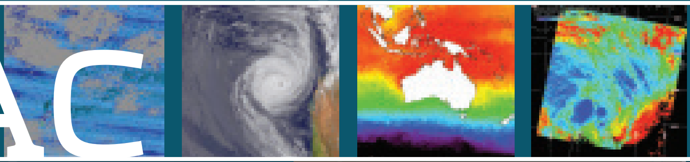
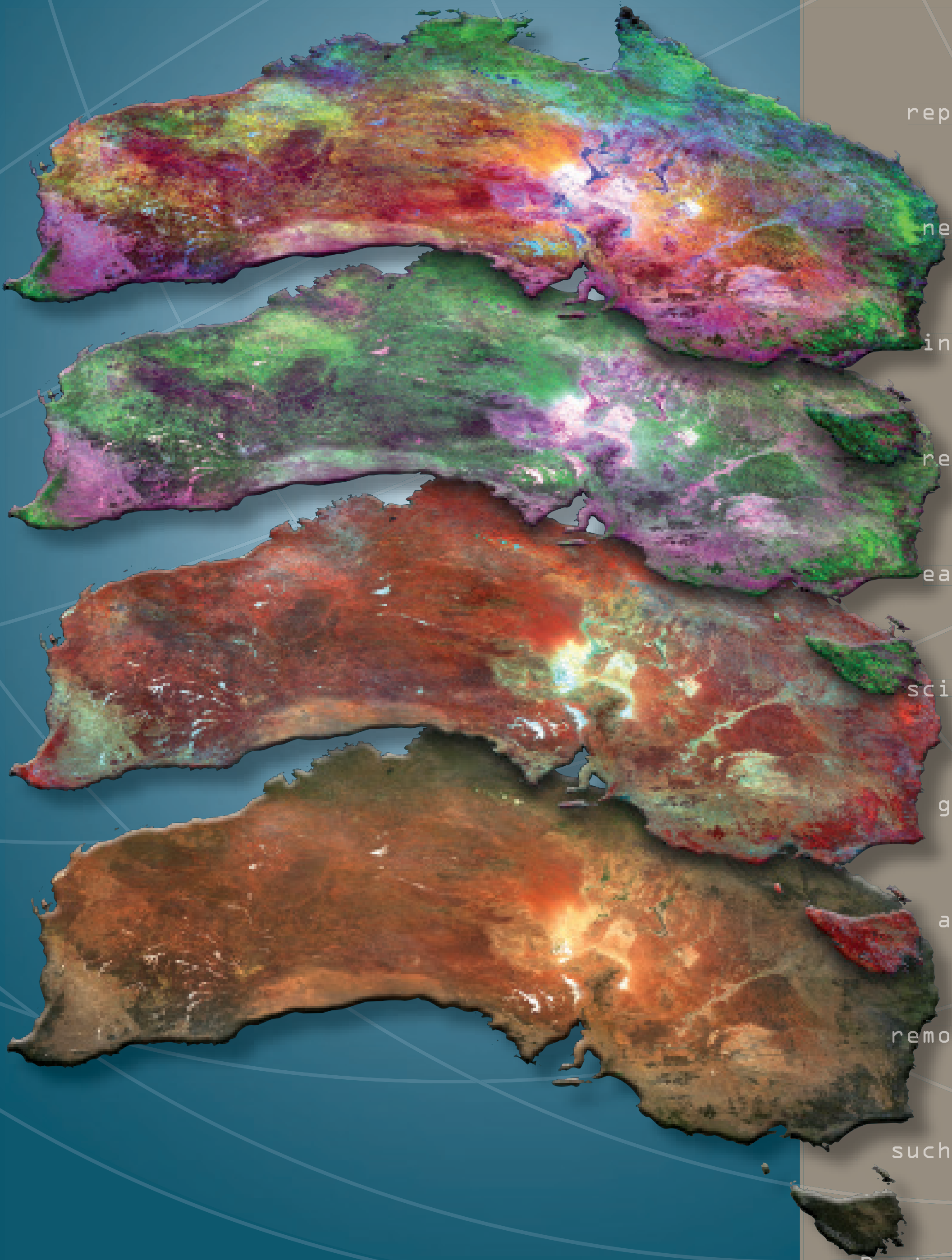
WASTAC

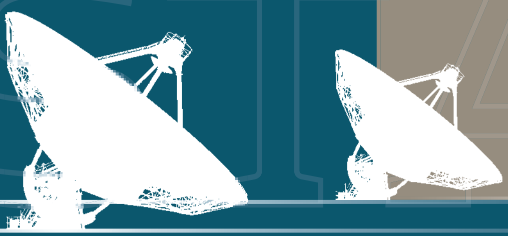


WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM



The images represent the new insights in ecosystem research and earth system science to be gained from advances in remote sensing such as the 19 Band reflectance product.

2011 ANNUAL REPORT



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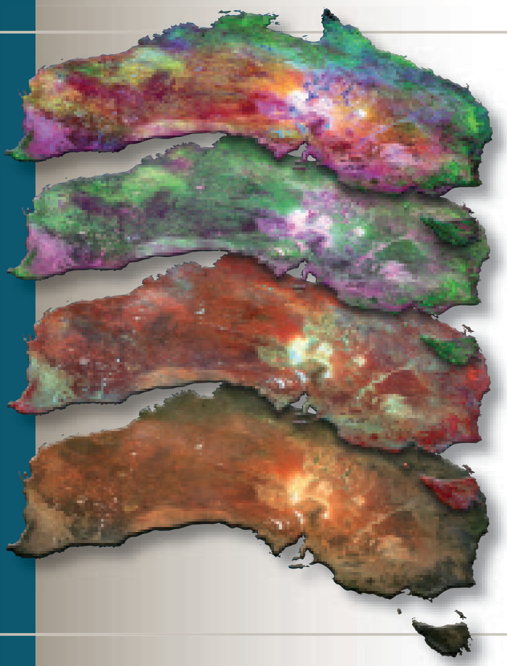


Front Page:

The Western Australian node of the Terrestrial Ecosystem Research Network (TERN) AusCover project is contributing a MODIS-derived 19 Band surface reflectance product to the AusCover data archive (http://www.auscover.org.au/). Commonly, only the first seven bands of the MODIS sensor are processed operationally for near-real time applications. The 19 Band reflectance product includes surface reflectance data for bands 1-19 and 26 of MODIS thereby providing access to previously unavailable spectral information across the continent.

The cover image depicts 4 combinations of bands chosen to highlight how the appearance of the Australian continent changes when viewed from space at different wavelengths. The bottom layer is the standard Red Green Blue (RGB) image created using bands 1,4 and 3 of MODIS. The other layers utilise combinations of bands including bands newly accessible through the AusCover project. The top layer displays the RGB image obtained using bands 7,11 and 18. The second layer displays the RGB image using bands 10,2 and 18 and the third layer shows the RGB image obtained using bands 19,8 and 3.

The images represent the new insights in ecosystem research and earth system science to be gained from advances in remote sensing such as the 19 Band reflectance product.

wastac.wa.gov.au

WASTAC CHAIRMAN

As a new Chairman for WASTAC I wish to acknowledge and thank Merv Lynch for his Chairmanship of WASTAC from 2008 and 2010 and I look forward to carrying on the excellent work that he and his predecessor, Richard Smith, have contributed to earth observation in Western Australia over the past decade.

The main focus of WASTAC in 2011 was on preparing to receive and process data from the NPOESS Preparatory Project (NPP) and METOP-B. The former was launched in November 2011 and the latter is due for launch in 3rd quarter 2012. We anticipate that all required hardware will be installed and tested during the 1st quarter of 2012 and WASTAC will be prepared to begin reception of NPP shortly thereafter.

WASTAC also installed a microwave link from the receiving dish at Murdoch to the Bureau's Perth Offices via Curtin as a business continuity measure if the AARNET links are interrupted. This is an important improvement in our systems to reduce our exposure to single points of failure as the broader community comes to expect products from satellite data to be available all of the time.

Of wider importance to WASTAC is an activity led by Geoscience Australia to articulate the operational requirements for earth observations for Australia to 2015 and beyond. Geoscience Australia produced a report entitled *Continuity of Earth Observation Data for Australia: Operational Requirements to 2015 for Lands, Coasts and Oceans*. This report and other activities resulted in the initiation of the development of a National Earth Observation Strategic Infrastructure Plan. This work is being jointly done by WASTAC partners Geoscience Australia and the Bureau of Meteorology. Requests for Submissions were made to a number of agencies, including Landgate, at the very end of 2011. All members, I am sure, will be keen to see how the Plan develops in 2012.

As the Operational Applications reports show, data sourced from WASTAC is contributing to the development of national scale datasets (Edward King, CSIRO), which are then converted into products that track and monitor cyclones (Willmott et al., BOM), monitor and predict bushfire spread (Steber et al., Landgate) and flood (Buchanan et al. Landgate), monitor agricultural production in southwestern Western Australia (Santich and Stovold, Landgate), and monitor changes to land cover (Geoscience Australia).

On the research front, Curtin University is providing the lead to the WA node of TERN Auscover, which will provide a processing and workflow platform to allow ecosystem researchers to more easily exploit the expanding archive of satellite imagery available at iVEC and other national computing facilities. Increased interest in standard products for near shore measurements of bathymetry and turbidity are coming from State and Federal agencies, as well as the oil and gas industry.

WASTAC is currently in a strong financial position with sufficient reserves to make modifications to existing systems as needed. The WASTAC partners have contributed generously to the efficient running of WASTAC. Ron Craig, Mike Steber, Jackie Marsden, Joe Cudmore and Justin Pitsikas (Landgate), along with Russell Steicke (BOM), have kept the stations and processing systems running with a high degree of reliability. CSIRO maintains the high speed data link needed for near real-time processing at the Leeuwin Centre, as well as production of the NOAA Stitched Archive utilizing WASTAC data. Our Secretary, Richard Stovold (Landgate), has kept the decision making on track and with Alan Pearce (Curtin University) edits an excellent Annual Report. Curtin University continues to manage our accounts. Murdoch University maintains an excellent site for the X-band antenna. Geoscience Australia provides valuable national coordination and access to MODIS data from Alice Springs for WASTAC members. As Chairman, I take pride in the major contributions WASTAC is making to advance our understanding of land, ocean and atmospheric processes within Australia.

Dr. Matthew Adams
Chair, WASTAC Board 2011

WASTAC BOARD 2011

Dr Matthew Adams- Chairman	Landgate
Mr Richard Stovold	Landgate
Professor Merv Lynch	Curtin University
Dr Doug Myers	Curtin University
Dr Kimberley Clayfield	CSIRO
Dr Edward King	CSIRO
Dr Anthony Rea	Bureau of Meteorology
Mr Andrew Burton	Bureau of Meteorology
Dr Adam Lewis	Geoscience Australia
Professor Tom Lyons	Murdoch University
Exec. Dean Yianni Attikiouzel	Murdoch University

WASTAC STANDING COMMITTEE AND PROXY TO THE BOARD

Dr Matthew Adams - Chairman	Landgate
Mr Richard Stovold	Landgate
Professor Merv Lynch	Curtin University
Dr Doug Myers	Curtin University
Mr Andrew Burton	Bureau of Meteorology
Mr Russell Steicke	Bureau of Meteorology
Professor Tom Lyons	Murdoch University
Dr Tom Cudahy	CSIRO

WASTAC SECRETARY:

Mr Richard Stovold	Secretary to the WASTAC Board and Standing Committee.

WASTAC TECHNICAL COMMITTEE:

Mr Russell Steicke (Chairman)

Professor Merv Lynch

Dr Doug Myers

Mr Ronald Craig

WASTAC STRATEGIC PLAN:

Improve the economy, society and environment through the acquisition of satellite observations of Western Australia and its oceans for research and near real-time applications.

MISSION:

- Provide high speed access to Aqua, Terra, NOAA, SeaWiFS and FY1D satellite data to members on a non-profit basis.
- Contribute these data for national and international initiatives in remote sensing.
- Adopt recognised data formats to ensure wide access to WASTAC data.
- Maintain the integrity of archived data for research and operational applications.
- Promote the development and calibration of value-added products.
- Prepare for utilisation of information from new technically and scientifically advanced sensors.
- Promote educational and research uses of WASTAC data.
- Promote use of Aqua, Terra, NOAA, SeaWiFS and FY1D data in climate studies, environmental and renewable resource management.
- Encourage WASTAC to promote awareness of products.

CURRENT STRATEGIES:

- Upgrade reception and processing capabilities for METOP (including AVHRR), NPP (including VIIRS) and FY3 (including MERS).
- Continue to improve the products derived from MODIS sensors.
- Advance the processing of AIRS data from Aqua and Terra.
- Improve the management and access of the WASTAC archive through collaboration with iVEC (Interactive Virtual Environment Computing Facility).
- Provide network access to other Earth Observation Satellite receiving stations in Australia.

FUTURE SATELLITE RECEPTION OPPORTUNITIES:

- National Polar Orbiting Environmental Satellite System and NPP/NPOESS.
- Landsat Continuity Data Mission.
- Chinese HY3 and ZY3 satellites.
- Russian Meteor Satellites.

OPERATIONS

WASTAC maintains an L band reception facility at Curtin University and a dual X and L band facility at Murdoch University. The L band facility has been operational since 1983, although satellite tracking at Curtin (then the WA Institute of Technology) began in the late 1970s. The X band facility has been operating since 2001. WASTAC members make use of the satellite data for weather prediction, vegetation and fire monitoring, and research. WASTAC maintains an ongoing near-realtime archive of L band images beginning in 1983, and X band images from 2001.

CURTIN UNIVERSITY – L BAND

The L band facility at Curtin University in Bentley consists of a 2.4m antenna and an antenna controller supplied by Environmental Systems and Services (ES&S) and dual ingestor computers running an AVHRR ingest and display system developed by the Bureau of Meteorology (BoM). There are other processing computers located at the Bureau of Meteorology in West Perth which run BoM software for image generation and product distribution.

The ingestors are isolated from the Curtin University network, but connected to the BoM in West Perth via a microwave link. This link has recently been upgraded to 100Mbit/second. A second microwave link connects from the BoM back to Curtin University.

During 2011-2012, the L band facility received 6596 passes.

The Curtin University satellite reception facility is maintained by BoM staff.

MURDOCH UNIVERSITY – L AND X BAND

The X band reception facility was supplied by SeaSpace Corporation in 2001. It consists of a 3.6m antenna in a fiberglass dome, and an antenna controller computer. This facility receives data from the Aqua, Terra, MetOp 2, NPP, FY3-B, and FY1-D, as well as the L band satellites. Having two reception facilities for L band allows some satellite conflicts to be resolved.

Data from the X band facility is delivered to Landgate via AARNET. A microwave link to the BoM via the Curtin University facility provides a backup, and data is delivered to the BoM via this link.

The Murdoch University satellite reception facility is maintained by Murdoch University staff.

APPLICATIONS

TOVS data, a subset of the AVHRR is automatically sent to the Bureau of Meteorology in Melbourne where the atmospheric temperature retrievals are ingested into global numerical weather prediction models. Sea Surface Temperature (SST) analyses are produced by the Bureau of Meteorology and Landgate. Landgate also produces vegetation maps and monitors fire scars in realtime.

FUTURE DIRECTIONS

WASTAC continues to be involved with the development of software which will allow easier on-line access to the data stored at the iVEC site in Technology Park, Bentley. A new Sun workstation has also been installed to provide processing of archive products and various metadata. A new MODIS software package and IPOP from NASA will be installed on a new processing computer at Landgate in Floreat, WA.

Early investigations into the possible upgrade of the Curtin University reception facility to dual L and X band capability have begun.

Russell Steicke, Regional Computing Manager (WA), Bureau of Meteorology

WASTAC DATA ARCHIVE

The WASTAC archive of NOAA, MODIS and SeaWiFS satellite passes is managed and maintained by Landgate's Satellite Remote Sensing Services (SRSS) group and held at the Leeuwin Centre at Floreat in Perth. The SRSS Group actively manages the daily archive and management systems that have been installed to ensure rapid and reliable delivery of WASTAC satellite data for research and wider community use.

A total of 17,855 passes were archived at Curtin and Murdoch in 2011.

The near realtime quick-look archive of MODIS and NOAA-AVHRR data continues to be maintained on the world wide web. This digital archive extends back to 1983. A similar archive of SeaWiFS quick-look data is also held on the Web. The archive of MODIS, NOAA and SeaWiFS data can be viewed at:

Landgate currently holds the archive on 8mm exabyte and DAT tapes. 20Gb DLT tapes were introduced as the archive medium in late 2000 for the L band data and since the commissioning of the facility in 2001. X band data has been archived on DLT 35Gb tapes and since this year on on-line mass storage devices.

Duplicate copies of the raw data archive are produced for a national archive program that is coordinated by the CSIRO Office of Space Science and Applications (COSSA) in Canberra.

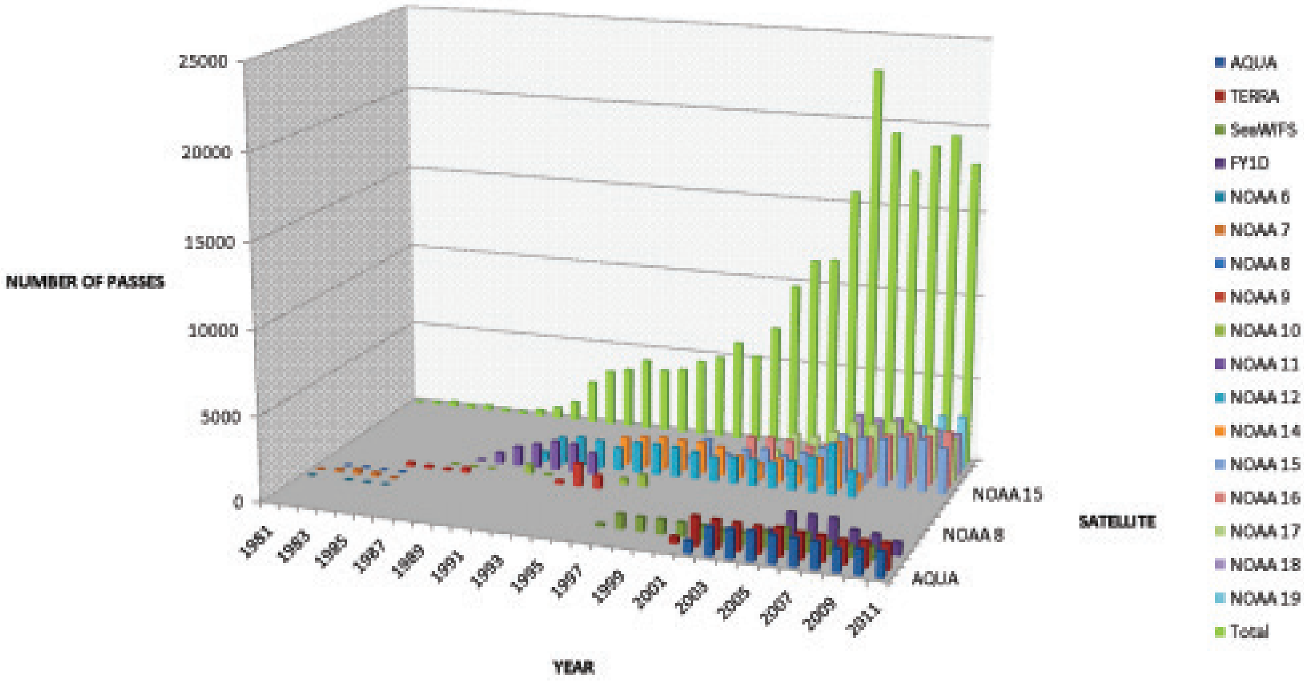
http://www.rss.dola.wa.gov.au/newsite/noaaql/NOAAql.html

http://www.rss.dola.wa.gov.au/newsite/modisql/MODISql.html

http://www.rss.dola.wa.gov.au/newsite/seawifsql/SeaWiFSql.html

	AQUA	TERRA	SeaWiFS	FY1D	NOAA 6	NOAA 7	NOAA 8	NOAA 9	NOAA 10
1981					5	22			
1982						115	1		
1983					12	244	12		
1984					7	179	4		
1985					7	33	4	212	
1986								151	
1987								97	18
1988								280	25
1989									21
1990									
1991									506
1992									47
1993								183	
1994								1362	
1995								770	
1996									354
1997			142						694
1998			859						
1999			822						
2000			843						
2001		390	811						
2002	734	1710	780						
2003	1651	1645	696						
2004	1665	1602	680						
2005	1705	1577	863	553					
2006	1635	1639	1239	1683					
2007	1615	1512	1092	1678					
2008	1553	1495	787	1673					
2009	1327	1411	687	1132					
2010	1454	1516	793	1040					
2011	1485	1537		751					

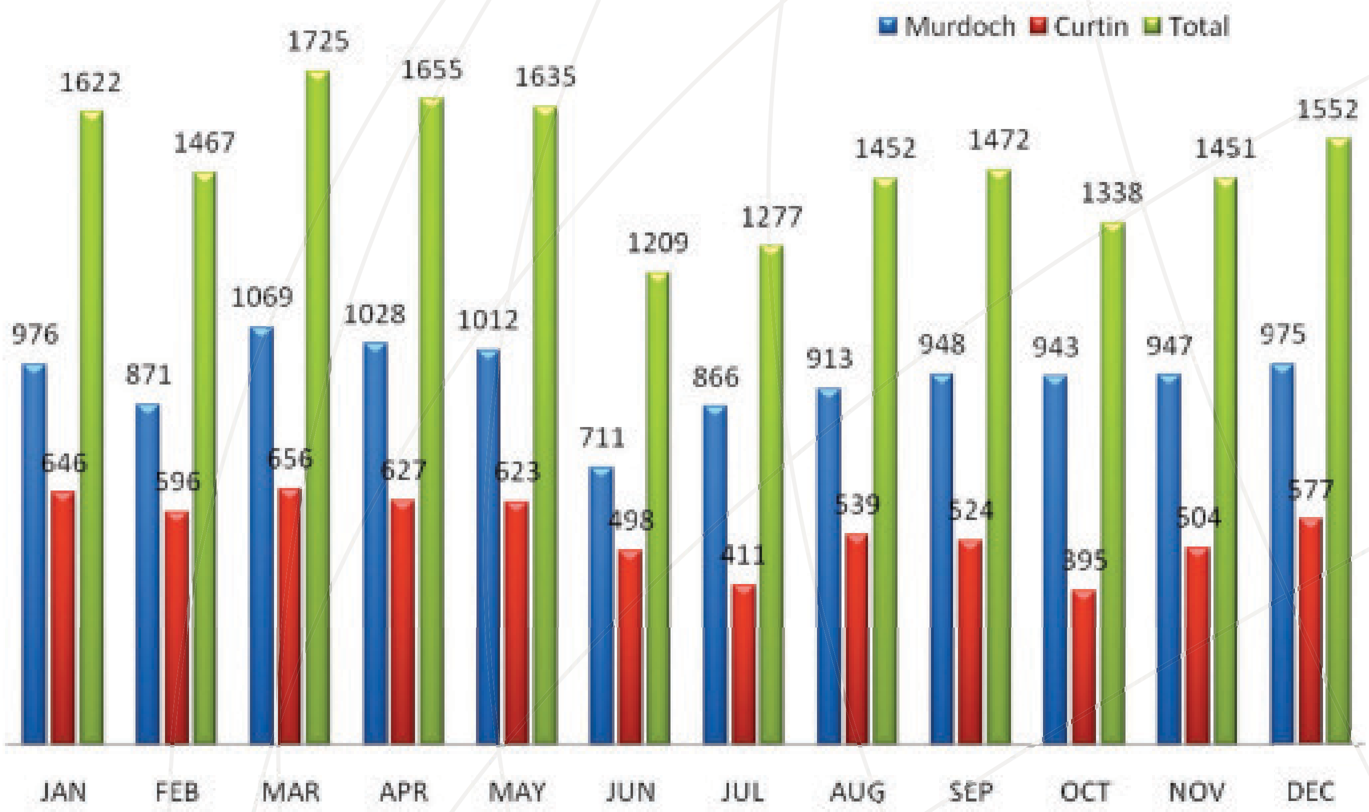
TOTAL ARCHIVED PASSES 1981 – 2011



NOAA 11	NOAA 12	NOAA 14	NOAA 15	NOAA 16	NOAA 17	NOAA 18	NOAA 19	Total
								27
								116
								268
								190
								256
								151
								115
53								358
601								622
1103								1103
1399	575							2480
1693	1571							3311
1656	1720							3559
1227	1641							4230
	1326	1615						3711
	1780	1776						3910
	1797	1876						4509
	1763	1828	432					4882
	1589	1839	1663					5912
	1427	1681	905	341				5197
	1548	1271	1292	1733				7045
	1579	976	1455	1789	709			9732
	1521	1351	1200	1728	1827			11388
	1727	1058	1481	1524	1797			11534
	2101	1706	1904	1743	2212	1339		15703
	3030	2761	2823	2240	2883	2989		22922
	1571	952	2777	2442	2869	2839		19347
			2844	2711	3165	2985		17213
			3055	2951	3254	2622	2306	18745
			3061	2895	3054	2567	3058	19438
			2692	3282	2527	2453	3128	17855

WASTAC DATA ARCHIVE

TOTAL ARCHIVED PASSES FOR 2011



		NOAA 15	NOAA 16	NOAA 17	NOAA 18	NOAA 19	FY1D	TERRA	AQUA	TOTAL
JAN	C	123	125	110	138	150				646
	M	139	143	117	128	129	97	111	112	976
										1622
FEB	C	112	130	92	128	134				596
	M	115	123	105	105	118	100	101	104	871
										1467
MAR	C	122	139	104	143	148				656
	M	138	146	137	136	126	115	138	133	1069
										1725
APR	C	122	141	98	122	144				627
	M	138	138	130	111	137	112	129	133	1028
										1655
MAY	C	120	147	107	103	146				623
	M	138	134	122	128	115	104	135	136	1012
										1635
JUN	C	113	136	88	16	145				498
	M	116	112	105	108	33	20	109	108	711
										1209
JUL	C	31	142	87	1	150				411
	M	151	136	129	88	88	0	137	137	866
										1277
AUG	C	90	145	92	59	153				539
	M	151	134	129	99	130	0	138	132	913
										1452
SEP	C	48	140	90	101	145				524
	M	149	138	122	139	135	0	135	130	948
										1472
OCT	C	21	133	62	44	135				395
	M	133	144	101	133	134	28	136	134	943
										1338
NOV	C	58	132	77	94	143				504
	M	128	145	114	105	118	90	130	117	947
										1451
DEC	C	95	137	87	111	147				577
	M	141	142	122	113	125	85	138	109	975
										1552
		2692	3282	2527	2453	3128	751	1537	1485	17855
	Curtin	1055	1647	1094	1060	1740	0	0	0	6596
	Murdoch	1637	1635	1433	1393	1388	751	1537	1485	11259

OPERATIONAL APPLICATIONS 2011

A variety of operational marine, terrestrial and atmospheric products have been developed using locally-received satellite data from the AVHRR, SeaWiFS and MODIS sensors. The principal agencies involved are the Bureau of Meteorology, CSIRO and Satellite Remote Sensing Services group in Landgate.

CSIRO, CANBERRA

Edward King

NATIONAL REMOTE SENSING DATA SETS

CSIRO includes WASTAC data in a number of national research infrastructure programs to create and distribute Earth Observation data sets of national significance.

Remote sensing imagery from polar orbiting spacecraft is a valuable research tool in both marine and terrestrial environments wherever large spatial coverage of observations are required. By their nature, direct broadcast reception stations only acquire data in their local region. For a country the size of Australia, national coverage requires a network of several stations with broad spatial coverage, something that is beyond the resources of any single organisation. Under the National Collaborative Research Infrastructure Strategy (NCRIS), and by partnering with agencies and consortia (including WASTAC) that operate reception stations, CSIRO operates ground networks and systems that collate direct broadcast data from all round Australia (Figure 1.) and combines them to make truly national data sets.

Two main systems are in place, corresponding to the main data sets received by the WASTAC stations, one for NOAA/AVHRR and one for the Terra and Aqua MODIS instruments.
In addition to meeting an internal research need, these data are made available to the community via the web in near real time for the widest possible benefit.

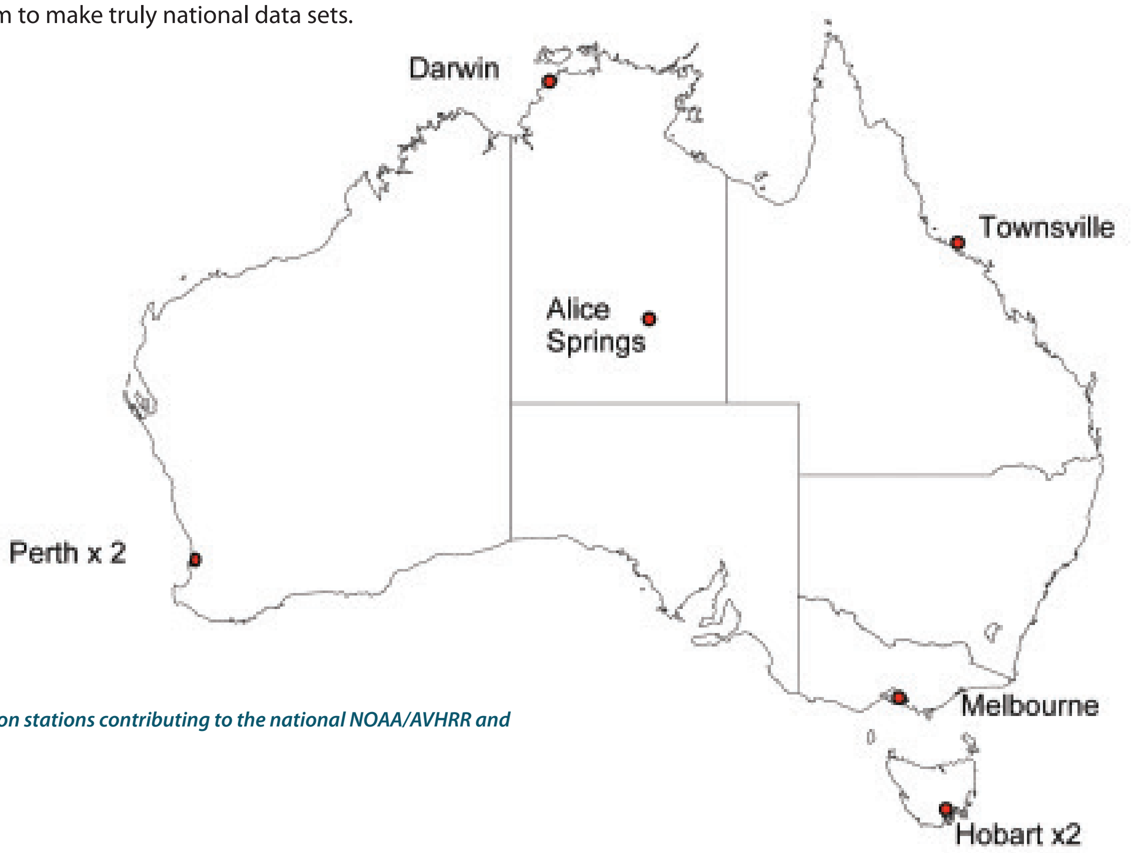


Figure 1. Reception stations contributing to the national NOAA/AVHRR and MODIS data sets.

The NOAA/AVHRR system has been in operation for over 5 years at the CSIRO Advanced Scientific Computing Centre in Melbourne. Data from all passes of all the NOAA spacecraft received by the eight L-band reception stations (including 2 run by WASTAC and 2 run by CSIRO in Hobart) indicated on Figure 1 are brought together and merged to eliminate overlaps and fill data gaps. The merging process uses a custom algorithm that assesses and takes into account both the intrinsic and relative quality of each overpass in choosing how to stitch the inputs and correct noisy data. The system routinely handles around 135 individual acquisitions per day, drawn from up to 40 unique spacecraft orbits, resulting in one high-quality continent-spanning swath per orbit (Figure 2.). WASTAC stations contribute between 20 and 30 percent of these input data.

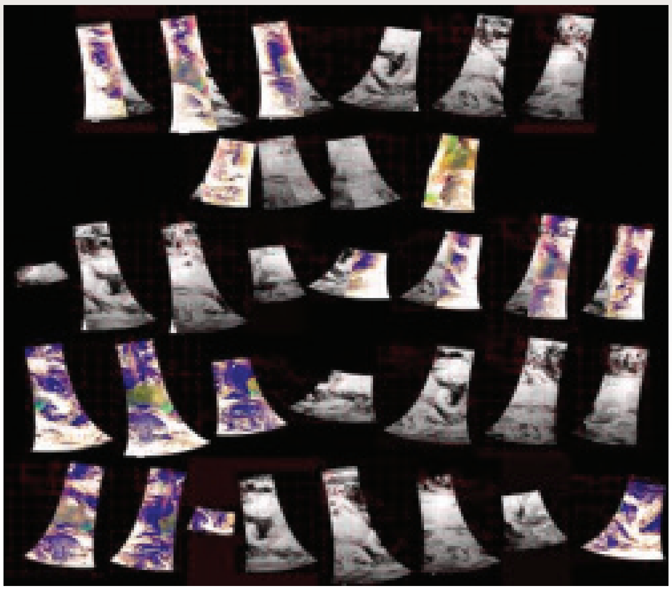


Figure 2. Output from a typical day of NOAA stitching, comprising data from 5 spacecraft (one satellite per row of images). Night passes are black and white, daytime passes are in colour.

The MODIS processing system has been under development throughout 2011 and is located on the National Compute Infrastructure Facility (an NCRIS supported system) in Canberra. Terra and Aqua MODIS Production Data Sets (PDS), which are the packetized output of the reception station demodulation and decoding systems, are received from five stations (Perth, Alice Springs, Townsville, Melbourne and Hobart) and merged using the packet checksums as a guide to data quality. The data are split into 5-minute granules matching the data that can be obtained in delayed mode via the US DAAC. Normally around 40-50 acquisitions are processed each day, resulting in approximately 50 5-minute granules corresponding to 14 to 16 distinct orbits (7-8 for each MODIS platform). The WASTAC Murdoch station is a key contributor to this data set, providing a very reliable stream of overpasses every day.

BUREAU OF METEOROLOGY, MELBOURNE

Compiled by Mike Wilmott, Ian Grant, Leon Majewski, Chris Down and staff of the severe weather warning section of WA

The L-band and X-band reception systems operated by WASTAC form an integral part of the Bureau of Meteorology's satellite reception network. These systems provide important and timely coverage over the west of Australia and out over the Indian and Southern Oceans. Data from these systems are used in a range of application areas including, importantly, numerical weather prediction, the generation of forecasts and warnings, analysis and post analysis of severe weather events and oceanography.

NORMALISED DIFFERENCE VEGETATION INDEX (NDVI)

The Bureau derives the Normalised Difference Vegetation Index (NDVI) from AVHRR data. NDVI is used to monitor the greenness of vegetation, and is an indication of its coverage and vigour (Tucker,1979). The NDVI standardised anomaly quantifies the vegetation state relative to its long-term average and variability for a particular month of the year; specifically it is the number of standard deviations above or below the long-term mean for the month. Maps of NDVI and NDVI standardised anomaly, as well as the underlying data grids, are available on the climate pages of the Bureau's website. The Bureau also distributes NDVI data through the AusCover (http://www.auscover.org.au) web portal which is under development as part of the Terrestrial Ecosystem Research Network.

The NDVI and NDVI anomaly production is based on data from the AVHRR on NOAA-18 that is acquired in near-real-time by the Bureau from WASTAC and other sites around Australia, together with historical AVHRR data supplied by CSIRO. These data are processed into national monthly maximum value composites. Geolocation and cloud masking are performed using the Common AVHRR Processing System (CAPS) software (http://www.eoc.csiro.au/cats/caps/capshome.html). Calibration detrending is by the method of invariant semi-arid sites developed by the Environmental Resource Information Network (ERIN) (McDonald and Cridland, 2004). The NDVI anomaly map for a given month is calculated from the NDVI for that month and the mean and standard deviation of the corresponding month over all years of the record.

The maps of NDVI in Figure 3 show that central Western Australia and southern Australia were greener in March 2011 (Figure 3 (b)) than one year earlier (Figure 3 (a)). This was in response to heavy widespread rain across those regions at the start of 2011. Although the absolute increase in NDVI is small in these semi-arid regions, the overall range of NDVI is normally small for these regions, and the NDVI anomaly map (Figure 3 (c)) shows the unusually large magnitude of this greening event.

OPERATIONAL APPLICATIONS

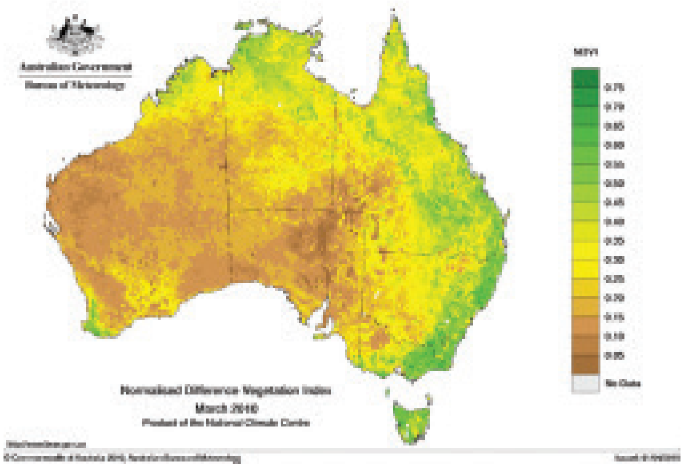


Figure 3(a)

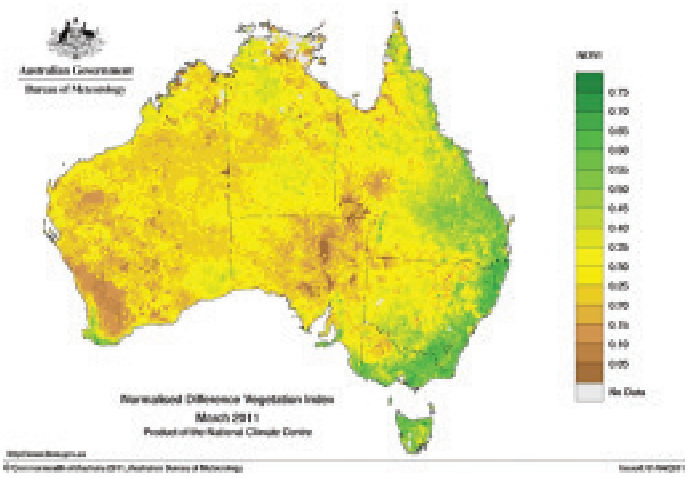


Figure 3(b)

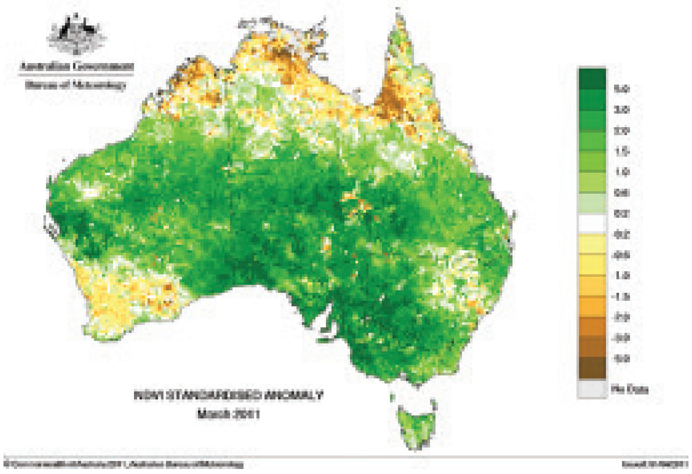


Figure 3(c)

Figure 3. The national AVHRR NDVI maps for March 2010 (Figure 3 (a)) and March 2011 (Figure 3 (b)), and the NDVI standardised anomaly map (Figure 3 (c)) for March 2011. These national maps, state maps at a finer resolution and data grids are available at the Bureau of Meteorology's climate web pages.

ATMOSPHERIC PROFILES FOR NUMERICAL WEATHER PREDICTION

THE ADVANCED TIROS OPERATIONAL VERTICAL SOUNDER (ATOVS)

The ATOVS suite of instruments on board the NOAA and MetOp satellites provides information on the vertical profiles of temperature and moisture in the atmosphere. Clear sky temperature retrievals have been shown to be accurate to ±2 K at 1 km vertical resolution compared to radiosonde soundings (Li et al, 1999). The all-weather microwave component of ATOVS provides the biggest impact on Numerical Weather Prediction (NWP) skill of any single data type, adding several days of predictability in the southern hemisphere (Simmons and Hollingsworth, 2002 , Hollis, 2004). Modern weather forecasting, in turn, relies heavily upon NWP. Global ATOVS coverage is provided by the United States (from NOAA satellites) and Europe (from MetOp), but with delays of three to six hours, which misses the cutoff for some operational NWP systems. In 2011, local ATOVS reception from WASTAC, Darwin, and Crib Point provided the Bureau with NOAA-15, -17, -18 and -19 coverage over the Australian region within 30 minutes of the start of acquisition. ATOVS data are processed through the international standard ATOVS and AVHRR Pre-processing Package (AAPP) and produce significant positive impact in the Bureau's NWP system.

All countries running global NWP systems require global-coverage ATOVS data as a key input; however, there are significant delays (of 3 hours or more) associated with global data streams sourced from the United States. This has stimulated the development of a rapid ATOVS dissemination service, facilitated by the World Meteorological Organisations Space Programme. The Regional ATOVS Retransmission Service (RARS) facilitates the delivery of locally-received ATOVS data, from 38 stations across the globe, providing data with a 30-minute latency over 74 per cent of the globe. The Bureau participates in and coordinates the Asia-Pacific (AP) RARS. In addition to contributing data through five local ATOVS reception facilities, including WASTAC, AP-RARS coordinates 10 international AP-RARS sites, including New Zealand, Singapore, China, Japan, Hong Kong and Korea. The coverage of AP-RARS stations is provided in Figure 4 (see http://www.bom.gov.au/australia/satellite/rars.shtml)

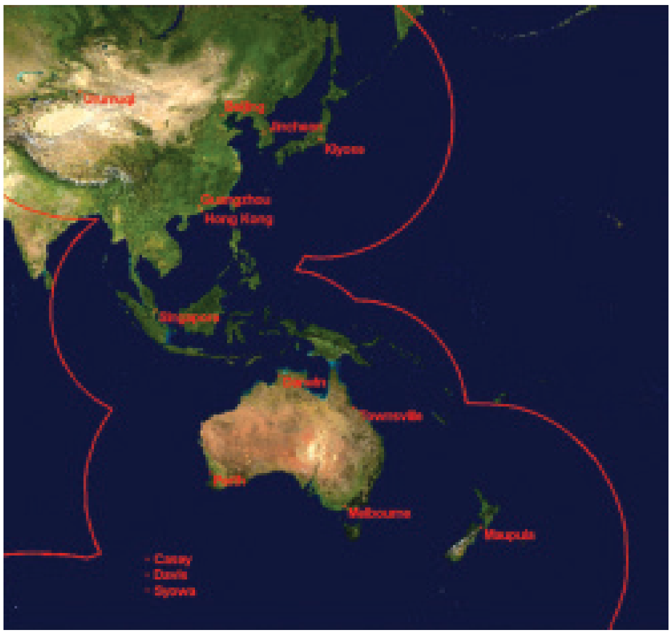


Figure 4. AP-RARS sites

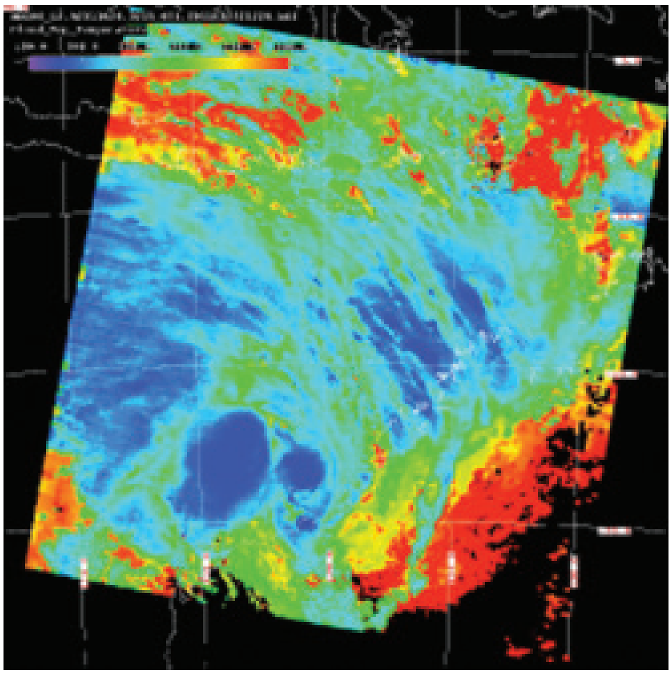


Figure 5. Cloud Top Temperature for 26th January 2011

MODIS AND AIRS DATA

The large number of spectral bands carried by the MODIS instrument on the Terra and Aqua spacecraft enables the derivation of a range of atmosphere and surface products. These include information on the spatial distribution of water vapour, temperature, cloud phase (ice or water) and cloud top properties (pressure, temperature, particle size). Products are generated using the International MODIS and AIRS Processing Package (IMAPP) software from the University of Wisconsin and delivered to forecasters via a developmental web-based system.

Figures 5 and 6 show MODIS data from WASTAC for the 26th January 2011. The RGB composite, Figure 7, highlights Severe Tropical Cyclone Bianca.

Figures 5 and 6 highlight the higher level composite MODIS imagery for the same interval. One can see that the tropical cyclone centre cloud top was extremely cold and through the severe winds the atmospheric composition was mixed with the cyclonic winds pulling the larger high level particles, red, through the rotation and into the eye.

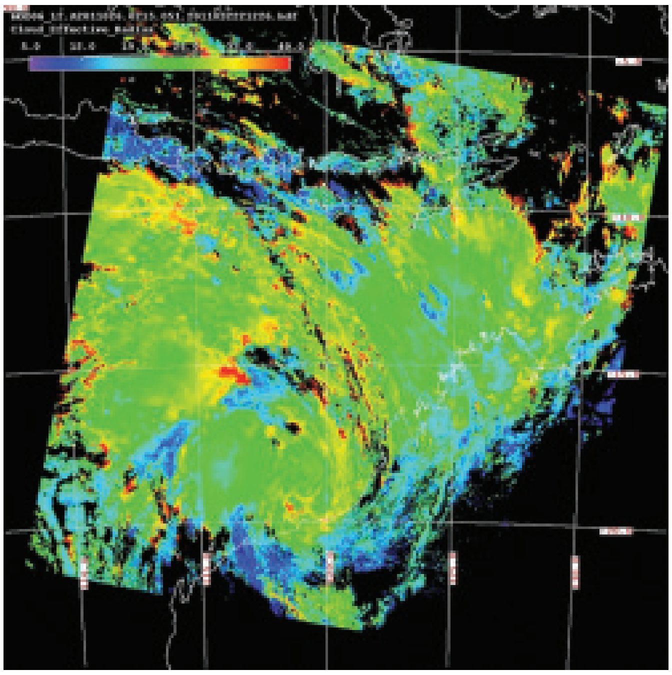


Figure 6. Cloud Particle Effective Radius for 26th January 2011

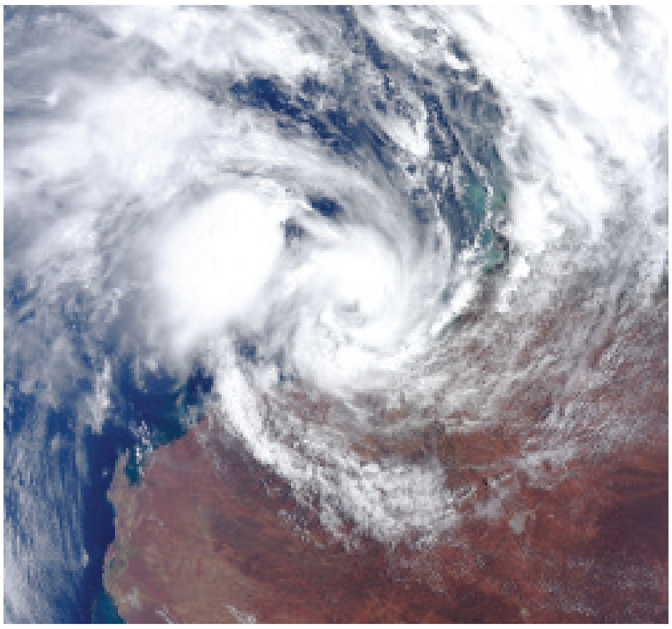


Figure 7. RGB composite image for the 26th January 2011

The Aqua satellite also carries the Atmospheric Infrared Sounder (AIRS), which provides atmospheric temperature and moisture profiles at high spectral resolution. Image products describing the temperature and moisture structure of the atmosphere are also produced by IMAPP software for delivery to forecasters. AIRS data have shown major positive NWP impact overseas (Tobin et al, 2006), and are being assimilated operationally in the Bureau's ACCESS NWP system. The Australian Community Climate and Earth System Simulator (ACCESS) is a local implementation of the United Kingdom Met Office Unified Model used for NWP and Climate modelling. Figure 8 highlights the impact of AIRS on model 1000hPa Anomaly Correlations for the Southern hemisphere for a case study period. This was the first of a series of experiments which, even at this early stage (2004), showed that there was a significant positive impact made using this data.

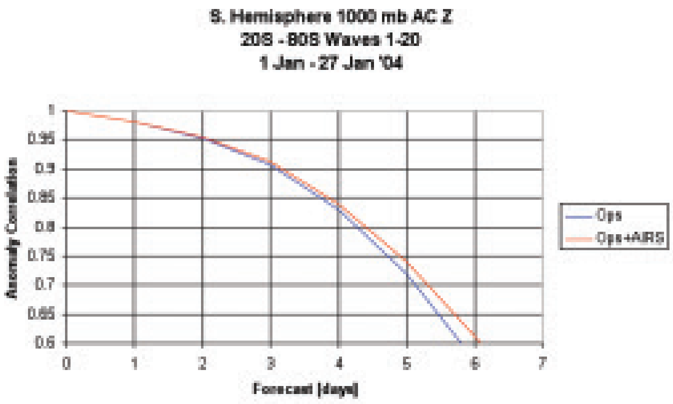


Figure 8. 1000hPa Anomaly Correlations for the GFS with (Ops.+AIRS) and without (Ops.) AIRS data, Southern hemisphere, January 2004. Graph provided by John Le Marshall.

SEA SURFACE TEMPERATURE (SST)

The Bureau produces moderate-resolution sea surface temperature (SST) products in near real time from AVHRR sensors on-board the POES Satellites. The POES data are captured using the network of L-Band receivers around the country, including the WASTAC L-Band receivers.

These AVHRR SST products are currently included in global (1/4° spatial resolution; Figure 9) and regional (1/12° spatial resolution; Figure 10) SST analyses that are used operationally in ocean forecasting and numerical weather prediction, including the prediction of tropical cyclones and severe weather events (Beggs, 2008). The AVHRR SST product is used to observe fine details and gradients in SST (Figure 11), while the Global Australian Multi-Sensor Sea surface temperature Analysis (GAMSSA) and the Regional Australian Multi-Sensor Sea surface temperature Analysis (RAMSSA) are used to provide a synoptic view of the ocean temperature. The AVHRR SST product is also used to monitor the performance and to quality control the Bureau's operational Ocean Model, Analysis and Prediction System (Brassington et.al, in press)

Because these products are incorporated in operational systems, it is important that both the service level and product performance are routinely monitored. A system was developed to monitor the service level for SST products. In 2011, 98% of SST data was processed and delivered within 3 hours. The performance of the Bureau's SST product is routinely monitored by observing the difference from contemporaneous in situ measurements provided by a network of drifting buoys. Summary statistics describing the performance of the derived SST algorithms during 2010 and 2011 are provided in Table 1. The levels of uncertainty enable the occurrence and magnitude of diurnal warming to be observed (Kaiser-Weiss et.al.).

The Bureau's SST products have been formatted following the Group for High Resolution SST (GHRSST) Data Processing Specification (GDS) and are compatible with the Integrated Marine Observing System (IMOS) Australian Oceans Distributed Active Archive Centre (AO-DAAC). Multi-day and multi-sensor composites are now downloadable from IMOS and from the Bureau upon request.

Quality Index	NOAA 18			NOAA 19		
	N	Bias	S.D.	N	Bias	S.D.
Night (Wind > 2 ms⁻¹)						
3	3253	-0.007	0.578	3378	-0.079	0.592
4	2269	0.019	0.380	2345	-0.056	0.407
5	2770	0.011	0.302	3116	-0.036	0.307
Day (Wind > 6 ms⁻¹)						
3	1683	-0.045	0.637	1902	-0.053	0.641
4	1752	-0.026	0.496	1828	-0.047	0.481
5	2296	0.011	0.404	2563	-0.009	0.380

Table 1. Summary statistics for comparisons between satellite and drifting buoy temperature measurements separated by quality level and time for 2010-2011. N = number of coincident observations; Bias = Satellite - Buoy (K); and, S.D. = standard deviation (K).

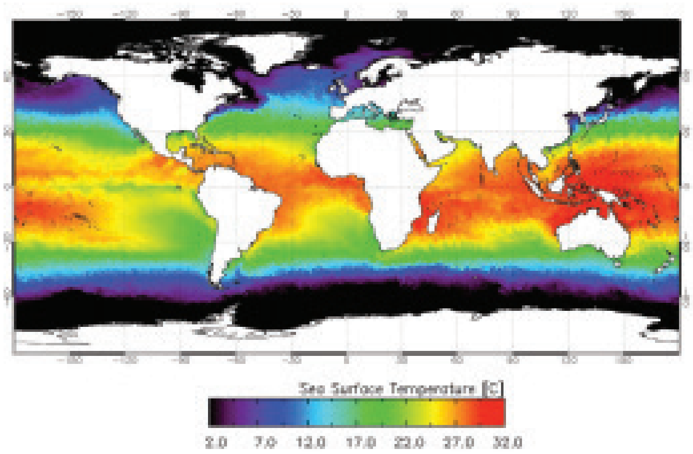


Figure 9. Global Multi-Sensor Sea Surface Temperature Analysis (GAMSSA) for 10/01/2011.

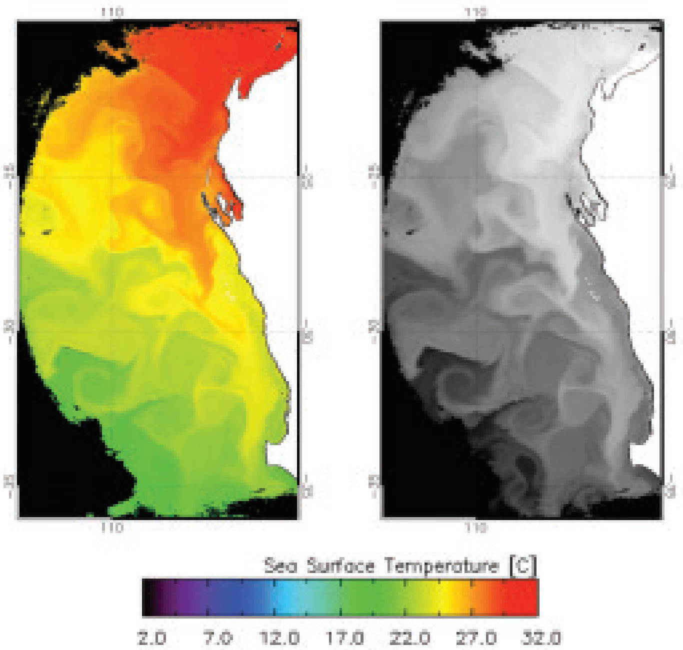


Figure 11: Night time AVHRR SST composite for 10/01/2011 (left) and corresponding enhancement (right). The turbulent nature of the Leeuwin Current can clearly be seen in the enhanced image.

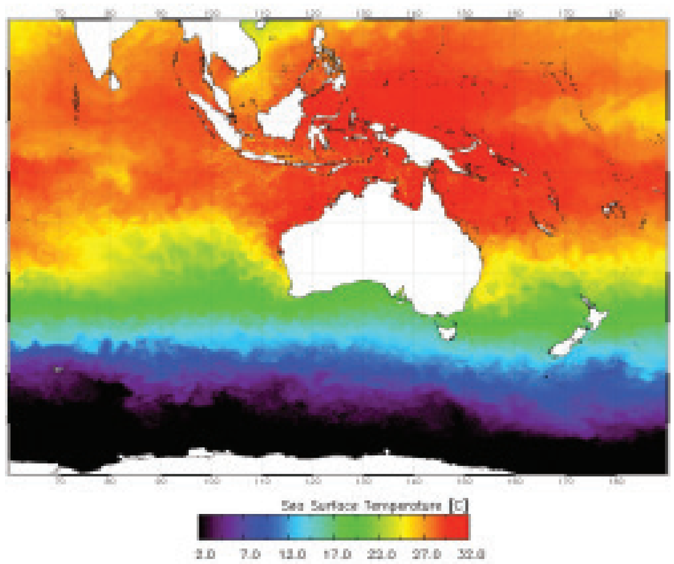


Figure 10. Regional Multi-Sensor Sea Surface Temperature Analysis (RAMSSA) for 10/01/2011

OPERATIONAL APPLICATIONS

TROPICAL CYCLONE MONITORING

The Bureau operates one of its three Tropical Cyclone Warning Centres (TCWC) from its Western Australian Regional Forecasting Centre in Perth. Within the Centre, data from WASTAC are used to assist in the monitoring of the fine detail of tropical cyclones and supplements the imaging of these large systems by radar and the geostationary satellites MTSAT-2, operated by Japan, and Feng Yun 2, operated by China.

For the period 1 January 2011 to 31 December 2011, there were six tropical cyclones that entered or formed within Perth TCWC's area of responsibility (See Table 2). Of these, the most severe tropical cyclone that threatened the Australian coastline was Severe Tropical Cyclone Bianca.

Tropical Cyclone	Period (2011)	Max Intensity	Impact on Coast or Other Aus. Territory	Means of Detection
Vince	9 – 16 January	Cat 1	Nil	Satellite
Bianca*	23 – 30 January	Cat 4	Slight	RADAR/Satellite
Dianne*	14 – 22 February	Cat 3	Nil	Satellite
Carlos*	13 – 25 February	Cat 3	Moderate	RADAR/Satellite
Errol	12 – 18 April	Cat 2	Nil	RADAR/Satellite
Alenga*	3 – 9 December	Cat 3	Nil	(DOAR)**

Table 2. List of Tropical Cyclones for the Period January 2011 to December 2011
** Classified as Severe Tropical Cyclone*
*** DOAR – Detected outside area of responsibility*

SEVERE TROPICAL CYCLONE BIANCA (23 - 30 JANUARY 2011)

A low developed over land near Wyndham on 21 January and moved north over the Joseph Bonaparte Gulf during 22 and 23 January. The system then tracked southwest across the Kimberley before moving over open water north of Broome again later on 25 January. The system reached cyclone strength and was named Bianca at 2 am WST 26 January (1800 UTC 25 January) and tracked west southwest, parallel to the Pilbara coastline. The system intensified, reaching category 3 at 2 pm WST 27 January (0600 UTC 27 January). Bianca then moved southwest and reached a peak intensity of category 4 at 8 am WST 28 January (0000 UTC 28 January). Bianca began to weaken by 2 am WST 29 January (1800 UTC 28 January) as it moved south over cooler SST's and experienced increased wind shear. The system eventually dissipated over open water to the west of Perth, never crossing the Western Australian coastline. Bianca became the first cyclone in twenty years to reach as far south as Perth.

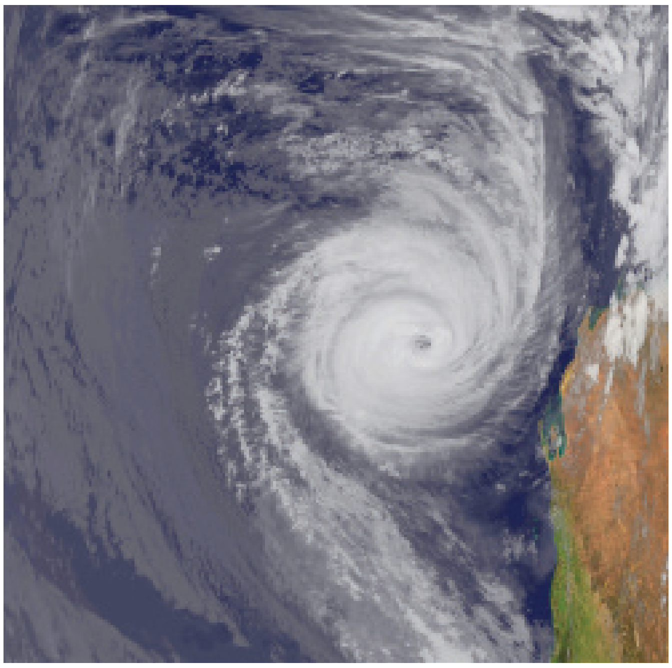


Figure 12. Severe Tropical Cyclone Bianca from NOAA-18. 28 January 2011 0706 UTC

The passage of Bianca produced no known damage but did produce heavy rainfall in the Kimberley and coastal parts of the Pilbara disrupting operations in Australia's major iron ore port and several oil facilities in the Pilbara region. The system also caused higher than normal tides along the Pilbara and west coasts. Figure 12 shows severe tropical cyclone Bianca at around peak intensity.

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LANDGATE, SATELLITE REMOTE SENSING SERVICES, FLOREAT

FIRE SPREAD SIMULATION

Mike Steber, Adrian Allen, Bonnie James and Keith Moss

Predicting probable fire spread is vital to the success of fire suppression and protection of lives and property. Fire authorities responsible for deploying resources gain a valuable advantage if they know in advance where the fire is likely to be by the time resources arrive. Researchers at the University of Western Australia (UWA) have developed software, called Australis, to simulate bushfire spread over the various fuel types found within Australia. Landgate has been detecting fire hotspots (FHSs) from the Moderate Resolution Imaging Spectroradiometer (MODIS), onboard the Terra and Aqua satellites, in near real-time for over 10 years using both NASA software and algorithms developed in-house. Aurora, a new web based system developed by Landgate in partnership with UWA and the Fire and Emergency Services Authority (FESA) of WA, uses these satellite derived FHSs as ignition points for the UWA simulator.

Other variables are also used including real-time gridded forecast weather and gridded drought factor data from the Bureau of Meteorology (BoM). This allows simulations of up to 24 hours to be activated automatically each time a set of FHSs from MODIS are detected. The output from each simulation is sent to the FireWatch-Aurora website (see Figure 13). This secure website allows fire controllers to overlay the bushfire spread simulations on other GIS datasets to determine what infrastructure is threatened and what access is available to enable suppression of the fire. Armed with this valuable information, a fire controller can then deploy resources with maximum efficiency. The fire controller is also able to run simulations using a combination of their own information (including firebreaks) and pre-existing data. This allows the testing of various ignition points and weather conditions in order to determine the best days for carrying out prescribed burns or to run a series of scenarios quickly to optimise fire suppression outcomes.

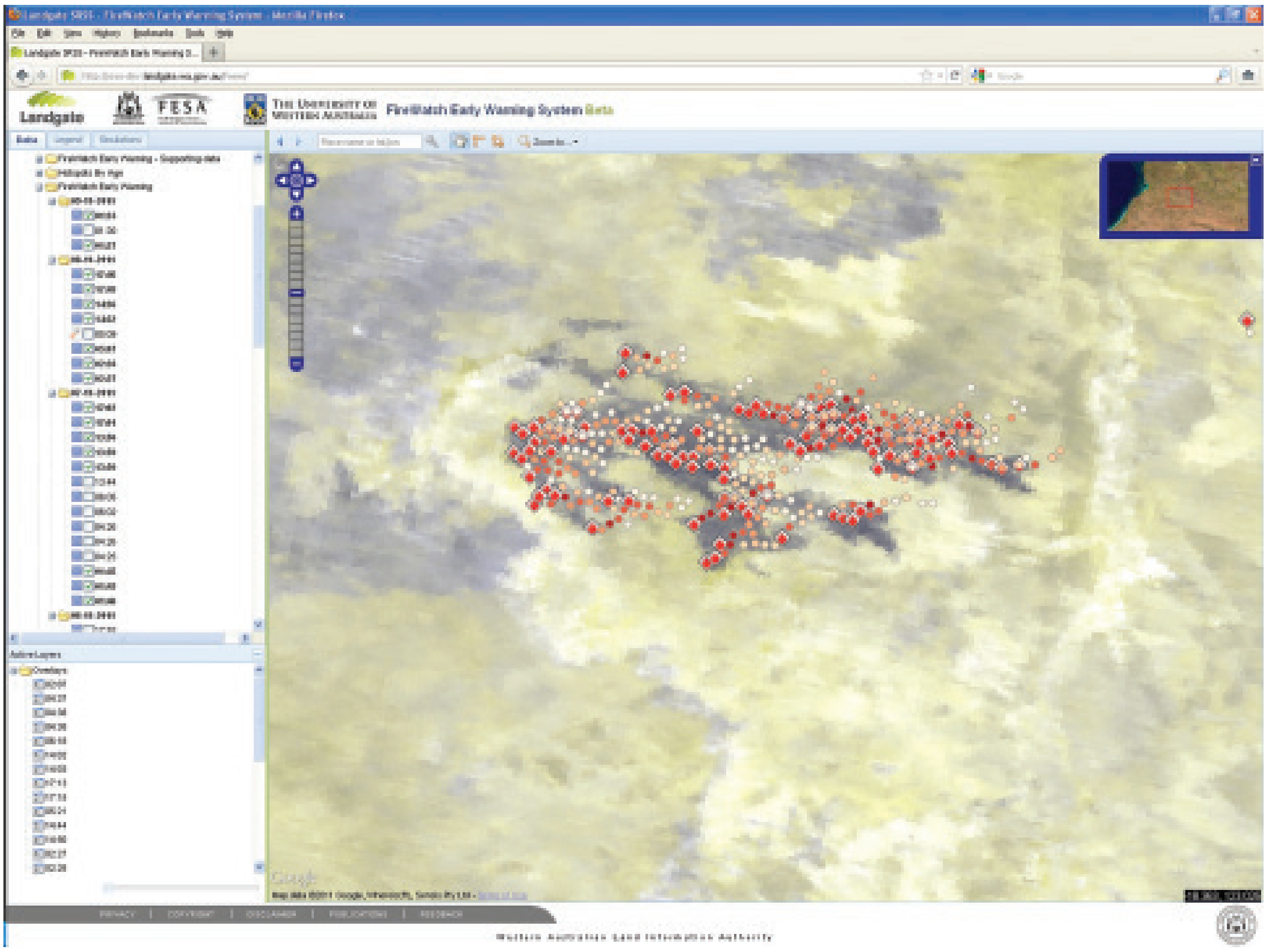


Figure 13. Aurora website showing fires (diamonds) east of Broome during early November 2011 with simulation points (circles) overlaid on MODIS imagery showing extent of fire scar.

MODIS SHOWS IMPROVING CONDITIONS FOR THE 2011 GROWING SEASON

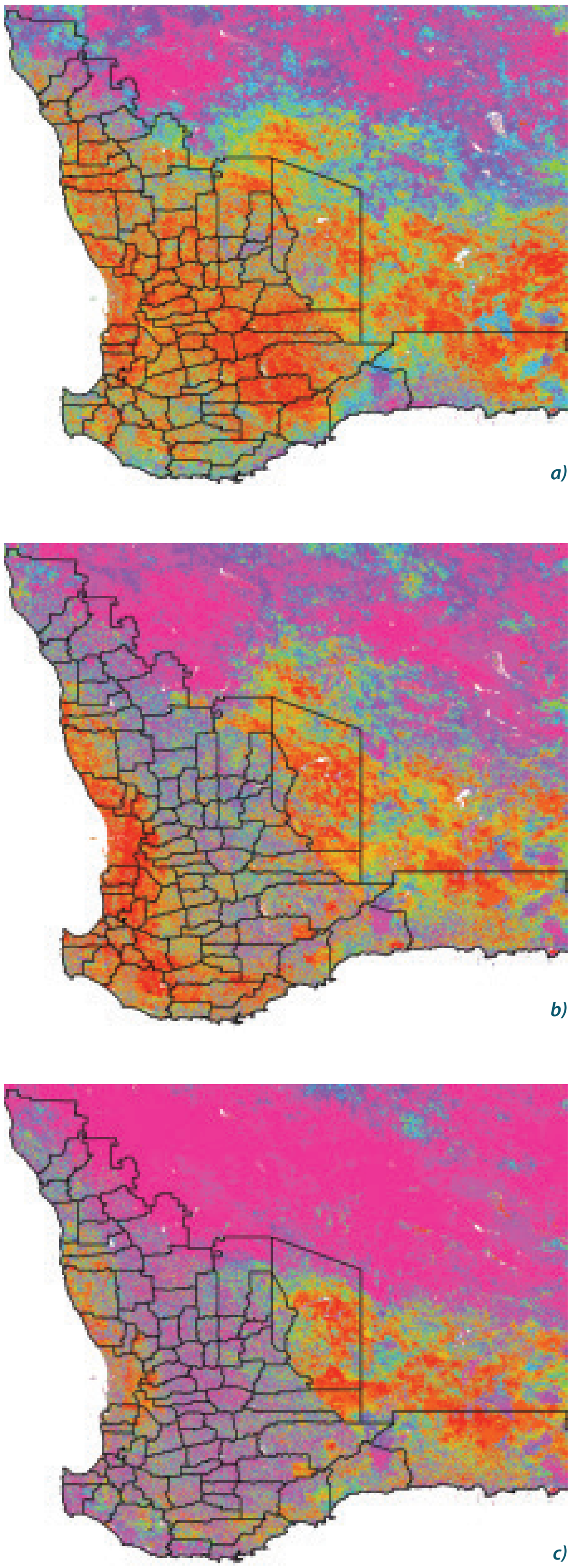
Norm Santich

The Moderate Resolution Imaging Spectroradiometer (MODIS) maximum value Normalised Difference Vegetation Index (NDVI) composite is used as an input to the pasture growth rate (PGR) model which is processed every Thursday for the preceding week Wednesday – Tuesday. This has been occurring since 2003, and consequently a sizeable archive has now built up from which farmers and agronomists are able to compare current growing seasons with previous growing seasons.

The growing season of 2011 in the southwest agricultural districts of Western Australia was characterised by a late break of season in mid to late May followed by a wetter than average spring. Following the drought conditions of 2010, this resulted in one of the driest first halves of the year since 2003 yet one of the greenest second halves of the year.

A year of interest can be put into context with other growing seasons by selecting a week from the same time of year from all growing seasons and sorting the pixels at each location in the corresponding NDVI imagery. The pixel rank can be determined by counting the number of pixels having a NDVI value greater than (or less than) that in the image of interest. This will show for a given week how many growing seasons have been greener (or drier) than the growing season of interest at every location.

This was done for each week of 2011 to compare with the previous growing seasons going back to 2003. The results (Figure 14) show that following the drought of 2010, the start of April 2011 was one of the driest since 2003 for many shires in the wheat belt, particularly the shires between Corrigin and Kent in the Great Southern district. Six months later a turnaround was evident and many wheat belt shires were exhibiting one of their greenest starts to August in parts since 2003. By the start of October, most shires across the southwest land division were experiencing some of the greenest conditions for that time of year since 2003



a)

b)

c)

Number of growing seasons drier than current

Figure 14: NDVI Rank Images for 2011. (a) Week starting 30/3/2011; (b) Week starting 27/7/2011; (c) Week commencing 28/9/2011. Pink/purple regions indicate one of the greenest years at that time of year since 2003. Red/orange purple regions indicate one of the driest years at that time of year since 2003.

PASTURES FROM SPACE FARM MANAGEMENT INFORMATION

Richard Stovold, Norm Santich, Sarfraz Khokhar

The Pastures From Space program continues to provide web based delivery of Pasture Growth Rate (PGR) and Feed on Offer (FOO) information, every week, to farmers in the south western agricultural zone of Western Australia and the southern agricultural regions of eastern Australia (Figure 15 and 16). The information is available as an annual subscription service and is distributed by our licensed consultant Fairport Technologies.

The consortium partners comprising Landgate, CSIRO and Department of Food and Agriculture WA continue their support of the program which has been used by the agricultural market for over 6 years

There is continuing and increased interest in the value of the Pastures From Space technology as a result of ongoing professional development workshops for secondary agriculture teachers. Valuable insights into the uses of the historical weekly PGR data in a spatial and temporal sense are being demonstrated. The reaction from this educational training is very positive with many teachers and their farm based students seeking further information on product access and availability of 'teaching licenses'.

The Pastures From Space technology has been adopted by the University of New England as part of the teaching program in the Graduate Certificate of Precision Agriculture (Precision Pasture Topic).
Farmers across Australia can subscribe to Pastures From Space as a weekly web-based delivery service through Fairport Technologies.
To view the Pastures From Space information visit **http://www.pasturesfromspace.csiro.au .**

To visit the Landgate website http://www.landgate.com.au (go to the Farm channel and select Pastures From Space) .

For information on the Fairport subscription service visit **http://www.fairport.com.au/pasturewatch**

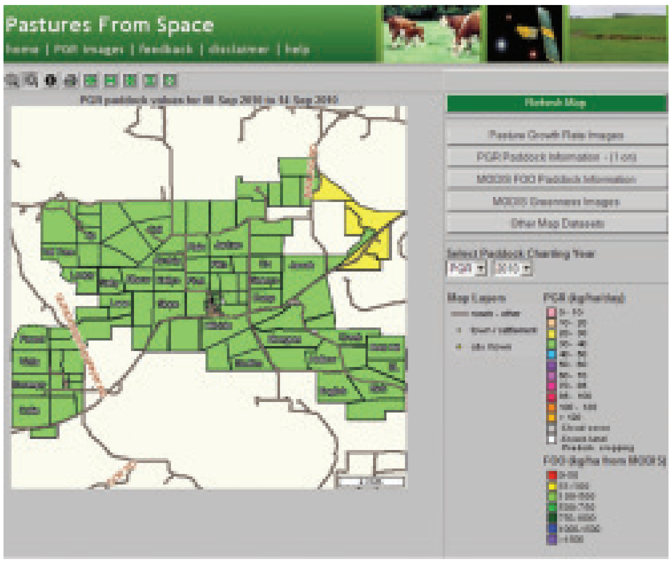


Figure 15: Weekly Pasture Growth Rate information available online at paddock level covering a farming property in Williams Western Australia.

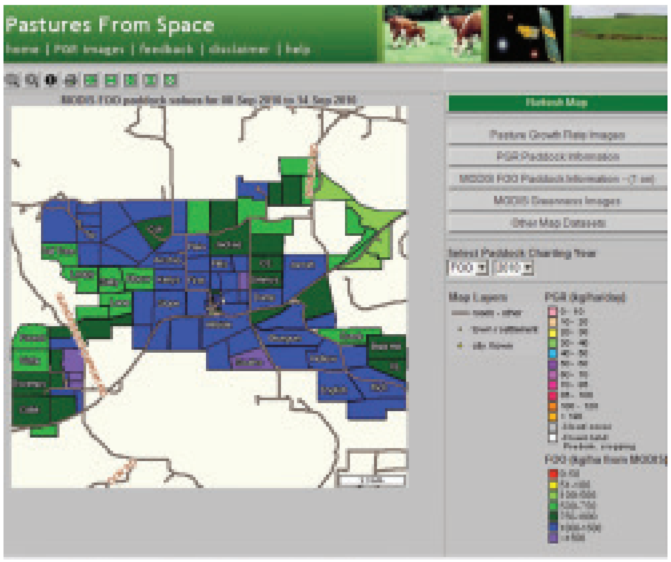


Figure 16: Weekly Feed On Offer (FOO) information available online at paddock level covering a farming property in Williams Western Australia.

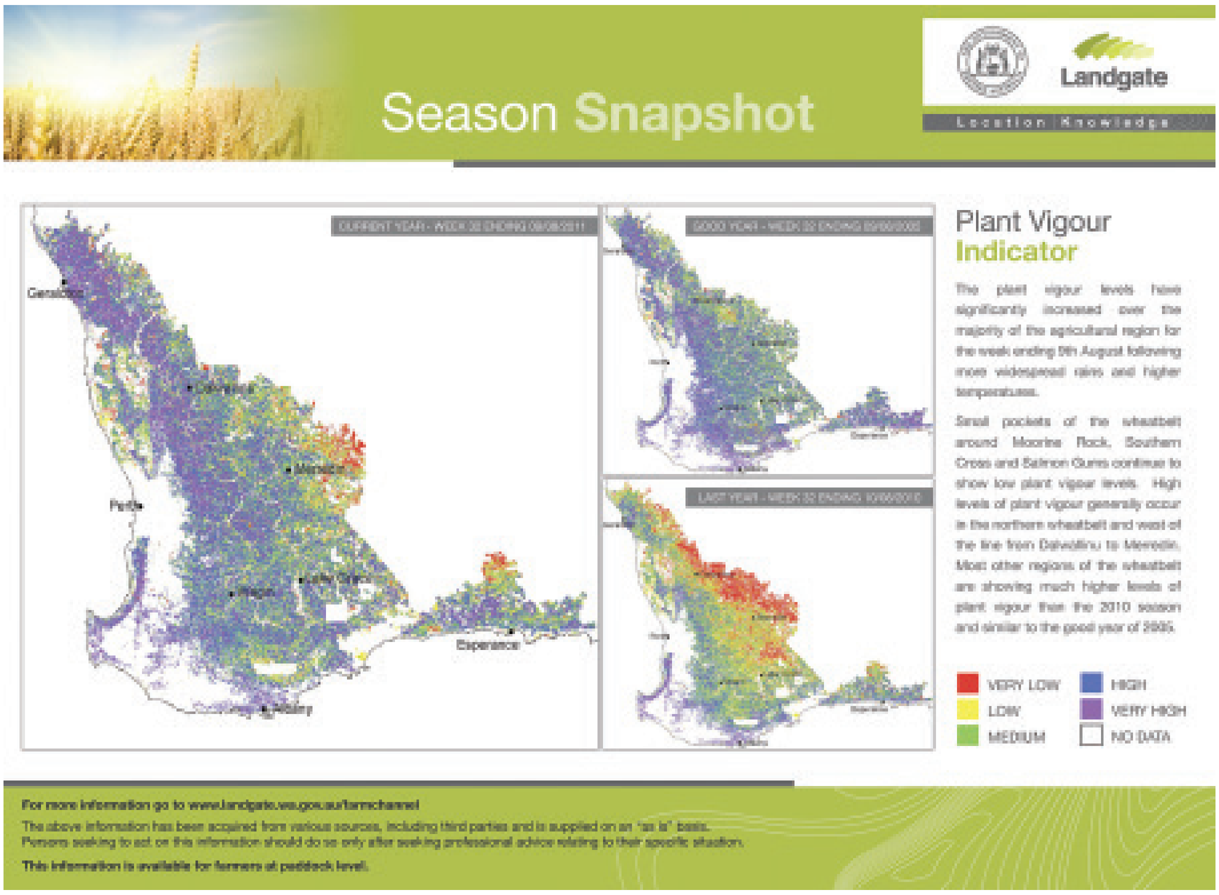
PLANT VIGOUR INDICATOR INDEX MAPS FOR REGIONAL AGRICULTURAL SEASON GROWTH TRENDS

Richard Stovold, Norm Santich

The Plant Vigour Indicator continues to be generated weekly from processed MODIS NDVI data providing a season update of plant growth in the South West wheatbelt of Western Australia. Landgate is providing farmers and land managers access to the data on the Agimage Landgate website under the farm channel. The information is published fortnightly in the Countryman newspaper.

The imagery (Figure 17) is assisting farmers to determine the progress of the season and provides vital production information for their properties. The data published monthly in the Countryman newspaper compares the current season to the good season of 2005 and the bad season of 2006.

Figure 17: Seasonal comparison of the Plant Vigour Indicator, week ending 9 August 2011, with the equivalent period in 2005 and 2006.



FIELD VALIDATION OF THE FLOODMAP MODIS DERIVED SURFACE WATER EXTENT ALGORITHM AT LIVERINGA STATION, WEST KIMBERLEY

A.Buchanan, M.Ferri, R.Stovold, K. Dawbin

Landgates FloodMap automatically generates a surface water classification and associated polygons, across Australia, on a daily basis (subject to cloud cover) and publishes this information to a webpage. The webpage can be viewed at Http://floodmap.dli.wa.gov.au/landgate_floodmap_public.asp. Attempts are now being made to provide mapping accuracy statements on the automatically generated surface water extent classification.

Field validation of the Floodmap imagery was undertaken over Liveringa Station in the Kimberley region of Western Australia after wet season flooding.Runoff from tropical thunderstorms in the upper catchment of the Fitzroy River Basin eventually worked their way downstream to the black soil plains of the Liveringa Station on Tuesday 20th March 2012 .On the afternoon of the 23rd March 2012 a field crew took six GPS readings of the northern boundary of the flood waters inundating the Liveringa Station black soil plains.

Figure 18, which shows GPS Site 4, is an example of a station track that has been cut by flood water.

Figure 18. GPS Site 4 – station track cut by flood water

On the day the GPS field recordings were taken (23rd March 2012) FloodMap supplied the raw MODIS data of the same date as well as an automatically generated flood water extent polygon. These polygons are generated in ArcGIS shape file format.

Figure 19 shows the FloodMap raw MODIS data with dry land, surface water and clouds. Figure 20 shows the automated flood water polygon overlaid on the raw MODIS data for comparison purposes.

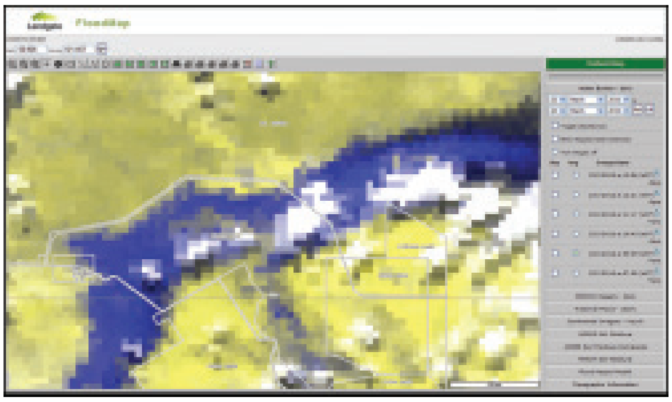


Figure 19. Raw MODIS data – flood water (blue), dry land (yellow) clouds (white)

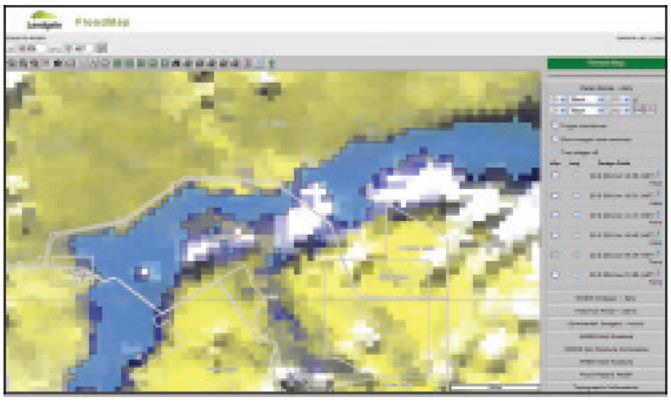


Figure 20. Automated flood polygon in pale blue with black border superimposed

The GPS sites were plotted against the FloodMap products and the shortest distance from the GPS site to the polygon boundary was measured. Figure 21 shows the distribution of the GPS readings with respect to the Floodmap polygon and Table 3 records the measured shortest distance from the GPS site to the polygon boundary.

Figure 21. GPS sites plotted against the automatically generated FloodMap polygon

GPS Site Number	Distance in pixels between GPS and FloodMap boundary on rectified basemap which has a 40m spatial resolution. (+/- outside/inside water)	Distance in meters from GPS site relative to FloodMap boundary
GPS Site 2	+ 4 basemap pixels	160m to water
GPS Site 3	+ 4 basemap pixels	160m to water
GPS Site 4	0 pixels	0 m to water
GPS Site 5	- 4 basemap pixels	160m inside water
GPS Site 6	+ 5 basemap pixels	200m to water
GPS Site 7	- 4 basemap pixels	250m inside water

Table 3. Shortest distance between the GPS site and the FloodMap boundary

Based on the Liveringa Station field validation exercise the FloodMap product has a surface water boundary mapping accuracy of +/- 160m.

CARNARVON FIRE MAPPING

Agnes Kristina

Numerous fire activities were detected by Landgate's Firewatch service around the Carnarvon area in December 2011. One of the earlier fires occurred around 24th December 2011. The fire started near Marrilla station, about 1200 kilometres north of Perth and moved quickly towards Yanrey station. MODIS and NOAA AVHRR fire hotspots were continually recorded by Firewatch from the 24th December 2011 until 28 December2011. More than 100,000 hectares of land were burnt and mapped (Figure 22).

On 28 December another fire advice was issued in the shire of Yalgoo following a lightning strike. The lightning activity provided courtesy of the University of Washington in Seattle can be viewed on the Firewatch website (Figure 23).

Another significant fire event occurred 90 kilometers north east of Carnarvon where fire hotspots were picked up as early as 27 December 2011 and continued to burn through to January 2012. By January 18, 2012, nearly 400,000 hectares of land were burnt (Figure 24).

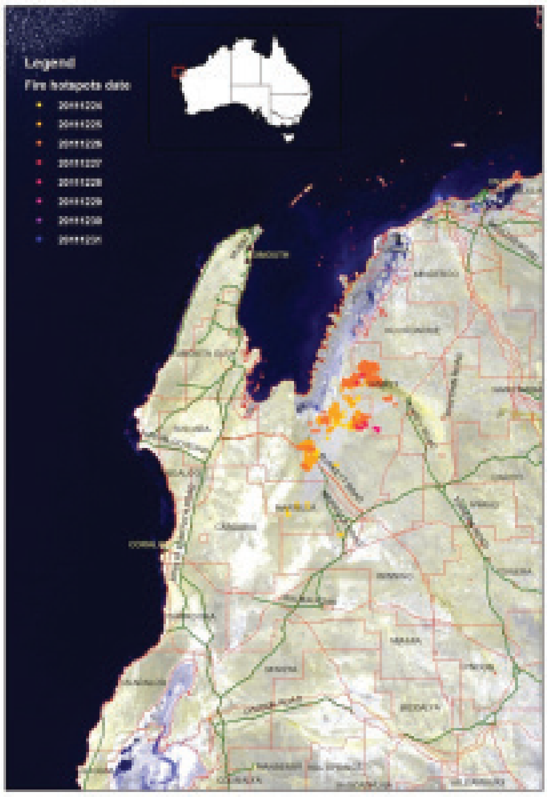


Figure 22. MODIS fire hotspots monitored by Landgate – Firewatch, from 24th to 26th December 2011

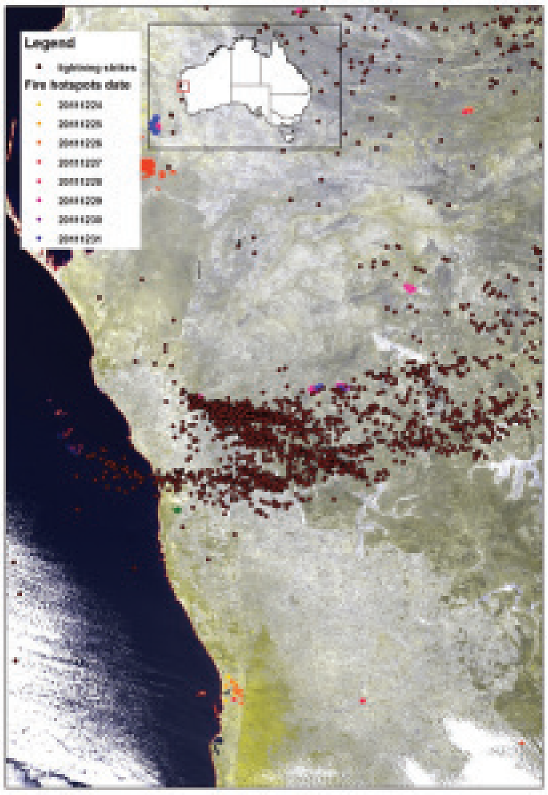


Figure 23. MODIS and NOAA AVHRR fire hotspots detected 28th to 31st December 2011, with fire ignited by lightning strikes.

OPERATIONAL APPLICATIONS

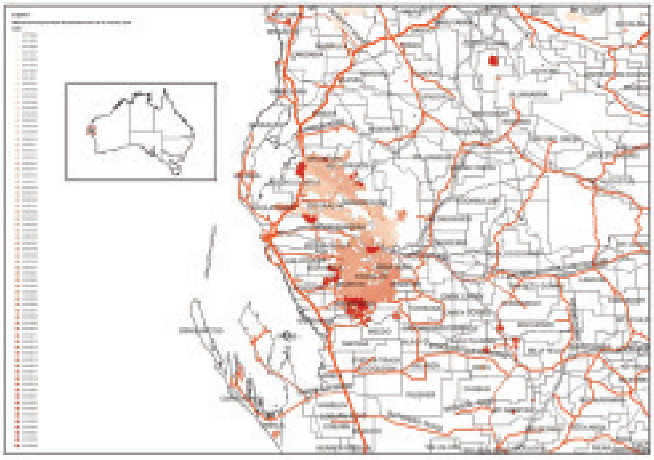


Figure 24. The extensive fire in Carnarvon ignited by lightning strike on December 28th 2011.

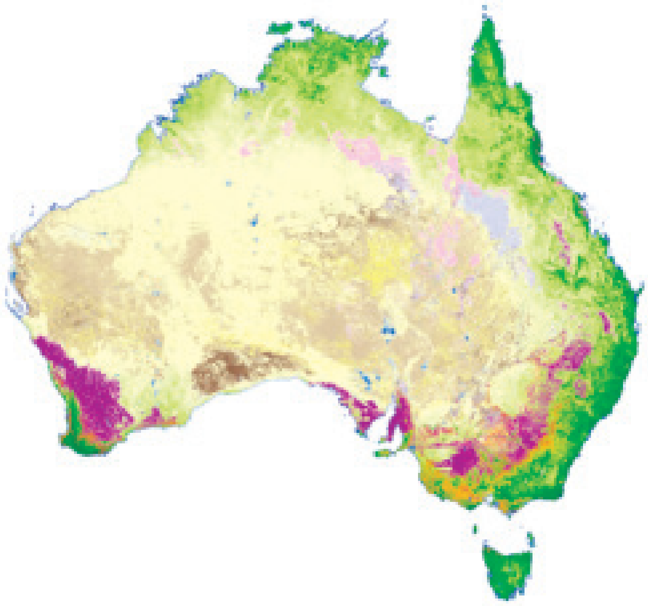


Figure 25. The Dynamic Land Cover Dataset of Australia is the first nationally consistent and thematically comprehensive land cover reference for Australia.

GEOSCIENCE AUSTRALIA

THE NATIONAL DYNAMIC LAND COVER DATASET

Geoscience Australia, with support from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), has recently completed the first comprehensive national dataset and map of Australia's land cover (Figure 25). This will give land and resource managers and researchers the opportunity to analyse changing trends in Australia's vegetation cover.

Land cover is the observed biophysical cover on the Earth's surface including trees, shrubs, grasses, soils, exposed rocks and water bodies, as well as anthropogenic elements such as plantations, crops and built environments.
Australia's land cover changes constantly due to weather, seasonal changes and land use, so nationally consistent land cover information is essential to understanding and addressing a range of natural resource challenges. These include sustainable farming practices, management of our water resources, air quality, soil erosion, and our forests.

The Minister for Resources and Energy, Martin Ferguson AM MP, released the new map and dataset on 16 November 2011. The Minister pointed out that '…the land cover map and dataset will allow users to compare vegetation over time, at a national and local level, to monitor trends associated with short term changes brought on by cyclones, long term drought and bushfires, as well as cropping and broadacre agriculture'.

The map and datasets were produced in partnership with ABARES, who have also developed an information hub to assist land managers, planners and others, who need to know more about land use and land management practices, to use in conjunction with the new national land cover data.
The National Dynamic Land Cover Dataset was produced from time-series analysis of the Enhanced Vegetation Index (EVI) data derived from eight years of observations by the Moderate Resolution Imaging Spectroradiometer (MODIS) instrument on the Terra satellite from 2000 to 2008 (Figure 26).

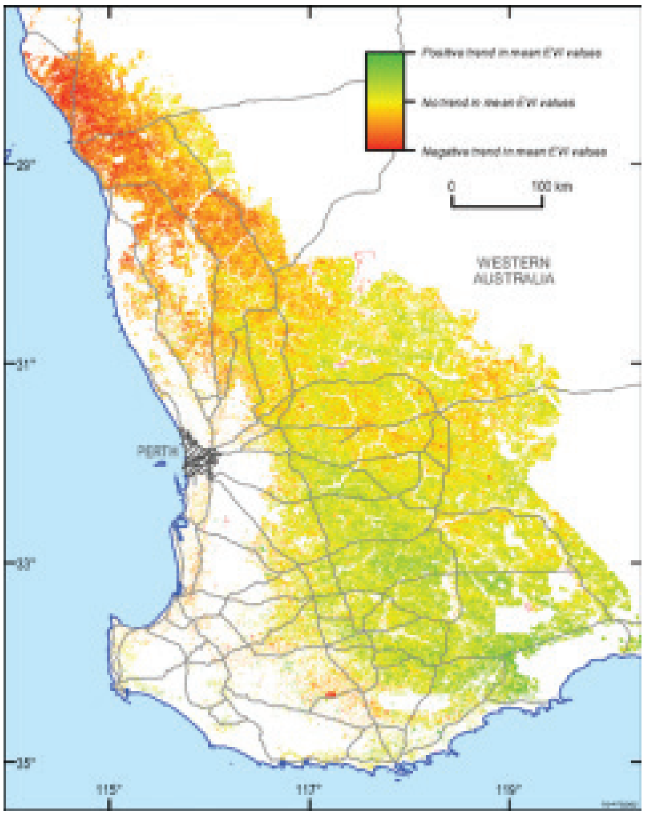


Figure 26 : Annual mean Enhanced Vegetation Index (EVI) for the cropping region of Western Australia, showing strong negative trend in the northwest and the opposite trend in the southeast; the trends are consistent with drought in the north-western parts of the WA wheat belt from 2002 onwards.

Future updated versions of the map will identify actual changes in the land cover which could provide evidence of a need for action in areas such as water management and soil erosion, or that patterns of land use are changing due to economic, climatic or other factors.

Both datasets are now available free online via the Geoscience Australia website or on DVD at cost of transfer from the Geoscience Australia Sales Centre. Hard copies of the land cover map are also available from the Geoscience Australia Sales Centre.

For more information visit
www.ga.gov.au/earth-observation/landcover.html
or contact Medhavy Thankappan at Geoscience Australia
email: Medhavy.Thankappan@ga.gov.au

RESEARCH DEVELOPMENTS

Investigations of new techniques for processing and applying satellite data continue at Curtin University, CSIRO and Landgate, and this section outlines some of the research being undertaken to underpin and improve the operational products described earlier.

CSIRO

Edward King

INTEGRATED MARINE OBSERVING SYSTEM (IMOS)

IMOS is a marine-focused capability of the National Collaborative Research Infrastructure Strategy (http://www.imos.org.au). One of its main aims is to sustainably produce data sets to support research.

The Satellite Remote Sensing (SRS) facility within IMOS is led by CSIRO and utilises both the NOAA and the MODIS national data streams. The Bureau of Meteorology operates the IMOS Sea Surface Temperature (SST) sub facility and directly accesses the NOAA stitched product to produce a wide range of high quality SST maps. The SST maps are continually validated by a network of drifting buoys and hull contact thermometers on ships of opportunity. Over the course of 2012 the stitching system, currently run as a research system by CSIRO, will be deployed within the Bureau to deliver an operational product.

The IMOS Ocean Colour sub facility, operated by CSIRO Land and Water, is using the national MODIS data system to develop ocean colour and marine water quality products for the whole Australasian region. The sub facility is also compiling a database of in-situ bio-optical measurements from around the Australian region which will be used to match up with and validate the ocean colour products.

TERRESTRIAL ECOSYSTEM RESEARCH NETWORK (TERN)

TERN is an NCRIS capability focused on terrestrial systems. The AusCover facility, also led by CSIRO, is responsible for national terrestrial remote sensing data sets **(http://www.auscover.org.au).**

AusCover is utilising the national NOAA/AVHRR data set to deliver a Normalised Difference Vegetation Index (NDVI) product for the whole country. This product, created by the Bureau of Meteorology in partnership with CSIRO, will extend back until early 1992, and successive releases will incorporate progressively more and more improvements accounting for the effects of sensor calibration drift, atmospheric absorption and scattering, and view and illumination geometry. The national stitched data set is also being used within CSIRO to deliver other products for AusCover, including vegetation fractional cover.

Geoscience Australia, another TERN/AusCover partner, is utilising the national MODIS data streams to deliver near real time surface reflectance and geometry corrected reflectance data streams for the whole of Australia. These in turn, will be used as the basis for a range of other products such as dynamic vegetation/landcover and maps of leaf area index.

Conclusion

Remote sensing data sets that are natively at continental scale, consistently processed and formatted, and are of high quality are valuable research inputs. They eliminate much of the data preparation and assembly work for researchers and allow a focus upon the research rather than data engineering. While this is true for any application, it is particularly important for studies at national scale, where comprehensive data sets have not previously been available, and for which the computational capacity now becoming available is permitting advanced work in emerging domains such as Earth Systems Science. Such data sets would not be possible without the partnership and data sharing of organisations such as WASTAC and the agencies that support it. It is to be hoped that the success of these national data sets will be repeated as we move into the era of the VIIRS sensor, the first of which was launched in late 2011 on the Suomi/NPP platform.

LANDGATE, SATELLITE REMOTE SENSING SERVICES, FLOREAT

TOWARDS AUTOMATED OPERATIONAL OIL SLICK DETECTION AND MONITORING USING MODIS

Carolyn McMillan, Russell Teede and Brendon McAtee

As part of the Natural Disaster Resilience Program (NDRP) Extending FireWatch project Landgate Satellite Remote Sensing Services (SRSS) is working to identify the optimal methodologies for operationally detecting and monitoring oil slicks in the Indian Ocean using the MODIS satellite-based sensor.

The research component of this work is focusing on algorithms utilising MODIS data in the visible, near-infra red and thermal parts of the electromagnetic spectrum. The Montara oil spill from 2009 is being used as a test case to evaluate which methodologies are robust enough to produce high confidence oil slick maps from a fully automated operational process.

Figure 1 shows an area of the Montara oil spill from August 31 2009 detected using sunglint in a MODIS image. While the utility of the sun glint method as an operational process is limited it does provide a well defined oil map for use as quality control against the results from other methodologies. Figure 2 shows the oil spill map produced by the RETIRA algorithm (Grimaldi et al., 2011) using thermal infrared sea surface temperature data. Figure 3 and 4, respectively, show the oil spill map produced using the MODIS Oil Spill Index (Shahini and Alesheikh, 2011) and the Fluorescence Index (Ismet et al, 2009) which use combinations of bands 1 to 4 of MODIS (note, grey in these figures represents clouds and the oil spill has a green hue).

The Figures show that, while further evaluation of the methodologies is required, there is potential for an automated oil slick detection and monitoring process to be developed based on MODIS data.

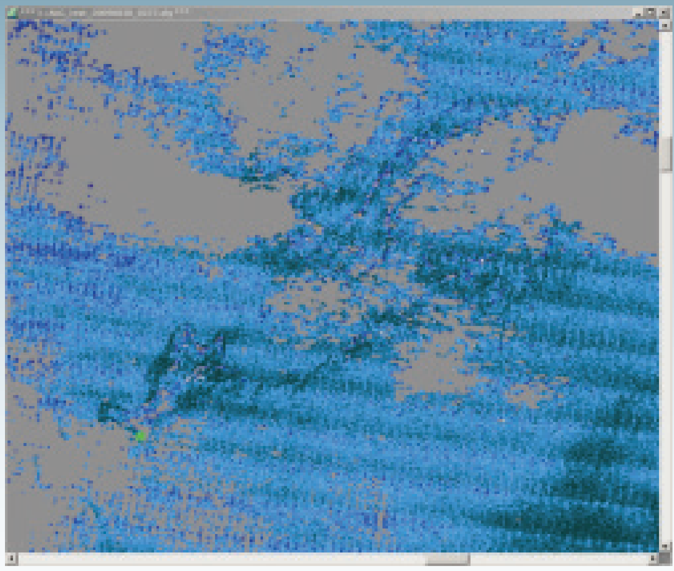


Figure 3: Oil spill map produced using the MODIS Oil Spill Index.

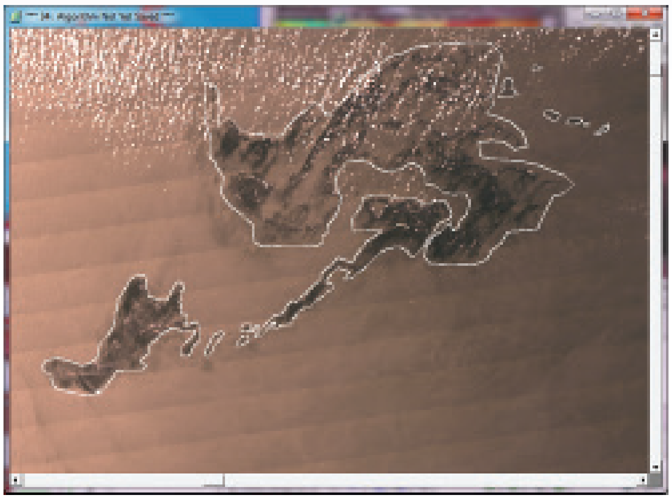


Figure 1: An area of the Montara oil spill from August 31 2009 detected using sunglint in a MODIS image.

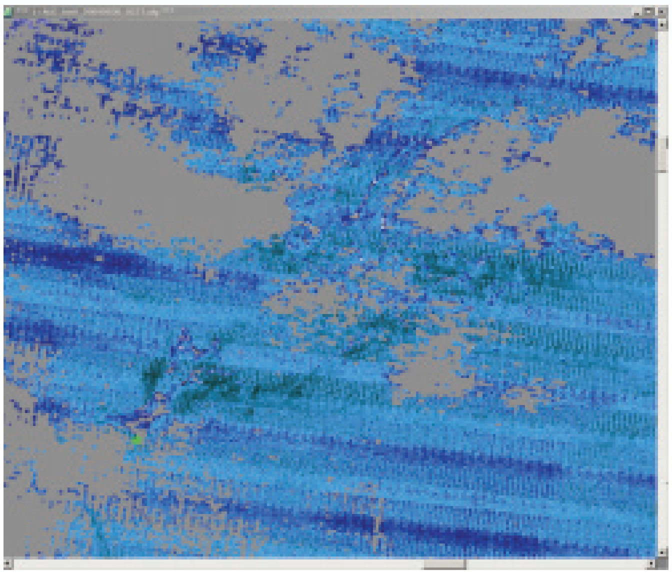


Figure 4: An oil spill map produced using the Fluorescence Index (Ismet et al, 2009) which use combinations of bands 1 to 4 of MODIS. Grey is cloud and green hues are oil spill.

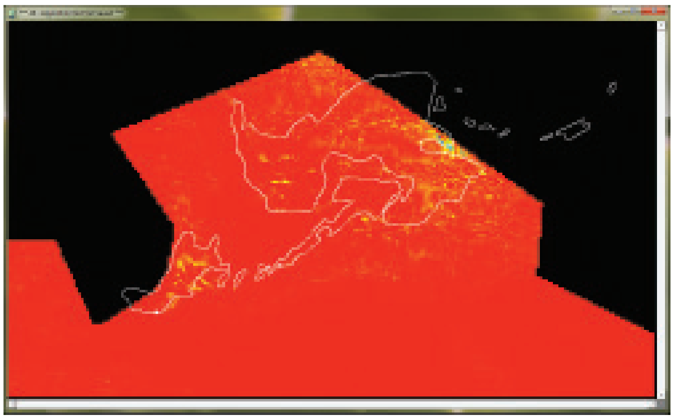


Figure 2: An oil spill map produced by the RETIRA algorithm using thermal infrared sea surface temperature data.

References:

Grimaldi, Casciello, Covello,Lavaca and Tramutolli 2011 "An Improved RST approach for timely alert and Near Real Time monitoring of oil spill disasters by using AVHRR data". Natural Hazards and Earth System Sciences 2011. Vol 11, 1281-1291

Ismet, I., Harto, A.B., Wikantika, K., 2011" Identification And Delineation Of Oil Spill Area By Means Of MODIS Sattelite Imagery (Case Study : Timor Sea 2009)" Asia Geospatial Forum Proceedings (2011)

Shahini, S.G., Alesheikh, A.A., 2011 "Oil Spill Detection and Monitoring Using MODIS Data" 5th SASTech 2011

CURTIN UNIVERSITY OF TECHNOLOGY

Remote Sensing and Satellite Research Group

MONITORING THE 'MARINE HEAT-WAVE' OF SUMMER 2011 USING MODIS SST DATA

Alan Pearce, Mark Broomhall and Peter Fearns

In late 2010, coastal water temperatures off Western Australia began rising well above normal levels, and by February 2011 it was evident that a major warming event was occurring. This had devastating consequences for marine life, from unprecedented coral bleaching to fish and invertebrate mortality. The "heat wave", as it was termed (Pearce et al. 2011), peaked in coastal waters at the end of February.

One of the local regions where the effects were evident was Rottnest Island, some 20 km west of Perth. MODIS sea-surface temperatures (SSTs) were derived for a nearshore area along the south coast of the Island for February 2011. All Terra and Aqua orbits were downloaded, and the following parameters processed: sea-surface temperature, brightness temperatures at 11 and 12 µm and the radiances at 667 and 869 nm (these being used both to check the position of the selected nearshore pixel in relation to the land and to screen for cloud contamination).

The temperatures rose from 23-24°C in early February to peak at 28°C by the end of the month (Figure 5). While these satellite-derived temperatures were somewhat higher than subsurface temperatures measured using in situ loggers elsewhere around the island, they illustrate the potential for deriving nearshore temperature trends for monitoring purposes provided land and cloud contamination are carefully screened.

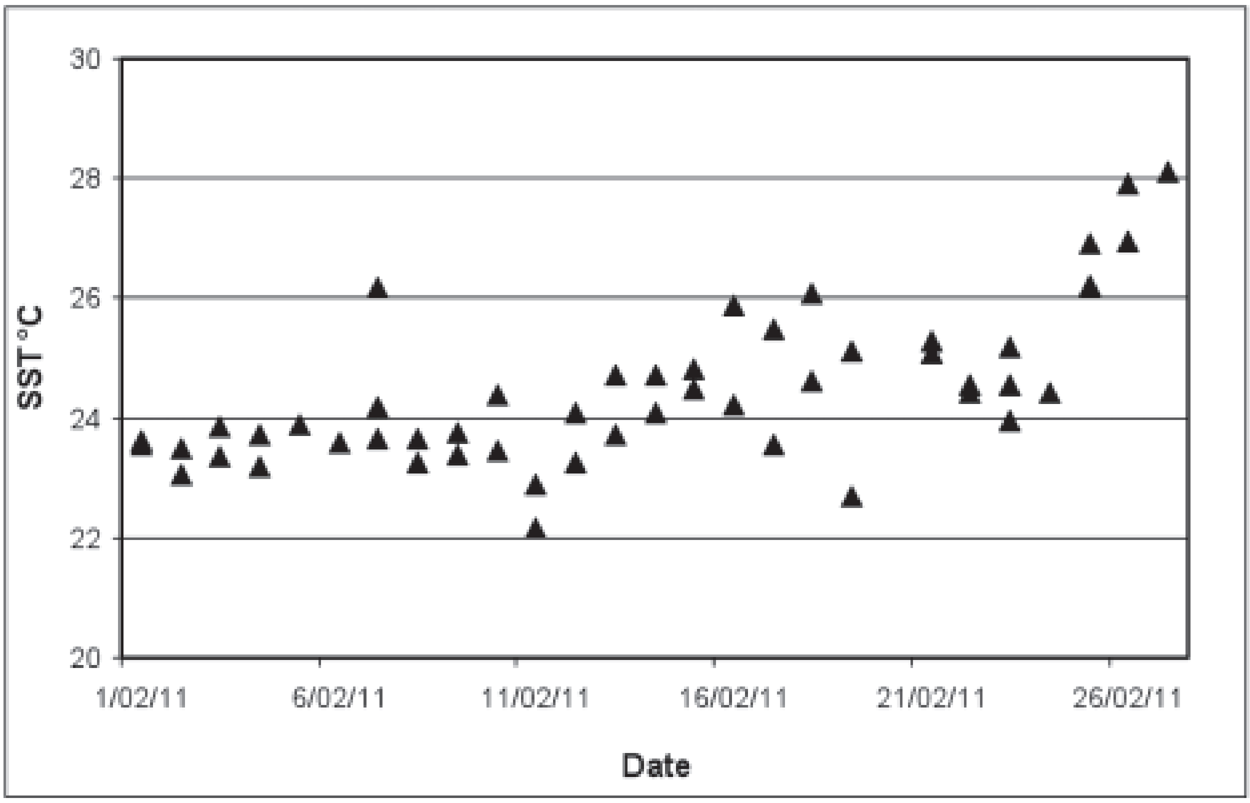


Figure 5: MODIS sea-surface temperatures derived for a nearshore area along the south coast of Rottnest Island during the marine heat wave in February 2011

MAPPING SUSPENDED SEDIMENT AT BARROW ISLAND

Peter Fearns [1], Mark Broomhall [1], Richard Evans [2]

[1] Curtin University Remote Sensing and Satellite Research Group
[2] Department of Environment and Conservation

Dredging activities at Barrow Island generate extensive plumes of suspended sediment. These plumes have the potential to spread many kilometres from the source and impact the sensitive pristine environments of the NW shelf. Increased turbidity decreases the transmission of light to the benthos, thus affecting the ability of marine flora to photosynthesise. Deposition of sediments can smother seagrass and algae and create stress for corals. The Department of Environment and Conservation (DEC) is charged with monitoring and managing the health and wellbeing of WA's valuable marine assets, and as such has utilised remote sensing technologies to map the spatial extent and frequency of occurrence of dredging plumes at Barrow Island. Curtin University developed a preliminary total suspended solids (TSS) algorithm to map TSS loads using MODIS data.

DEC applied hand digitising techniques in a GIS environment for comparison with the TSS algorithm approach. Figure 6 shows the true colour image of Barrow Island with a suspended sediment plume flowing to the south. A shallow reef is also evident to the south of the island. Figure 7 shows the MODIS derived TSS product. Note the shallow reef is incorrectly classified as suspended sediment. Figure 8 shows the results of combining hand digitised maps to generate a frequency-of-plume image. The longer term goal is to develop a fully automated process to generate TSS maps from MODIS where the effects of shallow reefs are accounted for.

Figure 6: A true colour image of Barrow Island with a suspended sediment plume flowing to the south

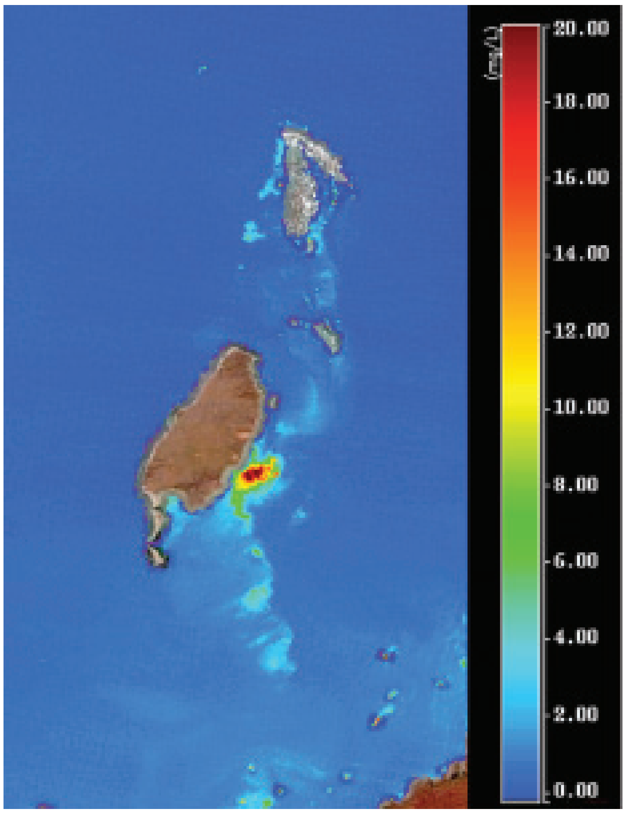


Figure 7: MODIS derived total suspended solids product

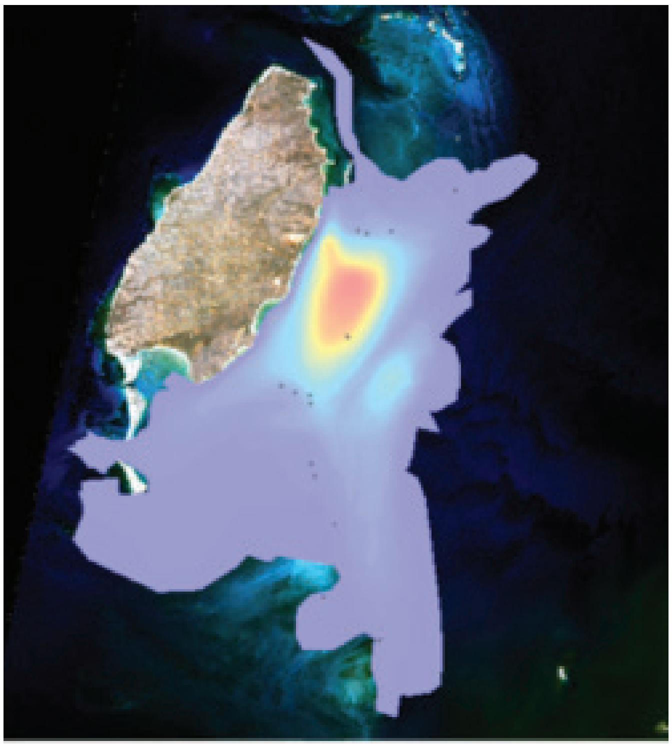


Figure 8: Results of combining hand digitised maps to generate a frequency-of-plume image. Red indicates high frequency through to purple with low frequency

AUSCOVER AT CURTIN

Mark A Gray[1], Helen Chedzey[1], Mark Broomhall[1], Dr Peter Fearns[1], Prof Mervyn Lynch[1], Brendon McAtee[2]

[1] Curtin University Remote Sensing and Satellite Research Group
[2] Landgate

The Remote Sensing and Satellite Research Group at Curtin University, in collaboration with Landgate, is the host for the WA Node of AusCover. AusCover is a national program providing calibrated and validated satellite and airborne remote sensing data for the Australian research community coordinated by CSIRO's Marine and Atmospheric Research Division.

The accompanying Figure 9 shows in-situ images and remote sensing products from the AusCover April 2012 field campaign conducted at the DEC site near Credo Station, WA. The Credo field campaign serves as a good example of the range of work undertaken for AusCover at the RSSRG. Subset (a) shows staff in the field with interstate collaborators from other TERN/AusCover facilities engaged in airborne hyperspectral validation and direct vegetation/ecosystem observation. Subset (b) is a pre-release quicklook generated from visible wavelength hyperspectral airborne data highlighting the ground target seen in subset (a). Subset (c) shows atmospherically corrected, cloud screened MODIS (Aqua) observations for all MODIS visible bands. All data collected is made freely available via AusCover data and discovery services for the use of the community.

Future work will use datasets such as these to establish validation for MODIS observations and employ airborne and satellite observations for the production of various vegetation and ecosystem analyses.

Relevant Links:

TERN:	http://www.tern.org.au
AusCover:	http://www.auscover.org.au
AusCover Data Console:	http://data.auscover.org.au

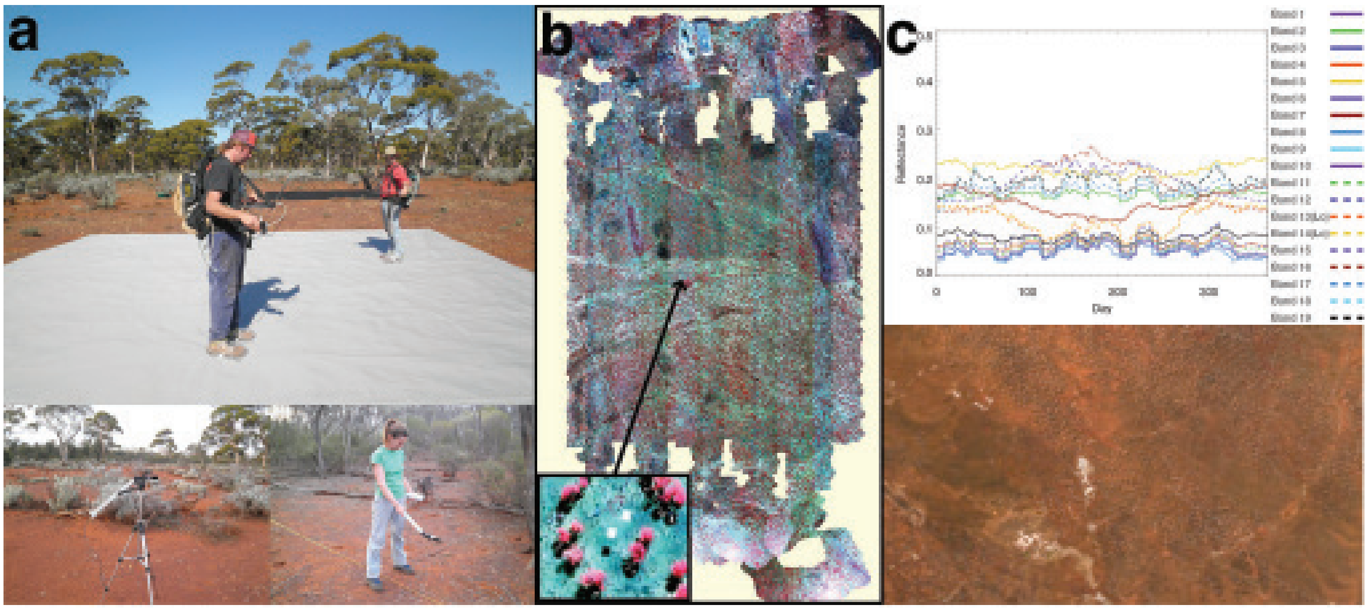


Figure 9:
AusCover activities at Curtin include (a) field measurement and ground validation of remotely sensed observations, (b) analysis of airborne hyperspectral data and (c) development of advanced remote sensing products

References:

Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M., Gaughan, D. (2011). The "marine heat wave" off Western Australia during the summer of 2010/11. Dept. Fish. West. Aust. Res. Rept. 222, Department of Fisheries, Western Australia, 36 pp.

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INDEPENDENT AUDITORS' REPORT

To The Members of the Board
WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM - L BAND

We have audited the accompanying financial report of the Western Australian Satellite Technology and Application Consortium – L Band which comprises the balance sheet as at 31 December 2011, income statement and cash flow statement for the period ended 31 December 2011 and notes comprising a summary of significant accounting policies and other explanatory information.

Officer's Responsibility for the Financial Report

The Board of the Western Australian Satellite Technology and Application Consortium – L Band is responsible for the preparation of the financial report information and has determined that the basis of preparation of this information described in Note 1, is appropriate to meet the reporting requirements of the Western Australian Satellite Technology and Application Consortium – L Band as per the existing joint venture agreement. The Board's responsibility also includes the establishment of internal control as the Board determines is necessary to enable the preparation of a financial report that is free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We have conducted our audit in accordance with Australian Auditing Standards. Those standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error.

In making those risk assessments, the auditor considers internal control relevant to Western Australian Satellite Technology and Application Consortium – L Band's preparation of the financial report, in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.

An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made, as well as evaluating the overall presentation of the financial report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, the financial report presents fairly, in all material respects, the financial position of Western Australian Satellite Technology and Application Consortium – L Band as at 31 December 2011 and its financial performance for the period then ended.

Emphasis of Matter

Without modifying our opinion, we draw attention to Note 1 to the financial report, which describes the basis of accounting. The financial report has been prepared to assist the Board and the joint venture participants of the Western Australian Satellite Technology and Application Consortium – L Band to meet the reporting requirements. As a result, the financial report may not be suitable for another purpose and should not be distributed to or used by parties other than the Board members and joint venture participants.

Santo Casilli CPA

Date: 19 March 2012

Perth

WASTAC L-BAND BUDGET 2011

Estimated expenditure for the year January 2011 – December 2011

		$ 2010	$ 2011
1.	Data Tapes	2000	0
2.	System maintenance/repairs	5000	5000
3.	Telecommunications license of facility	5000	5000
4.	Consultants	5000	15000
5.	Sundry consumables	1500	1500
6.	Traveling – Airfares	3000	3000
7.	Provision for major equipment	12000	12000
8.	Annual Report	8000	8000
TOTAL:		**$41,500**	**$49,500**

Estimated income/revenue for the year January 2011– December 2011

1.	Contributions received ($10,000 each)	40000	40000
2.	Interest	7500	6000
TOTAL INCOME:		**$47,500**	**$46,000**

Extra-ordinary expenditure January 2011– December 2011

1. Capital Reserve: No items

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM
L-BAND
INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2011

REVENUE		
Contributions Received	40,000	40,000
Interest Received	14,865	11,384
Total Revenue	**54,865**	**51,384**
EXPENDITURE		
Depreciation Expenses	17,486	19,537
Equipment maintenance	10,953	5,476
Hospitality	104	870
Microwave License	1,232	2,427
Other operating expenditure	5,942	4,825
Total Expenditure	**35,717**	**33,135**
Net Operating Result for the Year	**19,148**	**18,249**

Linda Chai
Senior Accountant- Client Service
Curtin University

5 March 2012

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

L-BAND

BALANCE SHEET AS AT 31 DECEMBER 2011

	NOTE	2011 $	2010 $
CURRENT ASSETS			
Cash at Bank		322,796	282,622
Prepayments		-	3,540
TOTAL CURRENT ASSETS		322,796	286,162
NON-CURRENT ASSETS			
Property, plant and equipment	2	30,545	48,031
TOTAL NON-CURRENT ASSETS		30,545	48,031
TOTAL ASSETS		353,341	334,193
TOTAL LIABILITIES			
NET ASSETS		353,341	334,193
EQUITY			
Retained Funds	4	353,341	334,193
TOTAL EQUITY		**353,341**	**334,193**

Linda Chai
Senior Accountant- Client Service
Curtin University

5 March 2012

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

L-BAND

CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2011

	Note	2011 $	2010 $
CASH FLOWS FROM OPERATING ACTIVITIES			
Receipts			
Contributions Received:			
Department of Land Information		10,000	10,000
CSIRO		10,000	10,000
Bureau of Meteorology		10,000	10,000
Curtin University of Technology		10,000	10,000
Interest Received		14,865	11,384
Total Receipts		**54,865**	**51,384**
Payments			
Payments to suppliers		(14,691)	(10,253)
Total Payments		(14,691)	(10,253)
Net cash provided by operating activities	3	40,174	41,131
CASH FLOWS FROM INVESTING ACTIVITIES			
Payments for property, plant and equipment			
Net cash used in investing activities			
Net increase/(decrease) in cash		**40,174**	**41,131**
Cash at the beginning of the year		282,622	241,491
Cash at the end of the year		**322,796**	**282,622**

Linda Chai
Senior Accountant- Client Service
Curtin University

5 March 2012

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM
L-BAND
NOTES TO THE FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2011

1 SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

The principal accounting policies adopted in the preparation of the financial report are set out below. These policies have been consistently applied unless otherwise stated.

Basis of Preparation

The Western Australian Satellite Technology and Application Consortium (WASTAC) L Band financial report is a special purpose financial report has been prepared in accordance with Australian Accounting Standards including Australian Accounting Interpretations, other authoritative pronouncements of the Australian Accounting Standards Board and Urgent Issues Group Consensus Views.

Compliance with AIFRS

Compliance with Australian Accounting standards ensures that the financial statements and Notes comply with International Financial Reporting Standards.

Historical cost convention

These financial statements have been prepared on the accrual basis of accounting using the historical cost convention.

(a) **Valuation of Property, Plant and Equipment**

All property, plant and equipment is shown at cost, less subsequent depreciation and impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the items. Subsequent costs are included in the asset carrying amount or recognised as a separate asset, as appropriate, only when it is probable that future economic benefits associated with the item will flow to the entity and the cost of the item can be measured reliably.

Any gains and losses on disposals are determined by comparing the disposal proceeds with the carrying amount and are included in the Income Statement.

(b) Depreciation of non-current assets

All property, plant and equipment having a limited useful life are depreciated over their estimated useful lives, in a manner which reflects the consumption of their future economic

Depreciation is calculated on a straight-line basis from the time the asset becomes available for use.
Estimated useful lives are as follows:

- Computing equipment 3 years
- Other equipment 8 years

Assets' residual values and useful lives are reviewed, and adjusted if appropriate, at each balance sheet date.

A class of asset's carrying amount is written down immediately to its recoverable amount if the class of asset's carrying amount is greater than its estimated recoverable amount (see note 1(c)).

(c) **Impairment of property, plant and equipment**

At each reporting date, WASTAC reviews the carrying amounts of each class of asset within property, plant and equipment to determine whether there is any indication that those asset classes have suffered an impairment loss. If any such indication exists, the recoverable amount of the class of asset is estimated in order to determine the extent of the impairment loss. Where the asset does not generate cash flows that are independent from other assets, WASTAC estimates the recoverable amount of the cash-generating unit to which the asset belongs.

Recoverable amount is the higher of fair value less costs to sell and value in use. In assessing value in use, the depreciated replacement cost is used where the future economic benefits of WASTAC's assets are not primarily dependent on the assets' ability to generate net cash inflows.

If the recoverable amount of a class of asset is estimated to be less than its carrying amount, the carrying amount is reduced to recoverable amount. An impairment loss is recognised as an expense to the Income Statement immediately.

(d) **Income Tax**

The Board considers that its operations are exempt from income tax under the provisions of section 50-25 of the Income Tax Assessment Act (1997) as amended.

(e) **Goods and Services Tax (GST)**

Revenues, expenses and assets are recognised net of the amount of GST, except where the amount of GST is not recoverable from the Australian Taxation Office. In these circumstances the GST is recognised as part of the cost of acquisition of the asset or as part of an item of the expense.

(f) **Income Recognition**

The Board recognises income as it is received. All income is stated net of the amount of goods and services tax (GST).

Interest is recognised on the effective interest rate method.

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

L-BAND

NOTES TO THE FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2011

2 PROPERTY, PLANT AND EQUIPMENT

	2011	2010
Computer Equipment		
At cost	151,468	151,468
Accumulated depreciation	(151,468)	(141,788)
	(0)	9,680
Other Equipment		
At cost	222,806	222,806
Accumulated depreciation	(192,260)	(184,455)
	30,546	38,351
Total Property, Plant and Equipment	30,545	48,031

Reconciliations

Reconciliations of the carrying amounts of property, plant and equipment at the beginning and end of the current financial year are set out below:

	Computer Equipment	Other Equipment	Total
Carrying amount at start of year	9,680	38,351	48,031
Additions	–	–	–
Depreciation expense	(9,680)	(7,805)	(17,486)
Carrying amount at end of year	**(0)**	**30,546**	**30,545**

3 NOTES TO THE CASH FLOW STATEMENT

Reconciliation of operating result from ordinary activities to net cash inflow from operating activities

	2011	2010
Net operating result	19,148	18,249
Depreciation expense	17,486	19,537
Movement in Current Assets	3,540	3,345
Net cash provided by operating activities	**40,174**	**41,131**

4 RETAINED EARNINGS

	2011	2010
Balance at beginning of the year	334,193	315,944
Operating surplus/(deficit) for the year	19,148	18,249
Balance at end of the year	**353,341**	**334,193**

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INDEPENDENT AUDITORS' REPORT

To The Members of the Board
WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM - X BAND

We have audited the accompanying financial report of the Western Australian Satellite Technology and Application Consortium – X Band which comprises the balance sheet as at 31 December 2011, the income statement and cash flow statement for the period ended 31 December 2011 and notes comprising a summary of significant accounting policies and other explanatory information.

Officer's Responsibility for the Financial Report

The Board of the Western Australian Satellite Technology and Application Consortium – X Band is responsible for the preparation of the financial report information and has determined that the basis of preparation of this information described in Note 1, is appropriate to meet the reporting requirements of the Western Australian Satellite Technology and Application Consortium – X Band as per the existing joint venture agreement. The Board's responsibility also includes the establishment of internal control as the Board determines is necessary to enable the preparation of a financial report that is free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the financial report based on our audit. We have conducted our audit in accordance with Australian Auditing Standards. Those standards require that we comply with relevant ethical requirements relating to audit engagements and plan and perform the audit to obtain reasonable assurance whether the financial report is free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial report. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial report, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to Western Australian Satellite Technology and Application Consortium – X Band's preparation of the financial report, in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.

An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made, as well as evaluating the overall presentation of the financial report.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion, the financial report presents fairly, in all material respects, the financial position of Western Australian Satellite Technology and Application Consortium – X Band as at 31 December 2011 and its financial performance for the period then ended.

Emphasis of Matter

Without modifying our opinion, we draw attention to Note 1 to the financial report, which describes the basis of accounting. The financial report has been prepared to assist the Board and the joint venture participants of the Western Australian Satellite Technology and Application Consortium – X Band to meet the reporting requirements. As a result, the financial report may not be suitable for another purpose and should not be distributed to or used by parties other than the Board members and joint venture participants.

Santo Casilli CPA

Date: 19 March 2012

Perth

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM
X-BAND
BUDGET 2011

Estimated expenditure for the year January 2011 – December 2011

		$ 2010	$ 2011
1.	Data Tapes	5,000	3,000
2.	System maintenance	15,000	25,000
3.	System repairs	4,000	4,000
4.	Consultants, product development	20,000	20,000
5.	Sundry consumables	2,000	2,000
6.	Travelling – Airfares	6,000	4,000
7.	Provision for major equipment	125,000	125,000
TOTAL:		**$177,000**	**$ 183,000**

Estimated income/revenue for the year January 2011– December 2011

1.	Annual Contributions $20,000 each	80,000	80,000
2.	Interest	10,000	7,000
TOTAL INCOME:		**$90,000**	**$87,000**

Committed expenditure (carry over) January 2011– December 2011

1.	Microwave Murdoch to BoM	85,000	85,000
TOTAL:		**$85,000**	**$85,000**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

X-BAND

INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2011

REVENUE		
Contributions Received	80,000	80,000
Interest Received	31,081	16,839
TOTAL REVENUE	**111,081**	**96,839**
EXPENDITURE		
Outsourced Work	4,846	
Fringe benefit tax	–	(121)
Equipment < $5000	2,674	–
Other Software & Licence <$5,000	6,897	–
Maintenance	1,200	–
Depreciation	18,372	14,256
TOTAL EXPENDITURE	33,989	14,135
NET OPERATING RESULT FOR THE YEAR	**77,092**	**82,704**

Linda Chai
Senior Accountant- Client Service
Curtin University

5 March 2012

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

X-BAND

BALANCE SHEET AS AT 31 DECEMBER 2011

	NOTE	2011 $	2010 $
CURRENT ASSETS			
Cash at Bank		440,321	434,045
TOTAL CURRENT ASSETS		440,321	434,045
NON-CURRENT ASSETS			
Property, plant and equipment	2	116,949	39,236
TOTAL NON-CURRENT ASSETS		116,949	39,236
TOTAL ASSETS		557,270	473,281
TOTAL LIABILITIES		6,897	–
NET ASSETS		**550,373**	**473,281**
EQUITY			
Retained Funds	4	550,373	473,281
TOTAL EQUITY		**550,373**	**473,281**

Linda Chai
Senior Accountant- Client Service
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5 March 2012

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

X-BAND

CASH FLOW FOR THE YEAR ENDED 31 DECEMBER 2011

	Note	2011 $	2010 $
Receipts			
Contributions Received:			
Landgate		20,000	20,000
CSIRO		20,000	20,000
Bureau of Meteorology		20,000	20,000
Geoscience Australia		20,000	20,000
Interest Received		31,081	16,839
Total Receipts		111,081	96,839
Payments			
Payments to suppliers		(8,720)	121
Total Payments		(8,720)	121
Net cash provided/(Used) by operating activities	3	102,361	96,960
CASH FLOWS FROM INVESTING ACTIVITIES			
Payments for property, plant and equipment		(96,086)	–
Net cash used in investing activities		(96,086)	–
Net increase/(decrease) in cash		6,276	96,960
Cash at the beginning of the year		434,045	337,085
Cash at the end of the year		**440,321**	**434,045**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM
X-BAND
NOTES FOR THE FINANCIAL STAEMENTS FOR THE YEAR ENDED 31 DECEMBER 2011

1 SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

The principal accounting policies adopted in the preparation of the financial report are set out below. These policies have been consistently applied unless otherwise stated.

Basis of Preparation

The Western Australian Satellite Technology and Application Consortium (WASTAC) X Band financial report is a special purpose financial report has been prepared in accordance with Australian Accounting Standards including Australian Accounting Interpretations, other authoritative pronouncements of the Australian Accounting Standards Board and Urgent Issues Group Consensus Views.

Compliance with AIFRS

Compliance with Australian Accounting standards ensures that the financial statements and Notes comply with International Financial Reporting Standards.

Historical cost convention

These financial statements have been prepared on the accrual basis of accounting using the historical cost convention.

(a) **Valuation of Property, Plant and Equipment**

All property, plant and equipment is shown at cost, less subsequent depreciation and impairment losses. Cost includes expenditure that is directly attributable to the acquisition of the items. Subsequent costs are included in the asset carrying amount or recognised as a separate asset, as appropriate, only when it is probable that future economic benefits associated with the item will flow to the entity and the cost of the item can be measured reliably.

Any gains and losses on disposals are determined by comparing the disposal proceeds with the carrying amount and are included in the Income Statement.

(b) Depreciation of non-current assets

All property, plant and equipment having a limited useful life are depreciated over their estimated useful lives, in a manner which reflects the consumption of their future economic

Depreciation is calculated on a straight-line basis from the time the asset becomes available for use.
Estimated useful lives are as follows:

- Computing equipment 3 years
- Other equipment 8 years

Assets' residual values and useful lives are reviewed, and adjusted if appropriate, at each balance sheet date.

A class of asset's carrying amount is written down immediately to its recoverable amount if the class of asset's carrying amount is greater than its estimated recoverable amount (see note 1(c)).

(c) **Impairment of property, plant and equipment**

At each reporting date, WASTAC reviews the carrying amounts of each class of asset within property, plant and equipment to determine whether there is any indication that those asset classes have suffered an impairment loss. If any such indication exists, the recoverable amount of the class of asset is estimated in order to determine the extent of the impairment loss. Where the asset does not generate cash flows that are independent from other assets, WASTAC estimates the recoverable amount of the cash-generating unit to which the asset belongs.

Recoverable amount is the higher of fair value less costs to sell and value in use. In assessing value in use, the depreciated replacement cost is used where the future economic benefits of WASTAC's assets are not primarily dependent on the assets' ability to generate net cash inflows.

If the recoverable amount of a class of asset is estimated to be less than its carrying amount, the carrying amount is reduced to recoverable amount. An impairment loss is recognised as an expense to the Income Statement immediately.

(d) **Income Tax**

The Board considers that its operations are exempt from income tax under the provisions of section 50-25 of the Income Tax Assessment Act (1997) as amended.

(e) **Goods and Services Tax (GST)**

Revenues, expenses and assets are recognised net of the amount of GST, except where the amount of GST is not recoverable from the Australian Taxation Office. In these circumstances the GST is recognised as part of the cost of acquisition of the asset or as part of an item of the expense.

(f) **Income Recognition**

The Board recognises income as it is received. All income is stated net of the amount of goods and services tax (GST).

Interest is recognised on the effective interest rate method.

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM
X-BAND

NOTES TO THE FINANCIAL STATEMENTS FOR THE YEAR ENDED 31 DECEMBER 2011

2 PROPERTY, PLANT AND EQUIPMENT

	2011	2010
Computer Equipment		
At cost	33,428	14,408
Accumulated depreciation	(19,376)	(14,408)
	14,052	–
Other Equipment		
At cost	866,833	789,767
Accumulated depreciation	(763,935)	(750,531)
	102,898	39,236
Total Property, Plant and Equipment	116,949	39,236

Reconciliations

Reconciliations of the carrying amounts of property, plant and equipment at the beginning and end of the current financial year are set out below:

	Computer Equipment	Other Equipment	Total
Carrying amount at start of year	–	39,236	39,236
Additions	96,086	–	96,086
Depreciation expense	(4,968)	(13,404)	(18,372)
Carrying amount at end of year	**(91,118)**	**25,832**	**116,949**

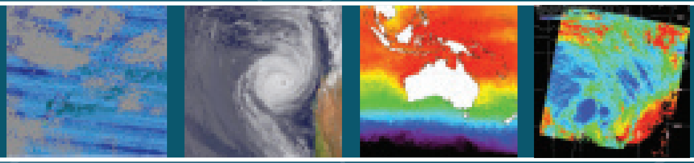
3 NOTES TO THE CASH FLOW STATEMENT

Reconciliation of operating result from ordinary activities to net cash inflow from operating activities

	2011	2010
Net operating result	77,092	82,704
Depreciation expense	18,372	14,256
Movement in Current Assets	–	–
Net cash provided by operating activities	**95,464**	**96,960**

4 RETAINED EARNINGS

	2011	2010
Balance at beginning of the year	473,281	390,577
Operating surplus/(deficit) for the year	77,092	82,704
Balance at end of the year	**550,373**	**473,281**



WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATIONS CONSORTIUM

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