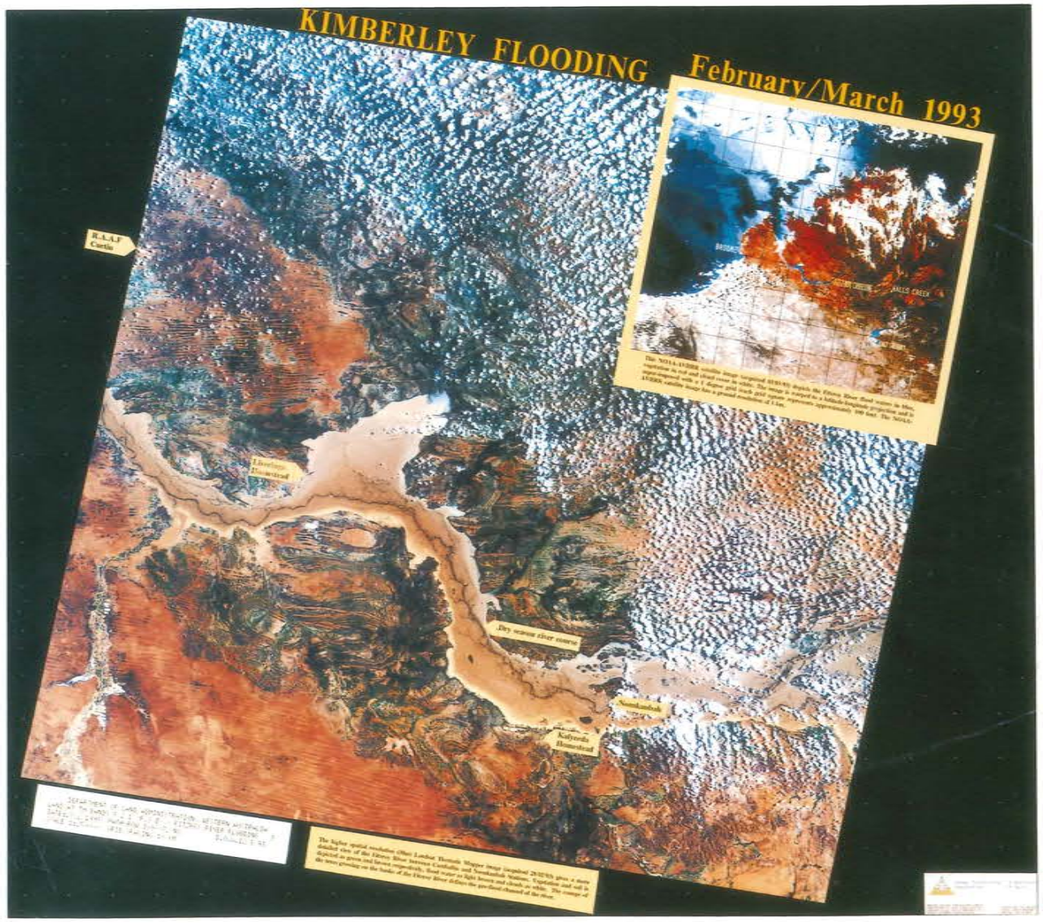

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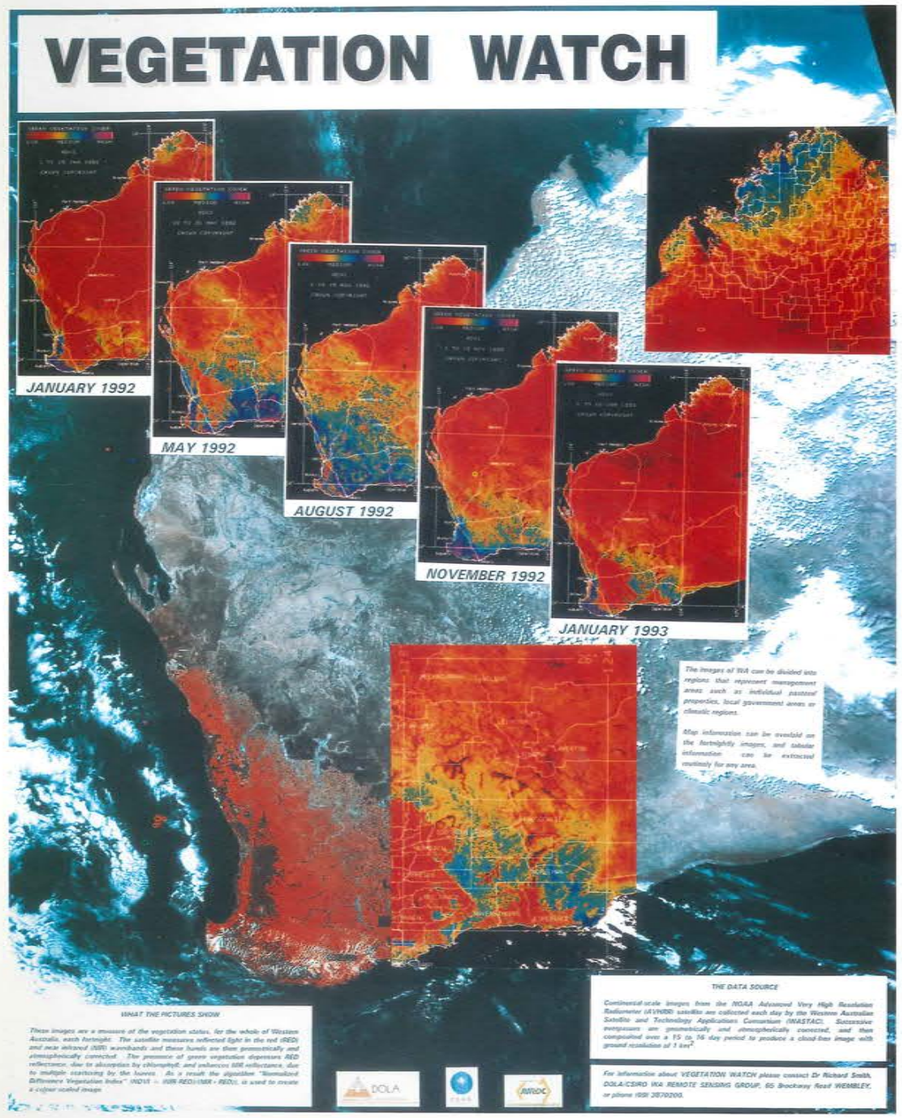
WASTAC

Western Australian Satellite Technology And Applications Consortium

ANNUAL REPORT 1992



WASTAC members

Bureau of Meteorology, GPO Box 1289K, Melbourne, Vic 3001

Department of Land Administration, Leeuwin Centre for Earth Sensing Technologies, 65 Brockway Road, Floreat, WA 6014

Curtin University of Technology, Kent Street, Bentley WA 6102

CSIRO, Private Bag PO, Wembley WA 6014

COVER IMAGE

These fortnightly composited images are produced from the NOAA Advanced Very High Resolution Radiometer (AVHRR) satellite data received in Perth by the Western Australian Satellite and Technology Applications Consortium (WASTAC). The images are a measure of the vegetation status. Sparse green vegetation cover is depicted in red tones, medium vegetation cover by yellow tones and green through to blue tones indicating high vegetation cover. Valuable land management information can be extracted from these images covering individual pastoral, agricultural or climatic regions.

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM

ANNUAL REPORT 1992

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CHAIRMAN'S REPORT

A major focus for WASTAC during 1992 has been the consolidation of a reliable and accessible archive of NOAA/AVHRR data for operational programmes at state, national and international level. An average of 10 satellite passes per day have been archived providing regular support for the global 1km data set (part of the International Space Year initiative). This study is producing a global picture of the earth's environment on a seasonal basis to improve our knowledge base on global change. More recently NOAA/AVHRR data has been used for a Western Australian "Vegetation Watch" project which presents monthly information on the status of vegetation cover (including crop and pasture) to key state agencies, the Pastoral and Graziers Association and the WA Farmers Federation. These activities are in addition to the normal requirements of WASTAC members and clients indicating an increasing recognition of the contribution satellite data makes to resource inventory and monitoring.

WASTAC is actively participating in early acquisition of satellite derived SEAWIFS ocean-monitoring data and will be processing data on behalf of Consortium members when this data becomes available during 1994. The objective is to contribute to Australia's international commitment to global monitoring and encourage research and development into new ways to manage ocean and land resources over the Southern Hemisphere, with particular emphasis on Western Australia and the Indian Ocean.

A preliminary review of the WASTAC Agreement has resulted in an acknowledgement that the role is changing - with more emphasis on value-added processing of archived data to ensure better information is accessible by a wider community. Existing communication linkages have been upgraded to guarantee supply to all members. This strategy will be developed in 1993 to link WASTAC to major State networks.

Again the Board acknowledges the enthusiasm and dedication of consortium members to the aims of WASTAC.

H J Houghton
Chairman
WASTAC

WASTAC BOARD

Back Row (L-R) Assoc. Prof. Merv Lynch, Curtin; Mr Richard Stovold, DOLA (Secretary); Dr Richard Smith, CSIRO

Front Row (L-R) Mr Alan Pearce, CSIRO; Mr Henry Houghton, DOLA (Chairman); Mr Don Ward, Bureau of Meteorology

Absent: Dr D Myers, Curtin; Mr L Broadbridge, Bureau of Meteorology

WASTAC ARCHIVE

WASTAC's archive continues to grow with a reliable supply of data now available.

A total of 3311 NOAA/AVHRR passes were collected during the year. Of these there were 1693 NOAA 11 passes and 1571 NOAA 12 with the balance being NOAA 10. The total data storage of 205 gigabytes on 126 exabyte tapes indicates the size of the archived data.

To complement the archive of digital data a series of cloud assessment quicklook prints is produced on a HP Paintjet plotter for each pass. These prints together with all archived digital data are available for use from the Remote Sensing Applications Centre (RSAC). Images can be easily displayed and viewed on the Centre's computer processing facilities.

During the year a decision was taken by the Board that the valuable archive of NOAA passes previously collected at Curtin from 1981 to 1986 should be copied. These passes are progressively being copied from the original CCT's to 8mm high quality exabyte tapes. A total of 377 passes from the NOAA 6, 7 and 8 series of satellites have been copied to December 31, 1992.

WASTAC is actively contributing to the global NOAA 1km Data Archive which is intended to provide researchers with a daily coverage of the entire land surface of the earth over the period 1 April 1992 - 30 September 1993. Specific uses include the study and understanding of the global consequences of natural and human induced environmental change.

The programme supporting the research objectives of the International Geosphere - Biosphere Programme (IGBP), is being coordinated by the CSIRO Office of Space Science and Applications (COSSA) who collect the data on behalf of six Australasian ground stations. A total of 620 NOAA 11 passes have been copied and supplied to COSSA who collect the data for research use by international agencies.

The management, data distribution and product sales are a result of the dedicated work of many of the staff at RSAC including Ian Dean, Ron Craig and Robert Shaw, and close collaboration with other consortium members.

Richard Stovold
Secretary, WASTAC

1992 NOAA DATA HELD BY WASTAC

	NOAA 10	NOAA 11	NOAA 12	TOTAL
JAN		152	156	308
FEB		139	130	269
MAR		138	134	272
APR		116	115	231
MAY		145	140	285
JUN		121	106	227
JULY		158	112	270
AUG	47	150	106	303
SEPT		142	136	278
OCT		156	159	315
NOV		141	139	280
DEC		135	138	273
TOTAL	47	1693	1571	3311 passes

Exabytes: 3311 passes on 126 Exabytes.

Total Data Received: 205 gigabytes.

ISY Data: 23 exabyte tapes containing 620 NOAA 11 Day Time Passes, (sent to CSIRO, Canberra).

CURTIN ARCHIVE COPIED TO EXABYTE - 1992

		NOAA 6	NOAA 7	NOAA 8	TOTAL
1981	Oct	3	9		12
	Nov	1	6		7
	Dec	1	7		8
		5	**22**		**27**
1982	Feb		3		3
	Mar		8		8
	Apr		10		10
	May		6		6
	June		6	1	7
	July		16		16
	Aug		13		13
	Sept		19		19
	Oct		9		9
	Nov		12		12
	Dec		11		11
			113	**1**	**114**
1983	Jan		21		21
	Feb		15		15
	Mar	7	20		27
	Apr		10		10
	May	3	21		24
	June		19	3	22
	July		22		22
	Aug		24		24
	Sept		18	1	19
	Oct		28	2	30
	Nov		18	4	22
		10	**216**	**10**	**236**

Total passes copied to 31 Dec 1992:

NOAA 6	15
NOAA 7	351
NOAA 8	11
TOTAL	**377**

Copied onto 20 Exabyte tapes.

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 real-time 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 exabyte 8mm cartridge tape and a special duplicate archive is currently produced for the ISY(international space year) NOAA program.

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 during the year resulted in the loss of 20 days of data. Due to the dedicated efforts of Ron Craig and Bureau of Meteorology personnel over 3311 passes were recorded for the year.

DOLA is currently holding WASTAC archived data on EXABYTE 8mm tapes. Orders for digital data are provided on EXABYTE or 6250/1600 bpi magnetic tape in raw or Sharp format.

Don Ward
Regional Computing Manager
Bureau of Meteorology, Perth

DATA APPLICATIONS AND RESEARCH

Satellite Remote Sensing of the Leeuwin Current

Alan Pearce, CSIRO Division of Oceanography, Marine Laboratories, Marmion

NOAA/AVHRR imagery of the Leeuwin Current and its associated eddies is being increasingly applied to a variety of oceanographic and fisheries situations.

Sampling of pilchard eggs off Albany by the State Fisheries Department has shown that the distribution is largely inshore of the Leeuwin Current (as mapped using AVHRR imagery), and are therefore locally retained. Those eggs and larvae which drift further offshore may be rapidly dispersed eastwards by the Current (Fletcher and Tregonning, 1992). Hutchins and Pearce (1993) have shown that the Leeuwin Current may be responsible for seasonal recruitment of larval tropical fish in the reefs of Rottnest Island.

Current measurements along the continental slope between Dongara and Rockingham by an oceanographic consultant were complemented by AVHRR imagery, enabling the temporal variability of the currents at the mooring sites to be related to spatial variability in the Leeuwin Current. This will provide us with a rare opportunity to relate satellite images to direct current measurements.

AVHRR imagery is also being used in modelling the oilspill from the tanker Kirki near Jurien Bay in July 1991. The movement of the slick in response to ocean currents and the wind is being examined, using AVHRR imagery which showed the presence of a large meander in the Leeuwin Current in the vicinity of the spill. The model incorporates estimates of surface current vectors deduced from the imagery in conjunction with previous satellite buoy tracks, and indicates the important role of the current in transporting the oil away from the coast, against the wind (Easton et al. 1992; Pearce et al. in preparation).

A comprehensive study of the dynamics of the Perth metropolitan waters by the Water Authority in collaboration with other government and private organisations is using AVHRR imagery, current measurements and observations of the temperature and salinity of the coastal waters. Results so far suggest that intrusions of Leeuwin Current water across the shelf may significantly influence the dispersal of coastal pollutants (Mills et al. 1992 (a), (b), Wyllie et al. 1992).

AVHRR imagery was used to delineate the boundaries of the Leeuwin Current during rock lobster larval surveys by the FRV Southern Surveyor off the Houtman Abrolhos Islands in late 1991 (Pearce 1992). Geostrophic currents derived from CTD (Conductivity-Temperature-Depth) sampling have confirmed the position of the Leeuwin Current as shown in the satellite imagery, and showed that the surface current speed (relative to 300m) exceeded 1.5 m/s (3 knots) in the alongshore jet (Phillips and Pearce, in prep.).

Acknowledgements

This research is being supported by a grant from the Western Australian Fisheries Research and Development Trust Account, and in collaboration with Curtin University, Centre for Water Research (University of Western Australia), and the Environmental Protection Authority.

Vegetation Watch

Dr Richard Smith, CSIRO, Division of Exploration Geoscience

VEGETATION WATCH of Western Australia was successfully launched in 1992 by a collaborative effort between CSIRO and DOLA's Remote Sensing Applications Centre (RSAC), with financial assistance from the Rural Industries Research and Development Corporation (RIRDC) to Dr Richard Smith, CSIRO/RSAC, the Principal Investigator. During 1992, over 200 of WASTAC's afternoon NOAA overpasses were processed into near real-time cloud-free composites of the Normalised Difference Vegetation Index (NDVI). These composites were distributed to potential users for evaluation at semi-monthly intervals throughout 1992.

With RIRDC funds a dedicated computing facility based on a Sun-sparc2 workstation (see Diagram 1) has been set up within RSAC for the routine processing of the afternoon NOAA-AVHRR overpasses. This was conducted by Mr John Adams, Data Analyst (RSAC) using software from Mac Dilley, CSIRO Division of Atmospheric Research to navigate, calibrate, atmospherically correct and composite successive NOAA-AVHRR overpasses over semi-monthly periods. The navigation accuracy was enhanced in mid 1992 by Ms Sue Furby, CSIRO Division of Mathematics and Statistics with the introduction of automatic co-registration. The whole processing system was managed and improved by Mr Ron Craig, Systems Analyst (RSAC) and networked into the RSAC computer system by Dr Peter Davison, Image Processing Specialist (RSAC).

For use by Dr Shane Cridland, WA Department of Agriculture Range Research group, in a RIRDC project "To use the NDVI to assist managers of pastoral properties to improve their grazing management", the NDVI images by mid-1992 were being distributed through the WA Land Information System (WALIS) digital network to the WA Department of Agriculture (WADA) by the efforts of Mr Mike Roderick (Curtin University).

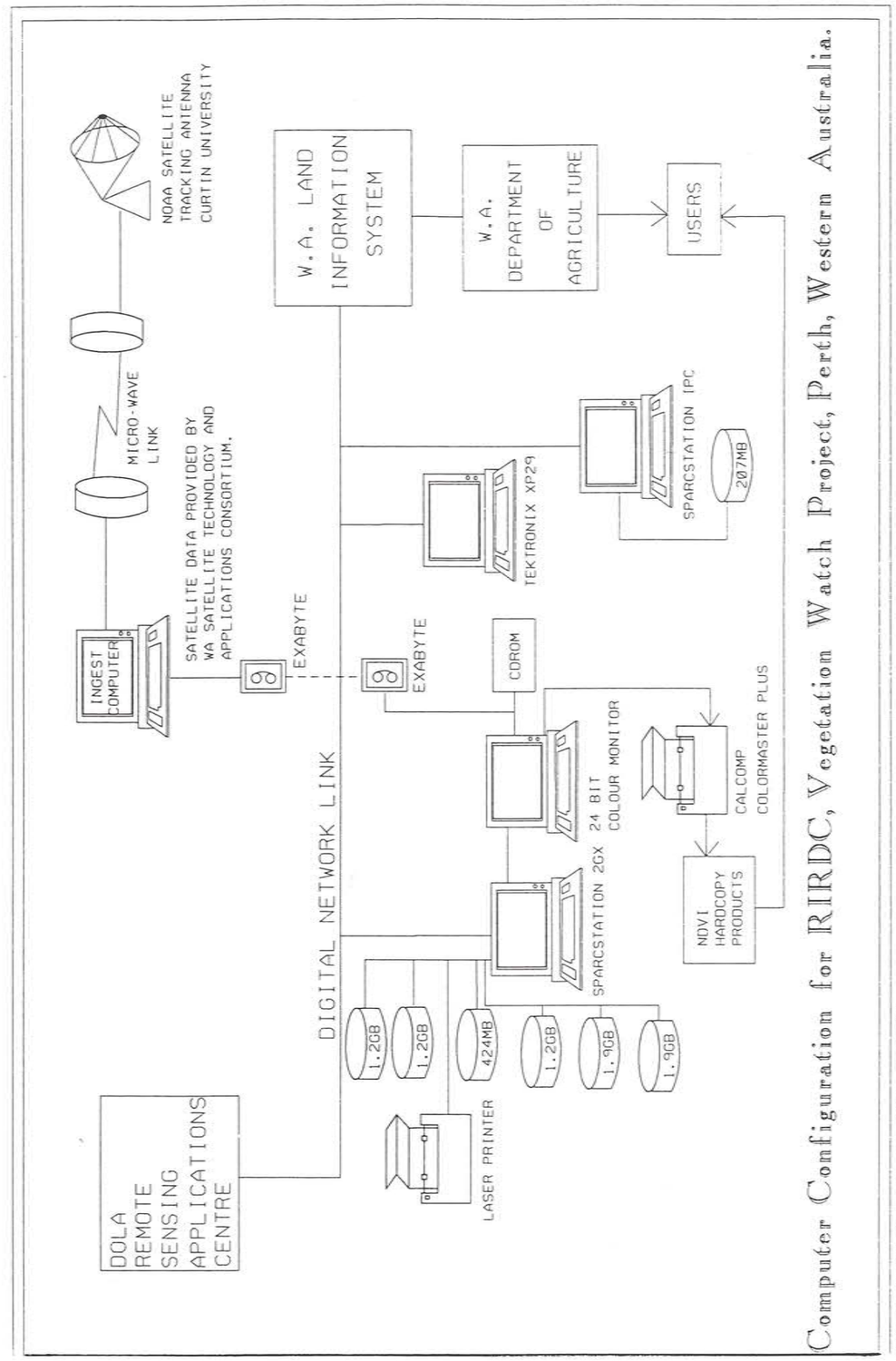
For evaluation by the Bush Fires Board, WA Farmers Federation, Pastoralist and Graziers Association, Department of Conservation and Land Management, and Agricultural Protection Board, the NDVI images were also distributed as hard copy colour-coded products (see Centre Fold). As a result of this evaluation, further development of the NDVI product was requested by the Bush Fires Board for fire prevention to monitor the fuel load and curing rates of grasslands across WA. Distribution and evaluation of the hard copy NDVI products was conducted by Mr Red Shaw, RSAC and Mr Peter Hick, CSIRO.

The NDVI images for 1992 revealed unseasonally dry conditions in the North West with the Tropical Monsoonal rains showing little penetration into the Kimberley. In contrast, good rains penetrated into southern inland areas during winter, leading to above average vegetation growth and a major fire alert by CALM and the Bush Fires Board.

Following a visit to the Canadian NDVI Crop Information System, overlays of cadastral and geographic data were introduced to improve geo-location of features. Also a series of regional products with overlays of pastoral boundaries, local government areas and bush fire forecast districts at higher resolution were introduced for distribution in 1993. Ms Fiona Chapman, RSAC, developed the cadastral overlays. The Northern Territory and South Australia were also included by using data for the more eastern areas covered by the WASTAC receiving dish.

The emphasis in 1993 is to develop the regional opportunities for the application of VEGETATION WATCH, to progressively automate the processing for the real time analysis of the NOAA-AVHRR data received by microwave link and relating the NDVI to ground observations.

The success of VEGETATION WATCH is a result of the support and help of many people across many organisations.



Western Australian wheat yields in 1992 and NOAA-AVHRR observations

Richard C.G. Smith, Peter T. Hick and John Adams

CSIRO Division of Exploration and Geoscience and Remote Sensing Applications Centre

The 1992 wheat area and grain receival statistics from Cooperative Bulk Handling Ltd that receives about 95% of Western Australia's wheat crop were related to the 1992 Vegetation Watch NDVI observations.

Each set of NDVI observations are derived from combining about eight successive NOAA overpasses, screening out cloud affected data and then retaining the maximum NDVI to represent each grid cell. The resultant images cover semi-monthly periods of 14-16 days covering all months of 1992.

The spatial mean NDVI for each of 68 local government areas where wheat was grown were then calculated for each period and related to resultant wheat yields calculated from the CBH statistics. The area of study covered 40.4 million ha of Western Australia, growing 3.73 million ha of wheat and producing 5.9 million tonnes of grain.

The relationships between the NDVI and wheat yields revealed some interesting correlations with known physiological features of wheat yields. For example, indicating the importance of the NDVI at anthesis, final wheat yield was highly correlated with NDVI in early September (Figure 1). Also the importance of the rate of senescence of the crop during grain filling was evident by the high correlation in early November (Figure 2). Of further interest was that the highest correlation was with the maximum NDVI throughout the season (Figure 3) and these maxima fell predominantly in two times of the year (Figure 4) August and September/early October which coincided with the two seeding times of May and June earlier in the year.

From this preliminary study it is evident that the seasonal 1992 NDVI data has considerable information about the status of the 1992 wheat crop.

Fig 1: NDVI from 1-15 Sept 1992

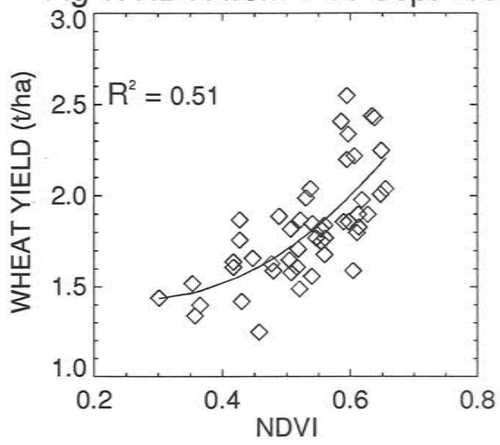


Fig 2: NDVI from 1-15 Nov 1992

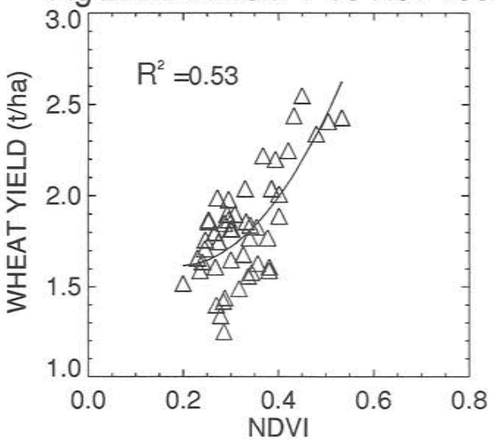


Fig 3: Maximum NDVI

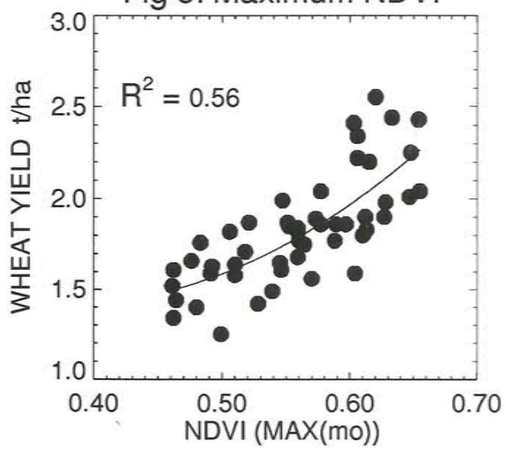
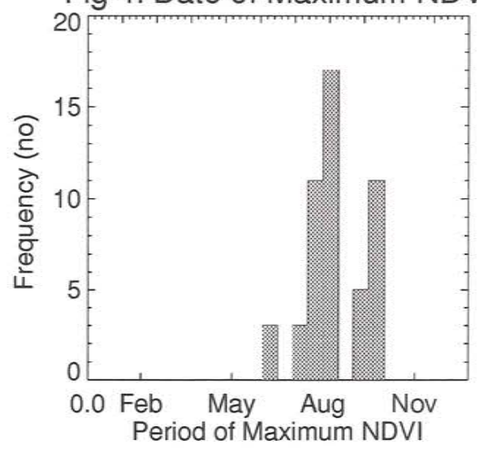


Fig 4: Date of Maximum NDVI



Remote Sensing and Satellite Research Group (RSSRG) Report

Assoc. Professor M J Lynch
School of Physical Sciences, Curtin University of Technology
PO Box U1987 Perth WA 6001

Introduction

The effort documented in this Report summarises the activities for the year 1992 of the Remote Sensing and Satellite Research Group (RSSRG) of the School of Physical Sciences, Curtin. The academic staffing of the RSSRG is small and to a large degree the endeavours are very much the product of the enthusiastic collective of research and project students that comprise the Group. Further, it would be difficult to make significant progress if it was not for the support of the many scientists external to Curtin who volunteer their efforts to assist with guidance and research support for the student body.

Year 1992 has been productive in the sense that progress has been made on a number of projects across a relatively broad research front. If any specific attribute characterises the work of the Group it is probably the pursuit of improving the science used in the conversion of raw remote sensing data (e.g. digital counts) into geophysical products. Until remote sensing is able to deliver products with known error characteristics and regimes of validity, the value of remote sensing to the community will remain limited.

Once properly validated remote sensing information is available, the opportunities for its use as a management support system becomes attractive. Within the Group we are progressively casting our output products into more user compatible formats for entry into such packages as Geographic Information Systems (GIS).

A further opportunity for remote sensing information utilisation is in Earth System Science studies. This thrust does not imply just monitoring but the more scientifically challenging field of the use of remote sensing information as input to numerical models of systems and Earth cycles; such as the hydrologic cycle. Within the RSSRG this trend is apparent in several of the projects reviewed in this Report. To advance this effort the RSSRG probably will need to establish collaborative links with research groups working in the modelling areas.

Fortunately, student interest at Curtin in the remote sensing field remains very high. As with research in most universities, one must continue to look outward for support and growth opportunities. The formalisation of the WASTAC agreements in 1988 has been an exceptional benefit to Curtin and the research student body. It is with expectation that we look forward to a new set of opportunities under WARSIDEC when the new Centre is occupied from late May, 1993.

Research Group Members

The complement of staff and students in the Group for 1992 reached a total of twenty-one people. Overall, 17 research projects described below were active during the year. The composition in terms of staff, graduate students and undergraduate students also are listed below. The student body clearly is the primary source of the research effort in the Group.

As will be noted when reading this Report, that there are strong links with a number of external-to-Curtin scientists and research agencies. These links are of direct benefit to Curtin's research students in that they typically have contributed research data sets, contributed field experiment support, provided access to specialised scientific instrumentation or permitted access to advanced computing facilities.

Academic Staff - Assoc Prof Merv Lynch, Mr Brian White and Dr Mario Zadnik;
Postdoctoral Fellow - Dr Gina Price;
Research Assistants - Mr D Foster and Mr H Lynch;

PhD Students - Mr P van Delst, Mr Cecep Rustana, Mr Tissa Weerasekera, Ms Jackie Marsden, Mr Roger Clifton and Mr Jim Davies;
MSc Students - Mr Len van Burgel, Mr Peter Fearns and Mr Ralph Martin;
Postgraduate Diploma Students - Mr Don Ward and Mr Anwar Khalil;
Honours student - Mr Brendon McAtee; and,
Third Year BSc Project Students - Mr Ian Dean, Mr Brad Lang and Mr Mark Gray.

Research Projects

1. Title: **Profiling of Atmospheric Trace Gas Concentrations Using High Spectral Resolution Interferometer Data.**

PhD Student: Paul van Delst*.

Collaborators: Prof W Smith, Dr H Revercomb and Dr R Knuteson, CIMSS, Space Science and Engineering Center, University of Wisconsin, Madison, USA.

Mr B White, School of Mathematics and Statistics, Curtin.

Sponsors: CIMSS/SSEC, University of Wisconsin for data sets, field support and per diem.
* APRA PhD scholarship awardee.

The project utilises data collected from a 4000 channel High spectral resolution Interferometer Sounder (HIS) operated by the University of Wisconsin. The data contain the vibrational and rotational spectra of many trace species (NO_2, CO, CH_4, O_3, freons). This particular project is concerned with the inversion of the radiative transfer equation to obtain concentration profiles for ozone.

2. Title: **Land Surface Temperature Estimation from Satellite Data: Application to Land Salinisation Identification.**

PhD Student: Cecep Rustana*.

Collaborators: Dr N Campbell, CSIRO DMS.
Dr A J Prata, CSIRO DAR.
Dr I Foster, WADA.

Sponsors: * PhD Scholarship from AIDAB.
WASTAC for satellite data sets.

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 is presently in progress using data sets from a CSIRO instrumented field site at Walpeup, Victoria and from 15 field stations operated by the WA Department of Agriculture (WADA).

3. Title: **Corrections to the Normalised Difference Vegetation Index (NDVI) Using NOAA/AVHRR Satellite Data.**

PhD Student: Tissa Weerasekera*.

Collaborator: Dr R G C Smith, CSIRO DEG and DOLA/RSAC.

Sponsor: * PhD Scholarship from AIDAB
WASTAC for satellite data sets.

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

Present research has implemented procedures for applying corrections for the molecular atmosphere, aerosols, and atmospheric moisture. Validation and improvements to these algorithms is continuing.

4. Title: **Estimation of Atmospheric Aerosols Optical Depth Over Oceanic Regions Using NOAA/AVHRR Satellite Data.**

PhD Student: Jackie Marsden.

Collaborators: Dr S Young, CSIRO DAR, Melbourne.
Dr B Forgan, Bureau of Meteorology, Melbourne.
Dr R Mitchell, CSIRO DAR, Melbourne.

Sponsors: WASTAC for satellite data sets.

Unless accounted for correctly the variability of the concentration of atmospheric aerosols (on daily and seasonal scales) contributes a source of error in satellite products derived from visible channel sensor data. There is considerable interest in aerosols over the ocean because of the impact of aerosols in the moist near-surface layer on maritime visibility.

Atmospheric scattering 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.

Only once algorithms over the sea are shown to perform adequately will there be confidence in the ability to accurately estimate aerosol optical depths over the land surface.

5. Title: **Monitoring the Mt Pinatubo Volcanic Aerosol.**

Res. Assist.: Huw Lynch, Dave Foster.

Collaborators: Dr S Young, CSIRO DAR, Melbourne.
Dr B Forgan, Bureau of Meteorology, Melbourne.

Sponsor: WASTAC for satellite data sets.

The eruption of Mt Pinatubo (Philippines) in June, 1991 and to a lesser degree, the Mt Hudson (Chile) eruption of August 12, 1991, produced extremely high levels of aerosol in the stratosphere at heights of 15-26 km and 12-14 km respectively. The residence time of the smaller aerosol particles is typically several years and, accordingly, any quantitative determination of visible channel remotely sensing products (ocean colour, reflectance, NDVI) will be significantly in error if the aerosol corrections are not correctly applied. Further, the scattering properties of volcanic aerosols is quite different to continental and maritime aerosols. Aerosol loadings of these magnitudes modify the albedo of the planet and result in a mean cooling of the Earth's land surface and oceans for extended periods.

This project is comparing aerosol optical depth data from satellite with lidar measurements and solar photometer data as part of an aerosol monitoring program. The validation of algorithms is a direct benefit of this program.

6. Title: **Remote Sensing Applied to the Mineral Industry.**

PhD Student: Roger Clifton.

Collaborators: Dr A Gabell, CSIRO DEG, Perth.

Sponsors: Yet to be identified.

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

The graduate student assigned to this project has only recently commenced and presently is undertaking a literature survey prior to the definition of the specific tasks to be researched.

The particular need for this research is to acquire suitable data sets together with validation data. Very high spectral resolution data has shown to have an advantage in this area.

7. Title: **Coastal Zone Research with SeaWiFS Satellite Data.**

PhD Student: Jim Davies*.

Collaborators: Mr A Pearce, CSIRO DO, Marmion.
Dr J Parslow, CSIRO DF.

Sponsors: Digital Equipment Corporation, Aust.
Oceanroutes (Aust) Pty Ltd, Perth.
WASTAC for satellite data (from 1993).
* APRA PhD scholarship awardee.

SEAWIFS is scheduled for launch in February, 1994. We have just recently initiated a project which will 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 will need to be very precise if coastal zone products are to be estimated to the design goal of 5% accuracy.

8. Title: **Satellite Microwave Data for Estimating Tropical Cyclone Intensity.**

MSc Student: Len van Burgel.

Collaborators: Dr A J Prata, CSIRO DAR, Melbourne.
Dr J Le Marshall, Bureau of Meteorology, Melbourne.

Sponsors: WASTAC for satellite data sets.

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.

9. Title: **Modelling Sea Surface Temperature (SST) Impact on WA Precipitation Using Satellite Data.**

Postgraduate Dip. Student: Peter Fearns.

Collaborators: Mr A Pearce, CSIRO DO, Marmion
Mr B Hunt, CSIRO DAR, Melbourne.

Sponsors: CSIRO Division of Atmospheric Research
WA Environmental Protection Authority
Curtin/CSIRO Collaborative Research Fund
WASTAC for satellite data sets.

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 two years of data (1985, 1988) and presently are extracting monthly gridded SST data for input to the CSIRO numerical model.

10. Title: **Precipitation Estimation Using the Japanese Geostationary Meteorological Satellite (GMS) Imagery.**

Postgraduate Dip. Student: Don Ward.

Collaborators: Dr W P Menzel, CIMSS, NOAA/NESDIS, Madison,USA.
Dr B Goodman, SSEC, University of Wisconsin, Madison, USA.
Dr B Ebert and Dr K Puri, Bureau of Meteorology, Melbourne.

Sponsors: Bureau of Meteorology, Melbourne and Bureau of Meteorology, Perth for assistance with data sets.

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.

11. Title: **Estimation of Ocean Current from Satellite Infrared Imagery.**

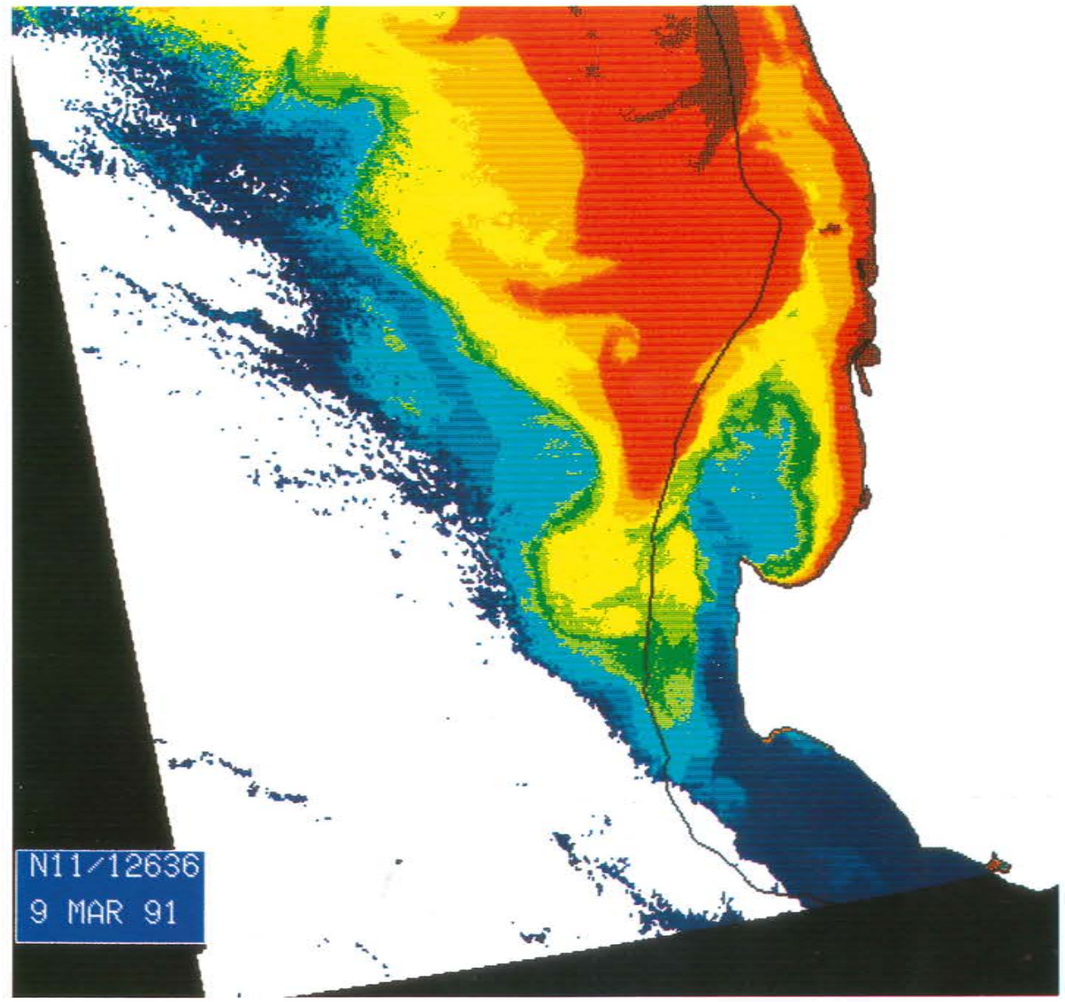
Honours Student: Brendon McAtee*.

Collaborators: Mr A Pearce, CSIRO DO, Marmion
Mr S Buchan, Steedman Science and Engineering, Perth.

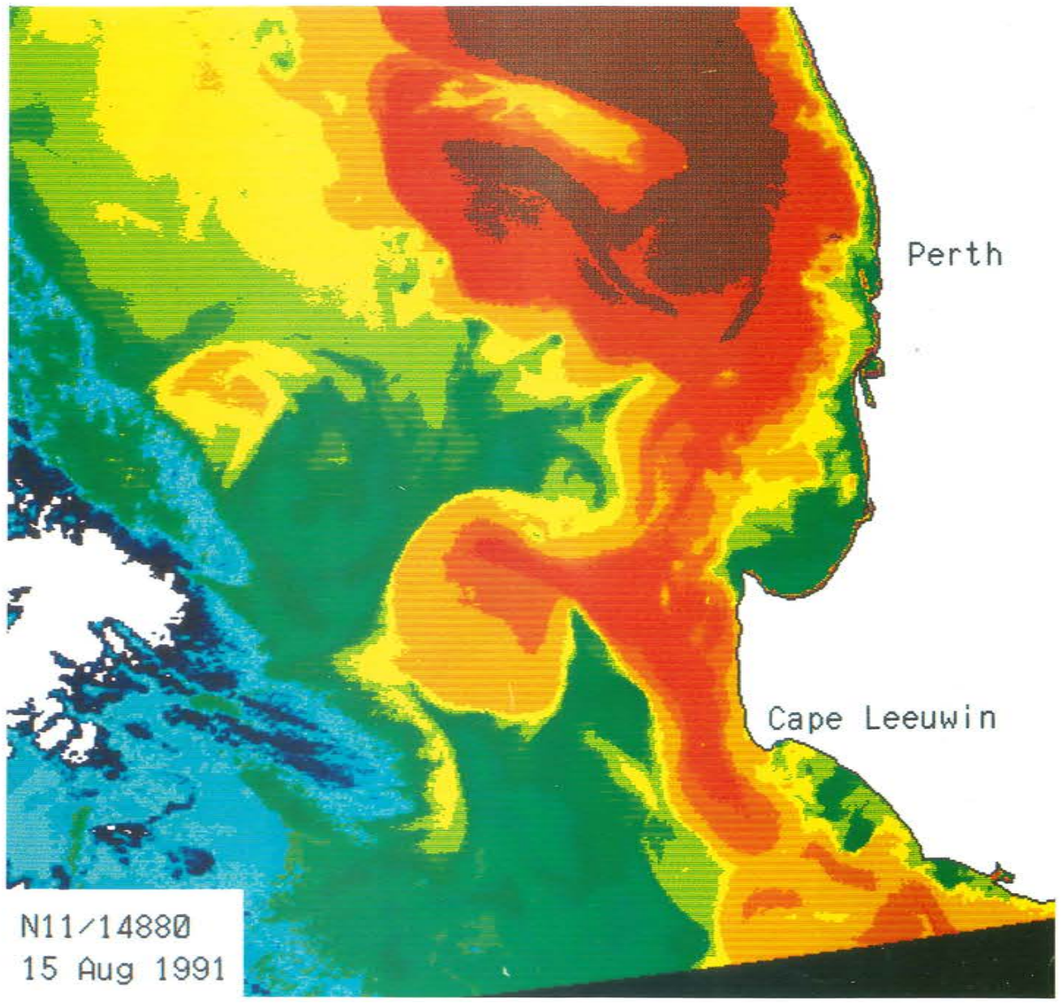
Sponsors: * Neville Stanley Studentship Scheme
Steedman Science and Engineering.
WASTAC for satellite data sets.

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, two additional approaches are under investigation. The intention is to apply the most successful approach to assist the Navy's cable laying project (associated with the submarine tracking range) off Garden Island in December 1993.

The project is continuing over the 1992/93 Summer sponsored by a Neville Stanley Studentship awarded to Brendon McAtee. The studentship will be undertaken via a collaboration between Steedman Science and Engineering and Curtin.



NOAA/AVHRR satellite imagery has revealed that there is often a northwards current of cooler water past Cape Leeuwin and Cape Naturaliste during the summer months. It is shown by the cool (blue) stream of water in the March 1991 image. In winter, by contrast, the Leeuwin Current (red/orange) is flowing strongly southward past the Cape (August 1991 image). (See over page)



August 1991 image

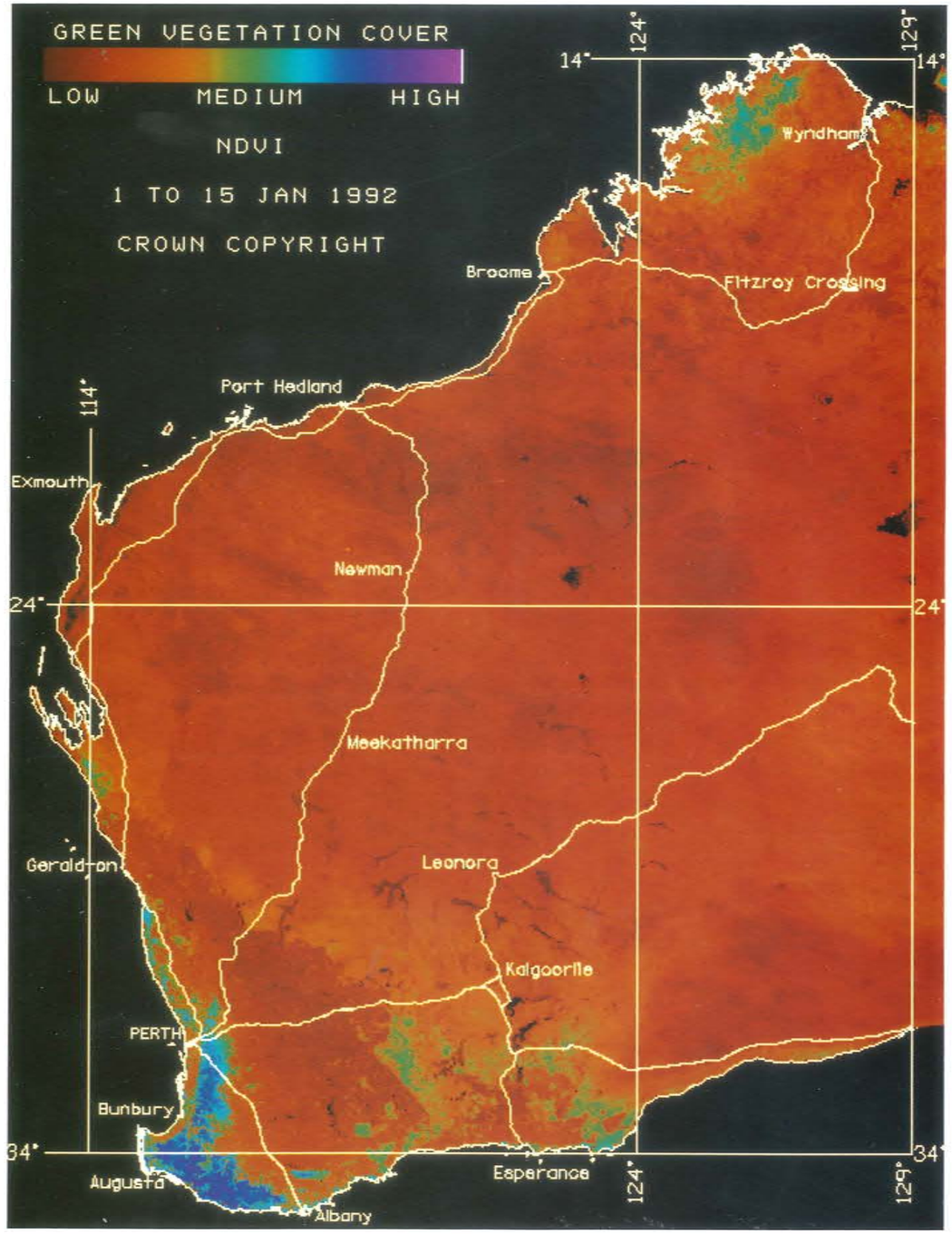


Image 1: The NDVI image of the period 1-15 January 1992 shows Western Australia in mid-summer. In the south west the area of Jarrah and Karri forest are identified by its blue colour and further east other areas of native perennial vegetation are also evident. The agricultural area of the south west is identified by its dark brown colour indicating the annual species with a virtual absence of active vegetation growth during the summer months. At the eastern margin of the agriculture area the dark brown grades into a lighter brown marking the beginning of the pastoral area composed of sparse perennial species. A limited area of vegetation growth is evident in the north west, due to poor summer monsoonal rains that occurred in late 1991 and early 1992.

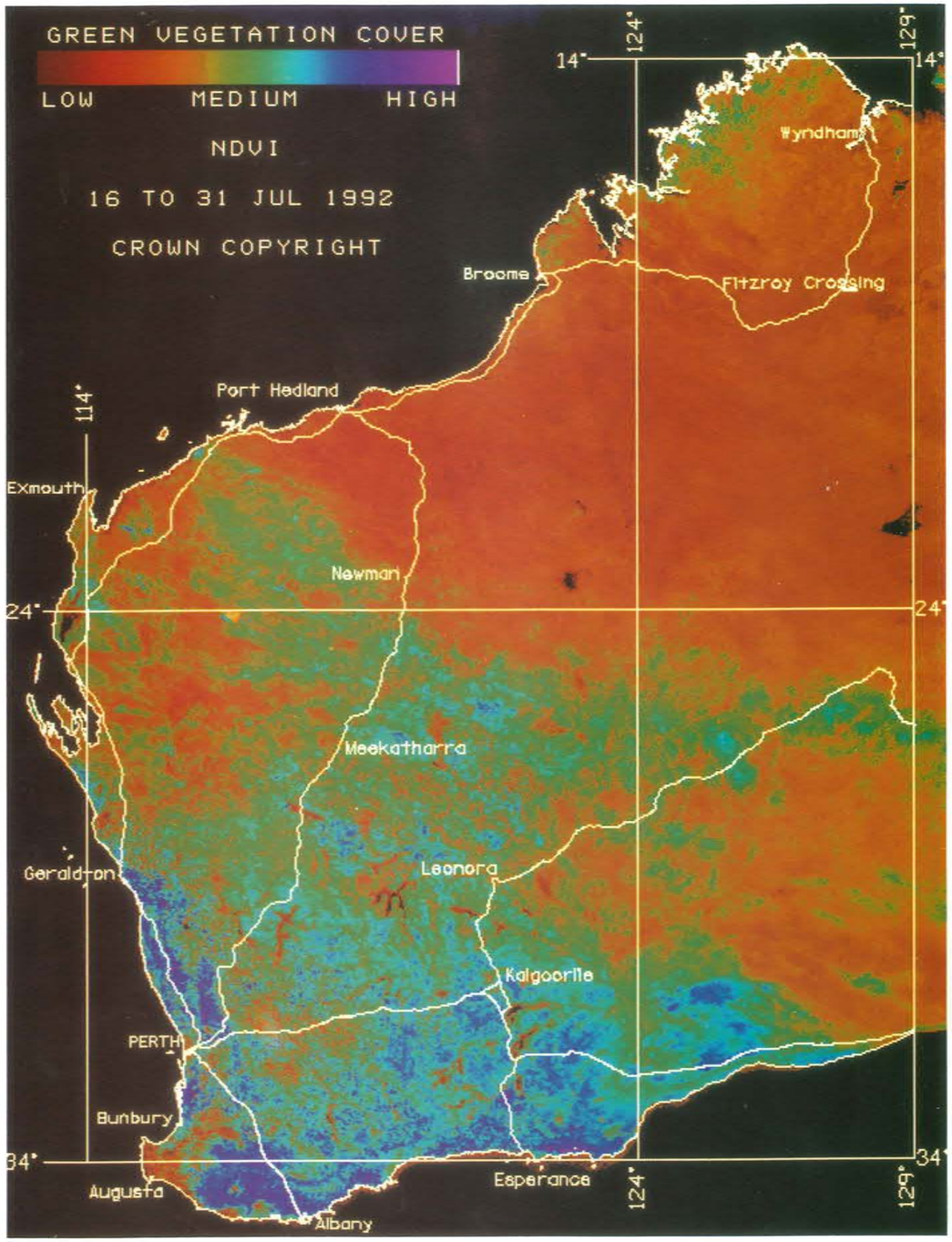


Image 2: The NDVI 6 months later from 16-31 July 1992 shows the results of good winter rains that occurred across the agricultural areas and into the inland bringing above average seasonal conditions to the southern pastoral areas and the Pilbara. The image shows the north west in its dry season, but with some limited vegetation growth on the wetter coastal margin.

12. Title: **Coefficient Tuning for Precipitation Estimation from Satellite Data.**

Third Year Student: Mark Gray.

Collaborators: Dr W P Menzel, CIMSS, NOAA/NESDIS, Madison,USA.
Dr B Goodman, SSEC, University of Wisconsin, Madison, USA.
Dr B Ebert, Bureau of Meteorology, Melbourne.
Mr D Ward, Bureau of Meteorology, Perth.

Sponsors: Bureau of Meteorology, Perth for GMS satellite data sets.
* Summer Studentship, Department of Applied Physics, Curtin.
* Summer Studentship, CSIRO Division of Oceanography, Hobart.

The estimation of precipitation levels from satellite infrared imagery requires the local tuning of regression coefficients. This work has tuned the coefficients using local precipitation data and GMS imagery. The project will continue through 1993 and will investigate the role of cloud history (e.g. cloud top cooling rates) on subsequent precipitation rates. This project forms part of the Global Energy and Water Experiment (GEWEX). GEWEX has designated Tropical Ocean Global Atmosphere / Coupled Ocean Atmosphere Response Experiment (TOGA/COARE) as the field experiment to be used to produce the third Algorithm Intercomparison Project under the Global Precipitation Climatology Project (GPCP). Curtin is a participant in the analysis of these data.

13. Title: **Improved Cloud Detection and Classification Scheme Using AVHRR Data.**

Third Year Student: Ian Dean.

Collaborators: Dr W P Menzel, CIMSS, NOAA/NESDIS, Madison,USA.

Sponsors: WASTAC for data sets.

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 (e.g. Gutman; Coakely and Bretherton) with a view to statistically assessing comparative performance as a first step toward developing a cloud climatology software package.

Acknowledgements

The Remote Sensing and Satellite Research Group (RSSRG) at Curtin remains small with respect to tenured academic staff. To a large degree it exists because of the considerable number of students interested in the Group's research and the support of those scientists and agencies external and internal to Curtin who provide either supervisionary assistance, othertimes data sets or access to specialised facilities not available at the University.

In particular, we acknowledge the assistance of the following scientists who have been consistent supporters of the RSSRG's research activities:

International Collaborators

Dr W P Menzel, NOAA/NESDIS, Madison, Wisconsin for his exceptional level of support and cooperation over the last decade; Prof W Smith, Dr H Revercomb, Dr R Knuteson and Dr T Achtor of the CIMSS high-resolution interferometry group at the University of Wisconsin; Dr R Fox and Mr W Hibbard of SSEC, University of Wisconsin; Dr Z Ninkov, Rochester Institute of Technology; and Dr J Eyre, at ECMWF, UK.

Australian Collaborators

From CSIRO, Dr A J Prata (DAR), Dr R G C Smith (DEG), Dr N Campbell (DMS), Dr A Gabell (DEG), Dr S Young (DAR), Mr A Pearce (DO), Dr J Parslow (DF) and Mr B Hunt (DAR). From the Bureau of Meteorology, Mr L Broadbridge, Mr D Ward and Dr G Foley (WA); Dr J Le Marshall, Dr B Forgan, and Dr E Ebert, Bureau of Meteorology Research Centre, Melbourne. Dr R Koch, Murdoch University; Dr I Foster, WA Department of Agriculture; Mr A Tate, Oceanroutes (Aust) Pty Ltd; Mr S Buchan, Steedman Science and Engineering.

Research and Project Funding

For specific project support we acknowledge WASTAC for access to the 13 year (1981-1993) environmental satellite data archive. DITAC for support via the International Collaborative Research Fund; Perth Observatory for a contribution to the latter project; CSIRO DAR, EPA (WA) and the University Office of R&D for a greenhouse project support; Oceanroutes (Aust) for endorsement of the SeaWiFS initiative; CIMSS (Wisconsin) for extended field work support in the USA on the HIS/ozone project; Digital Equipment Corporation's External Research Program; for student conference support, the Remote Sensing Association of Australia, the Australian Institute of Physics (WA Branch), the Conference Committee of the 6th Australasian Remote Sensing Conference (Wellington, NZ); AIDAB for student field work travel support; the Australian Space Office, the Australian Academy of Science and DSTO for travel assistance, honoraria, etc.

Internal to Curtin

At Curtin, for support of the work of the RSSRG and endorsement of the international collaborative agreements we acknowledge the Vice-Chancellor, Prof J Maloney and the assistance from the VCDR fund. Prof J R de Laeter, Deputy Vice-Chancellor Research and Development, is acknowledged for continuing support on a number of initiatives including WASTAC, WARSIDEC, PARG and our collaborative research with CSIRO.

A special thanks is due to colleagues, especially Mr Brian White for his mathematical skills and impressive level of supervisionary support for research students; to Dr Mario Zadnik, for support with student supervision, and to Assoc. Prof Dennis Moore, for his enthusiasm for cooperative research work and the many ventures he initiates which are a direct benefit to the RSSRG.

Within the RSSRG Laboratory special thanks must go to Dave Foster and Huw Lynch who provide impressive support for systems software, applications software, data conversions, image processing and the training needs of the team of RSSRG research students who work in the Remote Sensing Laboratory at location 301-045.

Department of Land Administration
Remote Sensing Applications Centre (RSAC)

Richard Stovold, RSAC

RSAC has been active in developing new initiatives and promoting the technology to government and industry users. The use of remote sensing data in both digital and hard copy format is continuing to be a valuable resource for management and monitoring of the state's huge resources. Of particular interest is the continuing monitoring of environmental conditions and the mapping of existing resources whether it be land, water or forest.

The Centre continues to actively contribute to the Vegetation Watch project in collaboration with the CSIRO. In addition, we provide major support to the WASTAC consortium actively managing the archive and data distribution, supplying analysis expertise, computing facilities and technical advice for applications.

Major applications supported by the Centre in collaborating with government agencies and industry groups include:

- **Sea Surface Temperature**

A series of sea surface temperature images depicting the varying warm currents off the Western Australian Coast were generated for private fishing groups in the Shark Bay and Dongara Region. These images assisted in determining the most likely areas for feeding rock lobster. A range of sea surface temperature products have also been supplied to yachting events to depict the position of the Leeuwin Current.

- **Leeuwin Current Studies**

NOAA/AVHRR data supplied by WASTAC provided assimilative capacity measurements of the waters within the Leeuwin Current. The project is being undertaken in conjunction with the Perth Metropolitan Waters Coastal Studies and involves the Environmental Protection Authority, Western Australian Water Authority and Centre for Water Research at the University of Western Australia.

- **Bush Fire Mapping**

A service is regularly being provided to the Bush Fires Board to map the extent and position of major bush fires in the State. The monitoring of these events assists in the planning, management and eventual mapping of their position. Direct benefits being the ability to predict fuel loads and manage a controlled burning programme.

- **Management and Technical Support**

Programmes initiated by WASTAC and facilitated by RSAC in conjunction with other consortium members are:

- supply of digital data to the 1 kilometre Global Data Set project.
- investigations into the establishment of a real time microwave link to the new remote sensing building at Floreat.
- negotiate an agreement with NASA for a near real time ground station operators license to acquire SEAWIFS ocean colour data.

The Remote Sensing Applications Centre is continuing to develop applications in conjunction with government agencies. With the collocation of the Centre to the Leeuwin Centre for Earth Sensing Technologies it is expected that new consortia initiatives will occur with industry, tertiary and research groups to further benefit remote sensing.

Curtin University of Technology

Professor G D Lodwick

Head School of Surveying and Land Information

Facilities

The major event in 1992 was the purchase of an Intergraph ImageStation System, a soft photogrammetry workstation, which can be used for research in photogrammetry, remote sensing and GIS. This system was purchased through the Analytical Photogrammetry and Applications Consortium (APAC) which consists of partners from industry, government and the university.

Members of APAC comprise:

Curtin, School of Surveying and Land Information
Department of Land Administration
Western Australian Land Information Systems (WALIS)
Main Roads Department
Department of Conservation and Land Management
Department of Marine and Harbours
Department of Minerals and Energy
Department of Agriculture

The system is worth half a million dollars. Half of this was contributed by Intergraph under a Professional Development Initiative and the remainder was met through contributions by APAC members.

The workstation brings the latest technology in photogrammetry and remote sensing to Western Australia and is one of the first installations of its type outside of North America. It enables real time viewing of stereo images of the earth's surface. The system merges the traditional manual skills of photogrammetry and image processing to provide clear and accurate images of sections of the earth's terrain.

In Western Australia, the technology can be applied to areas such as agriculture, mining, environmental management, surveying and cartography. It can be used by universities, public sector agencies, land care groups and commercial organisations.

Remote Sensing Research Projects

Automated Interpretation of Digital Remote Sensing Imagery

(G D Lodwick, C Domenikiotis, G L Wright)

The aim of this study is to develop knowledge-based system techniques to undertake automated image interpretation from SPOT images. The study area is to the north of Perth in the Gnangara State Forest. The data are being segmented using procedural algorithms and a knowledge base comprising spectral, spatial and contextual data is being developed. The rule base has been coded into an expert system shell in order to undertake the decision-making process.

Monitoring Bush Fires in the Kimberley Region Using NOAA AVHRR Imagery

(G D Lodwick, S B Hardstaff)

This project utilised NOAA AVHRR data to trace the movement of uncontrolled fire burns throughout the seasons. This work established a database for monitoring fire burns throughout the Kimberley region as an aid for both government instrumentalities and land owners.

Use of Satellite Derived Vegetation Data for Updating GIS Databases

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

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.

Digital Elevation Modelling

(S B Montgomery, R J Corner)

This investigation aims to test the suitability of elevations extracted automatically on the Intergraph ImageStation for hydrogeological studies in occasionally waterlogged areas near Narrogin. Comparison will be made with models measured on a conventional analytical stereodigitiser.

Pushbroom Scanner

(S B Montgomery, S Ho)

A project to convert an existing NOVA hosted orthoprojector into a pushbroom scanner is being supported by a $15,000 grant from APAC. Radiometric and geometric refinement will be the subject of further research in 1993.

Enhanced Regolith Interpretation Using Satellite Imagery and DEM Data

(G L Wright, G D Lodwick, S Khokhar, A Gabell)

This project is being conducted jointly with CSIRO and aims to develop a rigorous methodology for the integration of Landsat TM data and a Digital Elevation Model for mapping the regolith in the Yilgarn of WA.

Landform Mapping Using Remote Sensing and GIS

(G L Wright, D B Gardiner)

This project has been designed to enable landforms to be identified following the integration of soils, vegetation, enhanced Landsat TM and digital elevation data. Analysis of the data and identification of landforms is providing valuable information for land management activities, especially in remote regions where present map coverage is poor.

Monitoring Ground Water Use on the Perth Coastal Plain

(G L Wright, in conjunction with WAWA)

This research involves the use of Thematic Mapper satellite remote sensing data to monitor irrigation practices on the Swan Coastal Plain, WA. The aim is to enable the conservation and management of valuable ground water resources to be undertaken effectively.

SEAWIFS

WASTAC is committed to the acquisition of SeaWifs Ocean Colour Data in near real time. An agreement for a near real time research use licence from NASA is being negotiated by Assoc. Prof. M Lynch. To ensure continuity of data supply WASTAC will be separately submitting a NASA "Research Direct Readout Ground Station Terms and Conditions Agreement". This agreement will provide WASTAC access to SeaWifs data in near real time.

The research proposal focuses on two broad scientific themes of regional impact.

a) the use of SeaWifs to estimate regional biomass production rates, and

b) numerical modelling to establish the consistency of biomass production with local radiative forcing and coastal water dynamics.

FINANCIAL STATEMENT

A completed financial position statement has been prepared for WASTAC by the Financial Accountant at Curtin who has been officially appointed WASTAC Treasurer. The statement covers the standard university accounting period 1 January 1992 to 31 December 1992.

A Statement of Accounting Policies follows together with a cash flow statement, balance sheet, listing of income and expenditure and an auditor's report.

During the year the Board resolved to maintain the 1993 annual estimated expenditure budget to the same level as 1992 ($47,000). Special provision has been made for a communications upgrade to allow data to be accessible in real time to the Leeuwin Centre for Earth Sensing Technologies at Floreat. This will be determined following a feasibility and consultants report. Major items of expenditure are consultant fees to assist in WASTAC data handling, consumable supplies being primarily exabyte tapes and paintjet quicklook costs and provision for capital equipment purchase. No significant equipment purchases were made during the year.

Consortium member contributions were reviewed during the year. It was unanimously agreed that each member would maintain its contribution to $10,000 per year. Revenue from the sale of NOAA digital data was marginally higher than for the previous year. Most data was supplied for the joint CSIRO/DOLA RIRDC Vegetation Watch programme, CSIRO ocean studies, Curtin University research programmes and applications undertaken by RSAC.

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 1992 TO 31 DECEMBER 1992

1. STATEMENT OF ACCOUNTING POLICIES

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

(a) General Methodology

The financial statements are prepared in accordance with the provisions of approved Australian Accounting Standards Reporting is 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

	1992 $	1991 $
Computing Equipment (at cost)	186,037	95,279
Accumulated Depreciation	(117,697)	(18,053)
TOTAL COMPUTING EQUIPMENT	**68,340**	**77,226**
Other Equipment (at cost)	183,765	41,765
Accumulated Depreciation	(85,497)	(7,814)
TOTAL OTHER EQUIPMENT	**98,268**	**33,951**
TOTAL NON-CURRENT ASSETS	**166,608**	**111,777**

4. ASSET REVALUATION RESERVE

	1992 $	1991 $
Opening balance	37,747	(13,444)
Movement during the Year	92,250	51,191
CLOSING BALANCE	129,997	37,747

5. RETAINED PROFITS/(LOSSES)

Opening Balance	153,036	142,532
Net surplus (Deficit) for the year	(5,385)	10,504
CLOSING BALANCE	147,651	153,036

6. EXTRAORDINARY ITEMS

Extraordinary Income comprised the following:

Recognition of Non-Current Assets:		
Computing & Other Equipment	92,250	51,191
Transfers to Asset Revaluation Reserve	92,250	51,191
TOTAL EXTRAORDINARY INCOME AFTER TRANSFERS	—	—

7. CONTRIBUTIONS RECEIVED

Department of Land Administration	10,000	10,000
CSIRO	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	14,250	5,720
TOTAL	**14,250**	**5,720**

CURTIN UNIVERSITY OF TECHNOLOGY

WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 1992

	$
BALANCE OF CASH AS AT 1 JANUARY 1992	**79,606 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	14,250
Interest Received	2,791
Total Sundry Income	17,041
TOTAL RECEIPTS FOR 1992	**57,041**
PAYMENTS	
Salaries and Wages	8,186
Telephone	3,296
Travel	2,000
Consumables	10,145
Equipment	1,980
TOTAL PAYMENTS FOR 1992	**25,607**
EXCESS OF RECEIPTS OVER PAYMENTS FOR 1992	**31,434**
BALANCE OF CASH AS AT 31 DECEMBER 1992	**111,040 CREDIT**

CURTIN UNIVERSITY OF TECHNOLOGY

WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

BALANCE SHEET AS AT 31 DECEMBER 1992

	NOTE	1992	1991
CURRENT ASSETS			
Cash at Bank		111,040	79,606
TOTAL CURRENT ASSETS		**111,040**	**79,606**
NON-CURRENT ASSETS	3		
Computer Equipment		68,340	77,226
Other Equipment		98,268	33,951
TOTAL NON-CURRENT ASSETS		**166,608**	**111,177**
TOTAL ASSETS		**277,648**	**190,783**
CURRENT LIABILITIES			
Creditors & Borrowings		—	—
TOTAL CURRENT LIABILITIES		**—**	**—**
NON-CURRENT LIABILITIES			
Credits & Borrowings		—	—
TOTAL NON-CURRENT LIABILITIES		**—**	**—**
TOTAL LIABILITIES		**—**	**—**
NET ASSETS		**277,648**	**190,783**
SHAREHOLDERS EQUITY			
Asset Revaluation Reserve	4	129,997	37,747
Retained Profits/(Losses)	5	147,651	153,036
TOTAL SHAREHOLDERS EQUITY		**277,648**	**190,783**

CURTIN UNIVERSITY OF TECHNOLOGY

WA SATELLITE TECHNOLOGY CENTRE - SF COST CENTRE 1198

INCOME AND EXPENDITURE STATEMENT FOR THE PERIOD 1 JANUARY 1992 TO 31 DECEMBER 1992

	NOTE	1992	1991
INCOME			
Contributions Received	7	40,000	40,000
Sundry Income	8	14,250	5,720
Interest Received		2,791	7,661
TOTAL INCOME		**57,041**	**53,381**
EXPENDITURE			
Salaries & Wages		8,186	—
Telephone		3,296	1,866
Travel		2,000	—
Consumables		10,145	13,780
Equipment		1,980	1,518
Printing, Stationery & Photocopying		—	1,953
Depreciation		36,819	21,876
Maintenance of Equipment		—	1,884
TOTAL EXPENDITURE		**62,426**	**42,877**
NET SURPLUS (DEFICIT)		(5,385)	10,504
EXTRAORDINARY ITEMS	6	92,250	51,191
NET SURPLUS (DEFICIT) AND EXTRAORDINARY ITEMS		86,865	61,695
TRANSFERS TO ASSET REVALUATION RESERVE	4	92,250	51,191
NET SURPLUS (DEFICIT) TRANSFERRED TO RETAINED PROFITS/(LOSSES)		(5,385)	10,504

WASTAC BUDGET 1993

Estimated expenditure financial year January 1993 - December 1993.

		PER ANNUM $ 1993	1992
1	Telecom rental	2,500	2,500
2	Exabyte tapes $30 tape 15 passes per tape Maximum 12 passes/day 50 weeks/year 4200 passes/year	9,500	9,500
3	Tape drive maintenance	—	—
4	System maintenance (new based on 10% of equipment costs	4,000	7,500
5	Telecommunications licence of facility	500	500
6	Photographic/Ink jet quicklook costs	5,000	5,000
7	Consultants-Archive/product generation assistance	8,500	4,000
8	Sundries, consumables	4,000	4,000
9	Travelling - airfares	4,000	5,000
10	Provision for major equipment	9,000	9,000
11	Special provision for improved communications/existing facilities	100,000	
	TOTAL	**147,000**	**47,000**

WA SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM

Financial Statements: Year Ended 31 December 1992

AUDITOR'S REPORT

I have audited the attached financial statements and in my opinion they fairly represent the transactions of the Consortium during the 1992 calendar year, together with its financial status as at 31 December 1992. The statement is based on proper accounts and records.

P J Perriam
Manager, Internal Audit
CURTIN UNIVERSITY OF TECHNOLOGY

19 April 1993

COMPUTING EQUIPMENT AS AT 30 APRIL 1993

ASSET NO	DESCRIPTION	ORIGINAL COST	ACCUM DEPREC	WRITTEN DOWN VALUE
2494515	MICROSOFT OS /2 PM TOOLKITT	488.00	208.42	279.58
2587007	MATHS CO-PROC INTEL 20MHZ	570.00	243.44	326.56
2494511	ETHERLINK MC CARD	590.00	251.98	338.02
2587001	MOUSE	109.00	46.56	62.44
2552700	TAPE DRIVE 2 GBYTE X801A	6,840.00	3117.19	3722.81
2587010	2MB MEMORY MODULE	475.00	202.87	272.13
2494507	OS/2 EXTENDED EDITION V 1.2	700.00	298.96	401.04
2553701	ACQNR	3,800.00	1731.77	2068.23
2587200	ULTRA 1000 20"	2,870.00	1225.73	1644.27
2494506	PS/2 CARD TO OPTION SCSI	142.00	60.65	81.35
2494509	MATHS CO-PROCESSOR INTEL 25MHZ	726.00	310.06	415.94
2494503	PS/2 DUAL ASYNCH ADAPTER	233.50	99.73	133.77
2494500	PS/2 25MHZ A/320 MBHD & MONITOR	16,686.00	8261.53	8424.47
2478800	2.3GB 8MM EXABYTE	6,272.00	3105.38	3166.62
2587002	PS/2 DUAL ASYNCH ADAPTER	233.50	99.73	133.77
2494512	MONITOR DISPLAY CABLE	120.00	51.25	68.75
2587005	2MB MAIN MEMORY EXPANSION	953.00	407.01	545.99
2494510	4-16 MEMORY BOARD 4MB	1,501.00	641.06	859.94
2629700	CARTRIDGE SYSTEM 2.5 G BYTE 8MM	4,950.00	1972.26	2977.74
2494516	FORTRAN V2.0	754.00	322.02	431.98
2587011	2 MB MEMORY MODULE	475.00	202.87	272.13
2587000	PS/2 20MHZ 2/320MBHD VGA	8,846.00	3777.98	5068.02
2587300	5.25 DISKETTE	501.00	213.97	287.03
2494504	PS/2 DUAL ASYNCH ADAPTER	233.50	99.73	133.77
2587003	PS/2 DUAL ASYNCH ADAPTER	233.50	99.73	133.77
2587014	MONITOR DISPLAY CABLE	120.00	51.25	68.75
2587009	2MB MEMORY MODULE	475.00	202.87	272.13
2585200	PAINTJET XL C1602A	2,425.00	1035.68	1389.32
2587100	ULTRA 1000 20"	2,870.00	1225.73	1644.27
2494505	5.25 EXTERNAL DISKETTE ADAPTER	204.00	87.13	116.87
2587012	ETHERLINK MC CARD	590.00	251.98	338.02
2494517	LOCAL AREA NETWORK TECH MANUAL	70.00	29.90	40.10
2494501	MEMORY EXPANSION BOARD 4MB	1,911.00	946.17	964.83
2587008	2-8MB MEMORY EXPANSION	1,450.00	619.27	830.73
2494513	MS MACRO ASSEMBLER V 5.1	174.00	74.31	99.69
2494508	320MB HD DRIVE	4,739.00	2023.94	2715.06
2494518	PS/2 MOUSE	109.00	46.56	62.44
2487013	FUTURE DOMAIN	450.00	192.19	257.81
2587004	OS/2 EXTENDED EDITION V1.2	700.00	298.96	401.04
1358800	SYSTEM SATELITE TRACKING STATION	110,000.00	89062.79	20937.21
2494514	MICROSOFT C COMPILER V6	448.00	191.33	256.67
		186,037.00	**123,391.94**	**62645.06**

OTHER EQUIPMENT AS AT 30 APRIL 1993

ASSET NO	DESCRIPTION	ORIGINAL COST	ACCUM DEPRC	WRITTEN DOWN VALUE
2009000	MA 23 CC	20365.00	7971.44	12393.56
1358700	SATELITE STATION TRACKING	140000.00	75485.66	64514.34
2553700	RECEIVER NOAA I/F FORMAT	19,500.00	4,851.72	1,4648.28
1948500	POWER CONDITIONER	2,000.00	809.59	1,190.41
2552600	SGSI HOST ADAPTOR 598A	1,900.00	472.74	1,427.26
		183,765.00	**89591.15**	**94173.85**

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BACK COVER IMAGE

The extent of flooding of the Fitzroy River is vividly depicted in this satellite mosaic. The extent of floods in February and March 1993 are seen in light brown in the centre of the image. Vegetation and soil is depicted in this Thematic Mapper image as green and brown respectively. The NOAA/AVHRR image subset in the top right corner depicts the regional extent of flooding waters in blue stretching from the coast to east of Halls Creek and south to Lake Gregory.