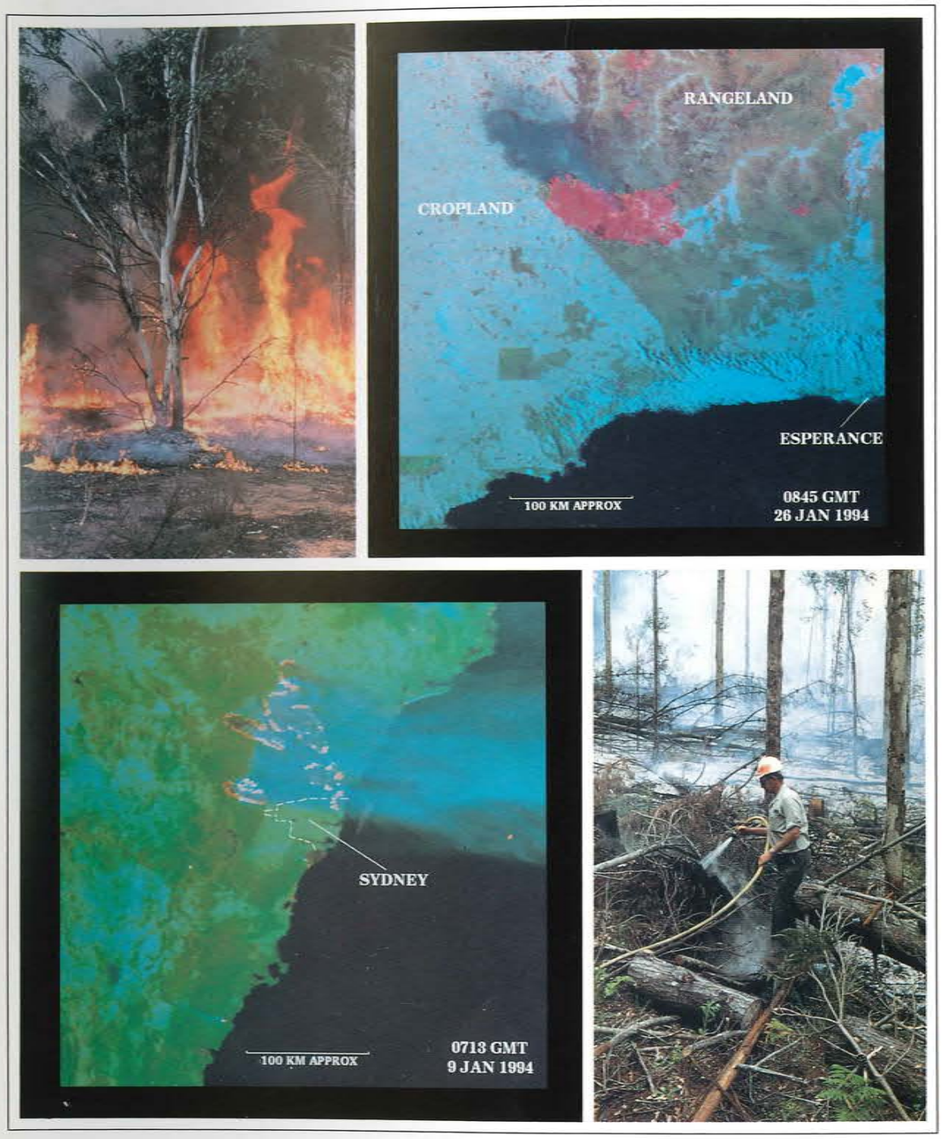
WASTAC

Western Australian Satellite Technology and Applications Consortium

ANNUAL REPORT 1993



WASTAC members

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Front Cover:

The top right NOAA satellite image, taken on 26th January 1994, vividly depicts the extent of bushfires sweeping through remote rangeland country in the south western corner of Western Australia. The extensive fire scar is depicted in red with associated smoke and haze in black to the north western edge of the image.

The destructive bushfires around Sydney were monitored using WASTAC NOAA/AVHRR data dated 9th January, 1994. The extent of the burnt areas is seen in red on the bottom image. Smoke associated with the fires and depicted in blue is being blown offshore by westerly winds.

NOAA data is used widely by State Agencies for the effective efficient management and monitoring of bushfires in Western Australia.

Satellite Images: *Remote Sensing Applications Centre*
Leeuwin Centre, Floreat

Slides: *Lachlan McCaw*
Department of CALM, Manjimup

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM

ANNUAL REPORT 1993

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CONTENTS

WASTAC CHAIRMAN'S REPORT - 1993

WASTAC activities have continued to focus on maintaining a reliable and accessible archive of NOAA/AVHRR satellite data for consortium members of operational, research and application purposes.

The daily real time acquisition of these data provides a continuous service to the Bureau of Meteorology for regional and national weather forecasting particularly covering the Indian and Southern Oceans. Additionally, major on-going support for this State for key applications in monitoring sea surface temperatures and vegetation changes over Western Australia for pastoral assessment, bush fire risk assessment and drought evaluation was provided.

To improve these services the WASTAC Board has investigated options for upgrading existing communications facilities for the supply of data on-line to the Leeuwin Centre at Floreat Park. Detailed studies to integrate with the Australian Academic Network (AARNET) and the proposed Perth Academic Network (PARNET) are also continuing.

In addition to consolidating archived NOAA data from 1981, WASTAC has investigated access to an application of future polar orbiting earth observation satellites. An application has been made to receive and archive SeaWiFS ocean colour data as a "NASA Research Direct Readout Ground Station" to support this objective.

A review of the WASTAC Deed of Agreement has commenced to assess future requirements for NOAA data reception given that the current agreement has been in effect for five years.

As in past years the success of the Consortium relies mainly on the willing co-operation of WASTAC participants. 1993 was no exception. I wish again to acknowledge the effort of key individuals in maintaining an efficient and professional service to all users of this important facility.

H J HOUGHTON

WASTAC BOARD FOR 1993

MR HENRY HOUGHTON	(Chairman), Department of Land Administration
MR RICHARD STOVOLD	(Secretary), Department of Land Administration
ASSOC. PROF. MERV LYNCH	Curtin University of Technology
DR DOUG MYERS	Curtin University of Technology
DR RICHARD SMITH	CSIRO
MR ALAN PEARCE	CSIRO
MR LEN BROADBRIDGE	Bureau of Meteorology
MR DON WARD	Bureau of Meteorology

OPERATIONAL STATUS

WASTAC facilities consist of antenna and antenna controller at Curtin University of Technology, ingest and display computers with hard disk storage located at the Bureau of Meteorology, West Perth. A microwave and dial up link exists between the two sites to facilitate realtime satellite data relay and acquisition scheduling.

Colour as well as black and white grey scale images are produced at 180dpi by a HP Paintjet inkjet printer and these are passed to DOLA(Remote Sensing Applications Centre) for archive, indexing and distribution. The AVHRR raw data archive is produced on 8mm cartridge tape and a special duplicate archive is copied to the CSIRO Office of Space Science and Applications (COSSA) for the Global 1km AVHRR Land Data Project.

The AVHRR ingest and display system is modelled on the Bureau of Meteorology's facilities at Casey in Antarctica and Darwin and consists of two IBM PS/2 model 80 personal computers.

One PS/2 is dedicated to automated data ingest and the other to providing processing and display facilities. The Bureau's MCIDAS software provides for display and post processing.

The TOVS data,a subset of AVHRR, is automatically sent to Melbourne so that atmospheric temperature retrievals can be included in the global numerical weather prediction models. SST's(sea surface temperatures) will also be generated from WASTAC data as well as NDVI(normalised vegetation indices).

Equipment failures resulted in the loss of 16 days of data during the year.

However, due to the dedicated efforts of Ron Craig and Bureau of Meteorology personnel, over 3559 passes were recorded for the year.

DOLA is currently holding all recent WASTAC archived data on 8mm tapes.

Orders for digital data are provided on 8mm or 6250/1600 bpi magnetic tape in raw or SHARP format.

Don Ward
Regional Computing Manager
Bureau of Meteorology, Perth

WASTAC DATA ARCHIVE

WASTAC has successfully run the satellite receiving station in Perth since 1988, using a consortium arrangement to combine expertise of various members. Through this unique co-operative effort, the facility has progressively been upgraded to provide reliable coverage of the eastern Indian Ocean region and the western half of the Australian Continent.

The maintenance of the active archive of all data is the responsibility of the Department of Land Administration through its Remote Sensing Applications Centre. This task is assisted by the Bureau of Meteorology and Curtin University who maintain and run the host computers and data receiving satellite equipment respectively.

In May of this year the Leeuwin Centre for Earth Sensing Technologies was completed. This facility was established with the aim of collocating companies and organisations in the remote sensing and earth observation industries. The full archive of WASTAC data was carefully relocated at the Remote Sensing Application Centre's new premises within the Leeuwin Centre.

During 1993 a total of 3559 passes were copied to 128 8mm tapes. Of these passes the majority were NOAA 11 and NOAA 12 passes (refer to page 5).

A further major commitment of the group was the continuation of the data copying programme. The older NOAA passes stored on magnetic tape from the Curtin University archive have been progressively copied to 8mm tape. To the end of 1993, 792 passes have been copied as summarised in the following tables.

Since February the Bureau of Meteorology has provided WASTAC with daily black and white afternoon GMS satellite prints to enhance the current quicklook archive. HP inkjet quicklook prints for every archived NOAA pass continue to be collected.

T Bus orbital element information, dating from 1981, is held by RSAC to assist researchers in data manipulation.

RSAC continues the archive management, distribution of data applications development, provision of computing facilities and analysis support for state government, industry and client groups.

There has been a strong use of data this year supporting major programmes:-

- CSIRO Division of Oceanography
- Vegetation Watch Project - CSIRO/DOLA
- Bush Fire Monitoring/Curing Index for Bush Fires Board and CALM
- Curtin University School of Physical Sciences and Surveying and Land Information group.
- Private client groups including fishing industry, S.A. Department of Mines and Energy, NRMA Sydney and Department of Transport's Marine Division.

1993 NOAA DATA HELD BY WASTAC

	NOAA 9	NOAA 11	NOAA 12	TOTAL
JAN		130	134	264
FEB		121	116	237
MAR		142	150	292
APR		132	136	268
MAY		125	122	247
JUN		150	150	300
JUL		147	156	303
AUG		145	153	298
SEPT		134	139	273
OCT		147	158	305
NOV	77	142	150	369
DEC	106	141	156	403
TOTAL	**183**	**1656**	**1720**	**3559**

8mm Tapes: 3559 passes on 128 tapes.

Total Data Received: 202 gigabytes.

ISY Data: 25 exabyte tapes containing 728 NOAA 11 Day Time Passes, (sent to CSIRO, Canberra)

Curtin Archive Copied to 8mm Tapes - 1993

1983	NOAA 6	NOAA 7	NOAA 8	TOTAL
NOV		22	5	27
DEC		16	1	17
	10	**236**	**12**	**258**

Totals include data copied during 1992 - see 1992 WASTAC Annual Report.

1984	NOAA 6	NOAA 7	NOAA 8	TOTAL
JAN		15	1	16
FEB		21	2	23
MAR		15	1	16
APR		9		9
MAY		8		8
JUN		14		14
JUL		11		11
AUG		10		10
SEPT		9		9
OCT	5	24		29
NOV		18		18
DEC	2	20		22
TOTAL	**7**	**174**	**4**	**185**

1985	NOAA 6	NOAA 7	NOAA 8	NOAA 9	TOTAL
JAN		10		7	17
FEB	3	6		18	27
MAR	2	16		24	42
APR				17	17
MAY				21	21
JUN				16	16
JUL			1	23	24
AUG			2	17	19
SEPT	2			20	22
OCT			1	18	19
NOV				4	4
DEC					
TOTAL	**7**	**32**	**4**	**185**	**228**

Total passes copied to 31 December 1993

NOAA 6	29
NOAA 7	557
NOAA 8	21
NOAA 9	185
TOTAL	**792**

Copied onto 45 8mm tapes

Highlights for 1993:

RESEARCH PROGRAMMES AND DATA APPLICATIONS:

CSIRO DIVISION OF OCEANOGRAPHY

Alan Pearce

Satellite Remote Sensing of the Leeuwin Current

Routine processing of AVHRR imagery for the south-eastern Indian Ocean and Western Australian continental shelf has now provided weekly images (cloud permitting) between 1988 and 1994. Increasing emphasis is being placed on the extraction and application of quantitative information from NOAA-AVHRR imagery, two important aspects of which are:

(a) **Analysis of digital sea-surface temperature (SST) transects**

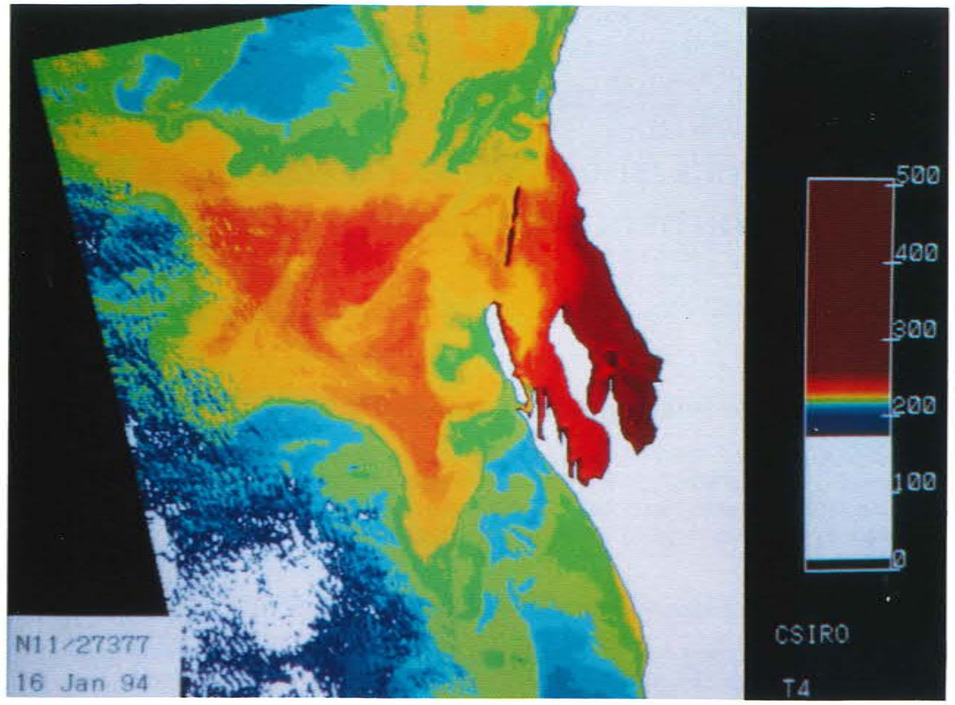
SST transects across the continental shelf along the Western Australian coast are being analysed to provide a "climatology" of temperature variability at selected sites where commercially important fisheries are located. AVHRR images of Shark Bay (26^{o}S), for example, reveal intrusions of Leeuwin Current water into the Bay in both summer and winter (Figure 1a, b), and the local circulation arising from these intrusions may play a major role in the dispersion and settlement of scallop larvae in the Bay. Transects from monthly AVHRR images across the Leeuwin Current and into Shark Bay clearly show both the expected seasonal SST cycle and a seasonally-reversing cross-shelf temperature gradient (Figure 2a, b). It is hoped that analysis of the transect data may assist in quantifying the strength of the circulation.

(b) **Validation of satellite-derived SSTs**

Initial comparisons of AVHRR-SSTs against *in situ* temperature measurements off Rottnest Island (32^{o}S) indicated that the RMS error of the satellite-derived values was about 0.6^{o}C; more recent spot checks have, however, suggested that on occasion the discrepancies may in fact be much greater. We have therefore commenced a program to extract SST data from AVHRR images on a routine basis for comparison with conventional oceanographic measurements such as expendable bathy-thermographs (XBTs), boat measurements and self-recording temperature loggers. While most of these *in situ* measurements are themselves relatively crude and certainly fail to sample the thin surface skin seen by the AVHRR thermal channels, the project will give an indication of the general reliability of the satellite-derived temperatures in terms of the "bulk" layer temperatures which are relevant to fisheries and oceanic heat flux processes.

Acknowledgements

Routine image processing is borne by Angela Way and Carol Bowron; Mike Bezaud is involved in numerical data extraction and the development of cloud screening methods, and Chris Burton has undertaken most of the analysis of the Shark Bay imagery. This research is being supported by the Western Australian Fisheries Research and Development Trust Account. Collaborators include the WA Fisheries Department, Curtin University, Department of Land Administration, Centre for Water Research (University of Western Australia) and the WA Environmental Protection Authority. Data supplied by WASTAC.



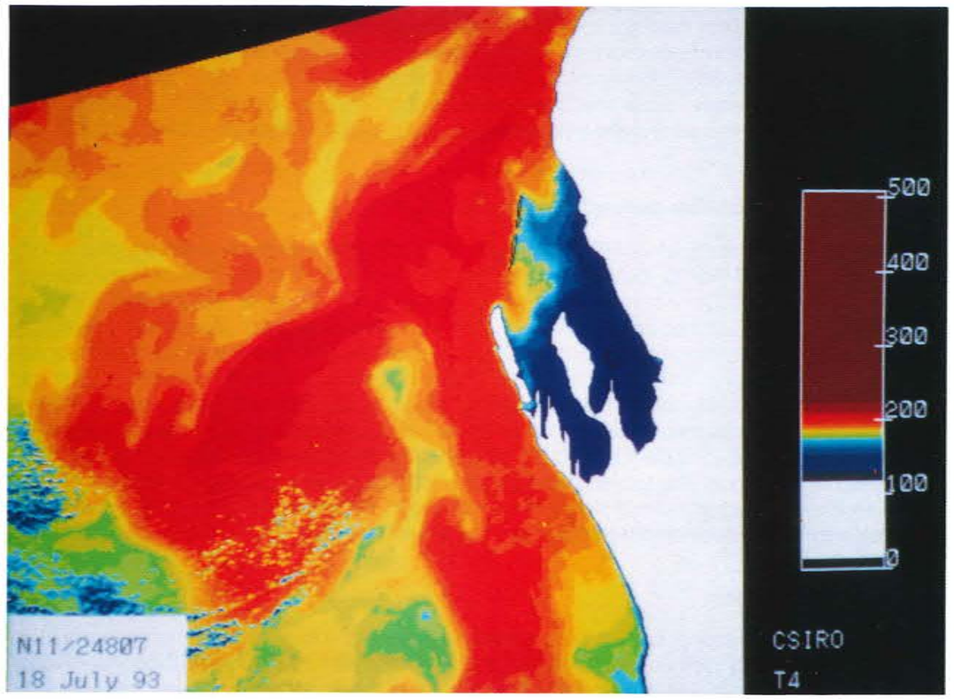
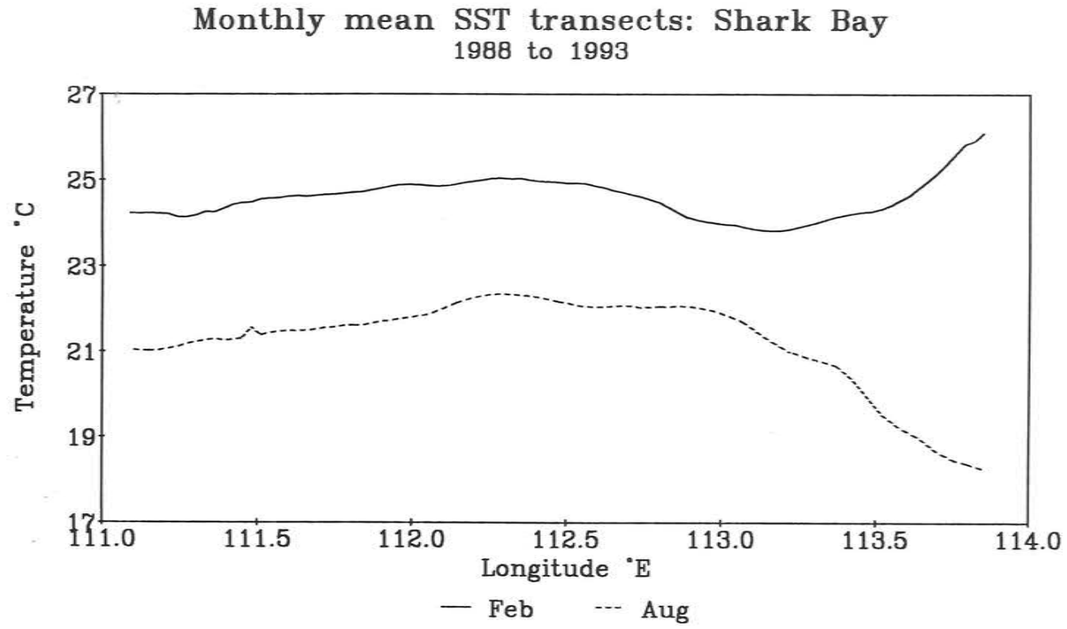


Figure 1: NOAA-AVHRR images of Shark Bay and the adjacent continental shelf area in (a) summer and (b) winter. Warmest water is depicted in brown/red, grading through yellow and green to the coolest water in blue. Note the warm water in the Bay in summer and cold in winter, and the strengthening of the Leeuwin Current offshore between summer and winter.



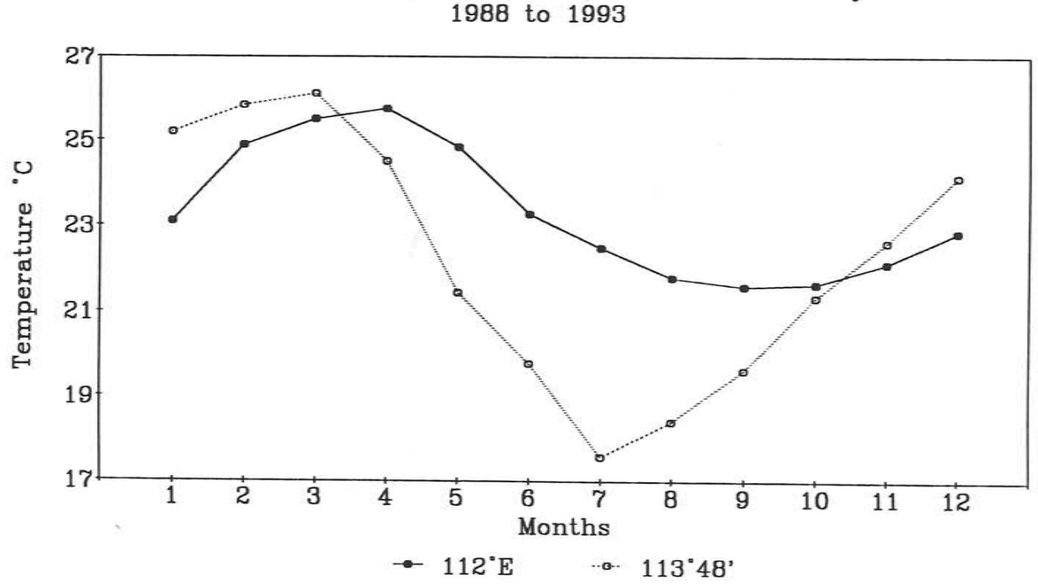
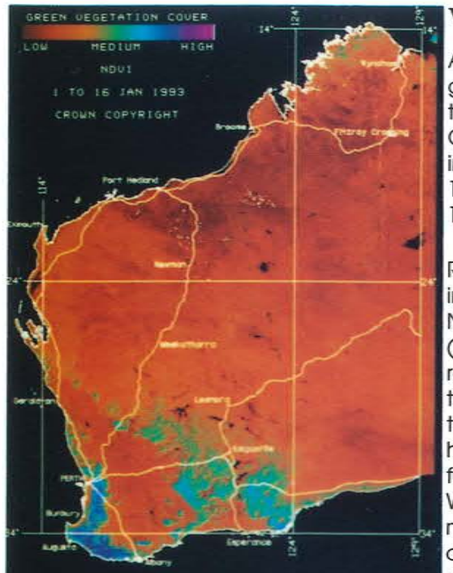


Figure 2: (a) Monthly mean sea-surface temperature transects across the Leeuwin Current off Shark Bay for February and August, over the 6-year period 1988 to 1993; (b) annual temperature cycles in the Leeuwin Current (solid line, filled circles) and in the shallow eastern region of the Bay (dotted line, open circles), averaged over years 1988-1993.

CSIRO DIVISION OF EXPLORATION GEOSCIENCE

Dr Richard Smith

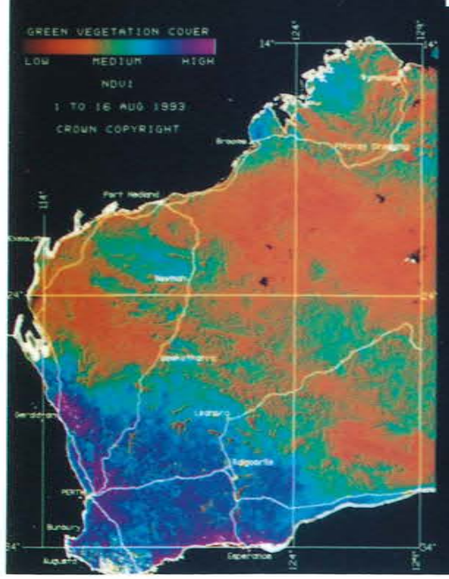
Vegetation Watch

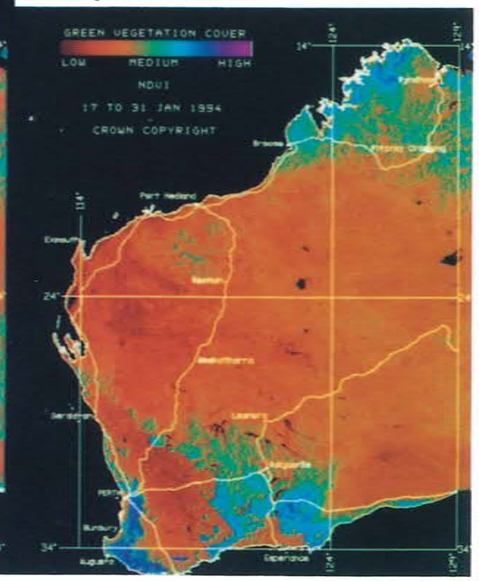


VEGETATION WATCH *1993*

A record of the 1993 season for vegetation growth across the State is given by these three NDVI images of Western Australia. Comparison with previous seasons indicated that for most of the State the 1993 season was significantly better than in 1991 and 1992.

Routine processing of NOAA-AVHRR data into bimonthly composites of the Normalised Difference Vegetation Index (NDVI) was continued throughout 1993. The resultant NDVI was distributed digitally to the WA Department of Agriculture through the WALIS network and to others as hardcopy images. The NDVI data was further processed by Dr Shane Cridland, WADA for use by the Pastoral Board to monitor leases and for use by pastoralists and Regional Officers to assist short term stocking rate decisions.

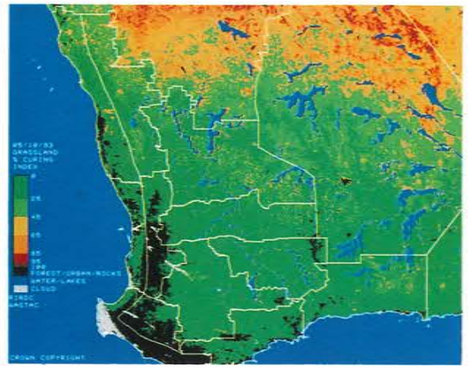


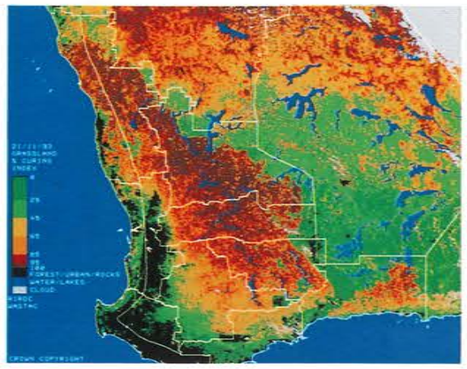


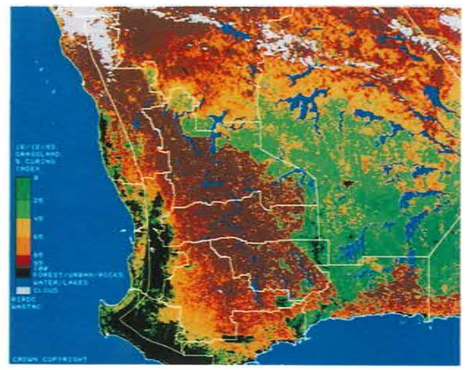
CURING INDEX introduced in 1993

Curing Index: This set of three images portrays the progressive curing of the grass and croplands during the spring of 1993. This index calculated from the NDVI is used by the Bush Fires Board to forecast the flammability of grass and croplands.

This Curing Index will be produced by the VEGETATION WATCH project between October and December each year for the Bush Fires Board to improve the accuracy of their forecasts of FIRE RISK. The accuracy of these forecasts can have a big impact in agricultural areas where total fire bans can be imposed restricting all on-farm activities during the critical harvest period.







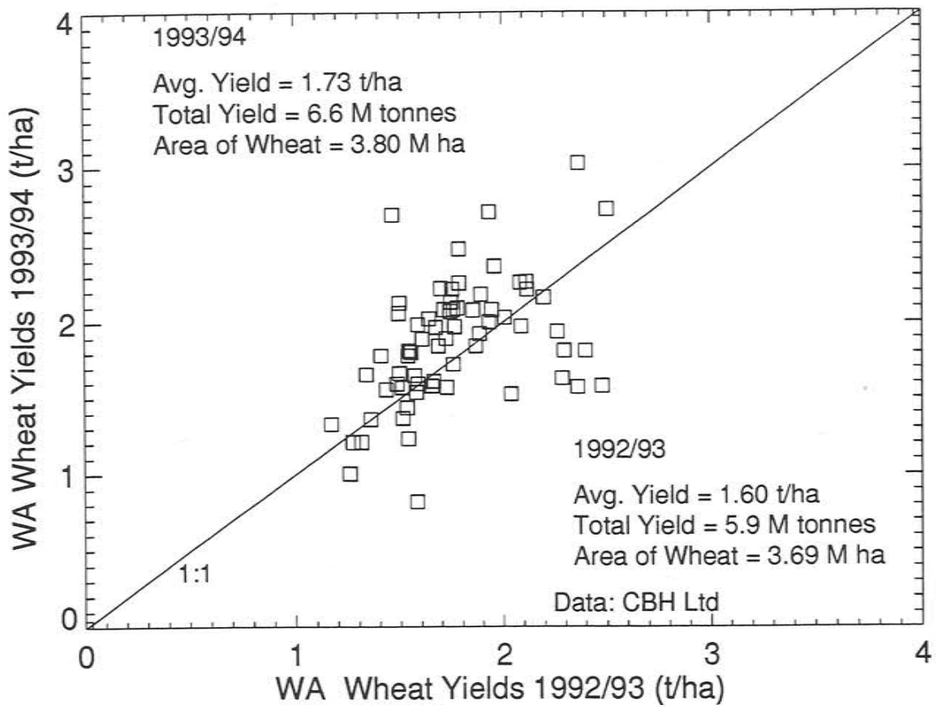


Fig. 1 A comparison of wheat yields between 1992/93 and 1993/94 from the 68 Shires in the Western Australian cropping zone.

Symbols above the 1:1 line are the Shires with higher yields in 1993/94 than in 1992/93.

SEASONAL CHANGE ANALYSIS *introduced in 1993*

For interpretation of the NDVI images, a change analysis product was developed for comparison of the current values of NDVI with those 1, 12 and 24 months ago. An example of this product is given in the image for August 1993 for the 12 month comparison.

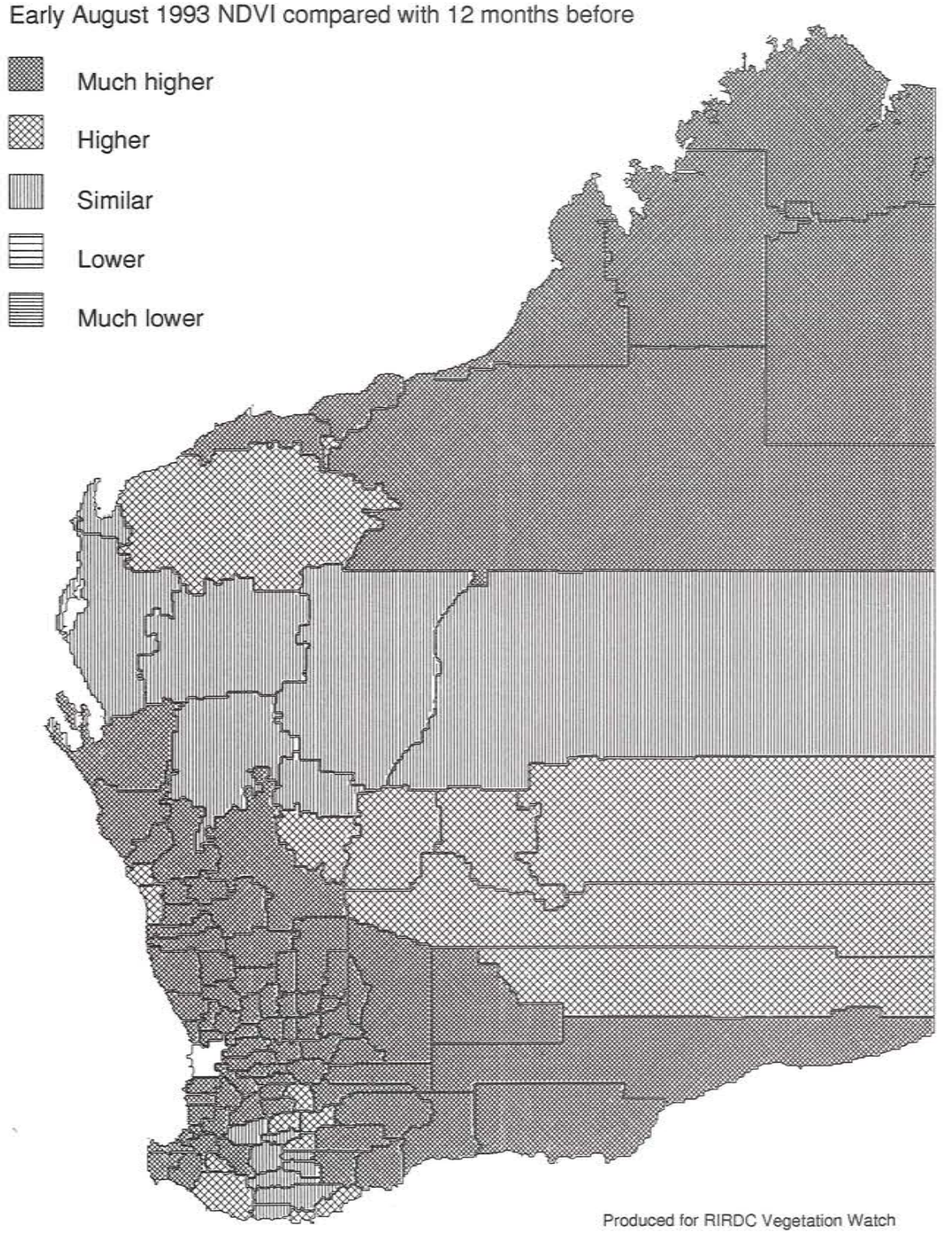
These data were of use to the Bush Fires Board in indicating the high fuel loads and hence the fire danger to be expected in many areas of the State. These data were also of value to the Pastoral Industry indicating the extent of the run of improving seasons and the opportunities this offered to increase stocking rates and hence increase output.

The change analysis for Agricultural areas indicates a generally better season in August 1993 than August 1992. This was a result of better opening rains in May 1993 than May 1992. This effect was in some degree reflected by higher wheat yields in 1993/94 compared with 1992/93 (Figure 1). However the higher yields did not occur in all areas indicating that other aspects of the distribution of rainfall affected final wheat yields.

VEGETATION WATCH

Change in Green Vegetation Cover of LGA's

Early August 1993 NDVI compared with 12 months before



Produced for RIRDC Vegetation Watch
by Remote Sensing Applications Centre,
Department of Land Administration
from NOAA-AVHRR satellite data supplied courtesy
of WASTAC

FORECASTING OF WHEAT and WOOL YIELDS under development

To further enhance the information of the NDVI products, relationships are being developed to forecast wheat yields from the early season increase in NDVI based on significant correlations between early season NDVI and yield (see WASTAC 1992 annual report). These forecasts will be of significant value to agricultural areas in improving the handling and marketing of the annual wheat crop.

Relationships are also being developed between wool cut/head and wool cut/ha for forecasting the production of this commodity. A preliminary study relating the mean NDVI for 1991 and wool yields, 6 months later from 1991/92, indicates that wool cut/head (Figure 2) is closely related to the NDVI in pastoral areas whereas in agricultural areas it is generally unrelated. However the wool cut/ha (Figure 3) while poorly related to the NDVI in pastoral areas is strongly related to the NDVI in agricultural areas.

The difference in the relationship between the pastoral and agricultural areas indicates the effect of the introduction of mediterranean annual legumes and superphosphate fertilisers with trace elements on both the quantity and quality of the pasture grown. This is reflected in both a higher number of sheep/ha carried and wool cut/head. The generally uniform wool cut/head in agricultural areas indicates that quality of feed is not generally limiting in these areas.

However, in pastoral areas where the sheep are dependent on native species, the much lower wool cut/ha and wool cut/head indicates that both the quantity and quality of feed are limiting production. In these pastoral areas forecasts of seasonal pasture growth and resultant carrying capacity from the VEGETATION WATCH information could assist in setting stocking rates to better match the feed supply.

Fig. 2 Wool cut/head (1991/92) and NDVI (1991) in W Australia

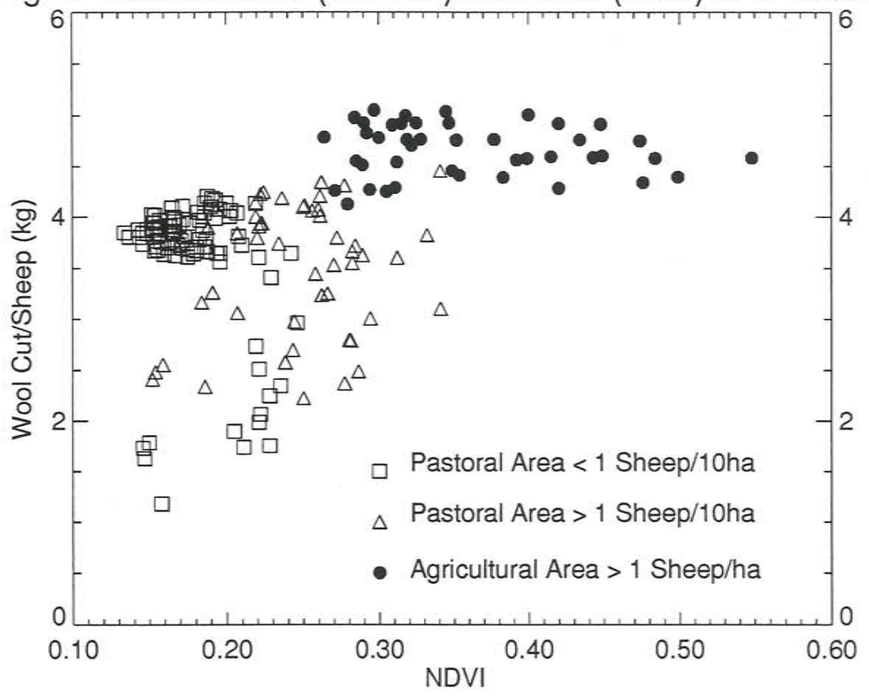
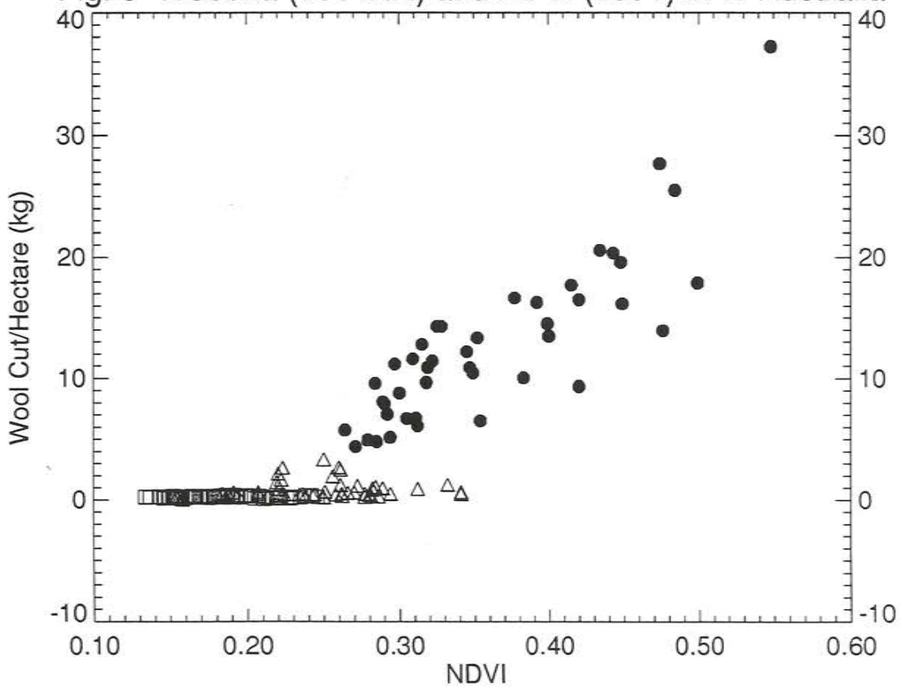


Fig. 3 Wool/ha (1991/92) and NDVI (1991) in W Australia



LAND CLEARING AND DECLINE IN RAINFALL

Studies were continued in 1993 using aircraft and NOAA-AVHRR on the impact of clearing native vegetation and replacement by agriculture on land surface albedo. This work was done in collaboration with Murdoch and Flinders Universities who have used the data to model the impact of increased albedo from land clearing on mesoscale convection and the evolution of the planetary boundary layer. A decrease in mesoscale convection following land clearing provides a mechanism to explain the 20% decline in rainfall in agricultural areas in south-western Australia over the last 30 years.

Acknowledgements

Major financial support has been received from the Rural Industries Research and Development Corporation and minor financial support from the Land and Water Resources Research and Development Corporation, Grains Research and Development Corporation and Australian Research Council.

All the NOAA-AVHRR satellite data has been supplied by WASTAC.

DEPARTMENT OF LAND ADMINISTRATION

Richard Stovold, Research Officer, RSAC

Remote Sensing Applications Centre

The Remote Sensing Applications Centre, a State Government centre within the Department of Land Administration, provides facilities for the acquisition, processing and analysis of digital data. RSAC maintains an extensive and expanding archive of satellite data and photographic products and has access to a wide range of local and international data archives. This source of land and ocean information enables the group to collaboratively develop applications in earth sensing for public and state good and promote industry development, technology transfer and assist education programmes.

Major applications utilising WASTAC archived data during 1993 include:

VEGETATION WATCH PROJECT

In collaboration with the CSIRO, this three year funded RIRDC project provides vegetation information to the Department of Conservation and Land Management and the Bush Fires Board allowing them to more effectively deploy resources to combat the significant bush fire risks in the State. Other main uses include monitoring of drought affected pastoral lands for the W.A. Department of Agriculture and provision of curing rates of grasslands in the agricultural region.

CLOUD DETECTION

In a collaborative project with Monash and Australian National Universities, WASTAC data has been used to detect the presence and formation of solitary cloud waves in the Gulf of Carpentaria in far Northern Australia. Utilising bands 1 and 2 of the NOAA/AVHRR satellite, the interacting cloud lines were visible on geometrically corrected imagery. This assisted the groups in the scientific analysis of the generation and evolution of these phenomena thereby supporting regional and national weather forecasting programmes.

BUSH FIRE DETECTION

RSAC continues to provide a regular and reliable service of fire detection to the Bush Fires Board and Conservation and Land Management Department. These images as depicted on the front cover have assisted in the tracking of fire fronts and associated smoke pollution as well as for mapping fire affected areas. The computerised client specified products presently being generated are assisting resource managers in Western Australia to better manage their natural resources for the public good.

COASTAL WATER STUDIES

A series of passes from the WASTAC archive have been used in the study of the ocean dynamics in and around the Perth coastal waters. This data is supporting the development of models to better understand the movement of the currents and relative sea surface temperatures. Benefits of this research, being undertaken by the Environmental Protection Agency, Western Australian Water Authority, Centre for Water Research at the University of Western Australia, Fisheries Department and CSIRO Division of Oceanography, include the improved commercial uses of the ocean's natural resources.

MANAGEMENT OF DATA ARCHIVE

The group within RSAC continues to maintain the oldest and most reliable archive of NOAA/AVHRR satellite data and provide a sales outlet for commercial and research use.

WASTAC has played a key role in the supply of daily AVHRR data to the Global 1 km Land Data Project. In collaboration with the CSIRO Office of Space Science and Applications in Canberra, US National Oceanic and Atmospheric Administration, US Geological Service, NASA and the European Space Agency, the first global vegetation condition view of the earth has been produced for mid 1992. The supply of WASTAC data is providing a quantitative data base over time of the condition of the earth's surface, in support of global change studies such as the International Geosphere Biosphere Programme.

TECHNICAL AND INFRASTRUCTURE SUPPORT

RSAC provides major computing resources and office infrastructure for the ongoing development of satellite applications and has contributed to the technical subcommittee investigating the upgrade of the existing WASTAC communications facilities. This upgrade will supply data directly to RSAC within the Leeuwin Centre in real time for use by all consortium members. Detailed investigations to integrate all groups within the Leeuwin Centre to the Australian Academic Research Network (AARNET) and the proposed Perth Academic Network (PARNET) are being pursued.

The corporate objectives of RSAC to provide resource information through the acquisition, analysis and application of remotely sensed data continue to be actively pursued.

The support of other consortium members and in particular the dedicated staff at RSAC is acknowledged.

CURTIN UNIVERSITY OF TECHNOLOGY

Assoc. Prof. Merv Lynch

Remote Sensing and Satellite Research Group

In 1993 there were a total of 29 people researching topics in quantitative remote sensing, image processing and process and systems modelling. The bulk of the participants were students enrolled in courses at Curtin (6 PhD candidates, 5 MSc candidates, 3 Graduate Diploma students, 3 Honours students and 4 undergraduate students).

The broad theme of the research continues to be monitoring and managing the environment and accordingly embraces topics including the land surface, the vegetation cover, oceanography, the coastal zone and the atmosphere. It continues to be the case that some of the more interesting opportunities to use remote sensing products are inhibited by the quality of the products themselves. Such matters as the satisfactory quantification of errors in derived products, algorithm refinement, the difficulty in accessing high quality quasi-operational validation data remain areas for attention. These problems need to be solved before products can be used with confidence in areas such as process studies and system interaction modelling.

1993 was significant in that Curtin committed to membership of the Leeuwin Centre for Earth Sensing Technologies and took up occupancy of an 80 square metre research laboratory in the Centre. This achievement was due in large part to the encouragement and support of Professor J R deLaeter and the University Research and Development Office. In late 1993 the Vice-Chancellor, Professor J Maloney, provided support through his Reserve fund to support the acquisition of computing equipment for the Laboratory at the Leeuwin Centre.

In terms of new ventures, Curtin has committed to lead a major initiative using data from the NASA/Orbital Sciences Corporation SeaWiFS satellite scheduled for launch in 1994. WASTAC has been approved as a reception site for taking down the daily imagery. This project is based at the Leeuwin Centre.

The enthusiasm and effort contributed by students continues to be the significant element in the Group. Special appreciation must be acknowledged to Assoc. Prof Brian White, School of Mathematics and Statistics for his continued contribution on mathematical rigour, and to Research Assistants Dave Foster and Hugh Lynch for the many software support and laboratory management tasks they undertook during 1993.

1993 Research Projects

Coastal Zone Research with SeaWiFS Satellite Data

Associate Professor M J Lynch, Mr J Davies#@, Mr P Fearns+@, Mr D Foster, Mr H Lynch, Mr A Pearce* and Dr J Parslow++

SeaWiFS has been rescheduled for launch in July, 1994. WASTAC has been approved by NASA as a data reception centre for SeaWiFS. A research project, with Assoc. Prof M J Lynch as principal investigator, has been approved by NASA which will enable Curtin and WASTAC to apply SeaWiFS data to the Australian coastal zone. Curtin is presently putting in place software to ensure that SeaWiFS raw data collected by WASTAC will be converted into coastal zone products. With some 90% of the radiometric signal received by a satellite sensor arising from the atmosphere and just 10% from the ocean, the correction for atmospheric effects is being researched. Corrections will need to be precise if coastal zone products are to be estimated to the design goal of 5% accuracy.

This continuing project is supported by:

Digital Equipment Corporation provided a MSc scholarship and a DEC 5000/25 workstation. Oceanroutes (Aust) Pty Ltd is providing funding for field campaigns and is supplementing graduate scholarships for J Davies and P Fearns. NASA is providing software support for data processing and coastal zone product generation. Direct readout satellite data will be made available courtesy of WASTAC.

* CSIRO Division of Oceanography

\# Recipient of an APRA PhD Scholarship

++ CSIRO Division of Fisheries, Hobart

\+ Recipient of a Digital Equipment Corporation MSc Scholarship

@ Scholarship supplementation by Oceanroutes(Aust) Pty Ltd

Land Surface Temperature Estimation from Satellite Data

Assoc. Prof M J Lynch, Mr C Rustana++, Dr A J Prata#, Dr N Campbell*, Dr I Foster+

Algorithms for the retrieval of land surface temperature (LST) depend on correctly accounting for the effects of atmospheric moisture and surface emissivity. This project has modelled regional and seasonal effects on LST estimation from satellite data and derived retrieval algorithm coefficients using atmospheric transmittances calculated from climatological atmospheres using LOWTRAN7 atmospheric transmittance code. Algorithm validation, using data sets from a CSIRO instrumented field site at Walpeup, Victoria and from field stations operated by the WA Department of Agriculture (WADA), has been completed.

This continuing project is supported by:

A PhD Fellowship from AIDAB. NOAA satellite data sets provided by WASTAC. Field data from the Walpeup Research Station provided by CSIRO DAR. WA field station data provided by the WADA.

\# CSIRO Division of Atmospheric Research (DAR), Melbourne

* CSIRO Division of Mathematics and Statistics (DMS), Perth

\+ WA Department of Agriculture (WADA)

++ Recipient of an AIDAB PhD Fellowship

Corrections to the Normalised Difference Vegetation Index (NDVI) Derived from NOAA/AVHRR Satellite Data

Assoc. Prof M J Lynch, Mr T Weerasekera*, Dr R G C Smith#

Atmospheric scattering due to the molecular atmosphere and aerosols, absorption due to atmospheric water vapour, and the angular dependence of surface bi-directional reflectance can cause NDVIs determined from remotely sensed data to be significantly in error.

Present research has drawn upon radiative transfer theory to develop and implement procedures for applying corrections for the molecular atmosphere, aerosols, and atmospheric moisture. Improvements to algorithms for deriving land and vegetation reflectances and ultimately NDVI are continuing.

This continuing project is supported by:

PhD Fellowship from AIDAB. WASTAC is acknowledged for the provision of NOAA/AVHRR satellite data sets

\# CSIRO Division of Exploration and Mining, Perth

* Recipient of an AIDAB PhD Fellowship

Estimation of Atmospheric Aerosols Optical Depth Over Oceanic Regions Using NOAA/AVHRR Satellite Data

Assoc. Prof M J Lynch, Ms J Marsden#, Dr R Mitchell*, Dr B Forgan+, Mr G Kirkpatrick@

Unless accounted for correctly, the variability in concentration and physical properties of atmospheric aerosols (on daily and seasonal scales) contributes a source of error to satellite products derived using visible channel sensor data. We are applying radiative transfer methods to develop improved algorithms for estimating aerosol optical depths. These algorithms are best tested over the oceans because this avoids the large and variable contribution from land surface reflectance. For this research we are comparing the aerosol optical depths derived from NOAA satellite data to ground-based solar photometer measurements taken at the Cape Grim Baseline Air Pollution Station, Tasmania. There is considerable practical interest in aerosols over the ocean because of their impact on maritime visibility.

This continuing project is supported by:

WASTAC who we acknowledge for the provision of NOAA/AVHRR satellite data sets; and Dr B Forgan for the provision of solar photometer data sets for use in validation studies.

* CSIRO Division of Atmospheric Research, Melbourne.

\+ Bureau of Meteorology Research Centre, Melbourne

\# PhD Student

@ undergraduate student

Remote Sensing Applied to the Mineral Industry

Assoc. Prof M J Lynch, Mr R Clifton#, Dr A Gabell*

The discrimination of land surface geology would be enhanced if it was possible to determine the spectral variability of the surface reflectance and emissivity using remotely sensed data.

The particular need for this research is to acquire suitable data sets together with validation data. Very high spectral resolution data has an advantage in this area. It is hoped to couple this research to the expected performance of the ASTER satellite to be launched later this decade by the Japanese Space Agency.

* CSIRO Division of Exploration and Mining, Perth

PhD Student

Satellite Microwave Data for Estimating Tropical Cyclone Intensity

Assoc. Prof M J Lynch, Mr L van Burgel+, Dr A J Prata# and Dr J Le Marshall*

This project uses microwave data from the NOAA Microwave Sounding Unit (MSU) to monitor the upper level temperature anomaly (at about 12 km altitude) in WA tropical cyclones. The anomaly is theoretically linked to the central pressure of the storm and therefore may be use directly to infer intensity. A regression relationship has been derived for this purpose. In 1994 an improved microwave sensor (Advanced MSU) will be fitted to the NOAA satellites.

This sensor will provide far superior opportunity for producing data for the estimation of the strengths of tropical cyclones. A final component of this research involves modelling the expected performance of AMSU using synthetic data sets generated with an atmospheric microwave transmittance model.

WASTAC is acknowledged for the provision of NOAA satellite data sets,

+ Bureau of Meteorology, Perth Office

CSIRO Division of Atmospheric Research, Melbourne

* Bureau of Meteorology Research Centre, Melbourne

The Genesis and Development of Tropical Cyclones in the NW Australia Region

Assoc. Prof M J Lynch, Mr G Hamilton#, Mr M Williams*

The development of tropical cyclones depends on a number of prerequisite conditions being met such as elevated sea surface temperature, convergence etc. The details of the progression from the formation and organisation of a cloud cluster through to the development and deepening of a low pressure system remains unclear. This project aims to collect both satellite and numerical model data on cloud clusters which develop and, importantly, those which fail to develop into tropical cyclones in NW Australian waters. The data will be analysed to look for system systematics and attributes with which to characterise these systems with the aim to improve the understanding of their dynamical properties.

The Bureau of Meteorology is acknowledged for the provision of both numerical model and GMS satellite data.

Bureau of Meteorology, Perth Office

* Bureau of Meteorology, Melbourne

Indian Ocean Sea Surface Temperature (SST) Impact on Western Australian Precipitation

Assoc. Prof M J Lynch, Mr A Pearce#, Mr B Hunt*, Mr P Fearns$, Ms K Rothenbury+

Current concerns about greenhouse warming and the impact on the regional climate system has led to a collaborative project involving Curtin and CSIRO Atmospheric Research (Aspendale, Vic), CSIRO Oceanography (Marmion, WA) and the EPA (WA). We have staged three years of data (1985, 1989 and 1992) and presently are extracting monthly gridded SST data for input to the CSIRO numerical model.

The provision of NOAA/AVHRR satellite data by WASTAC is acknowledged.

CSIRO Division of Oceanography, Marmion, WA

* CSIRO Division of Atmospheric Research,Melbourne.

$ MSc student

+ undergraduate student

Precipitation Estimation Using the Japanese Geostationary Meteorological Satellite (GMS) Imagery

Assoc. Prof M J Lynch, Dr W P Menzel#, Dr B Goodman*, Dr B Ebert+, Mr M Gray@ and Mr D Ward++

A significant component of greenhouse uncertainty is the cloud feedback and the consequence for precipitation. This project is concerned with the use of satellite data to estimate precipitation levels from infrared imagery. Data sets from the GMS satellite have been used and the predictions compared to surface gauge data.

We acknowledge the Bureau of Meteorology, Melbourne and Bureau of Meteorology, Perth for the provision of GMS satellite data sets.

CIMSS, NOAA/NESDIS, University of Wisconsin, Madison, USA

* Formerly SSEC, University of Wisconsin, Madison, USA

+ Bureau of Meteorology Research Centre, Melbourne

++ Bureau of Meteorology, Perth Office

@ Honours student

Estimation of Ocean Current from Satellite Infrared Imagery

Assoc. Prof M J Lynch, Mr S Buchan#, Mr A Pearce*, Dr J Hunter*, Mr B McAtee+

Estimation of the quality of vector fields of ocean current produced from sequential satellite thermal images is the thrust of this project. While feature tracking is the most straight forward approach, several additional approaches are under review.

This continuing project is supported by the award of a 1993 Neville Stanley Studentship to Mr B McAtee. The studentship was undertaken in collaboration with Steedman Science and Engineering. The satellite data sets were provided by WASTAC.

+ Neville Stanley Studentship Awardee and Honours student

Steedman Science and Engineering, Perth

* CSIRO Division of Oceanography, Marmion, WA

Improved Cloud Detection and Classification Scheme Using AVHRR Data

Assoc. Prof M J Lynch, Mr A Pearce#, Mr M Gray*, Mr M Bezaud+

It is apparent that many scientists use cloud detection schemes but are not particularly confident of their performance and a little uncertain of when they fail and how to detect failure. A typical motivation is to keep the cloud test both simple and computationally efficient. In practice, however, cloud detection is frequently a more complex problem than the particular application being addressed in the research itself. The absence of good truth data hampers progress in improving cloud detection algorithms. Further, some tasks, such as the detection of high thin cirrus cloud and sub-pixel cloud, are inherently difficult tasks. We are implementing a set of established algorithms with a view to statistically assessing comparative performances. Validation data is being sourced from a solar photometer operated by the Solar Observatory at Exmouth, WA.

We acknowledge the provision of NOAA/AVHRR satellite data from WASTAC; the award of a CSIRO 1993 Summer Studentship to Mr M Gray, a Department of Applied Physics Summer Studentship awarded to Mr M Gray.

- # CSIRO Division of Oceanography, Marmion, WA
- * CSIRO Summer Studentship
  Honours student
- \+ Graduate Diploma in Imaging Science student

Analysis of Astronomical CCD Images

Assoc. Prof M J Lynch, Dr R Koch#, Mr R Martin*

The development of a CCD camera by the Perth Astronomy Research Group has enabled a large number of digital images to be acquired using the 61 cm telescope at the Perth Observatory. During 1993 a major achievement was the discovery of a supernova (later designated Supernova 1993K) by Mr Martin and a co-worker Mr A Williams from University of WA. The research is continuing.

- # School of MPS, Murdoch University
- * Perth Observatory
  MSc student

CURTIN SCHOOL OF SURVEYING AND LAND INFORMATION

Prof. G. D. Lodwick

Introduction

The School of Surveying and Land Information offers remote sensing studies as part of its normal undergraduate courses, comprising the Bachelor of Surveying degree and the Bachelor of Science (Cartography) degree. In addition, it offers specialised studies in remote sensing, GIS and cartography through a Graduate Diploma in Remote Sensing and Land Information. Remote sensing teaching and research is also carried out as part of the graduate programs, which consist of a Postgraduate Diploma in Surveying and Mapping, Master of Science and Doctor of Philosophy.

The main remote sensing research interests of the School are in digital image processing and interpretation, as well as softcopy photogrammetry. Five members of School staff have research interests that are directly related to these topics. They are Professor Graham Lodwick, Mr Graeme Wright, Mr Bruce Montgomery, Mr Michael Roderick and Dr Zhilin Li. Several graduate and undergraduate students are undertaking work in these areas, which are supported by grants from both government and industry. The research involves a range of hardware and software systems. These include an Intergraph ImageStation soft photogrammetry workstation and several PCE486 computers. All of these have a range of input and output facilities allowing the presentation of remote sensing images and maps. In addition, they include a range of commercial image processing software packages.

Remote Sensing Research Project

Use of Satellite Derived Vegetation Data for Updating GIS Databases

(M. L. Roderick, G. D. Lodwick)

This research is investigating the relationship between NDVI responses and ground phenomena to develop interpretation methods. In particular, relationships are being investigated between periods of seasonal vegetation growth using a water balance model and NOAA AVHRR data.

BUREAU OF METEOROLOGY, PERTH REGIONAL COMPUTING

Mr Don Ward, Regional Computing Manager

NOAA HRPT Systems

The Bureau of Meteorology uses data from four HRPT stations:-

Casey on the Antarctic continent, the WASTAC facility in Perth and the Bureau's facilities in Darwin and Melbourne. The data is being used in real time operations and in research. All data is being archived on site as well as being sent to COSSA for input to the Global lkm Land Data Set Project. The Bureau uses the HRPT data operationally in three main ways:-

AVHRR - display using MCIDAS of mosiaced and enhanced imagery for use by operational weather forecasters/volcanic ash detection/value added products including sea surface temperatures, cloud classification, NDVIs, and sea ice monitoring.

TOVS - calculation of vertical temperature profiles used as input to numerical models/moisture/total ozone and cloud amount.

DCP - Drifting buoy data

Processing of the HRPT data is done largely at each reception station however only limited processed data is sent to the Bureau's central computing facility and corporate database in Melbourne. The WASTAC AVHRR and data from the Melbourne reception facility is available in Perth and is displayed on McIDAS (Man Computer Interactive Data Access System) which is soon to be converted to a more advanced UNIX graphics workstation. The use of AVHRR data in the West Australian office of the BOM (Bureau of Meteorology) is increasing within the forecasting domain where it is used to monitor/detect atmospheric phenomena such as fog or low cloud/dust/ thunderstorms/cyclones using various AVHRR channels and image enhancement techniques.

WASTAC BUDGET 1994

Estimated expenditure financial year January 1994 - December 1994.

		PER ANNUM $ 1994	1993
1	Telecom rental	2,500	2,500
2	Exabyte tapes	6,000	9,500
3	System maintenance (new based on 10% of equipment costs ($75,000))	4,000	4,000
4	Telecommunications licence of facility	500	500
5	Photographic/Ink jet quicklook costs	3,000	5,000
6	Consultants-Archive/product generation assistance	8,500	8,500
7	Sundries, consumables	1,000	4,000
8	Travelling - airfares	4,000	4,000
9	Provision for major equipment	12,000	9,000
10	Special provision for improved communications/ existing facilities (transferred from 1993)	100,000	100,000
11	Annual Report	3,000	
	TOTAL	**147,000**	**147,000**

WASTAC BUDGET 1994

Estimated income/revenue financial year January 1994 - December 1994.

INCOME	**1994**
Contributions received ($10,000 each member)	40,000
Sundry income (sale of data)	12,000
Interest	2,000
Total income	**54,000**

WA SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

FINANCIAL STATEMENTS: YEAR ENDED 31 DECEMBER 1993

AUDITOR'S REPORT

I have audited the attached financial statements and in my opinion they fairly represent the transactions of the Consortium during the 1993 calendar year, together with its financial status as at 31 December 1993. The statement is based on proper accounts and records.

P J Perriam
MANAGER, INTERNAL AUDIT
CURTIN UNIVERSITY OF TECHNOLOGY

8 March 1994

CURTIN UNIVERSITY OF TECHNOLOGY
WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

BALANCE SHEET AS AT 31 DECEMBER, 1993

	NOTE	1993 $	1992 $
CURRENT ASSETS			
Cash at Bank		142,158	111,040
TOTAL CURRENT ASSETS		**142,158**	**111,040**
NON-CURRENT ASSETS	3		
Computer Equipment		51,255	68,340
Other Equipment		85,985	98,268
TOTAL NON-CURRENT ASSETS		**137,240**	**166,608**
TOTAL ASSETS		**279,398**	**277,648**
CURRENT LIABILITIES			
Creditors & Borrowings		-	-
TOTAL CURRENT LIABILITIES		-	-
NON-CURRENT LIABILITIES			
Credits & Borrowings		-	-
TOTAL NON-CURRENT LIABILITIES		-	-
TOTAL LIABILITIES		**-**	**-**
NET ASSETS		**279,398**	**277,648**
SHAREHOLDERS' EQUITY			
Asset Revaluation Reserve	4	129,997	129,997
Retained Profits/(Losses)	5	149,401	147,651
TOTAL SHAREHOLDERS' EQUITY		**279,398**	**277,648**

CURTIN UNIVERSITY OF TECHNOLOGY
WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

INCOME AND EXPENDITURE STATEMENT FOR THE PERIOD 1 JANUARY 1993 TO 31 DECEMBER 1993

	NOTE	1993 $	1992 $
INCOME			
Contributions Received	7	40,000	40,000
Sundry Income	8	18,800	14,250
Interest Received		1,530	2,791
TOTAL INCOME		**60,330**	**57,041**
EXPENDITURE			
Salaries & Wages		11,110	8,186
Telephone		2,890	3,296
Travel		1,490	2,000
Consumables		8,116	10,145
Equipment < $1000		-	1,980
Printing, Stationery & Photocopying		2,715	-
Depreciation		29,369	36,819
Maintenance of Equipment		50	-
Feasibility Study		2,840	-
TOTAL EXPENDITURE		**58,580**	**62,426**
NET SURPLUS (DEFICIT)		1,750	(5,385)
EXTRAORDINARY ITEMS	6	Nil	92,250
NET SURPLUS (DEFICIT) AND EXTRAORDINARY ITEMS		1,750	86,865
TRANSFERS TO ASSET REVALUATION RESERVE	4	Nil	92,250
NET SURPLUS (DEFICIT) TRANSFERRED TO RETAINED PROFITS/(LOSSES)		1,750	(5,385)

CURTIN UNIVERSITY OF TECHNOLOGY
WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 1993

	$
BALANCE OF CASH AS AT 1 JANUARY 1993	**111,040 CREDIT**
RECEIPTS	
Contributions Received	
Department of Land Administration	10,000
CSIRO	10,000
Curtin University of Technology	10,000
Bureau of Meteorology	10,000
Total Contributions Received	**40,000**
SUNDRY INCOME	
Supply of Raw Data to various organisations	18,800
Interest Received	1,530
Total Sundry Income	**20,330**
TOTAL RECEIPTS FOR 1993	**60,330**
PAYMENTS	
Salaries and Wages	11,110
Telephone	2,890
Travel	1,490
Consumables	10,832
Feasibility Study	2,840
Maintenance of Equipment	50
TOTAL PAYMENTS FOR 1993	**29,212**
EXCESS OF RECEIPTS OVER PAYMENTS FOR 1993	**31,118**
BALANCE OF CASH AS AT 31 DECEMBER 1993	**142,158 CREDIT**

CURTIN UNIVERSITY OF TECHNOLOGY
WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

FOR THE PERIOD 1 JANUARY 1993 TO 31 DECEMBER 1993

1. STATEMENT OF ACCOUNTING POLICIES

The following accounting policies have been adopted in the preparation of the financial statements.

(a) **General Methodology**

The financial statements, prepared in accordance with the provisions of approved Australian Accounting Standards Reporting, are on the accrual basis of accounting and the accounts have been prepared under the historical cost convention.

(b) **Valuation of Fixed Assets**

In the years preceding 1990 the University operated on a cash accounting basis and consequently all fixed asset purchases were expensed in the year of acquisition. During 1990 all fixed assets were introduced into the financial statements at cost or valuation as an extraordinary item. This value was subsequently transferred to an Asset Revaluation Reserve.

In accordance with relevant Treasurer's Instructions, items costing less than $1,000 which were purchased during 1990 have been expensed in 1990. Items of plant purchased prior to 1 January 1990 which cost less than $1,000 have been excluded from the group of assets introduced during 1990.

(c) **Depreciation**

Plant and equipment present in these financial statements is depreciated in accordance with the following methodology.

Computer equipment	25% reducing balance method.
Other plant & equipment	12.5% reducing balance method.

3. NON CURRENT ASSETS

	1993 $	1992 $
Computing Equipment (at cost)	186,037	186,037
Accumulated Depreciation	(134,782)	(117,697)
TOTAL COMPUTING EQUIPMENT	51,255	68,340
Other Equipment (at cost)	183,765	183,765
Accumulated Depreciation	(97,780)	(85,497)
TOTAL OTHER EQUIPMENT	85,985	98,268
TOTAL NON-CURRENT ASSETS	137,240	166,608

		1993 $	1992 $
4.	**ASSET REVALUATION RESERVE**		
	Opening balance	129,997	37,747
	Movement During The Year	Nil	92,250
	CLOSING BALANCE	129,997	129,997
5.	**RETAINED PROFITS/(LOSSES)**		
	Opening Balance	147,651	153,036
	Net surplus (Deficit) for the year	1,750	(5,385)
	CLOSING BALANCE	149,401	147,651
6.	**EXTRAORDINARY ITEMS**		
	Extraordinary Income comprised the following:		
	Recognition of Non-Current Assets:		
	Computing & Other Equipment	Nil	92,250
	Transfers to Asset Revaluation Reserve	Nil	92,250
	TOTAL EXTRAORDINARY INCOME AFTER TRANSFERS	Nil	-
7.	**CONTRIBUTIONS RECEIVED**		
	Department of Land Administration	10,000	10,000
	C.S.I.R.O.	10,000	10,000
	Curtin University of Technology	10,000	10,000
	Bureau of Meteorology	10,000	10,000
		40,000	40,000
8.	**SUNDRY INCOME**		
	Supply of Raw Data to various organisations	18,800	14,250
		18,800	14,250

COMPUTING EQUIPMENT AS AT 31 DECEMBER 1993

ASSET NO.	DESCRIPTION	ORIGINAL COST	ACCUM DEPREC	WRITTEN DOWN VALUE
		$	$	$
2494515	MICROSOFT OS/2 PM TOOLKITT	488.00	259.25	228.75
2587007	MATHS CO-PROC INTEL 20MHZ	570.00	302.81	267.19
2494511	ETHERLINK MC CARD	590.00	313.44	276.56
2587001	MOUSE	109.00	57.91	51.09
2552700	TAPE DRIVE 2 GBYTE X801A	6,840.00	3,794.06	3,045.94
2587010	2MB MEMORY MODULE	475.00	252.35	222.65
2494507	OS/2 EXTENDED EDITION V1.2	700.00	371.88	328.12
2553701	ACQNR	3,800.00	2,107.81	1,692.19
2587200	ULTRA 1000 20"	2,870.00	1,524.69	1,345.31
2494506	PS/2 CARD TO OPTION SCSI	142.00	75.44	66.56
2494509	MATHS CO-PROCESSOR INTEL 25MHZ	726.00	385.69	340.31
2494503	PS/2 DUAL ASYNCH ADAPTER	233.50	124.05	109.45
2494500	PS/2 25MHZ A/320 MBHD & MONITOR	16,686.00	9,793.25	6,892.75
2478800	2.3GB 8MM EXABYTE	6,272.00	3,681.13	2,590.87
2587002	PS/2 DUAL ASYNCH ADAPTER	233.50	124.05	109.45
2494512	MONITOR DISPLAY CABLE	120.00	63.75	56.25
2587005	2MB MAIN MEMORY EXPANSION	953.00	506.28	446.72
2494510	4-16 MEMORY BOARD 4MB	1,501.00	797.41	703.59
2629700	CARTRIDGE SYSTEM 2.5 G BYTE 8MM	4,950.00	2,513.67	2,436.33
2494516	FORTRAN V2.0	754.00	400.56	353.44
2587011	2 MB MEMORY MODULE	475.00	252.35	222.65
2587000	PS/2 20MHZ 2/320MBHD VGA	8,846.00	4,699.44	4,146.56
25873000	5.25 DISKETTE	501.00	266.16	234.84
2494504	PS/2 DUAL ASYNCH ADAPTER	233.50	124.05	109.45
2587003	PS/2 DUAL ASYNCH ADAPTER	233.50	124.05	109.45
2587014	MONITOR DISPLAY CABLE	120.00	63.75	56.25
2587009	2MB MEMORY MODULE	475.00	252.35	222.65
2585200	PAINTJET XL C1602A	2,425.00	1,288.29	1,136.71
2587100	ULTRA 1000 20"	2,870.00	1,524.69	1,345.31
2494505	5.25 EXTERNAL DISKETTE ADAPTER	204.00	108.38	95.62
2587012	ETHERLINK MC CARD	590.00	313.44	276.56
2494517	LOCAL AREA NETWORK TECH MANUAL	70.00	37.19	32.81
2494501	MEMORY EXPANSION BOARD 4MB	1,911.00	1,121.60	789.40
2587008	2-8MB MEMORY EXPANSION	1,450.00	770.31	679.69
2494513	MS MACRO ASSEMBLER V 5.1	174.00	92.44	81.56
2494508	320MB HD DRIVE	4,739.00	2,517.59	2,221.41
2494518	PS/2 MOUSE	109.00	57.91	51.09
2487013	FUTURE DOMAIN	450.00	239.06	210.94
2587004	OS/2 EXTENDED EDITION V1.2	700.00	371.88	328.12
1358800	SYSTEM SATELLITE TRACKING STATION	110,000.00	92,869.56	17,130.44
2494514	MICROSOFT COMPILER V6	448.00	238.00	210.00
		186,037.00	**134,781.97**	**51,255.03**

OTHER EQUIPMENT AS AT 31 DECEMBER 1993

ASSET NO.	DESCRIPTION	ORIGINAL COST	ACCUM DEPREC	WRITTEN DOWN VALUE
		$	$	$
2009000	MA 23 CC	20,365.00	9,049.14	11,315.86
1358700	SATELLITE STATION TRACKING	140,000.00	81,095.60	58,904.40
2553700	RECEIVER NOAA I/F FORMAT	19,500.00	6,125.49	13,374.51
1948500	POWER CONDITIONER	2,000.00	913.10	1,086.90
2552600	SCSI HOST ADAPTOR 598A	1,900.00	596.85	1,303.15
		183,765.00	**97,780.18**	**85,984.82**
		369,802.00	**232,562.15**	**137,239.85**

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The Leeuwin Centre for Earth Sensing Technologies located at 65 Brockway Road, Floreat, W.A., is the new facility for colocating companies and organisations in the remote sensing and Earth Observation industries. It has been established with support from the State Government of Western Australia and the Australian Commonwealth Government, to:

- provide a comprehensive "one stop" service to commercial and government users of earth sensing technology:
- support industry development through collaborative programmes for research and development, technology transfer, and education and training:
- act as a focus for earth sensing activities at State, National and regional levels:

The Centre brings together, in one building, organisations with capabilities in data acquisition (both satellite and aerial), instrumentation, archive management, data processing, image enhancement, image interpretation, and education and training. These groups have skills and experience in application areas including mineral exploration, environmental monitoring, renewable resource management and coastal engineering.

Groups located within the Centre include :

- The Remote Sensing Application Centre of the Western Australian Government's Department of Land Administration
- CSIRO
- World Geoscience Corporation
- Curtin University of Technology
- Wembley Campus of TAFE

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