registration of ortho-corrected SPOT panchromatic products generated from SCPs.

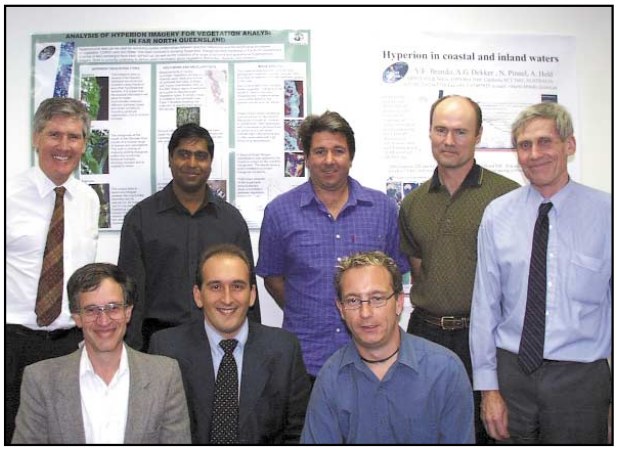
In areas where SCPs are available, they will totally replace the use of Ground Control Points (GCPs). The GCPs are typically derived from the largest scale topographic maps available for an area.

SCPs are now available in areas covered by Landsat 7 passes 89 – 98 and 107 – 112. It is planned to have SCPs available for Landsat 7 Passes 113 – 115 by September 2002.

Details of those areas where geocoded image chips are available for use in the production of Landsat and SPOT products are available at **www.auslig.gov.au/acres/referenc/gcpproj.htm**

By Craig Smith

HYPERSPECTRAL WORKSHOP



Speakers and presenters at the workshop (back row l-r): Ian Shepherd, ACRES; Bisun Datt, CSIRO; Tim McVicar, CSIRO; Tom Cudahy, CSIRO; David Jupp, CSIRO; (front row l-r): Jay Pearlman, TRW; Vittorio Brando, CSIRO and Nicholas Coops, CSIRO.

Geoscience Australia and CSIRO jointly hosted a workshop on 15 March 2002 to provide Australian users with information about EO-1 data access, opportunities and applications. The workshop was held at Geoscience Australia's Bruce office with information where nearly 70 people from around the country enjoyed presentations from a variety of well-respected scientists.

The EO-1 satellite was originally intended as an experimental mission to finish at the end of 2001, but its popularity has seen data availability continue into 2002. The two main sensors of interest are the hyperspectral Hyperion and multi-spectral ALI instruments.

Of special interest at the workshop were presentations by Jay Pearlman of TRW, a major US space technology company responsible for building the Hyperion sensor. Jay covered many issues relating to the data such as processing, quality, calibration, applications, satellite construction and the mission's future.

A CD containing all the workshop presentations, sample images and other related information from the workshop is available from CSIRO Earth Observation Centre for $10. Please contact Beth Reid on (02) 6216 7196 or see **www.eoc.csiro.au**

LAUNCH SCHEDULE FOR NEW REMOTE SENSING SATELLITES

Satellite	*Operators*	*Brief Description*	*Launch Date*	*More Information*
ENVISAT	ESA	Multi-sensor mission ASAR, MISR, MERIS	Launched successfully 01 March 2002	envisat.esa.int
GRACE - Twin satellites	CSR/GFZ/JPL/DLR USA, Germany	Gravity Recovery and Climate Experiment	Launched successfully 17 March 2002	www.csr.utexas.edu/grace/
Aqua (EOS PM-1)	NASA	Multi-sensor mission MODIS, AIRS	Launched successfully 04 May 2002	eos-pm.gsfc.nasa.gov
SPOT 5	CNES, Spot Image	2.5-5m PAN, 10 MS	Launched successfully 04 May 2002	www.spotimage.fr
OrbView-3	Orbital Imaging	1m PAN, 4m MS	September 2002	www.orbimage.com
ALOS	NASDA	2.5m PAN, 10 m MS, & 10-100m SAR	3rd Quarter 2003	www.nasda.go.jp
EROS B1	ImageSat International	0.82m PAN	4th Quarter 2003	www.imagesatintl.com
RADARSAT 2	CSA, Orbital Imaging	3-100m SAR Multi polarisation	2003	www.space.gc.ca

Anton Albina checks a large size photographic print of a satellite image.

STAFF CHANGES

December 2001 saw the closure of the ACRES photographic laboratory. The major reason for the closure was the decrease in demand for photographic products over the past few years and changing technology. With the closure came the departure of Anton Albina and Col Ellis.

Anton had 21 years service with ACRES and was responsible for implementing and improving many of the processes that ensured the high quality of photographic products. He has retired to Queensland.

Col had six years service and is now pursuing his photographic interests as a private business in the Canberra region.

Robert Denize, ACRES Chief Engineer, retired in March 2002 after 13 dedicated years in a demanding job.

Stuart Barr, who has taken over this challenging role, formerly worked with broadband communications company, ADC Australia Pty Limited. He holds a Masters degree in Electrical Engineering. One of the major challenges facing Stuart and his team is the ever-increasing expectation from customers for faster data delivery.

REMOTE SENSING IN THE 21ST CENTURY

There's still time to register for the 11th Conference of the Remote Sensing and Photogrammetry Association of Australasia being held in Brisbane from 2 - 6 September 2002. It is the biennial event providing a wealth of information and networking opportunities for professionals, students, academics and other industry personnel.

The theme of this year's conference is "Images to Information", and there will be more than 150 papers and posters presented on all aspects of remote sensing in the 21st Century.

"The mix and quality of submitted papers and posters is impressive. They will certainly provide all participants with detailed information on successful remote sensing applications in environmental management, forestry, aquatic and coastal monitoring and agriculture, as well as the latest developments in image processing hyperspectral, imaging radar and airborne laser scanning," said Conference Convener, Dr Stuart Phinn.

Challenging participants to consider issues facing the remote sensing community will be some impressive Key Note Speakers:

- John Gingerich, Director of Research and Technical Innovation for international mining and metals company, Noranda Inc
- Marc Imhoff, Aerospace Technology, NASA/Goddard Space Flight Centre
- Gary Richards, Manager and Principal Scientist for Australia's National Carbon Accounting System with Environment Australia, and
- Brett Whelan, Research Fellow at the Australian Centre for Precision Agriculture.

The Conference's Organising Committee invites you to participate in this crucial conference and be part of a forum that will shape the future of remote sensing in Australasia.

For further information on the conference, visit **www.geosp.uq.edu.au/11arspc**

ACRES DISTRIBUTORS

AUSTRALIAN CAPITAL TERRITORY

AGRECON
170 Haydon Drive
Bruce ACT 2617

Tel: +61 2 6201 2552 (BH)
Fax: +61 2 6201 5243 (BH)

Tel: +61 2 6255 0644 (AH)
Fax: +61 2 6255 0645 (AH)

Mobile: 0413 048863
Email:
buttonb@agrecon.canberra.edu.au
Web:
www.agrecon.canberra.edu.au

Mitchell Resource Intelligence
39 Geils Court
Deakin ACT 2600
PO Box 179
Deakin West ACT 2600

Tel: +61 2 6285 9966

Fax: +61 2 6285 9977
Email:
info@resourceintelligence.net
Web:
www.resourceintelligence.net

Resource Industry Associates Canberra Office
37 Hutchins Street
Yarralumla ACT 2600

Tel: +61 2 6260 5377

Fax: +61 2 6260 5388
Mobile: 0408 634 471l
Email:
johnlee@netspeed.com.au
Web: www.ria.com.au

Spot Imaging Services
Deakin Chambers,
4/14 Hannah Place
Deakin ACT 2600
PO Box 9141
Deakin ACT 2600

Tel: +61 2 6232 5171

Fax: +61 2 6232 5992
Email:
spotimage@spotimage.com.au
Web: www.spotimage.com.au

NEW SOUTH WALES

ENCOM Technology
Level 2
118 Alfred Street
Milsons Point NSW 2061

Tel: +61 2 9957 4117

Fax: +61 2 9922 6141
Email: info@encom.com.au
Web: www.encom.com.au

Land and Property Information New South Wales
Department of Information Technology and Management
Panorama Avenue
Bathurst NSW 2795
PO Box 143
Bathurst NSW 2795

Tel: +61 2 6332 8200
Fax: +61 2 6331 8095
Email: info@ditm.nsw.gov.au
Web: www.lpi.nsw.gov.au

Spot Imaging Services
PO Box 809
EPPING NSW 1710

Tel: +61 2 9617 0688

Fax: +61 2 9617 0734
Mobile: 0414 921 770
Email:
carroll@spotimage.com.au
Web: www.spotimage.com.au

NORTHERN TERRITORY

GEOIMAGE PTY LTD
Unit 5,
170 Coonawarra Road
Winnellie NT 0820
PO Box 36289
WINNELLIE NT 0820

Tel: +61 8 8947 1755

Fax: +61 8 8947 1788
Email:
darwin@geoimage.com.au
Web: www.geoimage.com.au

QUEENSLAND

Department of Natural Resources and Mines
Geographic Data Services
Cnr Main and Vulture Streets
Woolloongabba QLD 4102
Locked Bag 40
Coorparoo Delivery Centre
QLD 4151

Tel: +61 7 3896 3187

Fax: +61 7 3406 2762
Email: laszlo.tamas@dnr.qld.gov.au
Web: www.dnr.qld.gov.au/resourcenet/veg/slats/index.html

GEOIMAGE
13/180 Moggill Road
Taringa QLD 4068
PO Box 789
Indooroopilly QLD 4068

Tel: +61 7 3871 0088

Fax: +61 7 3871 0042
Email:
geoimage@geoimage.com.au
Web: www.geoimage.com.au

Geo Mapping Technologies
Suite 2A, 17 Peel Street
South Brisbane QLD 4101
PO Box 3857
South Brisbane QLD 4101

Tel: +61 7 3846 2992

Fax: +61 7 3846 2588
Email: info@geomap.com.au
Web: www.geomap.com.au

SPOT-LITE ONLY

ERSIS Australia
18 Merivale Street
South Brisbane QLD 4101
PO Box 3055
South Brisbane QLD 4101

Tel: +61 7 3844 7744

Fax: +61 7 3844 2400
Email: timb@ersis.com.au
Web: www.datamall.com.au

SOUTH AUSTRALIA

Department for Environment and Heritage
Environmental and Geographic Information
300 Richmond Road
Netley SA 5037
PO Box 550
Marleston SA 5033

Tel: +61 8 8226 4904

Fax: +61 8 8226 4906
Email: cameron.james@saugov.sa.gov.au
Web: www.mapland.sa.gov.au

TASMANIA

Space Images
Central Science Laboratory
University of Tasmania
Sandy Bay TAS 7005
GPO Box 252-74
Hobart TAS 7001

Tel: +61 3 6226 2156

Fax: +61 3 6226 2494
Answering Machine:
+61 3 6223 3975
Email:enquiries@spaceimages.utas.edu.au
Web: www.spaceimages.utas.edu.au

VICTORIA

Resource Industry Associates (RIA)
Suite 312, 370 St. Kilda Road
Melbourne VIC 3004

Tel: +61 3 9686 2733

Fax: +61 3 9686 2633
Email: info@ria.com.au
Web: www.ria.com.au

WESTERN AUSTRALIA

GEOIMAGE
Leeuwin Centre
65 Brockway Road
Floreat WA 6014
PO Box 287
Floreat Forum WA 6014

Tel: +61 8 9383 9555

Fax: +61 8 9383 9666
Email:
perth@geoimage.com.au
Web: www.geoimage.com.au

Satellite Remote Sensing Services
Department of Land Administration
65 Brockway Road
Floreat WA 6014
PO Box 471
Wembley WA 6913

Tel: +61 8 9340 9330

Fax: +61 8 9383 7142
Email: sanders@uranus.dola.wa.gov.au
Web: www.rss.dola.wa.gov.au

SPOT-LITE ONLY

NGIS Australia
Level 1,
161 Great Eastern Highway
Belmont WA 6104
PO Box 347
Belmont WA 6104

Tel: +61 8 9277 9600

Fax: +61 8 9277 9611
Email: ngis@ngis.com.au
Web: www.ngis.com.au

INTERNATIONAL

Landcare Research Canterbury Agriculture & Science Centre
Gerald Street
Lincoln New Zealand 8152
PO Box 69
Lincoln 8152 New Zealand

Tel: +64 3 325 6700

Fax: +64 3 325 2418
Email: BellissS@Landcare Research.co.nz
Web: www.landcare.cri.nz

Terralink International Limited
Level 2, 275 Cuba Street
PO Box 2872
Wellington New Zealand

Tel: +64 4 915 6000
Fax: +64 4 915 6030
Email: info@terralink.co.nz
Web: www.terralink.co.nz

PT Indica Dharma Consulting Services
Golden Plaza Blok G. 43-44
Fatmawati No15
Jakarta Selatan - 12420
Indonesia

Tel: +62 21 750 8986

Fax: +62 21 750 8985
Email: idcs@indo.net.id

Eurimage
Via E. D'Onofrio
00155 Rome Italy

Tel: +39 6 4069 4300

Fax: +39 6 4069 4305
Email: cust.service@eurimage.com
Web: www.eurimage.com

Infoterra Limited
Delta House
Southwood Crescent
Southwood, Farnborough
Hampshire GU14 0NL
United Kingdom

Tel: +44 1252 362080

Fax: +44 1252 375016
Email: sheena.wing@infoterra-global.com

Web: www.infoterra-global.com

ACRES

Published by the Australian Centre for Remote Sensing, a unit of Geoscience Australia
Scrivener Building, Dunlop Court,
Fern Hill Park, Bruce ACT 2617
PO Box 2, Belconnen ACT 2616
Freecall *(within Australia)* **1800 800 173**

Tel: +61 2 6201 4107
Fax: +61 2 6201 4199
Email: acres@ga.gov.au
Web: www.ga.gov.au

GEOSCIENCE AUSTRALIA