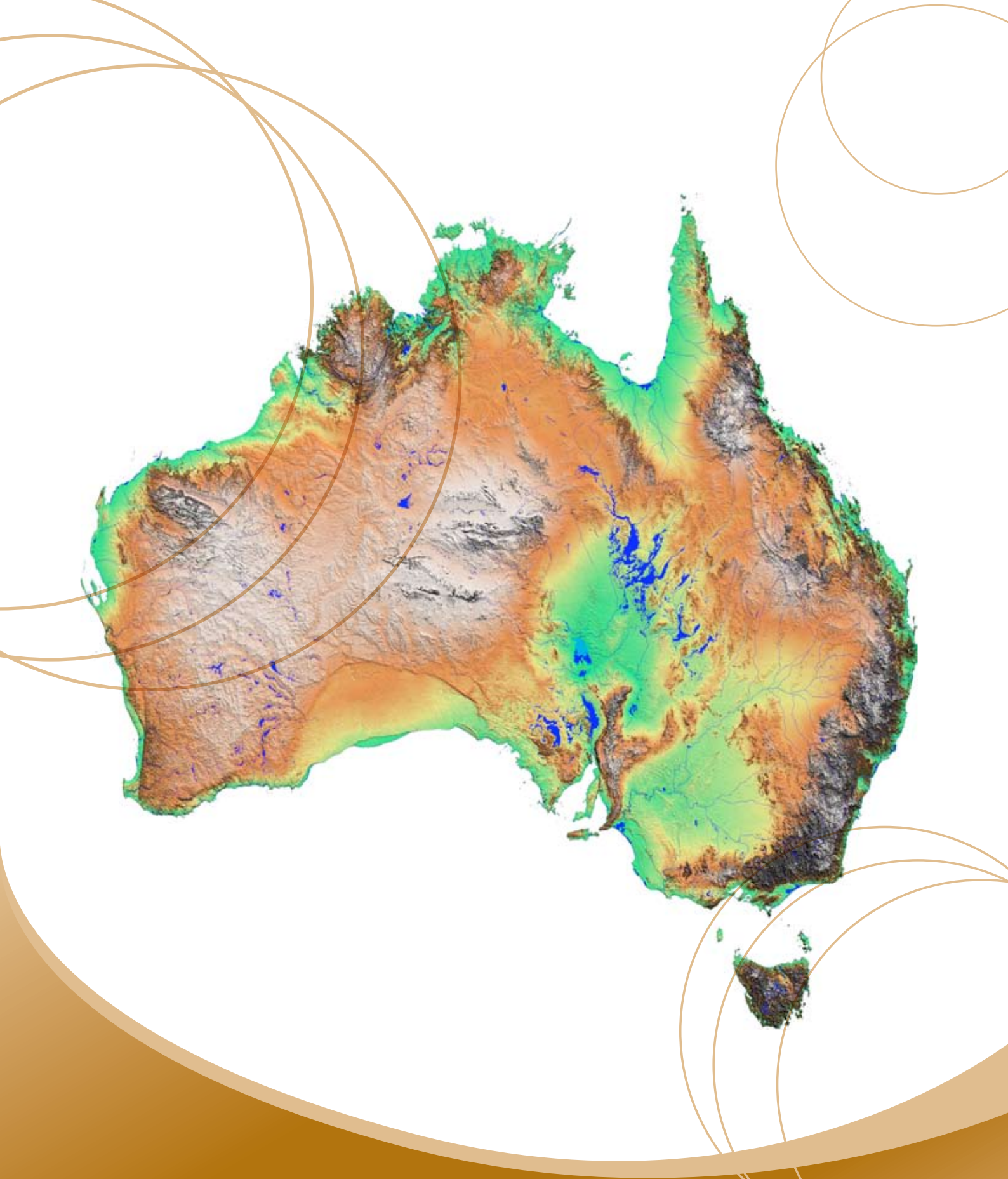

WASTAC

Annual Report 2007

Western Australian Satellite Technology
and Applications Consortium

www.wastac.wa.gov.au

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Front Page:
Cumulative surface water for the month of January 2007 displayed over a digital elevation model. The surface water is extracted from the MODIS sensors onboard the Terra and Aqua platforms. Surface water is captured daily as part of the FloodMap programme and published on the webpage FloodMap.landgate.wa.gov.au. Contact A.Buchanan - Landgate.

Editors:
R. Stovold - LANDGATE
A.F. Pearce

Contents

WASTAC CHAIRMAN'S REPORT 2007

Richard Smith

Collaboration began in 1979, WASTAC came into legal existence in 1989 with Henry Houghton as inaugural Chairman, I assumed the role in 1996, and in 2008 handed over to Professor Merv Lynch.

During my 11 years as Chairman, the amount of satellite data received in Perth increased from 4000 to over 16,000 Gbytes annually. Satellite receiving stations doubled with the installation of an X-band station in 2001 and membership increased with Geoscience Australia and Murdoch University joining the X-band Consortium. Coverage which began with the Western half of Australia, became continental with access to Bureau of Meteorology and Geoscience Australia receiving stations and global with access to MODIS data from the USA via the TDRSS satellite link.

There have been failures, the most notable being the attempt to form a CRC for Application of Earth Observations in 2001 which raised over $14 million in support. Externally assessed as an outstanding application, it lacked the political and commercial connections to get to the line. But the vision never faded and many of the proposals have come to fruition and others were absorbed into the CRC for Spatial Information.

On the supply side, technology provides the opportunities but it is the demand side pressures of economic growth, an expanding world population and global climate change that ultimately drives WASTAC's growth. The global impacts of these pressures on Western Australia are evident from droughts, floods, changing rainfall patterns and increased cyclonic activity to rising food and fuel prices, housing shortage and rampant house prices. To manage these inter-related pressures we have to think globally but act locally. WASTAC in some small way provides an example of this paradigm.

The next major challenge for WASTAC will come with the launch of the next generation of NPOESS (National Polar Orbiting Environmental Satellite System) around 2011. In the shorter term the Chinese Feng Yun 3A satellite which has a MODIS type sensor on board will present the next exciting challenge.

In 2007, thanks go to all members for their continued support and to Ron Craig and Richard Stovold of Landgate for key technical and secretarial support. Thanks also to Peter Fearns and Merv Lynch for developing the archiving project with iVEC.

Richard Smith

Chairman

WASTAC BOARD FOR 2007

Dr Richard Smith	(Chairman) Landgate
Dr Stefan Maier	Landgate
Assoc. Prof. Merv Lynch	Curtin University of Technology
Dr Doug Myers	Curtin University of Technology
Dr Alex Held	CSIRO, Earth Observation Centre
Dr David Griersmith	Bureau of Meteorology
Mr Alan Scott	Bureau of Meteorology
Mr Adam Lewis	Geoscience Australia
Professor Tom Lyons	Murdoch University
Exec. Dean Yianni Attikiouzel	Murdoch University

WASTAC STANDING COMMITTEE AND PROXY TO THE BOARD

Dr Richard Smith	(Chairman) Landgate
Dr Stefan Maier	Landgate
Assoc. Prof. Merv. Lynch	Curtin University of Technology
Dr Doug Myers	Curtin University of Technology
Mr Alan Scott	Bureau of Meteorology
Mr Don Ward	Bureau of Meteorology
Professor Tom Lyons	Murdoch University

WASTAC SECRETARY

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

WASTAC TECHNICAL COMMITTEE

Mr Don Ward (Chairman)
Assoc Prof Merv Lynch
Dr Doug Myers
Mr Ronald Craig

WASTAC STRATEGIC PLAN

VISION:
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 (TOVS and AVHRR), 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
- promote educational and research uses of WASTAC data
- ensure maximum use of Aqua, Terra, NOAA, SeaWiFS and FY1D data in the management of renewable resources.

FUTURE STRATEGIES:

- Upgrade reception and processing capabilities for METOP (including AVHRR), NPP (including VIIRS) and FY3 (including MERS).
- Advance MODIS processing from Level 1b to Level 2 (Below-atmosphere NADIR reflection) through introduction of atmospheric and view angle (BRDF) corrections.
- Advance the processing of AIRS data from Aqua and Terra.
- Improved management of the archive through collaboration with iVEC (Interactive Virtual Environment Computing Facility).
- Network access to other Earth Observation Satellite receiving stations in Australia.
- Facilitate reception and processing of data from the Chinese ZY3 photogrammetric satellite.

FUTURE SATELLITE RECEPTION OPPORTUNITIES:

- National Polar Orbiting Environmental Satellite System (NPOESS)
- Landsat Continuity Data Mission.
- Chinese FY3 (MODIS type sensor) and ZY3

OPERATIONAL STATUS

WASTAC facilities have both L and X band reception capabilities. The L band archive commenced in 1983 however satellite tracking commenced at Curtin University of Technology (then the WA Institute of Technology) in the late 1970s. The X band facility was commissioned at Murdoch University on 21 November 2001.

WASTAC L

The L band facility consists of a 2.4m antenna and antenna controller at Curtin University of Technology and ingest and display computers with hard disc storage and tape archive facilities at the Bureau of Meteorology's premises at 1100 Hay Street, West Perth. The antenna pedestal was replaced in December 2006. A low speed unidirectional microwave link connects the antenna to the ingest computers. This was replaced by a new high-speed bi-directional microwave unit in late 2007. The bi-directional microwave unit installed in June1996 continues to provide high-speed transmission of raw and processed data between the Bureau of Meteorology, the Leeuwin Centre and Curtin University.

The AVHRR ingest and display system, developed by the Bureau and installed in September 1996 consists of two HP UNIX workstations, one provided by WASTAC and the other by the Bureau.

Colour and grey scale quicklook images are produced by Landgate's Satellite Remote Sensing Services (SRSS) at the Leeuwin Centre for Earth Sensing Technologies at Floreat. Quicklook production is undertaken in near realtime for archiving, indexing and distribution. The raw data archive is transferred to 20Gb DLT tapes and duplicate copies are produced for a national NOAA archive program that is coordinated by the CSIRO Office of Space Science and Applications (COSSA) in Canberra.

The ingest program runs on both workstations to provide display, processing and backup facilities. The 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.

WASTAC X

The WASTAC X band facilities at the Environmental Science Building at Murdoch University were supplied and installed by SeaSpace Corporation in September 2001 and consist of a 3.6m diameter antenna mounted in a fibreglass dome and a Sun Sparc 400 antenna control computer. The ingest and display computers with hard disc and tape archive storage as well as a dual CPU LINUX processing computer are located at Landgate's SRSS at the Leeuwin Centre. The X band reception facility is connected through the Murdoch node to the high speed PARNET wide area network which allows data transfer to Landgate and via the internet to other WASTAC consortium members.

The X band computer has been upgraded by SeaSpace to incorporate ingest for new X band satellites. An L band ingest facility has also been added to provide backup and help resolve pass conflicts at the L band facility at Curtin University.

RECENT DEVELOPMENTS AND FUTURE DIRECTIONS

The L band facility at Curtin will be upgraded in 2008 to match similar Bureau facilities. This will involve the replacement of all of the ingest, processing and display equipment.

WASTAC funded the development of software which will allow easier on-line access to the data stored at the iVEC site in Technology Park, Bentley.

Future plans include upgrading the X band station to receive METOP, NPP and FY3 satellite data as well as the processing of MODIS data to level2 and AIRS data from Aqua and Terra.

WASTAC DATA ARCHIVE

The WASTAC archive of NOAA, MODIS and SeaWiFS satellite passes is managed and maintained by Landgate's 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 13,450 NOAA passes were archived at Curtin and Murdoch in 2007. Passes included data from the NOAA 12, 14, 15, 16, 17 and 18 satellites. NOAA 14 was turned off on 23 May 2007 and NOAA 12 on 10 August 2007. The number of SeaWiFS passes totalled 1092.

There were 1512 TERRA, 1615 AQUA and 1678 FY1D passes archived.

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:

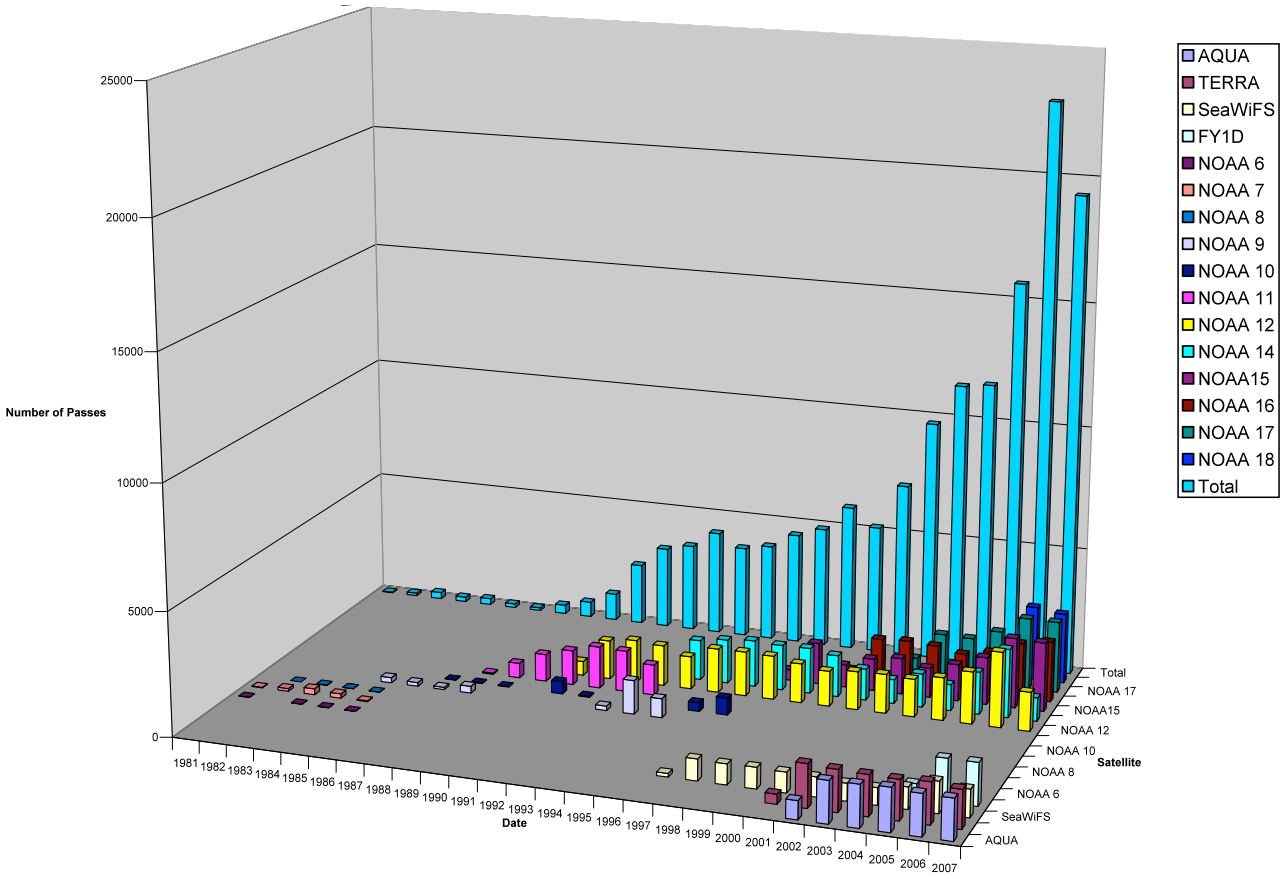
http://www.rss.dola.wa.gov.au/noaaql/NOAAql.html

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

Landgate currently holds the archive on 8mm exabyte and DAT tapes. 20Gb DLT tapes were introduced as the archive media 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.
Archive data is also being delivered to the IVEC data management facility at Technology Park, Bentley.

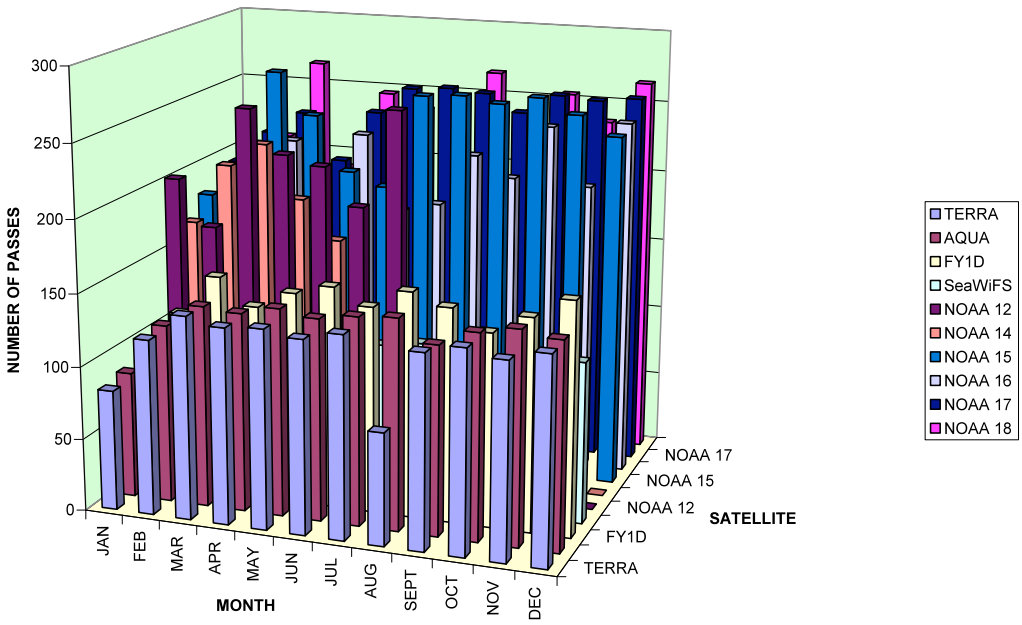
Orders for digital data can be provided via the internet (see www.wastac.wa.gov.au), on 8mm data tape, DAT tape, DLT tape or DVD/CD.

TOTAL NUMBER OF PASSES HELD IN THE WASTAC ARCHIVE



	AQUA	TERRA	Sea WiFS	FY1D	NOAA 6	NOAA 7	NOAA 8	NOAA 9	NOAA 10	NOAA 11	NOAA 12	NOAA 14	NOAA 15	NOAA 16	NOAA 17	NOAA 18	TOTAL
1981					5	22											27
1982						115	1										116
1983					12	244	12										268
1984					7	179	4										190
1985					7	33	4	212									256
1986								151									151
1987								97	18								115
1988								280	25	53							358
1989									21	601							622
1990										1103							1103
1991									506	1399	575						2480
1992									47	1693	1571						3311
1993								183		1656	1720						3559
1994								1362		1227	1641						4230
1995								770			1326	1615					3711
1996									354		1780	1776					3910
1997			142						694		1797	1876					4509
1998			859								1763	1828	432				4882
1999			822								1589	1839	1663				5912
2000			843								1427	1681	905	341			5197
2001		390	811								1548	1271	1292	1733			7045
2002	734	1710	780								1579	976	1455	1789	709		9732
2003	1651	1645	696								1521	1351	1200	1728	1827		11388
2004	1665	1602	680								1727	1058	1481	1524	1797		11534
2005	1705	1577	863	553							2101	1706	1904	1743	2212	1339	15703
2006	1635	1639	1239	1683							3030	2761	2823	2240	2883	2989	22922
2007	1615	1512	1092	1678							1571	952	2777	2442	2869	2839	19347

WASTAC SATELLITE DATA FOR 2007



WASTAC SATELLITE DATA FOR 2007

	TERRA	AQUA	FY1D	SeaWiFS	NOAA 12	NOAA 14	NOAA 15	NOAA 16	NOAA 17	NOAA 18	TOTAL
JAN	83	87	87	85	203	166	180	123	193	197	1404
FEB	121	123	124	91	171	209	128	183	217	209	1576
MAR	140	139	152	99	256	226	272	218	233	265	2000
APR	135	137	134	91	226	189	243	130	200	189	1674
MAY	137	143	146	96	220	162	205	226	237	246	1818
JUN	133	139	153	105	194	0	196	173	256	236	1585
JUL	139	143	142	108	262	0	262	180	258	247	1741
AUG	77	145	155	112	39	0	264	217	256	266	1531
SEPT	133	130	147	90	0	0	260	203	244	239	1446
OCT	139	141	133	66	0	0	266	241	258	254	1498
NOV	134	146	146	98	0	0	256	201	256	236	1473
DEC	141	142	160	111	0	0	243	247	259	265	1568

Operational Applications 2007

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 and the Satellite Remote Sensing Services group in Landgate.

BUREAU OF METEOROLOGY, MELBOURNE

Compiled by Mike Willmott, Ian Grant, Leon Majewski, Gary Weymouth & Rod Potts.

SEA SURFACE TEMPERATURES (SST)

The Bureau of Meteorology is currently upgrading its sea surface temperature (SST) processing system to output products that comply with the Global High Resolution SST Pilot Project (GHRSST-PP; see http://www.ghrsst-pp.org/). The GHRSST Science Team is an international group formed to provide guidance on implementing systems to process satellite data to derive estimates of SST, including algorithm development and data formats.

The GHRSST-PP format, as specified by the GHRSST-PP Data Processing Specification (GDS) v1.7, allows users to access SST data through the well described and often familiar netCDF interface. As such, the Bureau has, where possible and practical, adopted the GHRSST-PP format for storing and distributing SST products.

Shortly, AVHRR data received from WASTAC will be output in GHRSST-PP format and delivered to the Australian Ocean Distributed Active Archive Centre (AO-DAAC; http://www.eoc.csiro.au/aodaac) as part of the Bureau's commitment to the Integrated Marine Observing System (IMOS), where it will be available to researchers through an OPeNDAP interface (http://www.opendap.org/).

Currently WASTAC AVHRR data is used along with data received from other L-band reception sites around Australia and Antarctica and GHRSST-PP formatted data from other space-based sensors (e.g. AMSR-E) retrieved from international agencies to create high resolution local products (Figure 1), along with regional and global SST analyses. The Regional Australian Multi-Sensor SST Analysis (RAMSSA; Beggs 2007) produces 1/12° resolution, daily SST analyses (see Figure 2) over the Australian region (20°N - 70°S, 60°E - 170°W). An improved global analysis, Global Australian Multi-Sensor SST Analysis (GAMSSA; Beggs 2008), is currently being assessed (see Figure 3). When operational, GAMSSA will produce 1/4° resolution, daily SST analyses on a global scale.

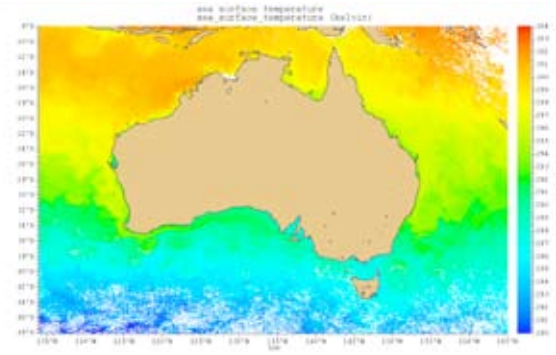


Figure 1: SST data derived from international agencies to create high resolution image.

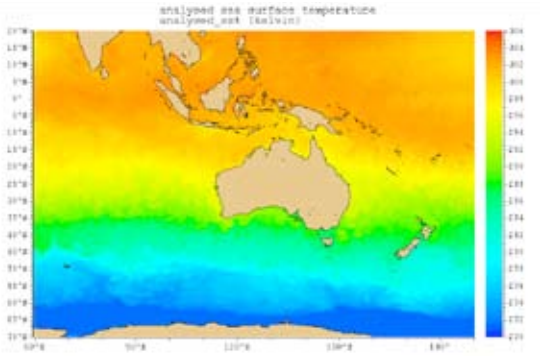


Figure 2: Regional Australian Multi-Sensor SST Analysis showing 1/12° resolution, daily SST analyses over the Australasian Region

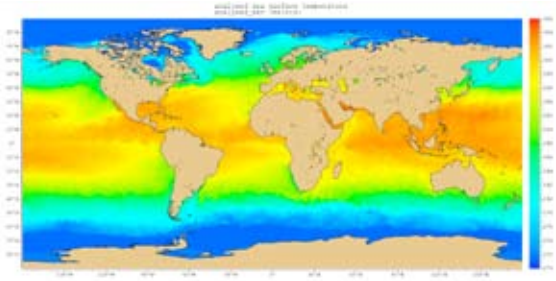


Figure 3: Output from the Global Australian Multi-Sensor SST Analysis which is currently under review.

TROPICAL CYCLONE MONITORING

The Bureau's Western Australian Regional Forecasting Centre in Perth provides warnings of tropical cyclones whenever the need arises from its Tropical Cyclone Warning Centre (TCWC). The AVHRR data is used to assist in the monitoring of fine detail of tropical cyclones and supplements the positioning of these large systems by radar, MTSAT-1R imagery and NWP analysis. It is also a critical back-up to MTSAT-1R imagery.

For the period 1 January to 31 December 2007, there were three tropical cyclones that impacted on the Western Australian coast with two others: tropical cyclone Melanie, which formed into a category three cyclone, moved south and dissipated over the ocean; and tropical cyclone Lee, which was declared but handed over to La Reunion (and renamed Ariel) 24 hours after the formation of the system when it moved out of Western Australia's area of responsibility.

Of these five tropical cyclones, George (see figure 4), Jacob and Kara (see Figure 5), all occurred off the northwest coast during March. George was the only Tropical Cyclone that had a direct wind impact to land areas. George crossed the coast near Port Hedland as a category 5 cyclone and caused extensive damage along its track. There were three deaths attributed to the impact of George. Just two days later, Jacob crossed the coast in a similar location but as a tropical low. George, Jacob and Kara were all severe tropical cyclones, George reaching category 5 intensity, Jacob category 3, and Kara category 4. Although not causing a direct impact to land areas, the threat of Jacob and Kara did cause a significant economic impact by disrupting mining and offshore industry activities.

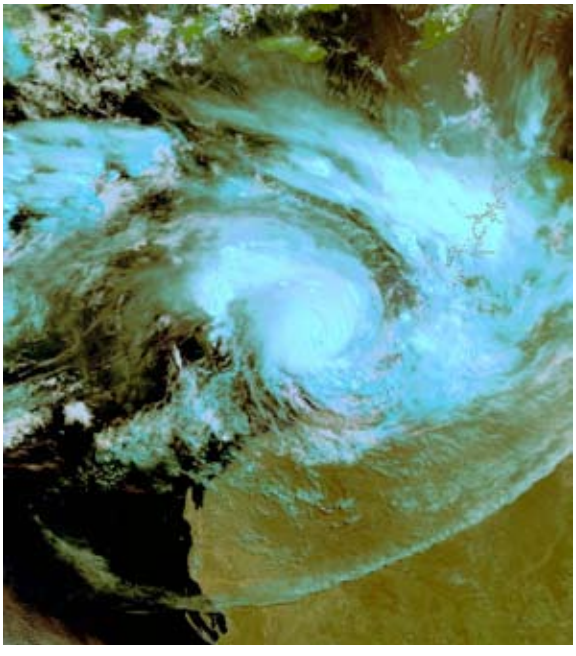


Figure 4: TC George from off the north-west coast of Western Australia (NOAA-17, 8 March 2007 02:00 UTC)

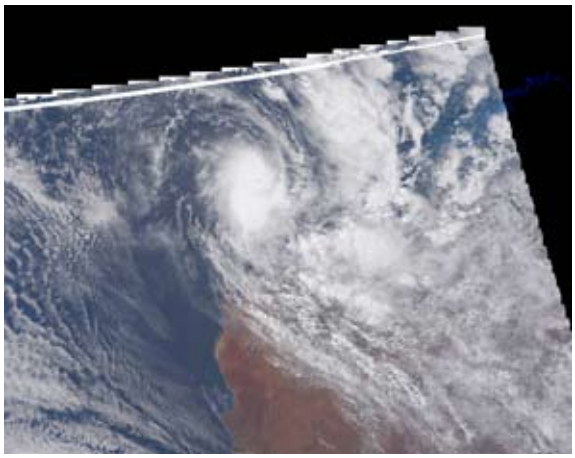


Figure 5: Tropical Cyclone Kara from Aqua (MODIS) on 26 March 2007 at 06 UTC

Melanie did remain far enough offshore not to have any direct impact on the WA coast. However, there was a significant economic impact to industry resulting from production shut downs and evacuations from offshore installations.

In addition to these tropical cyclones, in early January a tropical low was named Isobel (see figure 6) operationally but was later downgraded to a tropical low during the reanalysis. It combined with a strong mid-latitude trough to cause heavy rain and flooding in the Esperance region.

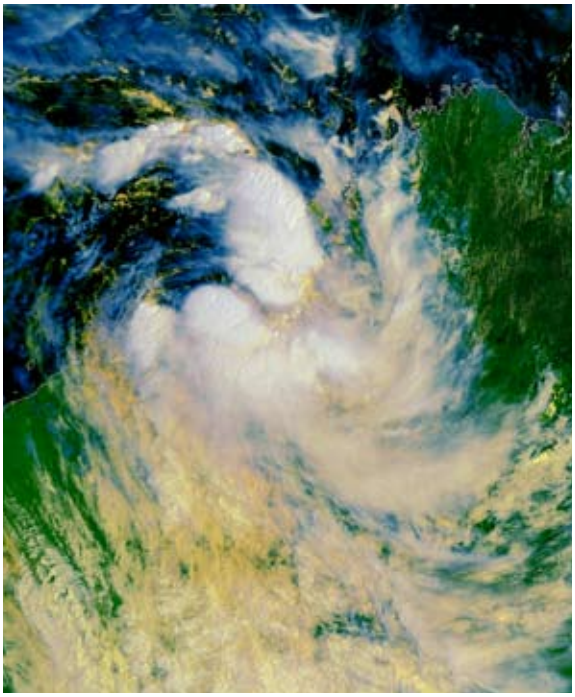


Figure 6: A tropical depression (original analysed as TC Isobel) that caused heavy rain and flooding over the north-west coast of Western Australia (NOAA-17, 3 January 2007 at 01:29 UTC)

NORMALISED DIFFERENCE VEGETATION INDEX (NDVI)

The Normalised Difference Vegetation Index (NDVI) monitors the greenness of vegetation, and is an indication of its coverage and vigour. The Bureau currently produces NDVI products from the AVHRR on NOAA-17. After the AVHRR data is geolocated and calibrated, it is remapped into a daily composite covering Australia. Each daily composite is manually inspected and may be rejected if degraded, for instance, by reception noise. The NDVI calculated from the red and near-infrared top-of-atmosphere reflectances is composited by maximum value over 9-day periods, The 9-day composites are further composited into monthly national maps which are distributed via the world wide web.

A notable application of NDVI is as an indicator of the dryness of bushfire fuels. Bureau NDVI maps such as those in Figure 7 are presented at the two annual Seasonal Bushfire Assessment Workshops which are held in the period leading up to the northern Australian and southern Australian bushfire seasons respectively. These workshops bring state fire managers together to consider the available data and forecasts on fuel and weather conditions and produce a consensus national map of severe fire potential for the coming season. Maps of the change in NDVI from the previous year (Figure 8) are valued by fire managers as they highlight regions of anomalous growth with respect to the previous year. Maps of NDVI change from the previous month highlight recent trends in growth or senescence.

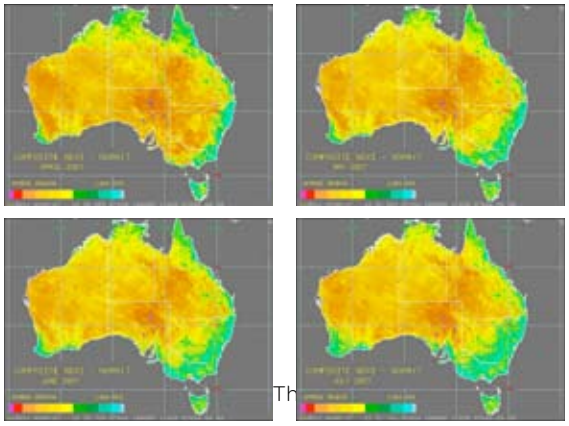


Figure 7: The Bureau of Meteorology's monthly Maximum Value Composite NDVI product for April to July 2007.

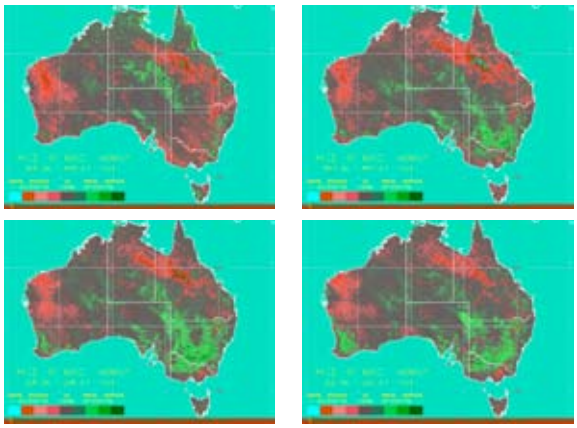


Figure 8: Annual NDVI difference (2007 – 2006) for months April to July produced by the Bureau of Meteorology.

The Bureau provides an experimental Grassland Curing Index (GCI) product derived from NOAA AVHRR data to fire agencies in Victoria, South Australia and the ACT to assist with fire danger assessment. The Bureau currently produces GCI, which is derived from NDVI, from NOAA-18 data using an algorithm and software developed by CSIRO. While the product covers only south-eastern Australia, the Bureau is a partner in a Bushfire Cooperative Research Centre project to develop a satellite curing assessment technique that is robust and validated across Australia.

ATMOSPHERIC PROFILES FOR NUMERICAL WEATHER PREDICTION

The Advanced TIROS Operational Vertical Sounder (ATOVS) suite of instruments on board the NOAA and MetOp satellites provides information on the vertical profiles of temperature and moisture in the atmosphere. 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 compared to use of no satellite data. Modern weather forecasting, in turn, relies heavily upon this modelling. Global ATOVS coverage is provided from the United States and Europe, but with delays of up to 6 hours, which is too late for optimal use by NWP. Local ATOVS reception in 2007 provided Australian Region NOAA-15, -17 and -18 coverage to Melbourne within 30 minutes from the start of acquisition, from WASTAC, Darwin, and Crib Point (southeast of Melbourne). The data are processed through the internationally standard ATOVS and AVHRR Pre-processing Package (AAPP), and produce significant positive impact in the Bureau's NWP system.

Accurate regional NWP for any country requires global ATOVS data. This has stimulated the development of rapid ATOVS dissemination through European, South American and Asia-Pacific (AP) Regional ATOVS Retransmission Services (RARS). The Bureau is the coordinator, a contributor through three local ATOVS reception facilities including WASTAC, and a major exchange node for AP-RARS. By the end of 2007, nine international AP-RARS sites were operational, with resulting positive operational NWP impact. Significant operational AP-RARS network expansion through 2008 is expected. (see http://www.bom.gov.au/weather/satellite/RARS/index.shtml)

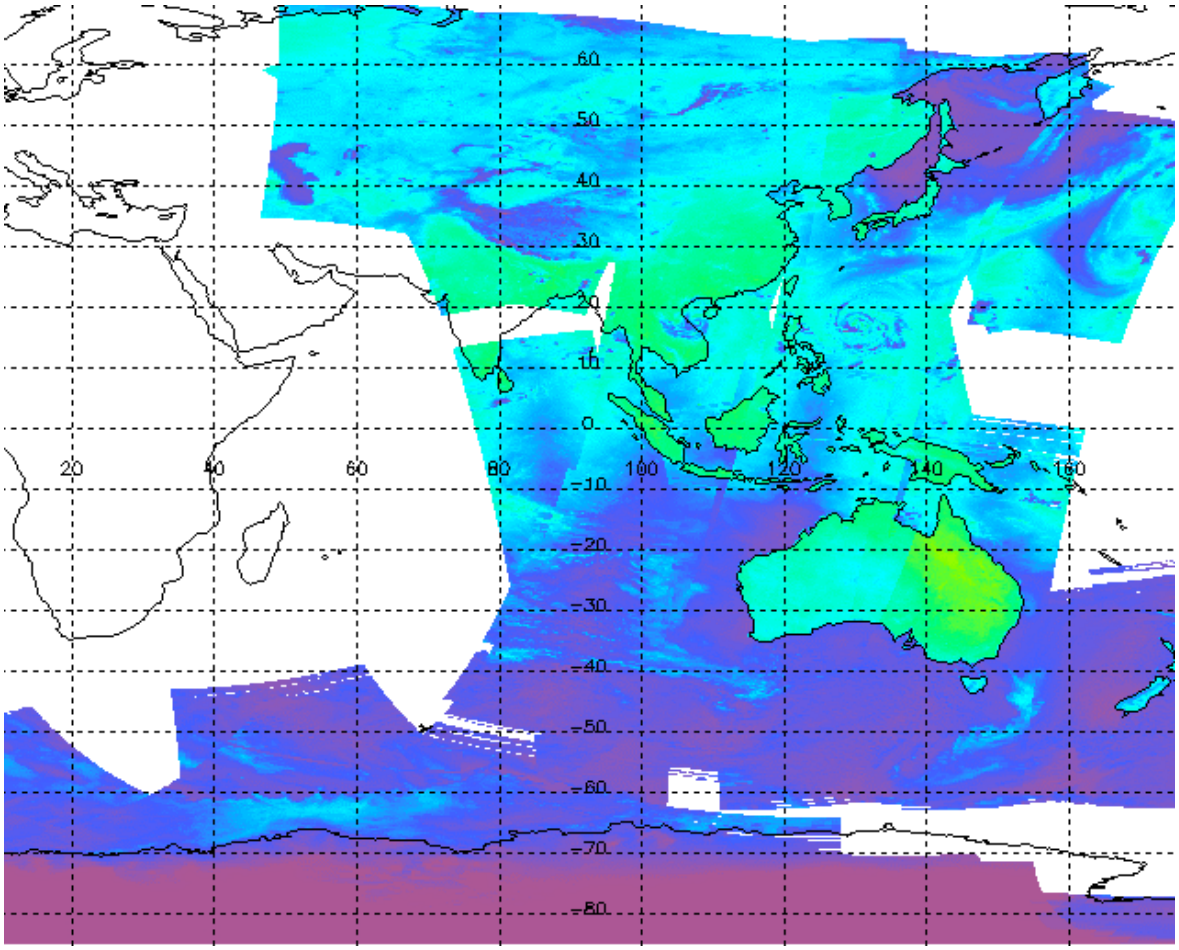


Figure 9: A 12-hour composite of AP-RARS microwave data coverage (incorporating data from WASTAC) in spring, 2007.

MODIS AND AIRS DATA

The large number of spectral bands carried by MODIS enables the derivation of a large range of image products that diagnose the state of the atmosphere and surface. These include information on the spatial distribution of water vapour, temperature, cloud phase (ice or water) and cloud top properties (pressure, temperature, particle size). The Bureau is using the International MODIS and AIRS Processing Package (IMAPP) software from the University of Wisconsin to generate these products, and has a developmental web-based system to deliver them to the Bureau's forecasters. Figure 10 is a sample of the web-page through which the forecasters in the Bureau's Western Australia Regional Office can access products derived from MODIS data received by WASTAC.

The Aqua satellite carries, besides MODIS, the Advanced Infrared Sounder (AIRS), which offers atmospheric profile data of unprecedented accuracy. Image products describing the temperature and moisture structure of the atmosphere will also be produced by IMAPP software for delivery to forecasters. AIRS data have shown major positive NWP impact, and are being assimilated on a trial basis into the Bureau's new NWP system, 'ACCESS' which is heavily based on the United Kingdom Met Office model.

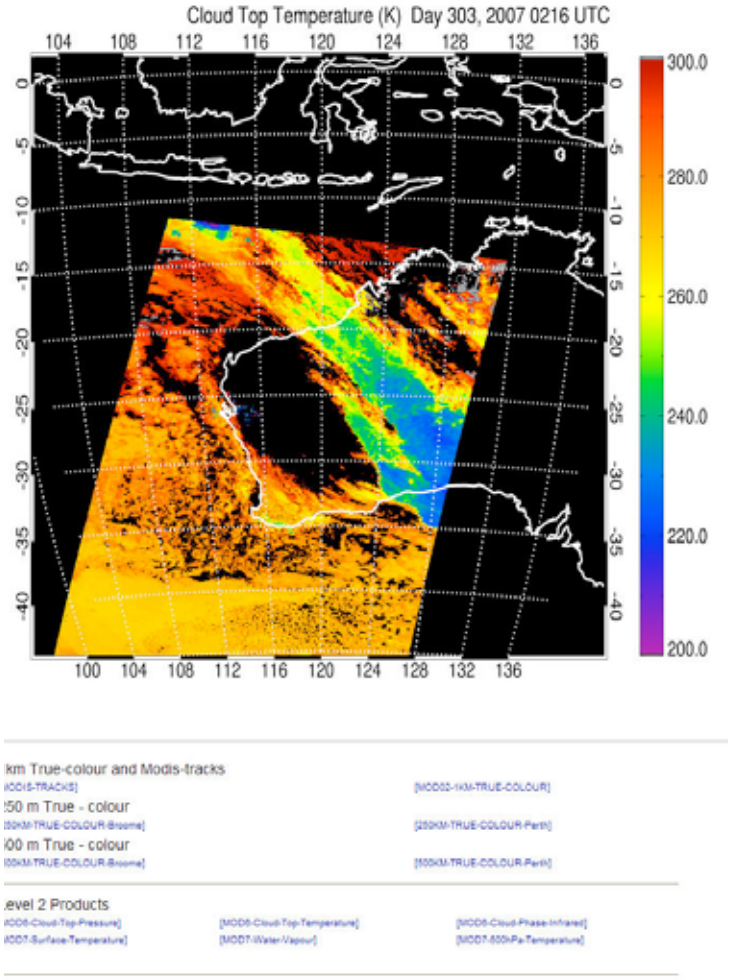


Figure 10: A sample of the web page to present MODIS products to Bureau forecasters. The links at the bottom give access to other parameters and high resolution true colour images.

FOG / LOW CLOUD

The fog/low cloud program developed by the Bureau of Meteorology Research Centre is aimed at improving our understanding and forecasting capability for fog. These forecasts are critical to efficient and safe aircraft operations. The low cloud software mosaics AVHRR infrared imagery onto a latitude-longitude grid (Figure 12), using near real-time NOAA-15 to -18 satellite data received at WASTAC, Darwin and Melbourne. Products are available within 10 minutes of the satellite pass being received, and are geometrically located to within one pixel (1 km).

Night time low cloud detection is performed using 3.7 micron and 11 micron IR NOAA data. Low altitude small-droplet water cloud emissivity at nighttime approximates that of a blackbody at 11 micron, but not 3.7 micron, leading to the apparent blackbody temperature being lower in the 3.7 micron band than the 11 micron band. Clouds composed of large droplets and/or ice crystals are not detected. The software provides cloud top height assignment with the use of topography and a land-sea mask.

The imagery is used in conjunction with MTSAT imagery, which provides lower spatial resolution (and hence sometimes fewer detections) than NOAA, but higher temporal resolution, with imagery every 15 minutes to one hour enabling image loops to determine cloud movement and help identify false detections. MODIS fog and low cloud imagery from WASTAC X-band reception will be produced by Autumn 2009.

Blue areas represent the lowest cloud tops (as estimated from thermal contrast with nearby cloud-free surface), with lighter shades representing a stronger signal (due to smaller droplet size and/or thicker cloud). Slightly higher cloud tops are denoted by olive-green shades. Sharp boundaries in height assignment occasionally result from dividing up low cloud masses into local areas for comparison against local surface temperatures, where cloud top temperatures are borderline between those for low and very low cloud.

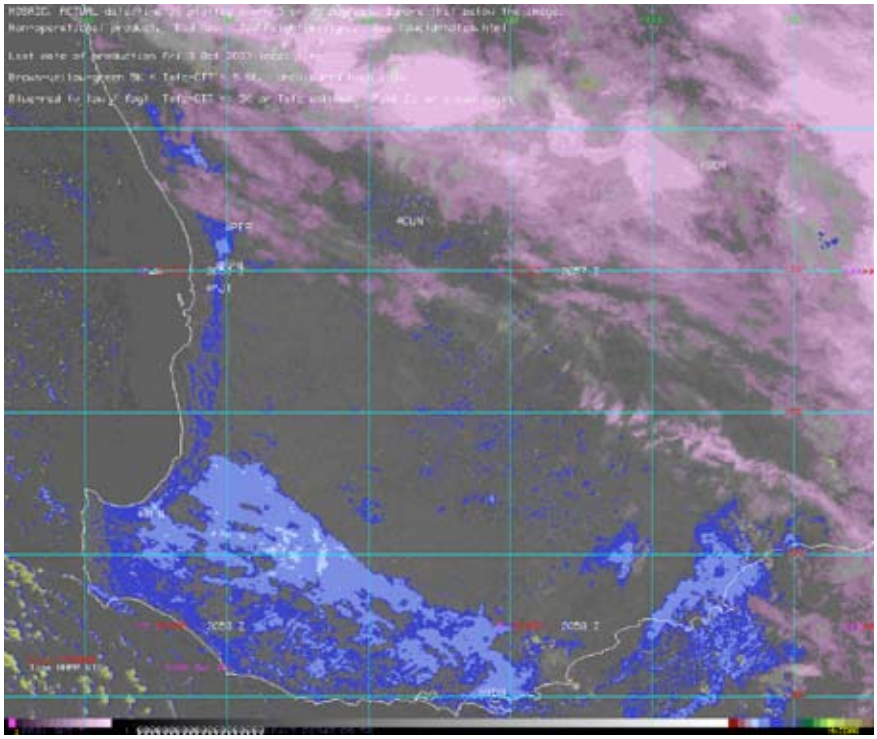


Figure 12: Fog and Low Cloud image from NOAA-15 ON 5 April 2007. Fog at Perth Airport lasted from 19:55 to 23:43 UTC. Fog is shown in blue along the plain on the coastal side of the escarpment, with a larger area on the southwest corner.

VOLCANIC ASH

Work is continuing on the use of AVHRR polar orbiter (and MTSAT-1R geostationary) satellite data for the detection and tracking of volcanic ash clouds, including the discrimination of volcanic ash from water/ice clouds. Work is also underway to implement a new approach using HIRS satellite data to detect SO2. When volcanoes erupt this gas is frequently present with volcanic ash and the technique will enable improved alerting for volcanic eruptions and the presence of ash.

The Bureau's Volcanic Ash Advisory Centre (VAAC) in Darwin provides advice on volcanic ash clouds within its area of responsibility for the aviation industry and the satellite data is critical to this operation. The Volcanic Ash Advisories (VAAs) issued are based on an initial report or detection of a volcanic eruption or ash cloud, an analysis of satellite data to identify and track the ash cloud, and a short term forecast of the ash movement based on upper level winds and a volcanic ash dispersion model. In the event of a volcanic eruption the provision of timely warnings is critical if the risk of an aircraft encounter with the ash is to be minimized.

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LANDGATE , SATELLITE REMOTE SENSING SERVICES, FLOREAT

FIRE FAX AND EMAIL SERVICE

Mike Steber and Miguel Tovar

During 2007 SRSS, Landgate continued to operate their fax and email service allowing pastoralists and government agencies to get a map of their region of interest faxed or emailed to them whenever there was a fire detected within the bounds of their region (see figure 1) . Clients for this service include pastoral stations and government agencies including several pastoral stations from the Northern Territory. Clients can also get ESRI shape files that can be used within a GIS such as ArcView or ArcGIS. The fire hotspot information used on the maps is derived from the MODIS sensor onboard the Terra and Aqua satellites and sent to clients twice a day when required. The first release of information occurs at 8am (WDST) and uses data from the Aqua satellite and the second at 2pm (WDST) uses data from the Terra satellite. Two different hotspot detection algorithms are used: a customized SRSS algorithm for the night time data and the MOD14 algorithm for the day time data. SRSS are also testing their own version of the MOD14 algorithm and this will eventually be used in the fire fax and email service. During 2007 over 2400 fax and email maps were transmitted.

In 2008 Landgate may trial a new service offering fire hotspot locations using SMS.

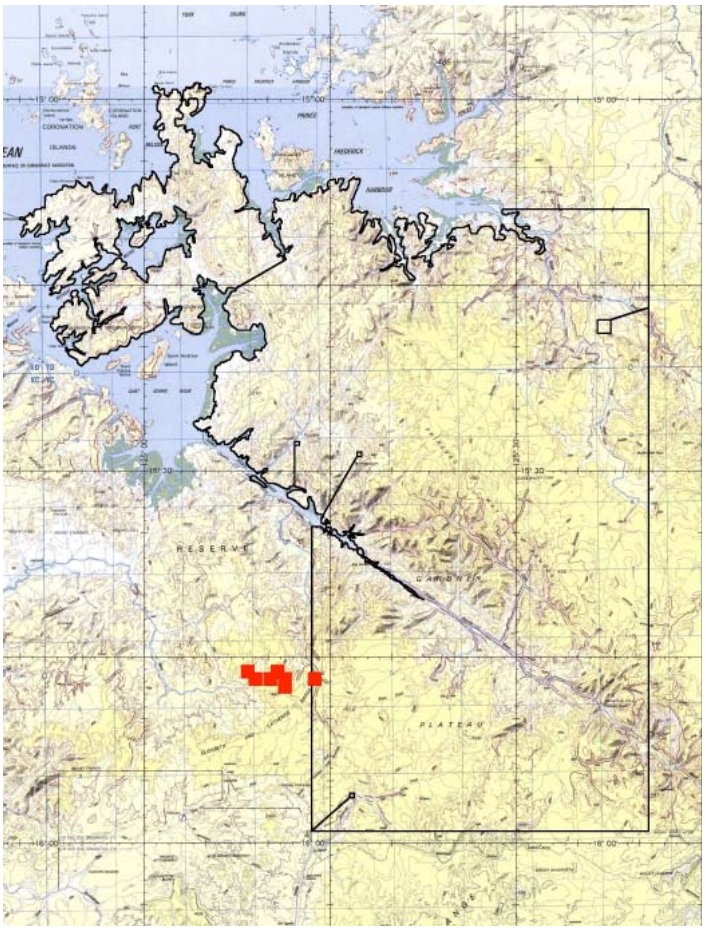

Figure 1. Fire email product showing fires in Prince Regent National Park in the Kimberley region of Western Australia.

MEASURING SOIL MOISTURE FROM AMSR-E

Miquel Tovar

The Advanced Microwave Scanning Radiometer - EOS (AMSR-E) is one of the six sensors aboard MODIS Aqua. AMSR-E is a passive microwave radiometer. Landgate now process Surface Soil Moisture, available as a daily continental composite which is distributed through FireWatch. The resolution is 25 Km.

Soil moisture is a key state variable in land surface hydrology. It controls the proportion of rainfall that percolates, runs off, or evaporates from land. Knowledge on moisture levels will help to determine if flooding might occur following large rainfall events (cyclones, tropical lows). It may be valuable for drought monitoring in agricultural areas.

In conjunction with AMRS-E soil moisture (Figure 2) and Tropical Rainfall Measuring Mission data (Figure 3) (TRMM) Landgate offers continental daily gridded rainfall from the Bureau of Meteorology at 25 kilometer resolution. The data provides a general overview of rainfall distribution across Australia and a synoptic view of land conditions associated with water.

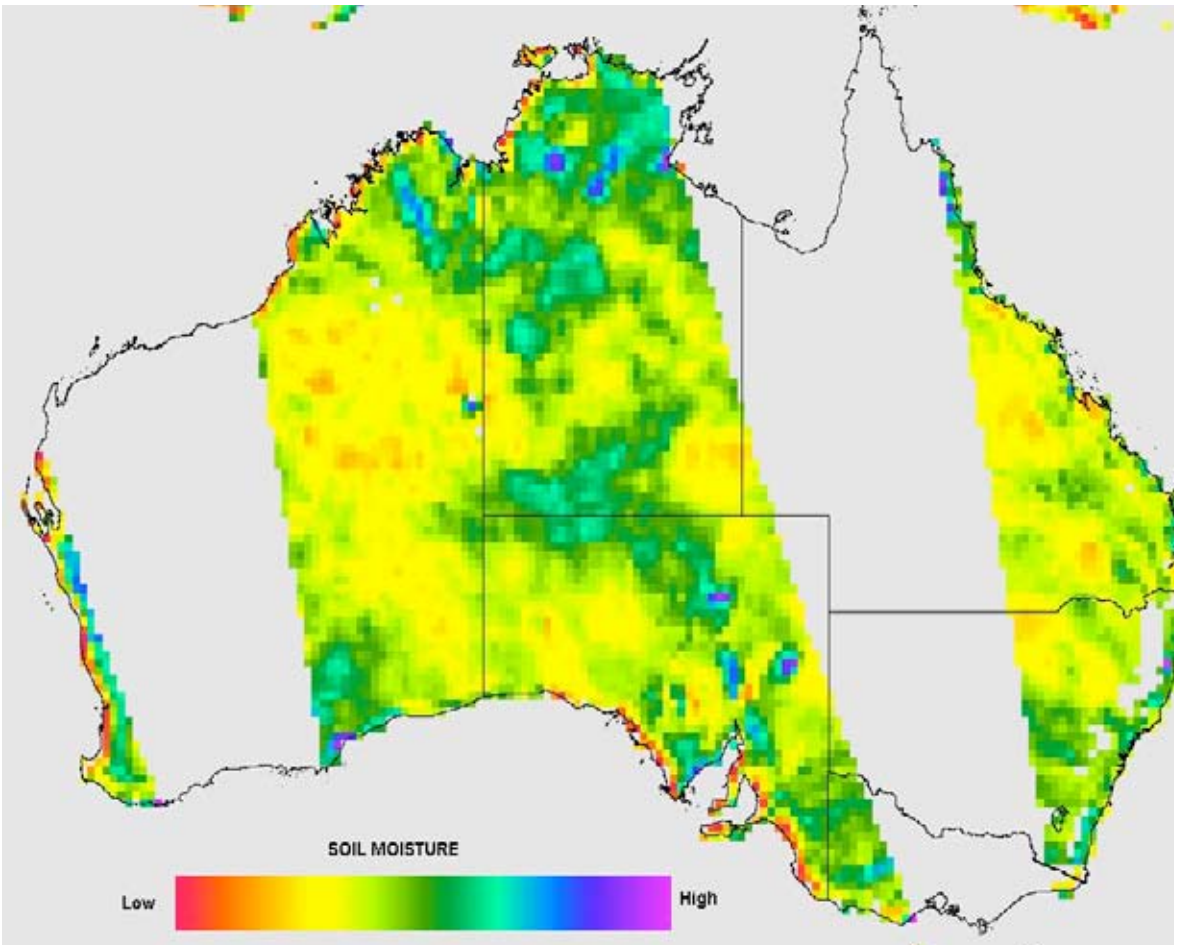

Figure 2: AMSR-E soil moisture image on the 6th November 2007.

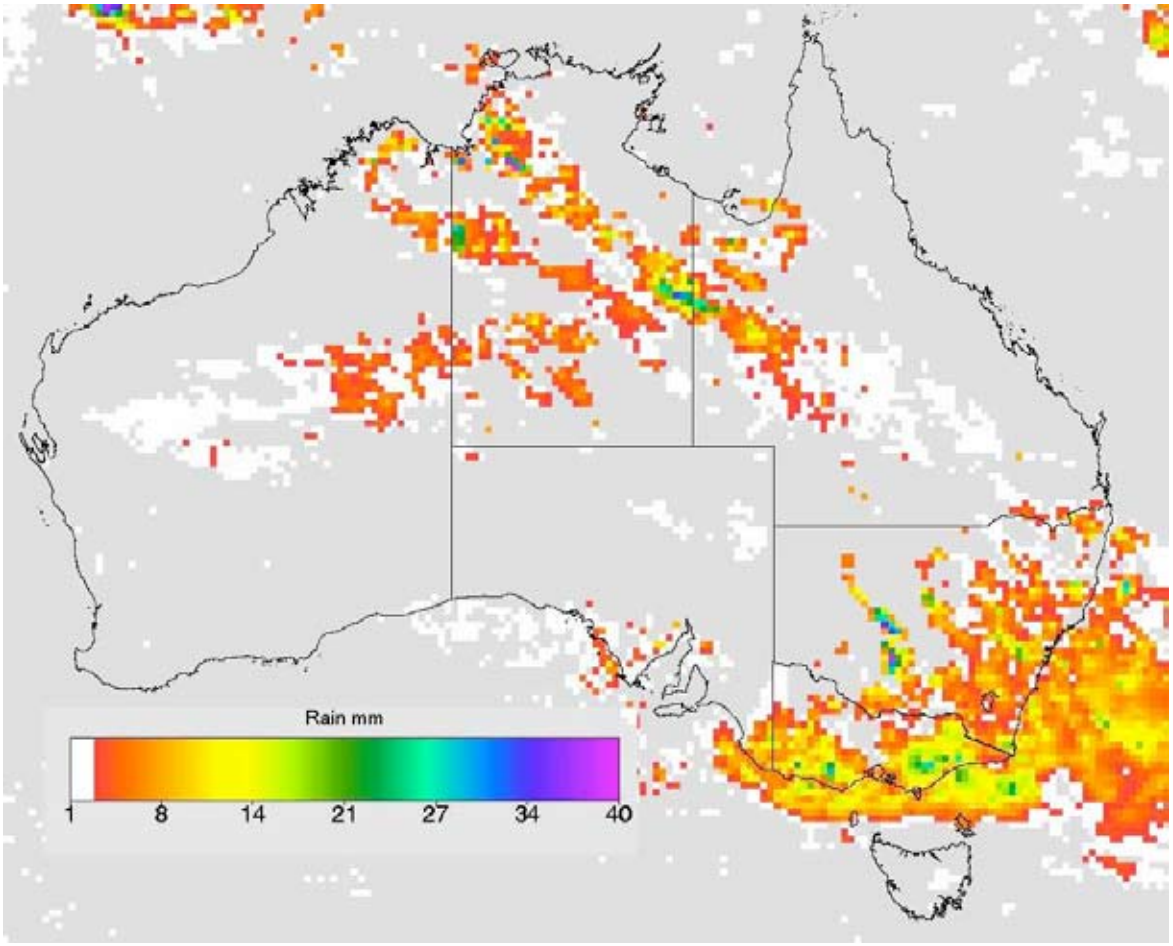

Figure 3: TRMM surface rainfall sum for the 3rd November 2007.

PASTURES FROM SPACE

Richard Stovold, Norm Santich, Sarfraz Khokhar, Matt Adams

The Pastures From Space program which delivers weekly MODIS satellite derived Pasture Growth Rate (PGR) data to farmers has been running for over 4 years. The PGR information is delivered every week as a subscription service over the internet. The information is being delivered through Fairport Technologies Pasture Watch software to producers in southern Australia.

Utilising this technology farmers have demonstrated they are able to increase their overall sheep gross margins from AUD$23- AUD$90/winter grazed hectare. This information helps to increase sheep production as a result of better management of available pastures on their properties. Other farm management improvements include better decisions on stocking rates, grazing rotations, feed budgeting and fertilizer applications.

Farmers in Western Australia and the Eastern States are routinely using this technology to assist them improve their management decisions resulting in higher profitability. Farmers are achieving increased pasture utilization using Pasture Growth Rate and Feed On Offer maps resulting in more wool and profit per hectare.

In 2007 the coverage of the Pastures From Space has been extended to include from Rockhampton in southern Queensland southward to include Tasmania and western areas of the Eyre Peninsula in South Australia (see Figure 4). Farmers are now able to access this larger coverage for every paddock as part of the weekly subscription service.

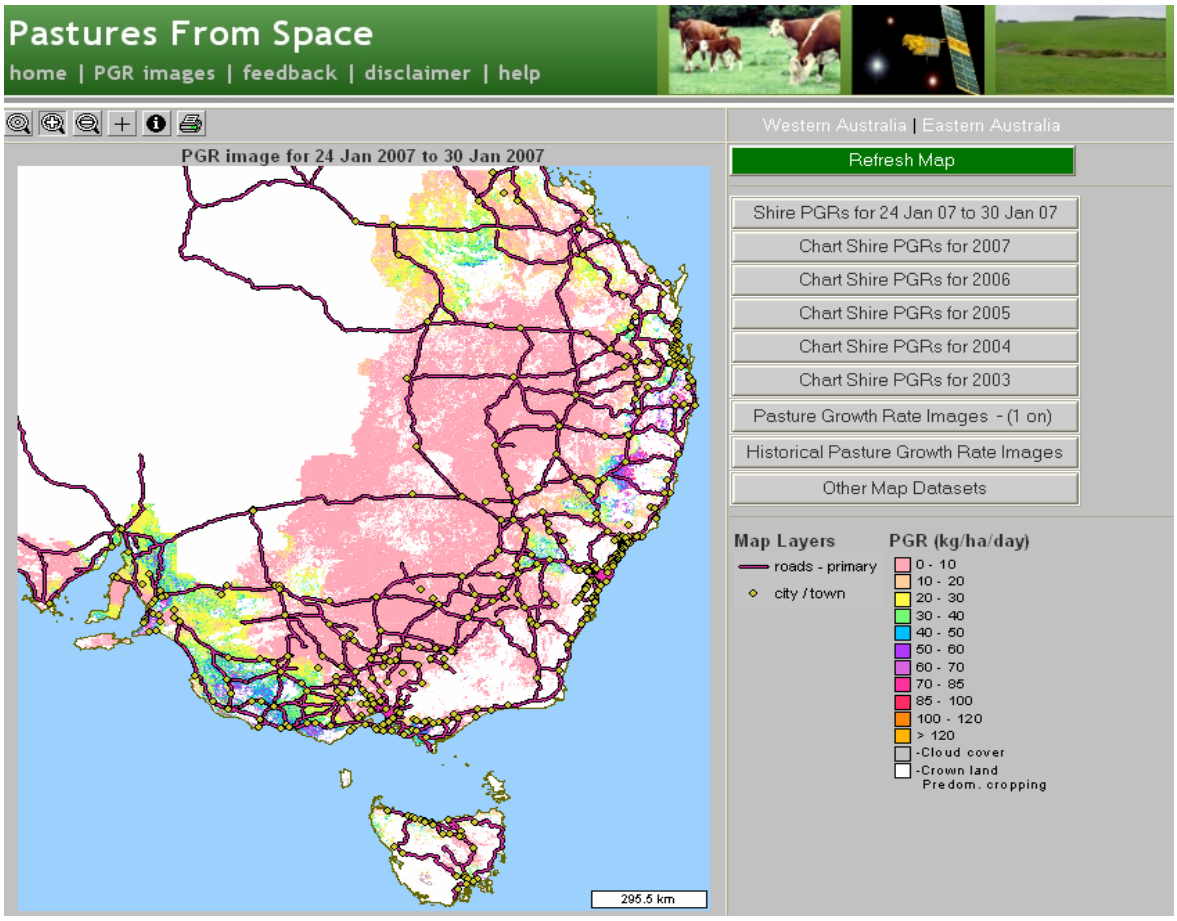

Figure 4: Eastern Australian Pastures From Space coverage

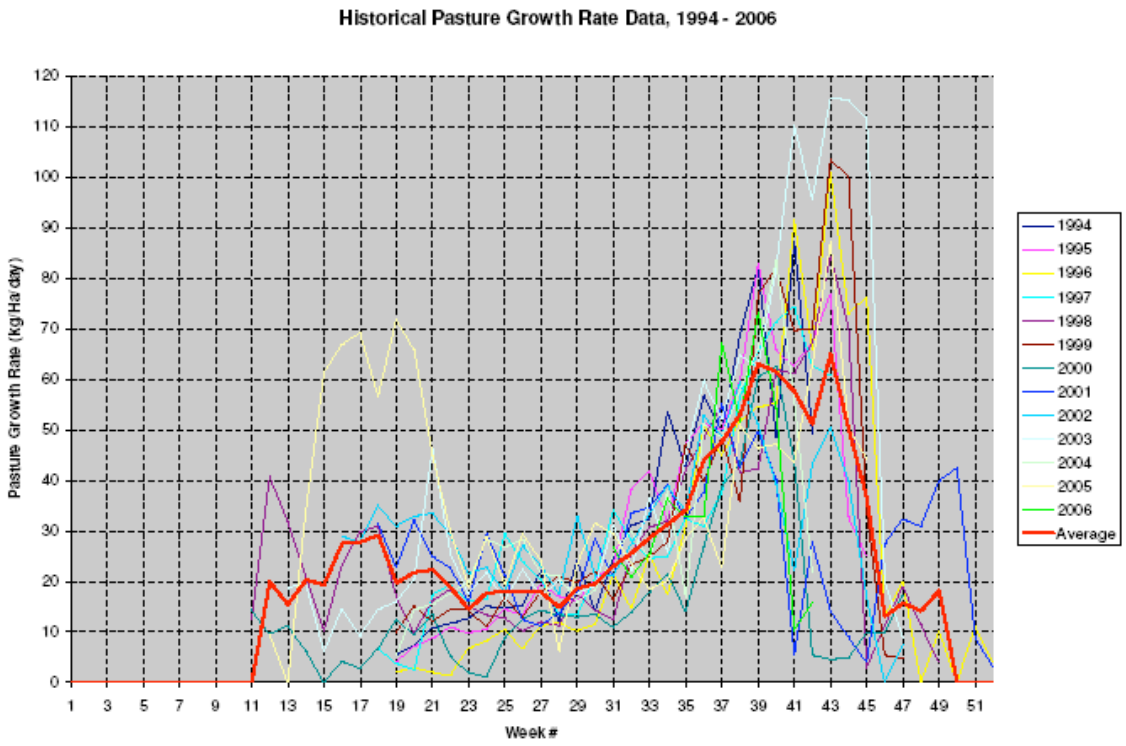

Figure 5: Weekly historical Pasture Growth Rate graphs of a farm in the south west of Western Australia from 1994 to 2006. Seasonal growth rate variations are apparent above and below the average (red line).

Pastures from Space is a collaborative project involving Landgate, CSIRO Livestock Industries and the Western Australian Department of Agriculture and Food.

A new Pastures From Space data analysis tool now available for the farmer is the provision of historical time series pasture growth and total dry matter (or feed available) graphs from 1993 to present for individual farm properties (Figures 5 and 6).

This information is providing farmers with weekly growth trends and gives an insight into seasonal patterns of growth, hence productivity, which then gives a clear picture of the climatic trends through the seasons.

It is assisting farmers to make decisions based on this information, or make predictions on the farm's productivity for the rest of the year.

The public Pastures from Space site now has improved shire PGR charting abilities, meaning it is possible to compare a shire's pasture growth rate performance in a given year with up to seven other shires (Figure 7).

The individual performance of a shire can also be compared to its previous years performance, going back to 2003 (Figure 8).

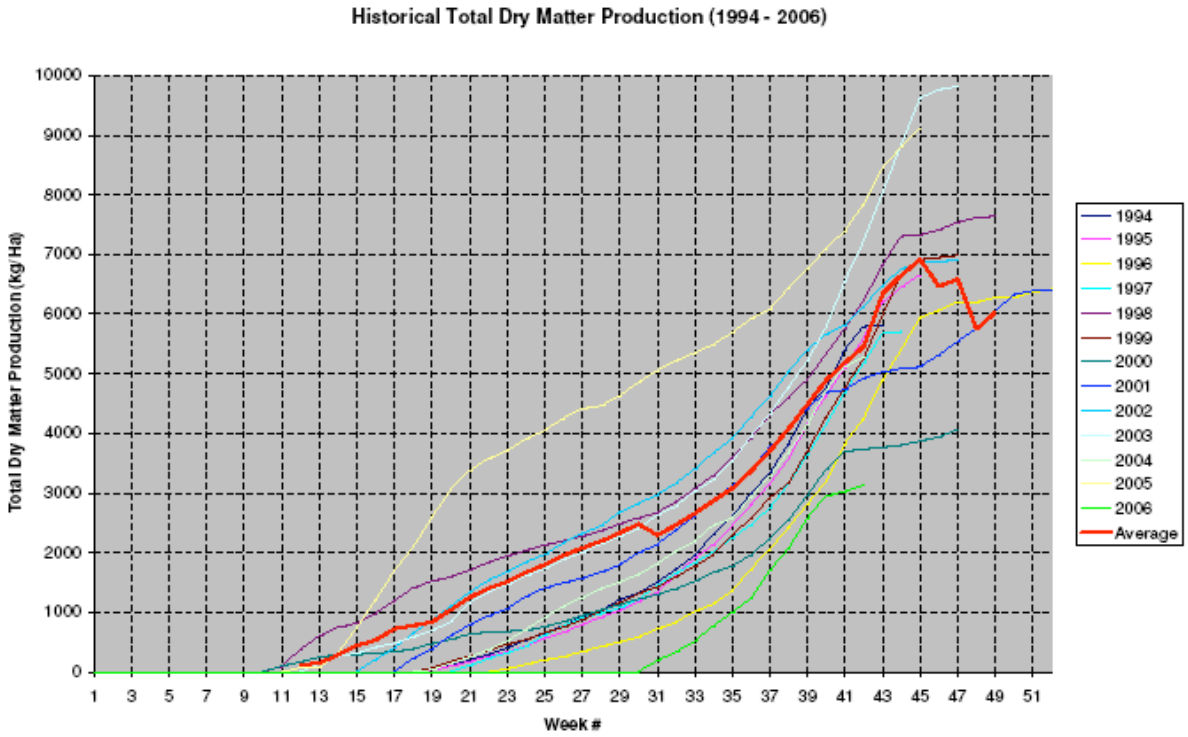

Figure 6: Weekly total dry matter production graphs of the same farm in the south west of Western Australia from 1994 to 2006. The total available stock feed or biomass on farm can be predicted by the seasonal trends.

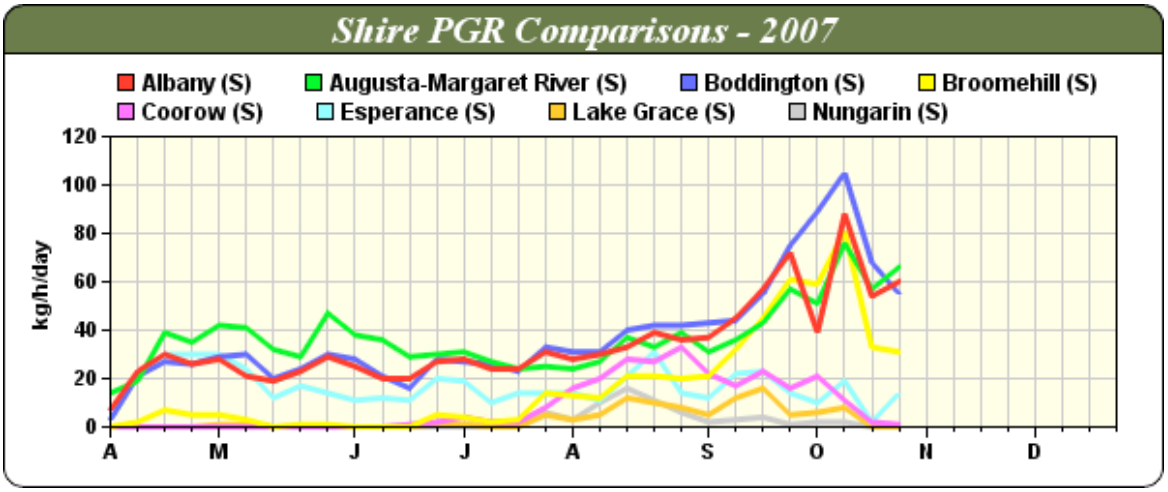

Figure 7: Comparison of Pasture Growth Rates of 8 shires in WA for the 2007 season

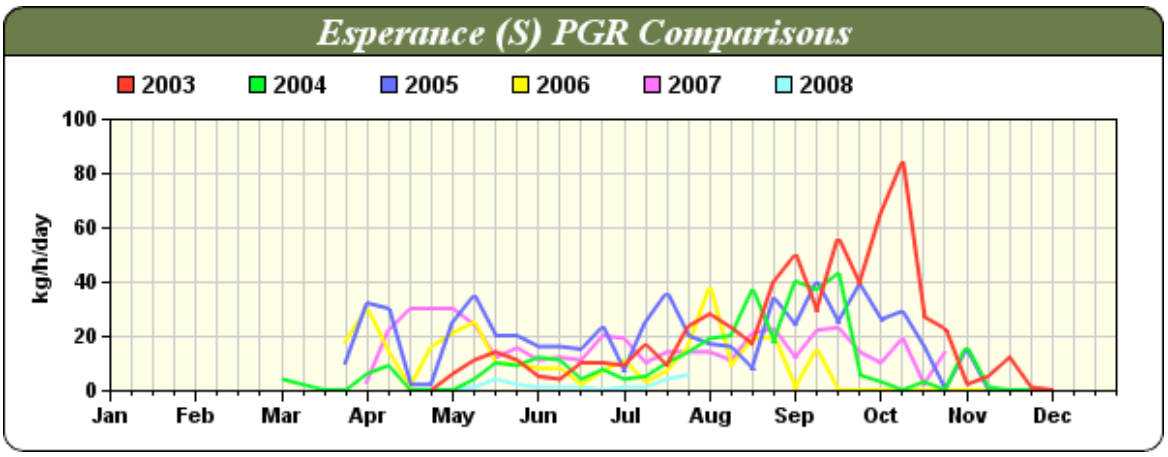

Figure 8: Comparison of Pasture Growth Rates of the Esperance shire for the seasons 2003 to 2008.

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.

PLANT VIGOUR INDEX

Norm Santich, Richard Stovold, Richard Smith

The plant vigour index is derived from MODIS daily satellite measurements of the Normalised Difference Vegetation Index (NDVI) which is a measure of plant greenness. Figures 9 and 10 indicate the high variability of plant biomass within shires primarily caused by varying rainfall. It can be used to indicate the amount of crop and pasture cover.

Figure 9 for the week ending May 15th, 2007 indicates the late break to the season particularly in the northern and north eastern wheatbelt of WA showing low to very low plant growth. By comparison the plant vigour index (Figure10) dated May 13th,2008 shows increased plant growth in the northern and central wheatbelt with considerably less growth in the Esperance region.

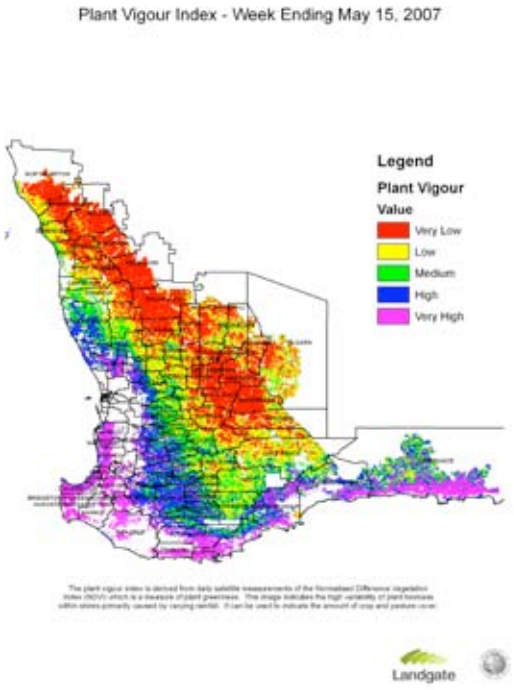

Figure 9: Plant Vigour Index, week ending May 15th 2007

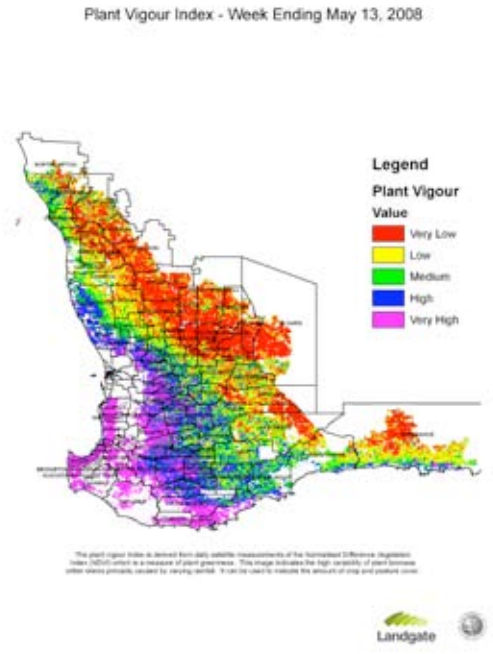

Figure 10: Plant Vigour Index, week ending May 13th 2008

Research Developments 2007

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

CURTIN UNIVERSITY OF TECHNOLOGY

(Remote Sensing and Satellite Research Group)

SUSPENDED SOLIDS FROM MODIS

Peter Fearns, Matt Slivkoff, Wojciech Klonowski

The RSSRG are developing Total Suspended Solid (TSS) algorithms for turbid coastal waters. In situ measurements of TSS and spectral reflectance are used to derive a regression relationship. The form of the relationship is supported by optical modelling studies using Hydrolight. The TSS algorithm has been used to produce TSS maps for turbid coastal waters along the north coast of WA. The figures below show examples of the products generated using MODIS 250 m resolution data. Figure 1 shows TSS for the 17th August 2007. Figure 2 shows the standard deviation of TSS over a period of 40 days. Algorithms of this form are typically applicable in waters of similar optical properties to those in which they were developed. Transfer of the algorithm to optically different waters often requires local tuning based on in situ measurements.

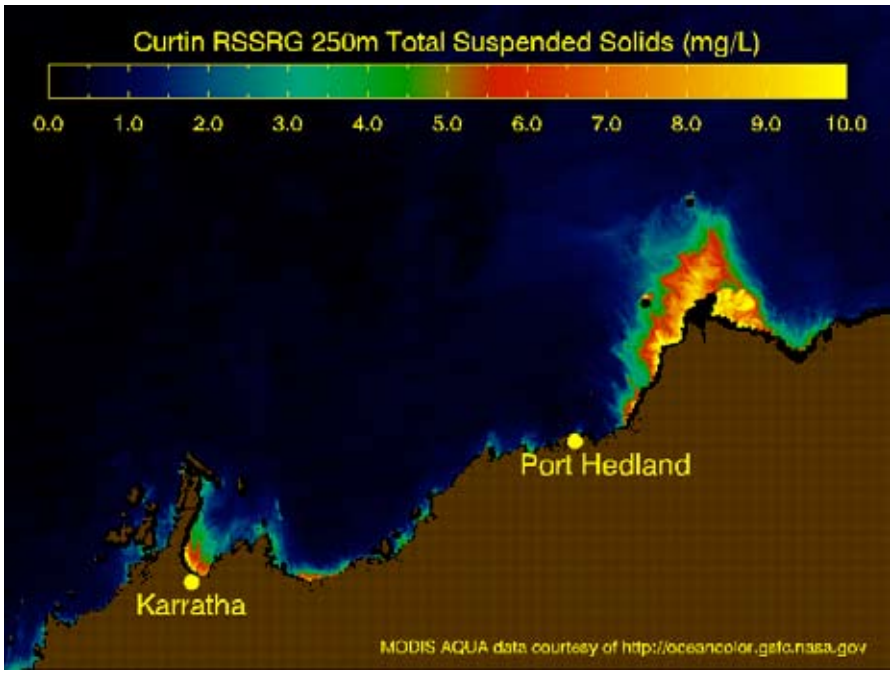

Figure 1. 250 m resolution TSS for the 17th August 2007. Derived from MODIS Aqua data.

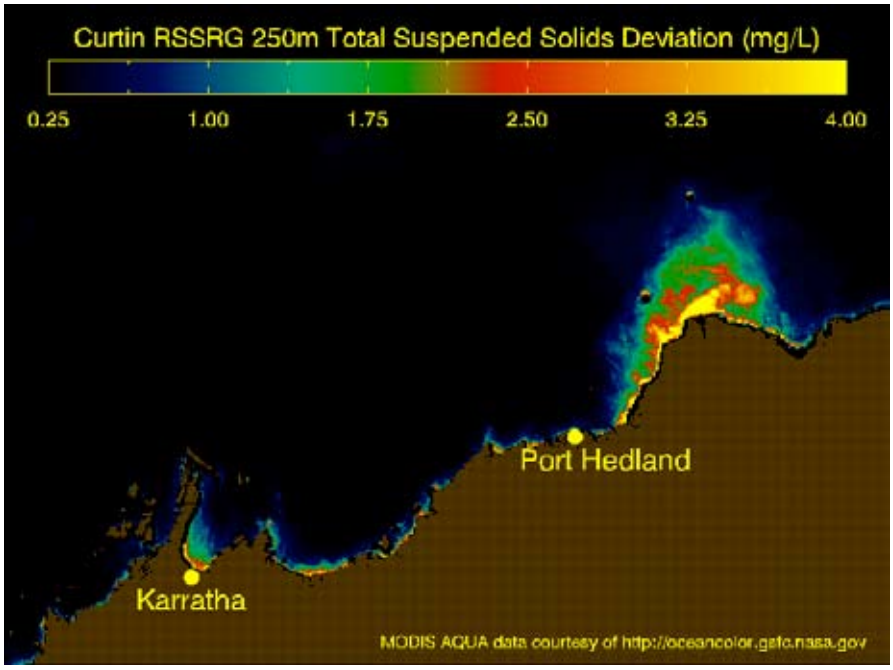

Figure 2. Standard Deviation of TSS over a 40 day period. Derived from MODIS Aqua data.

WASTAC SATELLITE DATA ARCHIVE ON IVEC

Peter Fearns, Merv Lynch, Andrew Rohl, Ron Craig, Huw Lynch, Nick Bower

The WASTAC satellite data archive volume has grown to approximately 7 TB. Timely access to the data for users has become difficult, and maintenance of some older storage media can be challenging. As such, WASTAC has initiated a project to utilise iVEC for the storage of, and access to, it's growing remote sensing data archive. iVEC is a High Performance Computing (HPC) facility based at Technology Park in Bentley and is a partner in the Advanced Partnership in Advanced Computing (APAC).

The WASTAC/iVEC data archive project is planned to progress in three phases. Phase 1 involves the development of a prototype data reduction algorithm, a meta-data store, and associated operational data processing system. Phase 2 will progress the system to an operational status providing users with a web-based data search and retrieve capability. The search criteria will include scene coverage, cloud coverage and swath metadata. Phase 3 will be defined clearly as Phase 1 and 2 progress, but is expected to incorporate higher level on-demand processing via a web interface, integration of historical data sets, including in situ ground truth instrument data, and enhanced data format delivery options (possibly openDAP).

Progress with Phase 1 is well underway. A comprehensive overview and project documentation is available via the web site http://wastac.ivec.org/. Figure 3 shows a screen grab of a prototype version of the web-based swath data search tool.

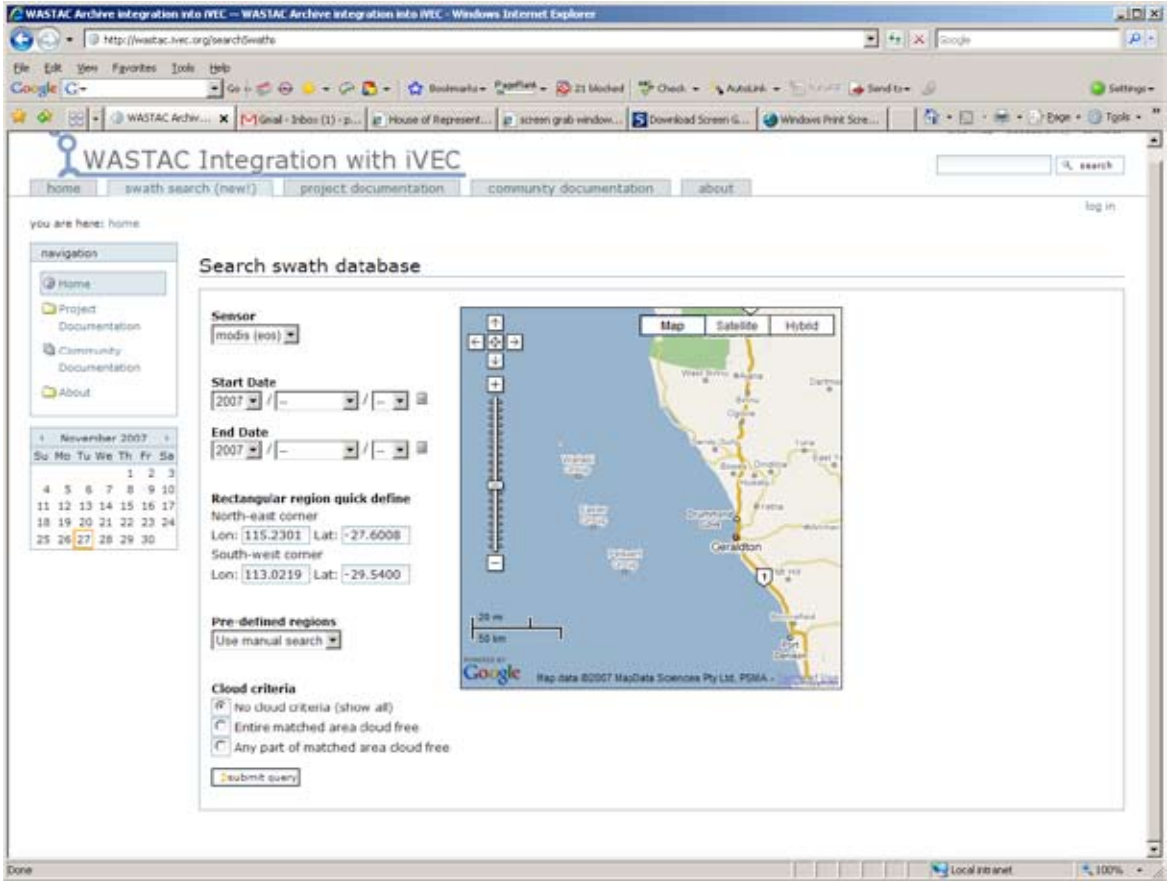

Figure 3. Example of the swath search tool being developed as part of the WASTAC archive integration with iVEC.

17 YEARS OF HIRS CLOUD DATA

Helen Chedzey, Merv Lynch

HIRS is the High-Resolution Infrared Radiation Sounder found aboard NOAA satellites. The second generation sounders (HIRS/2) on NOAA-9, NOAA-11 and NOAA-14 were used in this instance to investigate cloud frequency over the Australian region. Figure 4 provides a broad overview of cloud frequency of all types of cloud, at all levels between 1985 and 2001. Seasonal variations in cloud frequency become evident with high percentages of cloud frequency visible in the tropics during summer and lower percentages during winter and early spring. Presenting the information in this way also highlights individual years that may have consecutive months of low cloud frequency over land such as 1994. Rainfall data provided by the Bureau of Meteorology Research Centre for the WA region during this year show a large recorded rainfall of 96.23mm during February but a low recorded yearly rainfall total of 272.65mm relative to surrounding years.

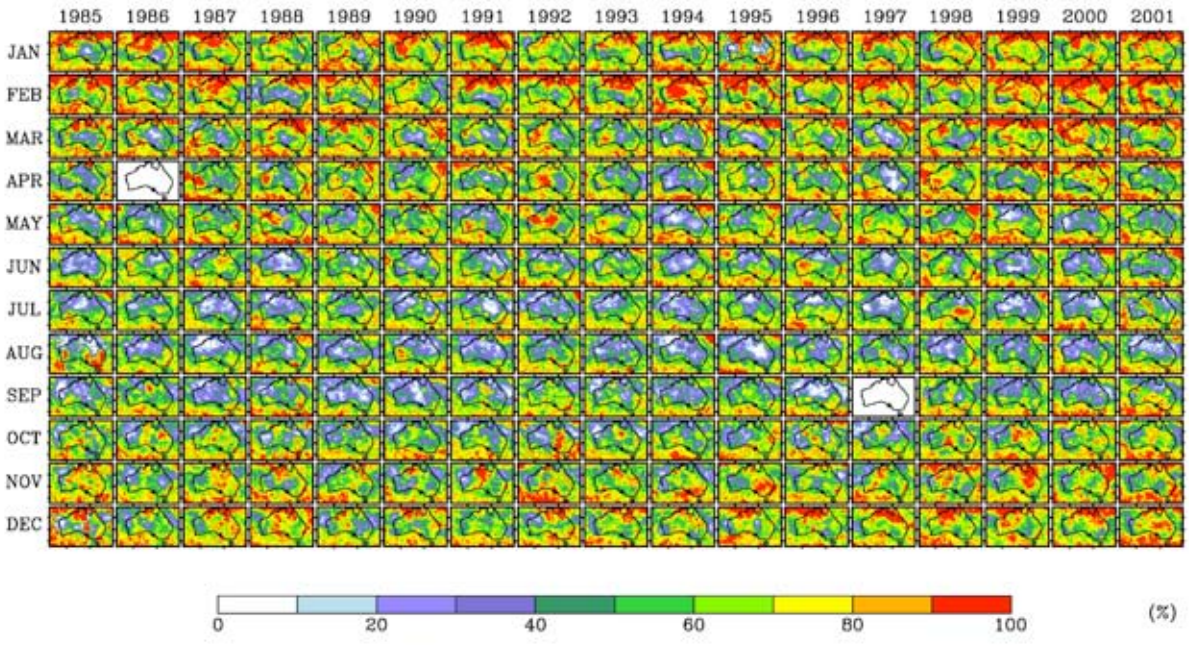

Figure 4: Cloud frequency (%) images of all cloud averaged monthly over a 17 year time-scale (1985 to 2001).

LANDGATE

SOIL MOISTURE IN AUSTRALIA FROM OPTICAL/THERMAL DATA

Mario Ferriç

Soil moisture is the quantity of water contained in the soil within reach of plant roots, generally referred to as the upper 1-2 m of soil. Therefore soil moisture plays an essential role in plant water availability. Nevertheless it may provide an early warning indicator for flooding if a soil reaches saturation conditions or be essential information to predict amounts of runoff, evaporation rates and soil erosion.

Methods for estimating soil moisture content from field work are complex, labour intensive and therefore expensive. Moreover, being point measurements, field sampling at continental scale is impossible.

By contrast, Remote Sensing (RS) techniques offer a unique possibility to widely assess the areal soil moisture content at low cost. Several active (radar) and passive microwave remote sensing methodologies have been used in the last few years to infer soil moisture content. Unfortunately, they provide information of the top soil layer (~ 1 cm) on 50-60 km cell size (Njoku et al., 2003; Njoku, 2004).

However, information on the soil moisture content of the soil profile up to a certain depth (normally 1m) and at relatively medium resolution is often required. For this purpose, within the framework of the National Disaster Mitigation Programme ~ FloodMap project at Landgate, the Apparent Thermal Inertia (ATI) generated from optical and thermal spectral information of MTSAT imagery (spatial resolution 4 km) for all Australia has been exploited. In particular ATI has been computed by using the albedo imagery, generated from the daytime MTSAT pass, and brightness temperature changes between the daytime and night-time data.

The approach to derive soil moisture content from ATI is based on the logic that water bodies have a higher ATI value than dry soils. When soil water content increases, ATI proportionally increases as well. Thus, ATI can be considered as the spatial and temporal variability of soil moisture. Pixel wise, the minimum and maximum ATI values retrieved from ATI time series, corresponding to the residual and saturated soil moisture contents respectively, allow us to derive the so-called Topsoil Moisture Saturation Index $TMSI_0$:

$$TMSI_0(t) = \frac{ATI(t) - ATI_{min}}{ATI_{max} - ATI_{min}} \quad (1)$$

The conversion of the topsoil moisture content to the Total Available Water at time t needs two steps. The first phase requires the calculation of the Soil Moisture Saturation Index for a 1 m soil profile SMSI(t) which can be computed by the following discrete formulation (Wagner et. al., 1999):

$$SMSI(t) = \frac{\sum_{i=1}^{n}\left[TMSI_0(t_i)\cdot e^{-\frac{t-t_i}{T}}\right]}{\sum_{i=1}^{n} e^{-\frac{t-t_i}{T}}} \quad \text{for } t_i \le t \quad (2)$$

where T is a characteristic time length and n is the number of days of the time series. Wagner et al. (1999) has found that the best correlation between soil moisture retrieved from ERS Scatterometer data (C-band radar) and the 0-100 cm layer field data is observed if T is set equal to 20 days. In our case SMSI(t) is calculated for a time series of [t-3T,t], i.e. 60 days before the considered time t.

The second step is the use of the auxiliary data regarding the following soil physical properties:

- the Available Water Capacity AWC, defined as the difference between Field Capacity FC and Wilting Point WL;
- the depth R_d of the plant root zone.

Both these data are available for Australia at 0.01 degree (~ 1km) grid cells (ANRDL, Australian Natural Resources Data Library). Particularly two different soil layers having AWC_1 and AWC_2 are available:

- AWC_1 in Layer 1, A-Horizon Top-Soil with thickness of soil layer R_{d1} (ranging from 5 cm to 45 cm);
- AWC_2 in Layer 2, B-Horizon Sub-Soil with thickness of soil layer R_{d2} (ranging from 10 cm to 130 cm).

In this case for each point P of latitude φ and longitude λ, summing up the contribution of the two layers, it is possible to find the Water Storage Capacity WSC:

$$WSC(\varphi,\lambda) = AWC_1(\varphi,\lambda)\cdot R_{d1}(\varphi,\lambda) + AWC_2(\varphi,\lambda)\cdot R_{d2}(\varphi,\lambda) \quad (3)$$

Merging remote sensing data [Eq. (2)] and soil data [Eq. (3)], the latter resampled at the same spatial resolution of MTSAT (4 km), the Total Available Water TAW at time t can be found in each pixel:

$$TAW(t,\varphi,\lambda) = SMSI(t,\varphi,\lambda)\cdot WSC(\varphi,\lambda) \quad (4)$$

Figure 1 and Figure 2 are examples of Soil Moisture Saturation Index SMSI. They are referred to 21 June 2007 and 24 December 2007, respectively. A significant increase of soil moisture can be observed in the eastern part of Queensland and New South Wales as well as in the northern part of Australia. This is in good agreement with the pattern of rainfall observed in the same periods (Figure 3 and Figure 4). Similar trend can be observed in Figure 5 and Figure 6 that show the Total Available Water resulting from the convolution of the above Soil Moisture Saturation Index maps with soil data.

References

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Wagner, W., Lemoine, G., & Rott (1999). A method for estimating soil moisture from ERS Scatterometer and soil data. Remote Sensing of Environment, 70, 191-207.

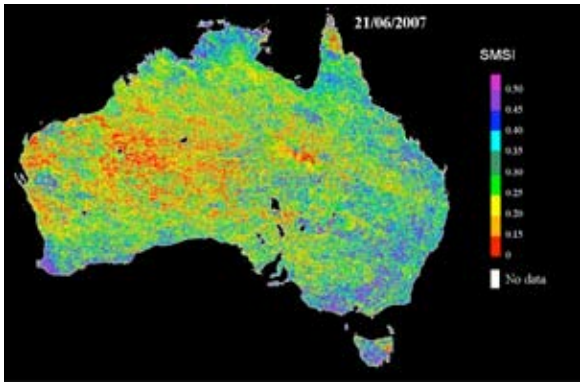

Figure 1. Soil Moisture Saturation Index from remote sensing data (21/06/2007).). Areas in white have no data.

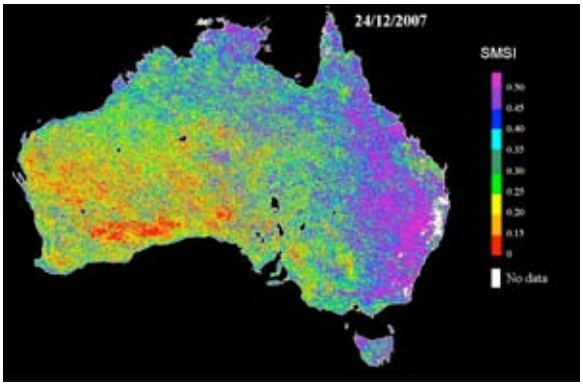

Figure 2. Soil Moisture Saturation Index from remote sensing data (24/12/2007). Areas in white have no data.

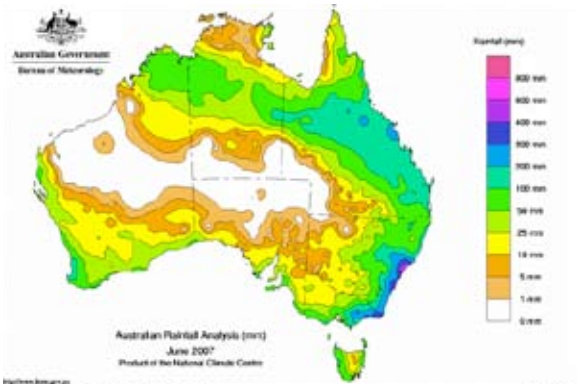

Figure 3. Australian Rainfall June 2007 (National Climate Centre).

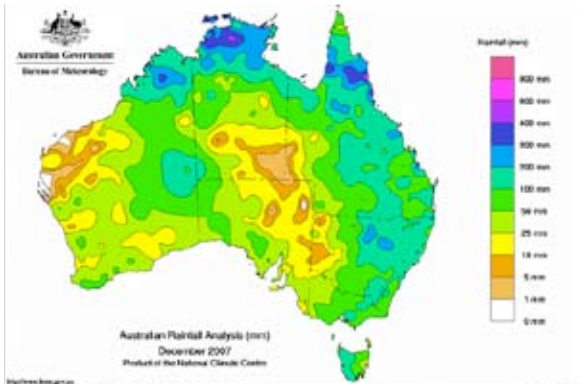

Figure 4. Australian Rainfall December 2007 (National Climate Centre).

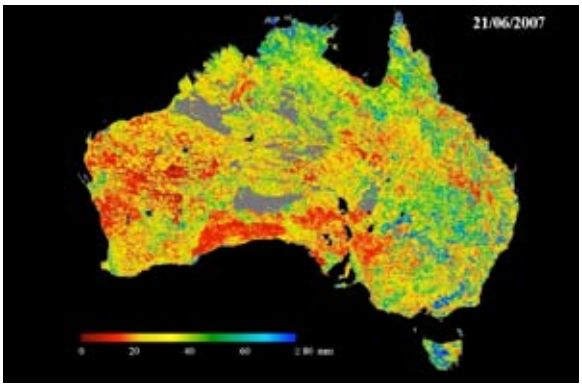

Figure 5. Total Available Water from soil data (A-Horizon+B-Horizon) and remote sensing data (21/06/2007). Areas in grey have no soil data.

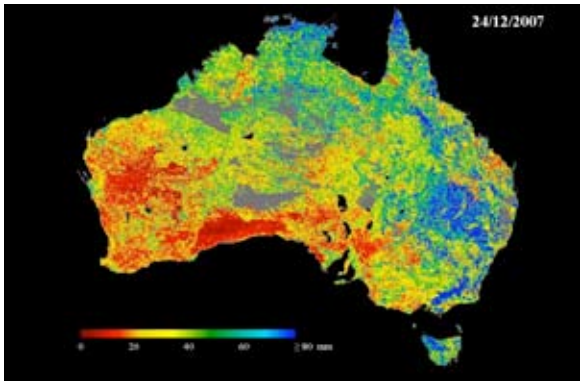

Figure 6. Total Available Water from soil data (A-Horizon+B-Horizon) and remote sensing data (24/12/2007). Areas in grey have no soil data.

WASTAC

FINANCIAL STATEMENTS

2006-07

Santo Casilli
Accounting and Auditing Services

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CERTIFIED PRACTISING ACCOUNTANT

INDEPENDENT AUDITORS' REPORT
The Members of the Board
WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

I have audited the accompanying special purpose financial report of the Western Australian Satellite Technology and Application Consortium – L Band which comprises the balance sheet as at 31 December 2007, the income statement and statement of cash flow for the year ended, a summary of significant accounting policies and other explanatory notes as attached.

Board Responsibility for the Financial Report
The Board is responsible for the preparation and fair presentation of the special purpose financial report. This responsibility includes establishing and maintaining internal controls relevant to the preparation and fair presentation of the financial report that is free from material misstatement, whether due to fraud or error and selecting and applying appropriate accounting policies.

Auditor's Responsibility
My responsibility is to express an opinion on the financial report based on my audit. I conducted the audit in accordance with Australian Auditing Standards. These Auditing Standards require that I 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 the entity's preparation and fair presentation 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 by the Board, as well as evaluating the overall presentation of the financial report.

I disclaim any assumption of responsibility for any reliance on this financial report to which it relates to any person other than the Board or for any purpose other than that for which it was prepared.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

Auditor Independence
In conducting my audit, I have complied with the independence requirements of the Australian professional accounting bodies.

Auditor's Opinion
In my opinion, the financial report presents fairly, in all material respects, the financial position of the Western Australian Satellite Technology and Application Consortium – L Band as of 31 December 2007 and of its financial performance and its cash flows for the year then ended.

Santo Casilli CPA
Date:
Perth

WASTAC L- Band BUDGET 2008

Estimated expenditure for the year
January 2008 – December 2008

		$ PER ANNUM	
		2007	2008
1.	Telstra Rental	4000	4000
2.	Data Tapes	2000	2000
3.	System maintenance/repairs	90000	124000
4.	Telecommunications licence of facility	1500	3500
5.	Consultants	57,000	72000
6.	Sundry consumables	1500	1500
7.	Travelling – Airfares	3000	3000
8.	Provision for major equipment	12000	12000
9.	Annual Report	10000	10000
	TOTAL INCOME	**$181,000**	**$232,000**

Estimated income/revenue for the year
January 2008– December 2008

1.	Contributions received ($10,000 each)	40000	40000
2.	Interest	6000	12000
	TOTAL INCOME	**$46,000**	**$52,000**

Extra-ordinary expenditure
January 2008– December 2008

		$ PER ANNUM	
		2007	2008
1.	Capital Reserve:	80,000	0
1.1	Antenna replacement and componentry	30,000	0
1.2	iVEC phase2 implementation		
	TOTAL INCOME	**$110,000**	**$0**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM L BAND INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2007

	2007 $	2006 $
INCOME		
Contributions Received	40,000	50,000
Interest Received	23,902	13,319
Total Income	**63,902**	**63,319**
EXPENDITURE		
Outsourced Work	-	3,200
Telephone Rent & Calls	5,312	965
Service and Equipment Charges	864	-
Microwave Licenses	1,013	-
Freight Costs	-	737
Network Software/Licence	-	976
External Printing Costs	5,638	6,550
Other Equipment Maintenance	4,686	45,991
Depreciation Expenses	3,092	2,112
Total Expenditure	**20,605**	**60,531**
Net Operating Result for the Year	**43,297**	**2,788**

Natalie Madden
Associate Director
Financial Services

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM L BAND BALANCE SHEET AS AT 31 DECEMBER 2007

	NOTE	2007 $	2006 $
CURRENT ASSETS			
Cash at Bank		288,777	315,002
Prepayment		596	-
Total Current Assets		**289,373**	**315,002**
NON - CURRENT ASSETS			
Property, plant and equipment	2	28,958	9,050
Total Non - Current Assets		**28,958**	**9,050**
Total Assets		**318,332**	**324,052**
CURRENT LIABILITIES			
Accrued expenses		-	48,216
Total Current Liabilities		**-**	**48,216**
Total Liabilities		**-**	**48,216**
Net Assets		**318,332**	**275,836**
EQUITY			
Retained Funds	4	318,332	275,836
Total Equity		**318,332**	**275,836**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM L - BAND CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2007

CASH FLOWS FROM OPERATING ACTIVITIES	NOTE	2007 $	2006 $
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	20,000
Interest Received		23,902	13,319
Total Receipts		**63,902**	**63,319**
PAYMENTS			
Payments to suppliers		(66,325)	(11,185)
Total Payments		**(66,325)**	**(11,185)**
Net cash provided by operating activities	3	**(2,423)**	**52,134**
CASH FLOWS FROM INVESTING ACTIVITIES			
Payments for property, plant and equipment		(23,802)	-
Net cash used in investing activities		**(23,802)**	**-**
Net increase/(decrease) in cash		**(26,225)**	**52,134**
Cash at the beginning of the year		315,002	262,868
Cash at the end of the year		**288,777**	**315,002**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM L - BAND CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2007

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 and 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

Australian Accounting Standards set out accounting policies that the AASB has concluded would result in a financial report containing relevant and reliable information about transactions, events and conditions to which they apply. 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 or fair value, 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 benefits.

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.

2 PROPERTY, PLANT AND EQUIPMENT

CASH FLOWS FROM OPERATING ACTIVITIES	2007 $	2006 $
COMPUTER EQUIPMENT		
At cost	116,272	121,222
Accumulated depreciation	(116,272)	(121,222)
OTHER EQUIPMENT		
At cost	210,892	190,258
Accumulated depreciation	(181,934)	(181,208)
	28,958	9,050
Total Property, Plant and Equipment	**28,958**	**9,050**

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	-	9,050	9,050
Additions	-	23,802	23,802
Depreciation expense	-	(3,092)	(3,092)
Adjustment due to change in asset policy	-	(802)	(802)
Carrying amount at end of year	-	**28,958**	**28,958**

3 NOTES TO THE CASH FLOW STATEMENT

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

	2007 $	2006 $
Net operating result	43,297	2,788
Depreciation expense	3,092	2,112
Movement in Current Liabilities	(48,216)	47,234
Movement in Current Assets	(596)	-
Net cash provided by operating activities	**(2,423)**	**52,134**

4 RETAINED EARNINGS

Balance at beginning of the year	275,836	273,048
Adjustment due to change in asset policy	(802)	-
Operating surplus/(deficit) for the year	43,297	2,788
Balance at end of the year	**318,332**	**275,836**

5 CHANGES IN ACCOUNTING POLICY

With restropective effective from 1 January 2006, WASTAC's asset capitalisation threshold was increased to $5,000 from previous amount of $1,000. Property, plant and equipment recorded with a cost below the capitalisation threshold is now expensed in the year of purchase. The increase in threshold was introduced in order to simplify administration of the WASTAC's assets, enabling, in particular, more reliable and relevant information from fixed asset stock takes. The 2006 comparatives have not been adjusted due to materiality. However, a net adjustment has been made to the opening Retained Earnings for 2007 for an amount of $802.00. See Note 4 above.

Santo Casilli
Accounting and Auditing Services

52 Lockeport Approach Madeley WA 6065 | Mobile: 0409 104 929 | Fax: (08) 9408 1782 | Email: scasilli@bbnet.com.au

CERTIFIED PRACTISING ACCOUNTANT

INDEPENDENT AUDITORS' REPORT
The Members of the Board
WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM

I have audited the accompanying special purpose financial report of the Western Australian Satellite Technology and Application Consortium – X Band which comprises the balance sheet as at 31 December 2007, the income statement and statement of cash flow for the year ended, a summary of significant accounting policies and other explanatory notes as attached.

Board Responsibility for the Financial Report
The Board is responsible for the preparation and fair presentation of the special purpose financial report. This responsibility includes establishing and maintaining internal controls relevant to the preparation and fair presentation of the financial report that is free from material misstatement, whether due to fraud or error and selecting and applying appropriate accounting policies.

The accompanying special purpose financial report has been prepared by the "Consortium Agent" (Curtin University) on behalf of the Board to satisfy the reporting requirements as outlined in the existing "Joint Venture Agreement".

Auditor's Responsibility
My responsibility is to express an opinion on the financial report based on my audit. I conducted the audit in accordance with Australian Auditing Standards. These Auditing Standards require that I 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 the entity's preparation and fair presentation 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 by the Board, as well as evaluating the overall presentation of the financial report.

I disclaim any assumption of responsibility for any reliance on this financial report to which it relates to any person other than the parties to the "Joint Venture Agreement", or for any purpose other than that for which it was prepared.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

Auditor Independence
In conducting my audit, I have complied with the independence requirements of the Australian professional accounting bodies.

Auditor's Opinion
In my opinion, the financial report presents fairly, in all material respects, the financial position of the Western Australian Satellite Technology and Application Consortium – X Band as of 31 December 2007 and of its financial performance and its cash flows for the year then ended.

Santo Casilli CPA
Date:
Perth

WASTAC X- Band BUDGET 2008

Estimated expenditure for the year
January 2008 – December 2008

		$ PER ANNUM	
		2007	2008
1.	Data Tapes	3000	3000
2.	System maintenance	15000	15000
3.	System repairs	4000	4000
4.	Consultants, product development	20000	20000
5.	Sundry consumables	2000	2000
6.	Travelling – Airfares	8000	8000
7.	Provision for major equipment	60000	60000
	TOTAL INCOME	**$112,000**	**$112,000**

Estimated income/revenue for the year
January 2008 – December 2008

		$ PER ANNUM	
		2007	2008
1.	Contributions received ($20,000 each)	80,000	80,000
2.	Interest	6,000	8,000
	TOTAL INCOME	**$86,000**	**$88,000**

Additional committed expenditure
January 2009– December 2010

1.	Receiver upgrade for NPP/NPOESS satellites	80,000	80,000
	TOTAL INCOME	**$80,000**	**$80,000**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM X BAND INCOME STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2007

	2007 $	2006 $
INCOME		
Contributions Received	80,000	80,000
Interest Received	23,818	9,955
Total Income	**103,818**	**89,955**
EXPENDITURE		
Hospitality	445	204
Microwave Licenses	-	56
Meeting Expenses	-	300
Refund (cancellation of insurance policy)	-	(828)
Depreciation	94,080	102,308
Loss on Disposal of Non-Current Asset	9,160	-
Total Expenditure	**103,685**	**102,040**
Net Operating Result for the Year	**133**	**(12,085)**

Natalie Madden
Associate Director
Financial Services

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM X BAND BALANCE SHEET AS AT 31 DECEMBER 2007

	NOTE	2007 $	2006 $
CURRENT ASSETS			
Cash at Bank		324,750	234,715
Prepayment		13,337	-
Total Current Assets		**338,086**	**234,715**
NON - CURRENT ASSETS			
Property, plant and equipment	2	190,886	294,125
Total Non - Current Assets		**190,886**	**294,125**
Total Assets		**528,973**	**528,840**
Total Liabilities		**-**	**-**
Net Assets		**528,973**	**528,840**
EQUITY			
Retained Funds	4	528,973	528,840
Total Equity		**528,973**	**528,840**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM X - BAND CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2007

CASH FLOWS FROM OPERATING ACTIVITIES	NOTE	2007 $	2006 $
RECEIPTS			
Contributions Received			
Department of Land Information		20,000	20,000
CSIRO		20,000	20,000
Bureau of Meteorology		20,000	20,000
Geoscience Australia		20,000	20,000
Interest Received		23,818	9,955
Total Receipts		**103,818**	**89,955**
PAYMENTS			
Payments to suppliers		(13,783)	268
Total Payments		**(13,783)**	**268**
Net cash provided by operating activities	3	**90,035**	**90,223**
CASH FLOWS FROM INVESTING ACTIVITIES			
Payments for property, plant and equipment		-	(23,062)
Net cash used in investing activities		**-**	**(23,062)**
Net increase/(decrease) in cash		**90,035**	**67,161**
Cash at the beginning of the year		234,715	167,554
Cash at the end of the year		**324,750**	**234,715**

WESTERN AUSTRALIAN SATELLITE TECHNOLOGY AND APPLICATION CONSORTIUM X - BAND CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER 2007

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 and 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

Australian Accounting Standards set out accounting policies that the AASB has concluded would result in a financial report containing relevant and reliable information about transactions, events and conditions to which they apply. 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 or fair value, 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 benefits.

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.

2 PROPERTY, PLANT AND EQUIPMENT

CASH FLOWS FROM OPERATING ACTIVITIES	2007 $	2006 $
COMPUTER EQUIPMENT		
At cost	14,408	41,373
Accumulated depreciation	(14,408)	(28,487)
	-	12,886
OTHER EQUIPMENT		
Equipment - work in progress	-	23,062
At cost	734,268	711,206
Accumulated depreciation	(543,382)	(453,029)
	190,886	281,239
Total Property, Plant and Equipment	**190,886**	**294,125**

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	12,886	281,239	294,125
Additions/(Disposals)	(26,965)	-	(26,965)
Accumulated Depreciation on Disposals	17,805	-	17,805
Depreciation expense	(3,726)	(90,353)	(94,079)
Carrying amount at end of year	**-**	**190,886**	**190,886**

3 NOTES TO THE CASH FLOW STATEMENT

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

	2007 $	2006 $
Net operating result	133	(12,085)
Depreciation expense	103,240	102,308
Movement in Current Assets	(13,337)	-
Net cash provided by operating activities	**90,035**	**90,223**

4 RETAINED EARNINGS

Balance at beginning of the year	528,840	540,925
Operating surplus/(deficit) for the year	133	(12,085)
Balance at end of the year	**528,973**	**528,973**

5 CHANGES IN ACCOUNTING POLICY

With restropective effective from 1 January 2006, WASTAC's asset capitalisation threshold was increased to $5,000 from previous amount of $1,000. Property, plant and equipment recorded with a cost below the capitalisation threshold is now expensed in the year of purchase. The increase in threshold was introduced in order to simplify administration of the WASTAC's Fixed assets, enabling, in particular, more reliable and relevant information from fixed asset stocktakes. The 2006 comparatives have not been adjusted due to materiality. No adjustment has been made to the opening Retained Earnings for 2007 as this policy did not impact on the cost of assets held as at 31 December 2007.

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WASTAC

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