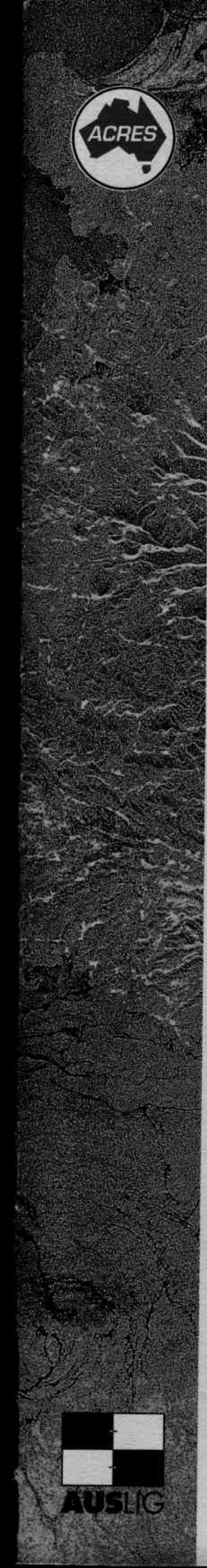
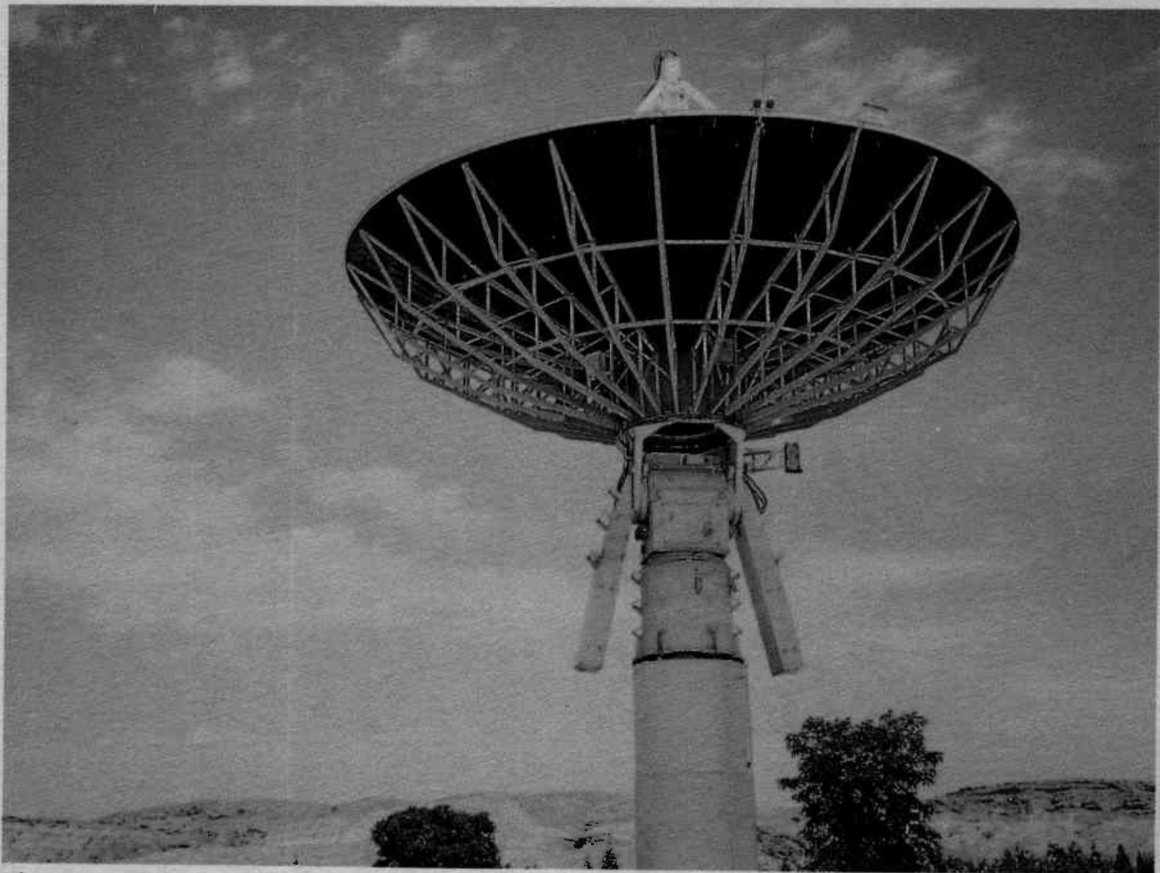
Australian Centre for Remote Sensing

ACRES

UPDATE





The Antenna at the Iranian Remote Sensing Centre near Tehran

Australia represented at key regional meeting

RADAR SPECIAL EDITION

JULY 1994

Dennis Puniard as Acting Manager of ACRES recently attended the 10th Meeting of the Directors of the National Remote Sensing Programmes (RRSP) in the ESCAP region and the 10th Session of the Intergovernmental Consultative Committee (ICC) on the Regional Remote Sensing Programme. The activity was sponsored by the Australian Space Office as part of its support for Australia's participation in significant space related international activity.

The meeting was hosted by the Islamic Republic of Iran and the Iranian Centre for Remote Sensing (ICRS). Meetings were held at the ICRS headquarters building in the northern suburbs of Tehran. The meeting was opened by the President of Iran, Akbar Hashemi Rafsanjani in the Presidential Chambers in central Tehran.

In his introductory remarks President Akbar Hashemi Rafsnajani said that negligence of the useful modern

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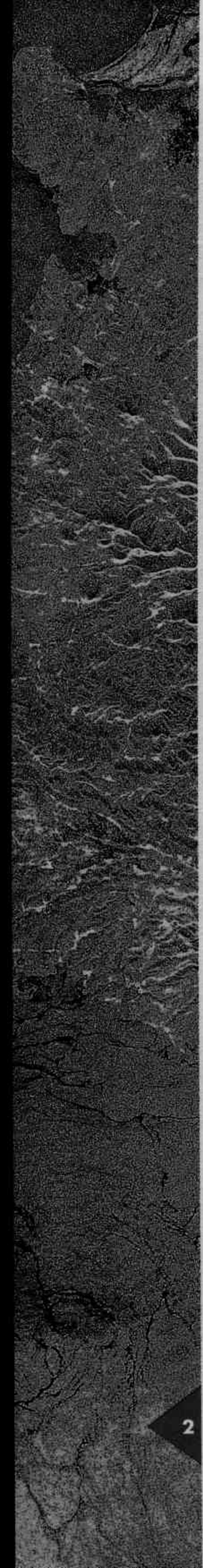

Manager's Message

Last month I was appointed by AUSLIG as the new Manager for ACRES. Following in Carl McMaster's footsteps is a pretty daunting task but one that I am looking forward to. There are clearly many exciting developments on the horizon.

My background consists of 20 years in the geographic information industry, including time in both the private and public sectors. While my educational background and initial work experience was as a surveyor, for the last twelve years I have worked primarily in the fields of digital cartography and Geographic Information Systems. Prior to commencing at ACRES I was Research and Development Manager for AUSLIG.

I would like to take this opportunity to thank Carl McMaster for his great efforts during his four years as Manager of ACRES. The industry has been very fortunate to have had the benefit of Carl's vision and drive during this critical period. I would also like to thank Dennis Puniard for his valuable contribution as Acting Manager over the last six months. We all wish Dennis well in his new role as AUSLIG's Product Manager for remote sensing.

One of my first official duties was to attend the opening of the Tasmanian Earth Resources Satellite Station (TERSS) in Hobart. TERSS is the first X-band satellite reception facility to be designed and built in Australia. It provides the opportunity to collect valuable earth observation data for scientific studies over the southern Ocean and parts of Antarctica. It also offers the potential to back up ACRES Alice Springs ground station for a large portion of Australia. TERSS will be operated by a consortium which includes the CSIRO Division of Oceanography, University of Tasmania, Bureau of Meteorology, COSSA, Antarctic Division and ACRES.

As I settle into my new job over the next few months I look forward to meeting many of ACRES distributors, customers and industry partners.

Paul Trezise

Peter Pistoor (ACRES System Manager) and Mike Linney (Production Coordinator) inspect the key.

LANDSAT'S future decided

At the recent LANDSAT Ground Station Operators Meeting held at Annapolis, USA the future of the US Government's LANDSAT programme was advised to the representatives of the international ground station operators. I represented Australia at the meeting. The LANDSAT 7 satellite will be a straight replacement for LANDSAT 6, lost at launch in October last year. The 15m Pan instrument and 7 band Enhanced Thematic Mapper will be the sensors on board. The resolution of Band 6 (Thermal Band) is to be improved. The downlinks are now to be 2 simultaneous 150 mbs links, not the 85 mbs of LANDSAT 6. These are the only differences to the technical specifications.

The whole LANDSAT programme is now to be managed by US Government agencies. NASA will oversee the contract to design, build and launch the satellite; NOAA will manage the operations and launch and negotiate international agreements whilst the Department of the Interior (USGS/EROS Data Centre) will carry out Data Distribution. Launch of LANDSAT 7 is planned for 1998. EOSAT, whilst still managing LANDSAT 4/5, is not to have a major role with LANDSAT 7.

Dennis Puniard

New manager takes over

Paul Trezise has been appointed as the new Manager of ACRES to replace Carl McMaster. Paul took over at a short ceremony at ACRES on 16th June. Paul was previously the Research and Development Manager in AUSLIG for two years. Prior to that he spent twelve months on secondment to Ordnance Survey in the UK.

Paul, Dennis and Tim discuss the future!

Laurie Oliver hands over the ACRES key to Paul Trezise – Tim Shirley, Paul Gardner and Bob Jones look on.

continued from page 1...

technology means disregard for the interests of regional countries, and it was time to give practical shape to decisions from mere words.

Speaking to the remote sensing and aerospace affairs body of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), he described the realm of ESCAP activity as a strong framework to take advantage of aerospace technology and remote sensing to discover new resources and make optimal use of the region's rich potential.

The president said different channels should be explored to promote science and technology in the contemporary world, and that Islamic Iran in view of the priorities attached to research and education in the world development plan, is ready to set up a centre to upgrade ESCAP's education and research section through investing money and workforce.

He said Iran as an active member of ESCAP and the Economic Co-operation Organisation (ECO) can play an important co-ordinating role to make proper use of scientific capabilities and the existing possibilities.

Rafsanjani appreciated UN assistance to ESCAP and its contribution to development plans in the region.

He hoped the Tehran meeting would pave the ground for taking practical decisions at the ESCAP ministerial meeting in Beijing in September.

Dr Jahedi addresses the official reception with Mr Michael Schulenburg (UNDP Tehran Representative) on his left and the Iranian Minister for Posts, Telegraph and Telephone, Mohammad Gharazi on his right.

The meeting was attended by representatives from Australia, Bangladesh, China (2), Fiji, India, Indonesia (2), Iran, Japan (5), Malaysia, Mongolia, Nepal, Pakistan, Philippines, Republic of Korea, Thailand, Vietnam, Mekong Delta Co-ordination Group, FAO, UNEP, UNDP and ITC (Netherlands). The Secretariat was represented by Mr He Changchui, Chief Space Technology Applications Unit (STAU), UNESCAP, Bangkok, and Mr M. Chaudhury (STAU). Members of the group not represented at the meeting were Vanuatu, Sri Lanka, Afghanistan and Singapore.

The meeting elected Mr Farshid Jahedi (Iran) as Chairman, Dr A.A.Z. Ahmad (Bangladesh) as Vice-Chairman and Mr Nik Nasruddin Mahmood (Malaysia) as Rapporteur.

Dennis Puniard (ACRES), Dr Farshid Jahedi (Chairman) and Mr He Changchui (ESCAP Secretariat).

RRSP MEETING

The meeting included:

- a report by the ESCAP Secretariat on Regional Activity;
- a report from each member country plus reports by ITC on regional training activities, the Mekong Secretariat on developments in the Mekong River catchment, United Nations Environment Programme (UNEP) and the Global Research Information Database (GRID) Programme based at the Asian Institute of Technology (AIT) in Bangkok, the Food and Agricultural Organisation (FAO) and the OLIVIA programme, and the United Nations Development Programme (UNDP) as the major sponsor and funding agency for the UNESCAP RRSP;
- a progress report on preparations for the Ministerial Conference on Space Applications to be held in Beijing in September; and
- the presentation by FAO of the results of a fact finding mission and concept formulation for the OLIVIA programme.

ICC MEETING

All countries and agencies involved in the RRSP meeting were also represented at the ICC meeting, also chaired by Mr Farshid Jahedi. The meeting endorsed the report of the RRSP meeting and in addition:

- reviewed the proposal work plan for RRSP for 1993 to 1996;
- discussed contributions from member countries to the programme, particularly training activities.

The Iranian Centre for Remote Sensing photolab

PACIFIC REGION DATA RECEPTION

One of the recommendations from the ICC meeting was that a mobile receiving capability be investigated for the Pacific sub region. Australia was seen as the potential provider, although France and New Zealand are identified as potential 'donors'. Fiji was particularly supporting of this proposal.

The computer facilities at IRSC being inspected by (left to right) Mr Mahsun Irysam and Mr Suharso Manta Diwirya (both Indonesia), Mr Jose Solis (Philippines) and Dr Bandarch Mendbayaryn (Mongolia)

AUSTRALIAN PARTICIPATION/SPONSORSHIP IN FUTURE ACTIVITIES

The RRSP programme for 1993-96 includes proposed activities that could be hosted/sponsored by Australia. These include:

M-95-2 An Expert Working Group

Meeting on GIS standardisation and guidelines proposed for March 1995

M-96-2 Workshop for Senior Decision Makers

on Operational use of Remote Sensing and GIS for Integrated Natural Resource, Environment and Development Planning proposed for February 1996. If this could be brought together with the 8th Australasian Remote Sensing Conference (March 1996) there could be considerable benefits.

Two other key regional activities, sponsored by ESCAP this year, include:

Regional Seminar on Tropical Ecosystem Management using RS/GIS

Bali, 23-28 August 1994
sponsored by NASDA/LAPAN

The Asian Remote Sensing Conference Hyderabad, India

17-23 November 1994
The next meeting of RRSP/ICC is to be held in Dhaka, Bangladesh in either June or August 1995. The elected officials for this meeting are:

- Mr A.A.Z. Ahmad (Bangladesh) – Chairman
- Mr Nik Nasruddin Mahmood (Malaysia) – Vice Chairman
- Mr Jose Solis (Philippines) – Rapporteur

Why microwaves for remote sensing?

Peter Radonyi, ACRES Project Engineer

Introduction

Historically microwave radiometric techniques were developed in the 1930's and 1940s to measure electromagnetic energy of extraterrestrial origin. Terrestrial microwave radiometric sensing had its beginnings in the late 1950s, following about two decades of radioastronomical and atmospheric observation made with antennas pointing away from the surface of the each. Photography has been used for over 100 years and colour photography for about 50 years, and more recently optical pictures from space. Why then use microwaves?

The question has several answers: the most important reason for using microwaves is their ability to penetrate clouds – and to some extent rain, and their independence of the sun as a source of illumination. Ice clouds that are dense enough to completely obscure the ground, thus precluding aerial photography almost have no effect on microwaves.

Another reason for use of microwaves is that they are able to penetrate more deeply into vegetation than optical waves can. The extent of penetration into vegetation depends upon the moisture content and density of the vegetation as well as upon the wavelength of the microwaves. The longer wavelengths penetrate much better than the shorter wavelength. The shorter wavelengths yield information about the upper layers and the shorter wavelengths yield information about the lower layers and the ground beneath. In sufficiently arid regions (not Australia) microwaves are able to penetrate significantly into the ground itself.

A third reason for the use of microwaves is simply that the information available from microwaves is different from that available in the visible and infrared regions, so that when conditions are suitable for all three regions, the sensors operating in these regions complement each other. For example, the colour observed in the visible and near infrared is determined primarily by molecular resonances in the surface layer of the vegetation or soil whereas the 'colour' in the microwave region is a result of geometric and bulk-dielectric properties of the surface volume studied.

The amount of radar backscatter is related mainly to the surface and near-surface physical properties – specifically slope, roughness and volumetric inhomogeneities and, to a lesser extent, the surface dielectric properties. Thus radar are particularly useful for morphological structural mapping, terrain classification, surface cover delineation, cartographic mapping, polar ice observation, and monitoring ocean features – all expressed as roughness or slope variation.

SAR images can provide two types of information: the patterns or shapes of the areas observed, and the tone and texture of the radar images. Large-scale geological formations, such as folds, domes, drainage patterns, and fault lines, can be detected by their shape, as in an optical image. Radar has the advantage that direction of illumination can be selected by the observer. Surface roughness can be used to distinguish and separate different types of surface, and for further enhancing contrasts.

Because of these factors the albedo of surfaces in the radar images varies much more than that in optical or IR (infrared) images. The maximum range in optical albedo is about a factor of 10 from the darkest base to the brightest salts. With radar the backscattered energy at high incidence angles is determined by the roughness and can easily change by a factor of 10 between neighbouring geological units. At small incidence angles (less than 30 degrees), a change in surface slope of a few degrees can change the amplitude of the radar by a factor of 2 or more.

More importantly if the conditions are right (depending on the orbit of the satellite) it is possible to detect the phase changes between two or more close orbits of the returned signal and use radar data for topographic mapping. SAR interferometry was used to capture the movements produced by the 1992 earthquake in Landers, California (Massonet, et al, Nature).

SAR DEVELOPMENT HISTORY

The first onboard digital SAR processor for non military applications is believed to be the Macdonald Dettwiler and Associates (MDA) system built for the Canadian Centre for Remote Sensing (CCRS), which is a one look system (Bennett et al., 1980).

Digital techniques are preferred today because with optical processing some of the radiometric information is lost. To produce DEM's (Digital Elevation Models) one needs to preserve the phase, which of course is preserved in the optical processing however it is much more convenient to manipulate this information digitally.

In the early days of SAR the digital technology could not handle the quantity of data in any reasonable time and analogue techniques using optics were used to give real-time processing. These techniques in some of the papers are referred to as optical computing.

The following table is reproduced from a paper by John C. Kirk from the IEEE, international radar conference, 1975.

Table 1: Important milestones in the development of SAR.

Date	Development
1951	Carl Wiley of Goodyear postulates doppler beam-sharpening concept.
1952	University of Illinois demonstrates beam sharpening concept.
1953	Project Wolverine formulates SAR radar development program
1957	Project Michigan produces first SAR imagery using optical correlator.
Mid 1960s	Analog electronic SAR correlation demonstrated in non-real time.
Late 1960s	Digital electronic SAR correlation demonstrated in non-real time.
Early 1970s	Real-time digital SAR demonstrated with motion compensation.

SAR Processor Evolution

The synthetic-aperture-radar permitted the production of an image whose pixel (picture resolution element) dimension in the along-track direction was independent of distance from the radar and could be much smaller than possible for a feasibly small antenna. This represented a major step forward in improved resolution for airborne radars and made feasible the concept of a spaceborne imaging radar with fine resolution.

Production of an image from the signal received, by a synthetic-aperture-radar is a complex task. Most of the early processing of SAR was done by an optical system similar to that used for producing holograms. (Harger, 1970). Development of electronic systems had to wait until the introduction of large scale integrated circuits (Kirk 1975).

At this time computers were not sophisticated enough to process the large volume of data in real time. Reading some of the early papers one finds an almost masochistic delight by the authors of overcoming the problems of processing which even today is a fertile area of research. To give some feel for the quantity of data and processing power required, here are some comparisons. To process a ERS-1 SAR image (100kmx100km) on a PC-486 DX running at 33MHz requires 87 hours, the same scene on a Silicon Graphics Computer requires 4 hours: On the fast delivery processor at ACRES it requires 2.5 minutes. To make these ideas quantitative consider a 100km swath, resolution of 25 meters and each synthetic array consists of 4000 elements, each line with 7000 elements, a rough indication of data handling rate is given by:

(Azimuth elements/sec) X (range elements/swath) X (array size)

=(7000/25)(100,000/25)(4000) = 7.28 billion steps/sec.

As a very rough comparison (ignoring compression, and other fancy ploys) a colour television will generate 10 million bytes/sec. In round figures to produce a SAR image requires the same volume of data as 100 television channels.

Spaceborne SAR History

Proposals for spaceborne earth-observation radars (using SAR) were made in the early 1960's. In 1962, JPL (Curlander et al; 1991) conducted the first of four rocket experiments at the White Sands, New Mexico missile range. These rockets carried an experimental L-Band sounding radar that was being evaluated for the lunar lander. Contrary to popular belief Seasat-A SAR, oceanographic satellite launched in June 1978, was not the first such radar to fly in space as stated by (Jordan, IEEE, 1980). Seasat-A was the first satellite mission. At the conclusion of these rocket experiments in 1966, the system was transferred to a JPL airborne SAR system.

In the period between the conclusion of the rocket experiment and the approval of the SEASAT mission in 1975, NASA initiated the Apollo Lunar Sounder Experiment (ALSE). This experiment conducted jointly by Environmental Research Institute of Michigan (ERIM) and JPL was flown aboard the Apollo 17 lunar orbiter in December, 1972. It consisted of four major hardware subsystems: (1) RF~8 electronics Coherent SAR (CSAR); (2) IF amplifiers; (3) VHF antenna; (4) optical recorder. At the heart of the system is the Coherent SAR which could operate at any of the three radar frequencies(5, 15 and 150 MHz).

The objectives of the experiment were three fold: to detect subsurface geologic structures; to generate a continuous lunar profile; and to map the lunar surface at radar wavelengths.

The success of the lunar sounder experiment, coupled with the oceanographic phenomena observed by the JPL L-band airborne SAR, led NASA in 1975 to approve the inclusion of SAR as part of the SEASAT mission. Despite the 10 years of oceanographic observation with airborne SAR systems, the proposed SEASAT SAR created tremendous controversy within the scientific community.

The dissenting camp argued that the coherent integration time was to long (~2.5s), and would result in decorrelation of the signal due to movement of the ocean surface. The issue was never solved theoretically and it was resolved the only solution was to fly SAR on Seasat. As it turned out, Seasat SAR observed a number of unique ocean features that significantly contributed to our understanding of the global oceans (Fu and Holt, 1982). Although it was primarily

Table 2: Spaceborne Imaging Radar Missions

Name	SEASAT	SIR-A	SIR-B	ERS-1	JERS-1	SIR-C	RADARSAT
Platform	Satellite	Shuttle	Shuttle	Satellite	Satellite	Shuttle	Satellite
Launch	Jun-78	Nov-81	Oct-84	Jul-91	Feb-92	Apr-94	1995
Wavelength	L	L	L	C	L	L/C	C
Polarisation(s) Transmit/Receive	HH	HH	HH	VV	HH	HH, VV, HV, VH	HH, VV
Range Resolution(m)	25	40	58-17	20	18	45-15	25
Azimuth Res(m)	25	40	25	16	18	25	28
At looks	4	6	4	3	3	4	4
Look Angles (deg)	20	47	15-60	23	35	15-55	20-50
Swath Width (Km)	100	50	10-60	100	75	20-300	45-500
Orbit (deg)	108	38	57	98.5	97,7	57	98.6

designed to image oceans, Seasat has found a wide variety of applications. The most significant of these are in geology, polar ice, and land use mapping (Elachi et al.; 1982). The success of Seasat, however, was limited in terms of its duration of the data collection. A complete power failure just 100 days after its July 1978 launch, attributed to a short circuit in the slip rings that articulated the solar panels, resulted in a premature end to what promised to be very important mission.

The early scientific results from Seasat quickly led to the approval by NASA of the Shuttle Imaging Radar (SIR) series of flights (Elachi, 1982b). These systems, which used many of the Seasat designs, were also L-band, HH, single channel SARs. The SIR-A was primarily for geologic and land applications and with a fixed angle of 45° off nadir, while SIR-B featured a mechanically steerable antenna mount for a range of look angles from 15-60°. The SIR-A system flew an optical recorder and all imagery was processed optically.

The SIR-B was a fully digital system with selectable quantisation (3-6 bits per sample). This gave the investigator the option of a large dynamic range (6bps) or a (3bps). The SIR-C instrument, launched this year in April is L- and C-band SAR. It will be flown with an X-band vertically polarised SAR developed jointly by Germany and Italy. These systems will operate synchronously and are capable of simultaneously recording nine polarisation (L- and C- bands HH, HV, VH, VV and X-band VV~9). Table 2 lists these parameters. ERS-2 has been left of Table-2 deliberately since it is for most purposes identical to ERS-1.

Conclusion

SAR is still relatively new in remote sensing. Whilst optical satellites initially took a while to establish their areas of usefulness, SAR is going through this evolutionary process. As new applications move out of Universities into the commercial markets it too will form part of the synergy of Geographical Information System (GIS).

Notes

The acronym RADAR comes from the second world war from RAdio Detection And Ranging.

ERS-1 (Earth Resources Satellite) is the European Space Agency's (ESA) first satellite devoted to remote sensing from a polar orbit launched in May 1991. The satellite payload does not have optical instruments. It consists of: a) Two separate radars – a SAR and Wind Scatterometer. b) Radar Altimeter. c) Along track scanning radiometer (ATSR). d.) Laser reflector (built in Australia under contract to BAeA). e) Precise Range and-rate Equipment (PRARE). This instrument failed and has been fixed for ERS-2 (due for launch, May 1995). Except for the PRARE, ERS-2 in all respects is identical to ERS-1.

The fast delivery processor at ACRES, 'Aethers' (Fensom et al; 1989) requires a sustained arithmetic effort of 350Mflops/s plus data unpacking, control and addressing calculations. Clearly these are not the kind of calculations one does on the back of an envelope.

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Acknowledgments

I gratefully acknowledge the help of Yvette Pascoe-Webe DAS library services for obtaining the references listed and many more which are not listed. Thanks to Karen Thomsett for the illustrations and colleagues within ACRES and outside who gave their time to patiently read the draft copies and pointed out the ambiguities.

RADARSAT being readied for launch

The payload module of the RADARSAT satellite has just arrived at the Canadian Space Agency's David Florida Laboratory (DFL), Nepean, Ontario, from SPAR Aerospace Limited in Ste-Anne-de-Bellevue, Quebec, to undergo extensive testing and integration into the RADARSAT spacecraft. The payload is the central element of RADARSAT and its arrival at DFL marks the beginning of the full assembly of the satellite in anticipation for launch in March 1995.

RADARSAT, one of the most technically sophisticated satellites built by Canada, will be the world's most advanced radar-based Earth Observation satellite, and the first radar satellite system devoted solely to a consistent operational mode. When launched in 1995, it will provide large volumes of near real time data in support of environmental monitoring and resource management

RADARSAT's payload module contains a Synthetic Aperture Radar (SAR), a powerful microwave instrument which enables it to see through clouds and darkness, as well as haze, smoke and other forms of atmospheric pollution. Detailed images of Earth, regardless of weather or time of day, will be readily available to users.

Through the use of SAR technology, RADARSAT will provide an important source of information in a number of diverse applications including sea ice monitoring, coastal surveillance, geology, natural disasters, cartography, forestry and agriculture. RADARSAT data will help further the understanding of environmental changes and contribute valuable information to the management of the earth's resources.

RADARSAT is being developed by the Canadian Space Agency in collaboration with an industrial team located across the country. A consortium of leading edge Canadian companies involved in space and remote sensing have formed RADARSAT international (RSI) to market, process and distribute RADARSAT data world-wide. RSI, a Vancouver-based company, is currently the North American distributor of ERS-1 imagery and is Canada's distributor of data from the American LANDSAT and the French SPOT satellites

The Canadian Centre for Remote Sensing (CCRS) will provide ground reception facilities and applications development. RADARSAT International Inc. will be the marketing and data distribution agency. The satellite launch is being provided by NASA as the US Government contribution to the programme.

Announcement of RADARSAT's Application Development and Research Opportunity (ADRO)

A program is being prepared to support research and development activities using RADARSAT synthetic aperture radar data and to invite a statements of interest from your organisation. The program will be known by the acronym ADRO, standing for Application Development and Research. This program will be jointly sponsored by the Governments of Canada, the United States, and RADARSAT International Inc.

The sponsors will select projects through a competition according to specific criteria. Portions of the ADRO program will be open to all groups and organisations throughout the world. There will be several sub-programs with different objectives and, therefore, separate criteria for proposal evaluation. The selected programs will be provided with data sets from the RADARSAT satellite.

The sponsors will be requesting projects which build upon the knowledge obtained through other radar remote sensing systems, both airborne and spaceborne. The application of these data sets to operational programs will be a strong consideration.

ADRO sponsors will seek two types of programs, namely:

1. Those which exhibit innovative scientific research utilising RADARSAT data; and
2. Demonstrations of new radar applications or the development of products for specific applications

PURPOSE OF THE PROGRAM

- To evaluate the data sets from RADARSAT, quickly after the launch, under a wide variety of applications and conditions
- To apply RADARSAT data to a variety of research and demonstration projects
- Increase the opportunity for benefits to the RADARSAT Program, the scientific user communities
- To assist in the design of information extraction algorithms and knowledge base for future satellites and supposing programs.

KEY OBJECTIVES

1. Evaluate the data sets received from RADARSAT
    - different modes
    - different applications
    - different environments
2. Stimulate promising application development and commercial sales
3. Provide opportunity for companies to demonstrate their capabilities for processing and applying radar data

4. Reduce the risk of real-time users in applying the data sets to their programs
5. To gain the support of the world-wide community in the evaluation RADARSAT data
6. Assist in development of new applications
7. Realise potential research applications of RADARSAT data

DRAFT EVALUATION CRITERIA FOR INTERNATIONAL APPLICATION, DEMONSTRATION, AND PILOT PROJECTS

- Will be determined by the Sponsors and announced with each ADRO sub-program
- Build upon the knowledge and experience gained from both ERS-I and JERS-I.

Some of the key criteria will be:

- Projects concentrating on the differences in the RADARSAT satellite and its ability to service different markets.
- Amount of end user involvement
- The development of new products and services using RADARSAT data

Other criteria for selection may include:

- Socio-economic impacts over wide areas and time periods
- Demonstration capability within 1-2 years
- Best use of radar characteristic or data merging
- Proposers that have operational responsibilities
- Credibility, resources, work plan, deliverables, commitment

ADDITIONAL INFORMATION

To receive an information package on ADRO contact:

Ken Link
Canadian Space Agency
6767 Route de L'Aeroport
Saint Hubert, Quebec
Canada J3Y 8Y9
Tel: (514) 926 4414
Fax: (514) 926 4424

JERS-1 SAR Wairau/Blenheim Subscene with features noted

JERS-1 radar mapping

During a recent investigation in New Zealand using satellite radar data, Landcare Research staff noticed some unusual bright spots on JERS1 SAR imagery of the Marlborough area. Field checks identified the bright areas as wires supporting grapevines! Only the rows planted at right angles, or almost right angles, showed as bright spots. The radar signal had penetrated the leaves to the wires below which gave the strong reflection. Researcher Stella Belliss said "the combination of wire orientation and radar look- direction meant that the radar sensor was seeing the vineyard as a field of wires".

This investigation, using data from the Japanese Earth Resources Satellite (JERS-1), is part of ongoing research by the Image Analysis Team at the LANDCARE Research Unit at Gracefield. The Team's aim is to improve understanding of the ways radar can be used for environmental monitoring and mapping in New Zealand.

JERS-1 radar imagery will be used next to aid geological mapping in the Coromandel/ Kaimai region. The variety of rock types, the very hilly terrain and range of environments which occur on the Coromandel Peninsula will make this a very different exercise to mapping on the Wairau Plains.

Radar imagery has the potential to provide data for regular environmental monitoring with the added advantage of being able to view the earth at night and through cloud cover. Similarly, synthetic aperture radar can 'see' through vegetation, displaying the shape of the land underneath. Researchers are finding the radar view useful for detecting boundaries between rock types, for mapping structure, and detecting differences between moist and dry areas. In very dry environments it can be used to detect the rock formations under loose sediments such as sand dunes.

The radar imagery has been made available through an international collaborative project (the JERS-1 Announcement of Opportunity). Landcare Research, the National Institute of Atmosphere and Water (NIWA) and the Institute of Geological and Nuclear Sciences are the principal investigations for New Zealand on this project.

Further information can be obtained from:

Stella Belliss
Landcare Research,
New Zealand
Tel: (045) 569 0180

Announcement on JERS-1 Data for Research Use

NASDA has decided that the researchers can utilise JERS-1 data for non-commercial research purposes only at marginal cost on and after May 1994. RESTEC has been entrusted by NASDA with the duty of JERS-1 data distributing agency for Research Use.

General terms of JERS-1 data for research use (Application requirements)

AVAILABLE DATA AND PRODUCTS

SAR and OPS data of JERS-1, processed at NASDA/EOC stations, in the form of Computer Compatible Tape (CCT) are available. The Products List below list available data and formats.

THE CONDITIONS FOR APPLYING RESEARCH USE

- Provided Data should be used only for non-commercial research purposes,
- Researchers should belong to non-profit organisations such as national and local government, government institute, college, or university

DOCUMENTS REQUIRED FOR APPLICATION

The documents to be submitted are as follows:

- Application form
- Evidence which indicates your eligibility for research use
- Memorandum of Understanding

HOW TO SEND YOUR APPLICATION FORM

An application form is available from Laurie Oliver at ACRES. There is no due date. Applications will be accepted at any time. All documents are to be sent to the following address by mail. No documents through facsimile are acceptable.

Contact:

Remote Sensing Technology Centre of Japan (RESTEC)
Uni-Roppongi Building
7-15-17, Roppongi, Minato-ku
Tokyo 106, Japan

Products List of JERS-1 Data for Research Use

Code	Format, etc.	Density	Volume	Cost(J-Yen)*
SAR: Synthetic Aperture Radar				
SAR CCT: Computer Compatible Tape, 9-track				
G75510	BSQ Level 2.1 (Standard Geocoded Image)	6250BPI	1	8,800
Level 2.1: Standard Geocoded Image = PixelSpacing: 12.5m; Multi-Looks: 3; Map Projection: UTM; Resampling Methods: Nearest Neighbour				
OPS-VNIR: Optical Sensors – Visible and Near-Infrared Radiometer				
VNIR CCT: Computer Compatible Tape, 9-track				
N75210	BSQ Level 2 (system Corrected Image)	6250BPI	1	8,800
N75510	BSQ Level 5 (stereo Image)	6250BPI	1	
N75210	BIL Level 2 (system Corrected Image)	6250BPI	1	8,800
Level 2: System Corrected Image = Bands: 1–3; Pixel Spacing: 18m; Map Projection: UTM; Resampling Methods: Cubic Convolution				
Level 5: Stereo Image = Bands: 3 and 4; Pixel Spacing: 18m; Map Projection: UTM; Resampling Methods: Cubic Convolution				
OPS-SWIR: Optical Sensors – Short Wavelength Infrared Radiometer				
SWIR CCT: Computer Compatible Tape, 9-track				
W7521 0	BSQ Level 2 (system Corrected Image)	6250BPI	1	8,800
W7521 0	BIL Level 2 (system Corrected Image)	6250BPI	1	8,800
Level 2: System Corrected Image = Bands: 1~3, Pixel Spacing: 18m, Map Projection: UTM, Resampling Methods: Cubic Convolution				

*Please note this cost does not include any tax nor shipping cost.

Defence airborne SAR project well underway

The new Defence Science and Technology Organisation's airborne SAR project has produced some interesting preliminary results. Figure 1 shows agricultural land near Yass, in NSW, flown to assist an ACRES sponsored project to look at land degradation. Initial analysis has given good results in detecting salinity areas. This particular image has 3m resolution.

THE PROJECT IS CALLED INGARA

The parameters of the INGARA data acquisition system are shown in the table below. INGARA is currently installed in an Airforce Research and Development Unit (ARDU) DC3 aircraft, however, it is platform independent and could be installed on a faster or higher flying aircraft. The transmit signal in the baseline system is a FM chirp generated by a surface acoustic wave (SAW) device which yields a range resolution of approximately 3m. By the middle of 1994 the radio frequency components will be upgraded to 100mhz bandwidth permitting 1.5m spatial resolution with the trade off being a halving of the image swath widths and number of independent looks in stripmode operation. In addition a Global Positioning System (GPS) receiver will be added to the radar system permitting accurate location of the aircraft and resampling of the image data to a standard map co-ordinate system. The radar implementation is based around industry standard open systems including a VME bus radar control processor utilising off the shelf hardware where possible and a UNIX workstation front end with a X-windows graphical user interface.

INGARA System Parameters

Dakota DC3 Aircraft	
Operating Altitude	3000m
Velocity	70m/sec
Radar Frequency	X Band, 9.375 Ghz
Polarization	HH
Baseline Transmit Waveform	FM Chirp, 8 msec, 50mhz
Baseline resolution – Swath Width	3m (4 looks) – 12km
Interlaced Resolution – Swath Widths	3m (4 looks) – 24, 36 & 48km
Upgraded Resolution – Swath Widths	1.5m (2 looks) – 6, 12, 18 & 24km
Swath Standoff Distance	5km – 36km
Pulse Repetition Frequency (PRF)	130 – 400Hz
Baseline Number of Looks	4
Antenna Size	1.46m by 0.16m
Peak Transmit Power	1.4kw
Quantization	8 bits I and Q
Raw Data Rate	4 MB/sec
Incidence Angles	60° – 86°
Sensitivity	s0 < -30dB (3m pixels, 4lks & 24km standoff)
Radar Control Processor	VME computer, dedicated hardware
Radar Operator Interface	SUN Workstation

The raw radar data is currently processed at DSTO on a development SAR signal processing system implemented on a SUN workstation. The performance of this system is approximately one fiftieth real time when processing a 24km wide swath at 3m resolution. Under development is a real time SAR processor utilising a VME rack of CSPI Supercard I860 based array processors. This system will be installed on the aircraft in early 1994 and in early 1995 an air to ground datalink will be implemented so real time image and ancillary data can be transferred to an image analysis ground station. The ground station will provide a research and development environment for the testing of real time image analysis algorithms for the Australian Defence Forces.

These algorithms include a simple thresholding, change detection and moving target analysis. Thresholding will be used to isolate areas of high radar backscatter, a characteristic often associated with man made objects. Change detection will align the down-linked image data with previous images of the same area acquired in a similar geometry to highlight changes in scene backscatter. This imaging alignment will be facilitated by the on-board GPS system and image resampling to a standard map co-ordinate system.

Figure 1. INGARA Image near Yass, NSW

The moving target analysis discussed below will investigate blurred features in the image data together with strong echoes outside of the ground clutter Doppler bandwidth. The automatic thresholding, change detection and moving target analysis information will be presented as an overlay to the image data in an Geographical Information System (GIS) style display together with any available supporting geographical information.

For more information on the Yass project contact Jenny Weissel at ACRES or for information on the INGARA system contact:

Dr Nick Stacey, DSTO,
Salisbury, South Australia,
Tel: (08) 259 7191
Fax: (08) 259 5200

EOSAT to be world-wide agent for Indian remote sensing data

EOSAT and the National Remote Sensing Agency of India (NRSA) have signed an agreement that allows EOSAT to receive Indian data and makes EOSAT the exclusive world-wide agent for marketing India's IRS data. EOSAT will begin receiving data in 1994.

The most exciting aspect of the agreement is that it gives EOSAT the rights to market data from India's next generation of satellites, IRS-1C and IRS-1D, which will capture imagery in specifications very close to what LANDSAT 6 was to have provided. IRS-IC is scheduled for launch in October 1994, and IRS-1D by 1996.

India currently operates two satellites, IRS-1A, launched March 17, 1988, and IRS-1B, launched August 29, 1991. The satellites acquire data with three Linear Self Scanning Sensors (LISS-I and LISS-IIA and B) at 72 m and 36.25 m spatial resolution. The data is in four spectral bands, all of which are nearly identical to the TM visible and VNIR bands (1 through 4). These bands are excellent for vegetation discrimination, land use, and mapping. IRS-1C and 1D also will have a band comparable to TM's SWIR band 5.

The satellites' altitude is 904 km, the orbit is sun-synchronous, repeat coverage is every 22 days at the equator (11 day repeat coverage with two satellites), and inclination is 99.5°, all of which are comparable to the LANDSAT system.

IRS-1C and 1D each will carry three sensors: LISS-III, with 20 m resolution; a panchromatic camera with 10 m resolution; and a Wide Field Sensor (WiFS) with approximately 188 m resolution. (The WiFS is for vegetation cover monitoring and will have five-day repeat coverage, 740 km swath, and two bands comparable to NOAA's satellite.

The chart below summarises the features of and IRS satellites:

TECHNICAL FEATURES OF LANDSAT AND IRS SATELLITES

IRS-1A, 1B (1988, 1991)
LISS-I and LISS-II

Blue	0.45-0.52 µm
Green	0.52-0.59 µm
Red	0.62-0.68 µm
Near Infrared	0.77-0.86 µm

72 m spatial resolution (LISS-I)
36.25 m spatial resolution (LISS-II)
148 km swath – 72 m resolution
74 km swath – 36.25 m resolution
Revisit time: 22 days at equator

IRS-1C, IRS-1D (1994, 1996)
LISS-III

Blue	–
Green	0.52-0.59 mm
Red	0.62-0.68 mm
Near Infrared	0.77-0.86 mm
SW Infrared	1.55-1.70 mm

20 m spatial resolution, all bands
Except 70 m for SW Infrared
Revisit time: 24 days at equator

Pan

0.5-0.75 mm
10 m spatial resolution
70 km swath
Stereo
Revisit time: 24 days at equator – every 5 days with off-nadir viewing

WiFS

Red	0.62-0.68 mm
NIR	0.77-0.86 mm

188 m spatial resolution
740 km swath
Revisit time: 5 days at equator

LANDSAT 5 (1984) Thematic Mapper

Blue	0.45-0.52 mm
Green	0.52-0.60 mm
Red	0.63-0.69 mm
Near Infrared	0.76-0.90 mm
SWIR	1.55-1.75 mm
SWIR	2.08-2.35 mm
Thermal	10.4-12.4 mm

30 m spatial resolution
Revisit time: 16 days at equator
185 km swath

IRS sample data

ACRES is able to provide a sample data set and information package of IRS-1B and LANDSAT data for review and examination.

Acquired at the Indian ground receiving station in Shadnagar, the sample data set includes imagery of a region near Bangalore, India captured by the IRS-1B satellite's LISS-I sensor (at 72.5 m spatial resolution), the LISS-II sensor (at 36.25 m spatial resolution).

In the USA, EOSAT's Norman, Oklahoma ground station capabilities are currently being expanded to receive and process IRS data EOSAT is also working with the international network of ground receiving stations to expand the number of stations receiving IRS data, thereby increasing the availability of IRS data world-wide. Discussions have commenced with ACRES.

Remote sensing in India – a brief history

The Republic of India is one of the few countries in the world that has successfully developed, launched, and operated its own remote sensing satellites. India is numbered among other leaders such as the United States, Japan, Russia, France, and the European Space Agency as innovators in a field that provides vital information for land and resource management.

POPULATION GROWTH AND DEPLETED RESOURCES

The government of India, recognising the issues associated with the country's growing population of more than 860 million people, made resource management a priority for its planners. A major focus of the Indian Space Program has been to accelerate the country's economic development by improving management of land and water resources.

To fulfil this mission, India established the National Natural Resources Management System (NNRMS) and the Regional Remote Sensing Service Centres (RRSSCs)and has developed a series of remote sensing satellites.

India began to experiment with remote sensing in the late 1960s when it used aerial surveys to monitor crops with a variety of sensors, such as infrared scanners, multispectral scanners, and radiometers. The information obtained by these sensors, backed by ground truth measurements, helped regional and national planners better evaluate crop yields, map soil salinity and alkalinity, and monitor water pollution and deforestation.

DEVELOPING A PROGRAM

A major step toward developing its own remote sensing program occurred in 1979, when India, in co-operation with the United States, established a LANDSAT ground receiving at the National Remote Sensing Agency in Hyderabad. The station was a training ground for scientists to interpret and analyse remote sensing data, giving them experience that helped prepare India for the operation of its first remote sensing satellites, Bhaskara 1 (1979) and Bhaskara 2 (1981).

The Bhaskara satellites carried a two-band TV camera system, one in visible, one in infrared, and a three-frequency passive microwave radiometer system. The systems had a resolution of about 1 km. Data acquired from these satellites was used to study resources relating to forestry, hydrology, large water bodies, and geology.

THE IRS SYSTEM

By the mid-1980s India was well on its way to developing the India Remote Sensing Satellite (IRS) system: IRS-1A was launched in 1988, and its identical follow-on satellite, IRS-1B, was launched in 1991. Both satellites are equipped with sensors that acquire multi-spectral data with 36.25 m and 72.5 m spatial resolution. They continue to operate successfully, and data sales are increasing steadily within India.

The next generation of satellites, IRS-1C and 1D, will carry multispectral sensors with a spatial resolution of 20 m; panchromatic sensors with a spatial resolution of less than 10 m; and Wide Field Sensors (WiFS) with a spatial resolution of 188 m, for vegetation monitoring. IRS-1C is scheduled to be launched in early 1995, and IRS-1D, by 1996.

USING THE DATA

Information derived from data acquired by the IRS satellites has been used extensively in India to help planners revise national and regional policies in many areas, including:

- monitoring droughts
- providing timely area and crop yield assessment
- nation-wide mapping of potential ground water zones to provide potable drinking water
- studying potential for irrigation, land use, and land cover maps for the entire country.

ACRES sponsors of 7th Australasian remote sensing conference

The 7th Australasian Remote Sensing Conference was held in Melbourne in March this year. ACRES supported the Conference through sponsorship of the opening reception, through a large technical display and the sponsorship of the prize for the best poster paper presentation. ACRES also conducted a Distributor's workshop during the conference and participated in the Data Providers panel discussions.

The prize for the best poster presentation was a certificate and a framed ACRES image of the winner's choice. The prize was awarded to Claire Howell and Andrew McAllister of the Institute of Sustainable Irrigated Agriculture, Victorian Department of Agriculture based at Tatura, Victoria for the presentation on Land Cover Classification in Irrigated Agriculture Using Multi-temporal Satellite Images. Their paper is reproduced in this newsletter. (See page 19)

AUSLIG/ACRES display at 7th ARSC

ACRES appoints Tasmanian distributor

For some years customers for remote sensing data in Tasmania have not had a local contact point. This has now been remedied with the appointment of a new ACRES distributor based in Hobart. The new agency will be managed by Mr Ross Lincolne and will be based at the Central Science Laboratory at the Sandy Bay campus of the University of Tasmania. Commercial agreements have been negotiated with Unitas Consulting Limited, the commercial and consulting arm of the university. Ross and his staff will offer personalised service for data selection and ordering, and a remote sensing consulting service.

The new distributor arrangements will provide local sales advice and access to quick look prints in Hobart. For a number of years the nearest facilities have been in Melbourne, which has created problems for ACRES Tasmanian clients when selecting their data.

The Central Science Laboratory has been involved in remote sensing since 1983, specialising in vegetation analysis using LANDSAT data. Data is processed using DISIMP image processing software and ERDAS image processing/GIS software. The ARC/Info GIS package is also available.

The Central Science Laboratory has developed a specialisation in the integration of a digital elevation model (DEM) with remotely sensed data. Images have been processed to remove the solar illumination variations prior to classification, resulting in improved classification accuracy in undulating or mountainous terrain. The remotely sensed data can also be integrated with other GIS data.

The new agency will service the Tasmanian requirements for LANDSAT, SPOT, and ERS-1 data. Local remote sensing applications include oceanography, agriculture, forestry, geology and mining, fisheries and meteorology.

For enquiries about data sales or image processing requirements please contact:

Ross Lincolne
Central Science Laboratory
University of Tasmania
Sandy Bay, Hobart
Tasmania 7005
Tel: (002) 233975
Fax: (002) 202494

RIA releases TERRASCAN PROGPS

RESOURCE MAPPING THAT DOESN'T COST THE EARTH

ACRES Distributor, Resource Industry Associates, based in Melbourne has recently released new versions of it's TERRASCAN suite of software for image processing and GPS operations.

Powerful low cost software for the earth scientist. TerraScan brings image processing/GIS facilities to the PC with the ease of use of Microsoft Windows and simple integration with other packages.

Version 2.1 is a full 32 Bit program operating under Microsoft W32S (supplied at no charge by RIA) on a minimum of 386 MS DOS computer. A Digital Alpha Station Windows NT version is also available.

EASY TO USE

If you can use a Windows program such as Microsoft Excel or Word you can use TerraScan. If you've never performed any image processing/GIS before, then this is the perfect introduction. You'll be displaying images and performing image processing within minutes of installing the software via easy to understand mouse operated pull-down menus, toolbars and icons.

SYSTEM COMPATIBILITY

TerraScan lets you work with Raster (imagery) and Vector (maps, linework, annotations) data in a variety of standard formats.

Raster data may be raw or georeferenced and of virtually any size. Full scene 300 megabyte LANDSAT TM & SPOT images can easily be displayed from hard disk or CD-ROM. With the built in support for a variety of standard raster formats such as AMIRA & ACRES LANDSAT CCT, SPOT, ERMapper, GEOSOFT, DISIMP, Arc/Info Grid, Windows BMP, you can quickly work with data without the need for importing or conversion to special formats which is time consuming and consumes valuable disk space.

TerraScan now also reads 8, 16 and 32 Bit signed and unsigned integer data, single and double precision real numbers. TerraScan can display 12 channel Daedalus ATM data.

Vector data such as maps are also easy to use in TerraScan through support for standard file formats such as DXF, Arc/Info Lines, ASCII Text and Windows Metafiles. With features such as automatic map projection conversion of vectors, you can overlay maps in latitude/longitude co-ordinates over images in AMG without the need for special conversion.

Processed images can easily be exported to other Windows programs through the Windows Bitmap format (BMP). Images can then be pasted into documents for inclusion in reports or presentations etc.

IMAGE PROCESSING

Formulae, clipping, colour draping and filtering (edge enhancement, sun angle shading etc) allow high quality images to be produced with minimal expertise and effort. Advanced users can create or modify colour lookup tables fro data classification.

Now with a Macro for saving of processing settings for individual data sets

Most PCs have SuperVGA display adaptors that allow the display of 256 colour images, and most now also support 16.7 million colours without the need to purchase expensive hardware. Through Windows hundreds of different display cards are supported. RIA can supply the Diamond Pro (16 million) card for $350.00

MAPPING AND ANNOTATION

On screen mapping and annotation give the user easy to use drawing facilities for the creation of maps, image interpretations and annotations. Areas and distances can now be calculated. Data profiles along lines may now be viewed. Created vector drawings can be saved in standard file formats (DXF, Arc/Info, ASCII & WMF) for use in other systems such as AutoCAD. Existing vector files can also be modified.

Map grid overlays in a number of styles and projection can also be created and overlayed over other images and vector fields.

PRINTING

TerraScan will produce hard copies of imagery and vector overlays to virtually any scale. Printouts larger than your paper size are automatically split over as many pages as necessary. Through the hundreds of printers supported by Windows and third party drivers, TerraScan will print to almost any raster device ranging from low cost inkjet printers to photographic quality with the SONY dye sublimation image printer in colour or black and white.

GPS AND DATA LOGGING

With the inbuilt support for popular GPS instrumentation, TerraScan will pinpoint your location on screen over images and vectors. Combined with data logging facilities, you can create attributed data files in the field that can then be displayed over images, gridded into imagery or used with other software. The automatic vector logging allows you to automatically create maps while driving around in you vehicle with a GPS and notebook or pen computer running TerraScan.

DATA GRIDDING/SURFACE GENERATION

Point data sets (such as data collected with GPS data logging) can be gridded to create raster images such as Digital Elevation Models (DEM), geochemical images et. A number of gridding techniques are supported but when sophisticated gridding is required you can easily integrate with other powerful applications such as Intrepid and Geosoft.

VIRTUAL REALITY

The 3D viewer in TerraScan adds another dimension to how you look at your data. Images can be displayed in 3D and then rotated and manipulated using the mouse. By being able to position yourself anywhere in an image you have the ability to fly-through a scene. The 3D component requires no special hardware, software or expertise to operate.

Features under development for Version 2.2

TerraScan Lite features have been stabilised at Version 2.0. All subsequent development has been on the 32 bit TerraScan ProGPS. Features are constantly being added as the range of users increases.

The following features are being developed for the next release:

- *Contouring*
  The simple contouring facility will be able to generate vector contours specified with contour intervals from raster data such as DEMs, geophysical and geochemical images. These can be overlayed over georeferenced data sets.
- *Real-time Sun Angle Shading and Filtering*
  The current sun angle shading and filtering methods will be used in a real-time method.
- *On Line Help*

OTHER DEVELOPMENTS IN PROGRESS

TerraScan's features are being developed from advice given by its growing user base and industry trends. It is developed by Elvin Slavik and RIA here in Australia with the needs of Australian users in mind. Suggestions put forward have sparked developments that will be available in the near future such as support for more map projections and more advanced image processing techniques.

TerraScan is available from RIA in several forms:

- TerraScan Lite $100
- TerraScan Lite with GPS $600
- TerraScan ProGPS $2000
- TerraScan ProGPS Educational Licence $1000

The purchase price includes twelve months free backup and upgrades. An optional service agreement for successive years is available for $300 per annum.

Site Licences are available by negotiation.

Contact: Jeff Bailey or Terry Boyd at RIA for advice on TerraScan and all your LANDSAT, SPOT and GPS. RIA is a National Distributor for ACRES, SPOT, Magellan and SONY.

Asian conference on remote sensing to be held in India

J N Tata National Science Seminar Complex, Bangalore, India

17-23 November 1994

OBJECTIVES

The 15th Asian Conference on remote Sensing will be held at J N Tata National Science Seminar Complex, Indian Institute of Science Campus, Bangalore 560 012, India, from 17-23 November 1994.

The 15th ACRS will be organised by the Asian Association on Remote Sensing and Indian Space Research Organisation.

The conference will consist of Plenary Sessions, Technical Papers in Oral and Poster Presentation and a Commercial Exhibition, emphasising the following objectives.

- To discuss Asian problems in Remote Sensing
- To exchange academic, application and technical information
- To promote regional co-operation amongst the member countries
- To promote operational applications of remote sensing and GIS

CALL FOR PAPERS

All persons interested in contributing a paper for consideration should submit the abstract of the proposed presentation, not later than August 10, 1994 to General Secretary. The technical program will include oral presentation and poster sessions formulated to address the following sessions:

Session A – agriculture and soil
Session B – water resources
Session C – disasters
Session D – education/training
Session E – forestry
Session F – mapping from space
Session G – oceanography
Session H – land use
Session I – digital image processing
Session J – geology
Session K – GIS
Session L – global environment

Contributed papers will be selected and classified into the oral presentation or poster session by the program committee. Final manuscripts of not more than 6 pages should be submitted in English not later than September 10, 1994. Late paper submitted after the deadline will not be included in the proceedings but will be distributed to the participants at the cost of the author.

REGISTRATION

The registration fee for overseas participants including one copy of the proceedings is 40 US Dollars per person which may be accepted at the Conference. All participants shall submit a registration card to General Secretary not later than September 20, 1994.

ACCOMMODATION

These hotels near the conference hall will be arranged for the 15th ACRS Conference at a moderate rate by the Organising Committee.

Name	single room	double room
The Oberoi	$120+25% tax	$130+25% tax
Windsor Manor *	$60+25% tax	$70+25% tax
Hotel Ashok	$60+25% tax	$70+25% tax
Taj Residency	$40+25% tax	$70+25% tax

*Windsor Manor is the main hotel for the 15th ACRS

TRAVEL

All participants should get visas to INDIA except for countries which have a special immigration agreement.

Those persons who need official invitation letters to acquire passports or visas should contact Prof. U.R. Rao, Chairman, the National Organising Committee.

COMMERCIAL EXHIBITION

An exhibition of commercial products and services will be included in the 15th ACRS. The Commercial Exhibition will address the following spaces.

- Exhibit Booths: Booths will be made available with a size of 2 meters square. Exhibitors will be required to contact Organising Committee for custom clearance, booth construction etc.

- Session of Technical Information: Oral presentation with aid of slides or documents to introduce commercially available products and services will be made available at the cost of $250 US per one unit of twenty minutes.

Contact:

Conference Chairman
Prof. U.R. Rao
Indian Space Research Organisation, Dept. of Space
Government of India
Atariksh Bhavan, New B.E.L. Road
Bangalore 560094, India
Tel: +91-80-3332677
Fax: +91-80-3334298
Telex: 845-8867

1995 Australia Prize topic announced

Science Minister, Senator Chris Schacht, today announced that Remote Sensing will be the topic for the 1995 Australia Prize. The Minister also announced a $50,000 increase in the prize money, which will take the value of the award to $300,000.

"I believe Australians will enter the last years of this century with an acute awareness of the powerful and positive role science and technology plays in economic growth and human welfare," Senator Schacht said.

"This is reflected in the extensive coverage these issues now receive in our prim and electronic media.

"The Prize shows Australia to be a nation which recognises the universal applicability of advances in science and technology, and the need to reward individuals of whatever nationality, who make outstanding contributions to those advances."

Senator Schacht said the level of prize money places the Australia Prize among the most prestigious international prizes.

"International exposure brings Australia valuable collaboration and economic benefits. Through the Australia Prize we acknowledge excellence at the highest levels in science and technology," the Minister said.

"Remote Sensing, which refers to the use of sophisticated airborne or satellite equipment to monitor the earth's characteristics and resources, is an exciting choice for the 1995 Prize topic.

"It is as an area which promises inventive solutions to some of the world's problems, but is not yet fully recognised as such.

"For example, in the recent NSW bushfires, data gathered by a Learjet equipped with remote sensing equipment was extensively used for fire front mapping and spot fire detection, providing detailed infrared images of the bushfires."

Senator Schacht expressed a particular interest in the space aspects of remote sensing. Australia has been involved in using remote sensing data since LANDSAT 1 in 1972. He noted that space-derived remote sensing data is seen as the only way that global monitoring of the environment can be achieved.

"Perhaps most importantly, remote sensing can give early warning about potentially calamitous natural phenomena such as crop failure, cyclones and flood, whose impacts fall most harshly on people in the least developed areas of the world, and can enable early intervention to avert the worst consequences."

In addition to these applications, Senator Schacht said remote sensing was used in areas as diverse as geology, marine science, wildlife monitoring, and the management of land and water resources. He emphasised that the field was chosen after wide consultation within the scientific and technological communities.

Senator Schacht said the 1995 Australia Prize will be the fifth awarded since the inaugural prize in 1990. The 1994 Australia Prize, in the field of sustainable land management, was awarded to

Dr Gene Likens for his substantial contribution to the study and understanding of whole-ecosystems. The award to Dr Likens has reinforced Australia's position as a leader among developed nations in recognising the need for ecologically sustainable development.

Dr Likens will receive the Prize and undertake a lecture tour throughout Australia in April-May.

Canberra contact:

Carol Sutherland/Graeme Rankin
Minister's Office
Tel: (06) 277 7080

Dr Carmel Statham
Department of Science, Industry and Technology
Tel: (06) 276 1780

CONDITIONS OF AWARD

The Australia Prize is an international award given by the Government of the Commonwealth of Australia for an outstanding specific achievement in a selected area of science and technology promoting human welfare.

In this context, science encompasses natural and technological sciences, engineering and mathematics.

The area selected for the 1995 Prize is Remote Sensing

The Prize is $A300 000, not taxed in Australia, together with an inscribed medal.

The Australia Prize Committee consists of the Presidents of the Australian Academy of Technological Sciences and Engineering and the Australian Academy of Science (alternating in the Chair), two additional Fellows of each Academy nominated by the Presidents, and other distinguished Australians.

The Prize may be awarded to an individual or awarded jointly to up to four persons who will share the prize money in equal parts. Persons who have already received a prestigious international award for the nominated achievement will not normally be considered for the award of the Australia Prize.

Awardees will normally be expected to attend the Prize-giving ceremony in Canberra, the national capital, and to participate in associated events. Airfares to, within and from Australia and all reasonable expenses arising from the award program will be provided.

A posthumous award will only be made in the event of the death of a prize winner between the announcement and the award ceremony.

Written confidential nominations will be sought from appropriate learned and professional bodies and from individuals. Self-nominations will not be considered. The Committee reserves the right to seek further nominations.

Nominations must be submitted in the format specified under 'Nomination Requirements'. In particular they are to be in English and signed by the nominator and two supporters familiar with the nominated achievement. Nominations (original documents) arc to be received by the Australia Prize Secretariat by the closing date. For the 1995 Prize the closing date is 31 July 1994.

The Committee, in consultation with a Specialist Advisory Panel established by the Committee on the basis of expertise relevant to the area of the particular award, will recommend the recipient of the Australia Prize to the Government of the Commonwealth of Australia.

All material considered by the Committee and its Advisory Panel. and their deliberations thereon. will remain confidential. The Committee reserves the right not to recommend an award in any year.

All decisions taken and recommendations made by the Australia Prize Committee shall be binding and final and no correspondence will be entered into on such matters. No contractual or other legal relationship shall arise as between the Committee, its members or the Commonwealth and any person nominated for the Australia Prize.

NOMINATION OF REQUIREMENTS

In 1995, the international award for outstanding achievement in science and technology promoting human welfare will be made in the field of:

Remote sensing

Nominations for the 1995 Australia Prize close on 31 July 1994. All nominations will be acknowledged.

All documents relating to each nomination are to be in English (excluding copies of publications) and in original Form. The Conditions of Award must be complied with when completing a nomination. Nominations should be in a typed format and contain the following details:

Nominee's details

- title and full name
- current and, if appropriate, Former substantive position/s
- address
- contact numbers for telephone, facsimile and/or telex
- curriculum vitae of not more than TWO (2) pages on A4 size paper

Description of nominated achievement

- not more than FOUR (4) pages of typed information on A4 size paper
- list and append copies of not more than SIX (6) publications or other written material which best describe the nominated achievement

Details of nominator and supporters

- titles and full names
- current positions
- addresses
- contact numbers for telephone, facsimile and/or telex
- dated signatures

Forward nominations marked 'confidential' to:

Australia Prize Secretariat
Tel: 61-6-276 1780
Fax: 61-6-276 2188
GPO Box 9839
Canberra ACT 2611
Australia

Courier Delivery
51 Allara Street
Canberra ACT 2601
Australia

to be received by 31 July 1994.

Satellites and software work for the farm

With an innovative software program farmers can now use satellite images to help them manage their properties. Developed by UNSW staff, the program Farm Image is a low cost PC based software program which gives farmers access to remotely sensed images acquired by satellite. It received an enthusiastic vote of approval when it won a highly commended prize at the Sydney Royal Easter Show.

If you are interested in receiving more information or purchasing the software, please get in touch with:

Dr Brian Button
Managing Director Agrecon Pty Ltd
Tel: (06) 201 2565
Fax: (06) 201 5030
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Land cover classification in irrigated agriculture using multitemporal satellite images

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INTRODUCTION AND BACKGROUND

In 1989 it was estimated that the northern Victorian irrigation area of Tragowel Plains (see locality map on Figure 1) lost $14.9 million annually in agricultural production, caused primarily by soil salinity. In the same year the Tragowel Plains Salinity Management Plan (TPSMP) was released. One of its key objectives is to encourage the more efficient use of land and water resources by concentrating production on less saline soils. This goal becomes more urgent when it is understood that irrigation water and low salinity soils are the region's two most important resources; misuse of either contribute to limiting agricultural production in the Plains (Tragowel Plains Sub-Regional Working Group, 1989).

OBJECTIVE

Our objective is to accurately map land cover across the Tragowel Plains to reveal the location and areal extent of irrigation water being applied. This, when combined with root zone soil salinity surveys, will reveal the degree to which the Management Plan's objective in transferring water from highly saline soils to soils with low root zone salinity is being met.

LAND COVER VERSUS LAND USE

Land use implies management of land for a particular purpose. A unit of land may be managed for irrigated annual pasture, summer cropping or swamps. Land cover refers only to the vegetation response of the land. The same land unit, described by a landholder as irrigated annual pasture, may in fact have a land cover of only 60% irrigated annual pasture and 40% exposed soil due to high root zone salinity. In a degraded environment, the term land use has obvious implications for overestimating land cover.

As our key interest in this paper is to map irrigated agriculture, we are therefore more interested in land cover.

SATELLITE IMAGE DATE SELECTION

It is the nature of irrigated agriculture that different land covers are active at different times of the year, according to their respective phenology. The development of a pasture and crop calendar enables comparison of the spectral responses of various land covers at different times of the year. This is particularly useful when selecting satellite image dates to maximise discrimination between the different agricultural vegetation types.

A pasture and crop calendar was developed for the Tragowel Plains, using the knowledge of local agronomists. In conjunction with rainfall records, the calendar was used to select two appropriate dates for land cover analysis, and also used to interpret the resulting vegetation responses in the imagery.

With its resolution, overpass frequency and spectral range, Landsat TM provided suitable imagery for this mapping project.

Typical mediterranean summer scenes usually provide a strong contrast between dryland and irrigated vegetation. Any summer active vegetation in the Tragowel Plains corresponds to either irrigated perennial pasture or summer cropping. A scene prior to the autumn break (rain event) would include both the irrigated perennial plus irrigated annual pastures and winter cropping as active vegetation. Areas or irrigated annual pastures or, less likely, emerging winter crops, can therefore be identified as the difference in areas of active vegetation between a scene immediately prior to an autumn break and in a mid-summer scene.

To ensure active vegetation was the result of irrigation and not rain, rainfall records were used to finalise the date of imagery.

LAND COVER CLASSIFICATION SCHEME

An hierarchical system of land cover classification has been designed for Tragowel Plains, based on the crop and pasture calendar. Land cover has been initially separated into four major classes, reflecting four distinct water use regimes.

IRRIGATED PERMANENT

This category includes land covers which receive water throughout the irrigation season. They include clover and rye grass pastures, lucerne that is active throughout the year, and some summer cropping that had an irrigated land cover the season before (e.g. irrigated annual pasture). This category receives the highest water application.

IRRIGATED ANNUAL

This category is dominated by the irrigated annual pastures which receive irrigation in Spring and Autumn only. These pastures are not active in the summer months.

NON-ACTIVE

This category is dominated by dryland pastures that are active through the winter rainfall months only. There are however several other significant classes in this category, including non-active irrigated agriculture which is generally the result of excessively saline soils, drainage lines and swamps that have never supported agriculture. Winter cropping, which relies predominantly on winter rainfall but is supplemented by irrigation in the late autumn and spring, also falls in this category. Winter cropping is the only land cover in this dry category that receives irrigation, however due to the timing of the imagery we were unable to distinguish it as an irrigated active crop.

SUMMER CROPPING

Summer cropping consists mainly of crops planted in early spring and harvested in late summer. These crops receive irrigation throughout the summer months. Some lucerne crops that were idle in late autumn and active in summer were included in this category. *(See Table 1)*

This classification structure presents us with a method for discriminating Major Category land covers based on the difference of the vegetation activity for each category between the May image in 1991 and the January image in 1992.

Once these Major Category land covers are classified, it is envisaged that separation of sub-category land covers will be a much simpler task as we are dealing with a much smaller range of potential covers.

One of the most commonly used algorithms for enhancing the activity of crops and pastures is the Normalised Difference Vegetation Index. As the feature of interest we wish to monitor is that of irrigated pastures and crops (active vegetation), the NDVI algorithm for Landsat TM data:

NDVI = [{(band4 - band3)/(band4 + band 3)} + 1] * 127

as provided by ERDAS image processing software, was used to produce images showing active vegetation for each of the two dates.

The two images were then registered to a map base and converted to the ARC/INFO raster based GIS format known as GRID. Once in GRID, the two images were processed using a series of conditional statements which classified each pixel based on the activity of the vegetation at the two dates. Table 2 illustrates the thresholds set for each major category in terms of vegetation response.

The result of processing, using the criteria outlined above, was a single raster grid that contained the four categories of land cover. The classified grid was then simplified using a smoothing filter, which enable the transfer of the grid from raster to vector format. Once stored as an ARC/INFO polygon coverage, areas less than one hectare in size were eliminated. A subsequent accuracy assessment of the classification was carried out using additional groundtruth data acquired from farmer survey.

RESULTS AND DISCUSSION

Interpretation of the classification reveals that the summer cropping and irrigated permanent categories have been classified into fairly distinct management units. In contrast, the irrigated annual category tends to be fairly patchy. This is an expected pattern as irrigated permanent and summer cropping activities tend to be carried out on good quality (low salinity) soils and as a consequence the entire paddock (management unit) will be active.

Irrigated annual pasture, however, tends to exist on poorer quality (higher salinity) soils and often their performance is restricted due to limited availability of water prior to the autumn break. Consequently, irrigated annual paddocks tend to be patchy at zones of salinity intolerance or saline drainage lines.

ACCURACY ASSESSMENT

An error matrix is presented in Table 3 which depicts the errors of omission (producer's accuracy) and commission (user's accuracy) (Congalton, 1991).

As can be seen, the classification of Major land cover categories, using selective multitemporal imagery and a series of rules, has proven to be highly accurate, at 94.6%.

Table 1: Hierarchical Land Cover Classification for Tragowel Plains and Expected Satellite Image Responses

Major Category	Sub-Category	May 1991 Pre-Autumn Break	January 199 Summer Scene
Irrigated Permanent	12 month active pasture	Active	Active
	Lucerne	Active	Active
	Pasture/Cropping	Active (as previous pasture)	Active (Summer Crop)
Irrigated - Annual	Sub clover - Pasture	Active	Idle
Non-Active	Non-Irrigated Annual	Idle	Idle
	Ineffective Irrigation	Idle	Idle
	Irrigated Winter Cropping	Idle	Idle
Summer Cropping	Crop	Idle	Active
	Lucerne	Idle	Active

Table 2: NDVI Thresholds for Major Category Land Cover Classes

	13 May 1991		24 January 1992	
Major Category	Response	Threshold	Response	Threshold
Irrigated Permanent	Active	> 150	Active	> 190
Irrigated Annual	Active	> 170	Idle	< 190
Non-Active	Idle	< 170	Idle	< 180
Summer Cropping	Idle	< 150	Active	> 180

The errors that have occurred are associated either with sketchy ground truth data or, in the case of irrigated annual pastures, occur at the fringe of the category. (*See Table 3*)

CLASSIFICATION REFINEMENT

The next step in refinement of this product is to classify out sub-category land covers (refer Table 1). This will enable accurate assessments of water application and productivity to be carried out over the region.

The proposed methodology is to look at each sub-category land cover and assess the appropriate information required to separate that land cover from others within that major category. For example, use of the TM thermal band may help us separate out the recently fallowed and watered winter cropping from other dryland land covers. This information will be incorporated in the GRID environment using the macro language of grid to further develop the initial NDVI rule base outlined in this paper (Table 2).

APPLICATIONS OF LAND COVER MAPPING

A highly accurate final landcover map will provide us with a base from which to repeat the procedure in the future. In years when weather or image quality are less favourable, this classification can be incorporated into future classifications and used to assess reasonable and unreasonable changes in the classification over time.

Accurate land cover mapping is required for ongoing regional salinity and irrigation management. For example, major objectives of the TPSMP include the allocation of production inputs, including irrigation water, away from saline and onto less saline soils, and increased irrigation efficiency.

Land cover monitoring using the methods outlined here, combined with modelling of crop water use, could be used to predict regional irrigation water requirements and provide a measure of success of the plan in achieving these objectives.

CONCLUSION

With a knowledge of the crop and pasture phenology of Tragowel Plains, and rainfall event, two Landsat TM images were selected and analysed for vegetation response using Normalised Difference Vegetation Index. The subsequent registration and gridding of the two images enabled a series of conditional statements to be applied which classified each pixel based on the activity of the vegetation at the two dates, resulting in a single raster grid. From this grid, an accurate map was produced which identified four major categories of land cover: Irrigated Permanent, Irrigated Annual, Summer Crops and Non-Active.

The first three major categories enable us to clearly identify the productive areas receiving irrigation water, and the period of irrigation. Land in the fourth category may or may not be irrigated because even with irrigation, highly saline land will not produce active vegetation.

Acknowledgements

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Tragowel Plains Sub-Regional Working Group (1989). Tragowel Plains Salinity Management Plan - Draft report.

Note: Reproduced from proceedings of 7th Australian Remote Sensing Conference.

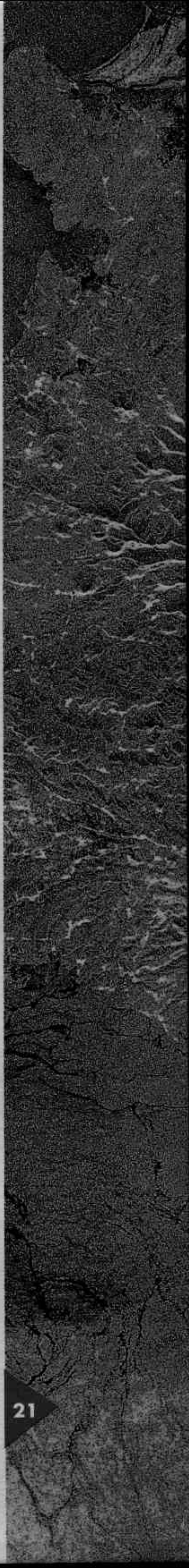
Table 3: Error Matrix for Classification of Major Category Land Covers in Tragowel Plains (refer Table 1)

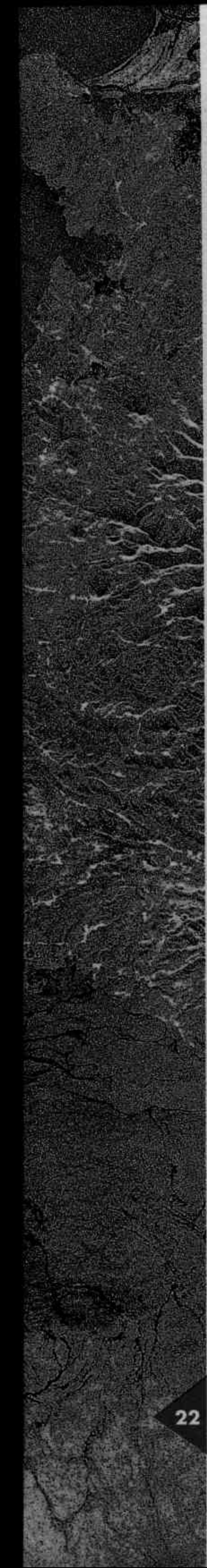
Land Cover Class

Satellite Cover Class	Error Matrix	Irrigated Permanent	Irrigated Annual	Dryland	Summer Cropping	Total
	Irrigated	21	0	0	0	21
	Irrigated Annual	1	31	0	0	32
	Dryland	0	3	57	0	60
	Summer Cropping	2	0	1	13	16
	Total	24	34	58	13	129

Overall Accuracy = 94.574

Producer's Accuracy	(%)	User's Accuracy	(%)
Irrigated Permanent	87.500	Irrigated Permanent	100.000
Irrigated Annual	91.176	Irrigated Annual	96.875
Dryland	98.276	Dryland	95.000
Summer Cropping	100.000	Summer Cropping	81.250





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