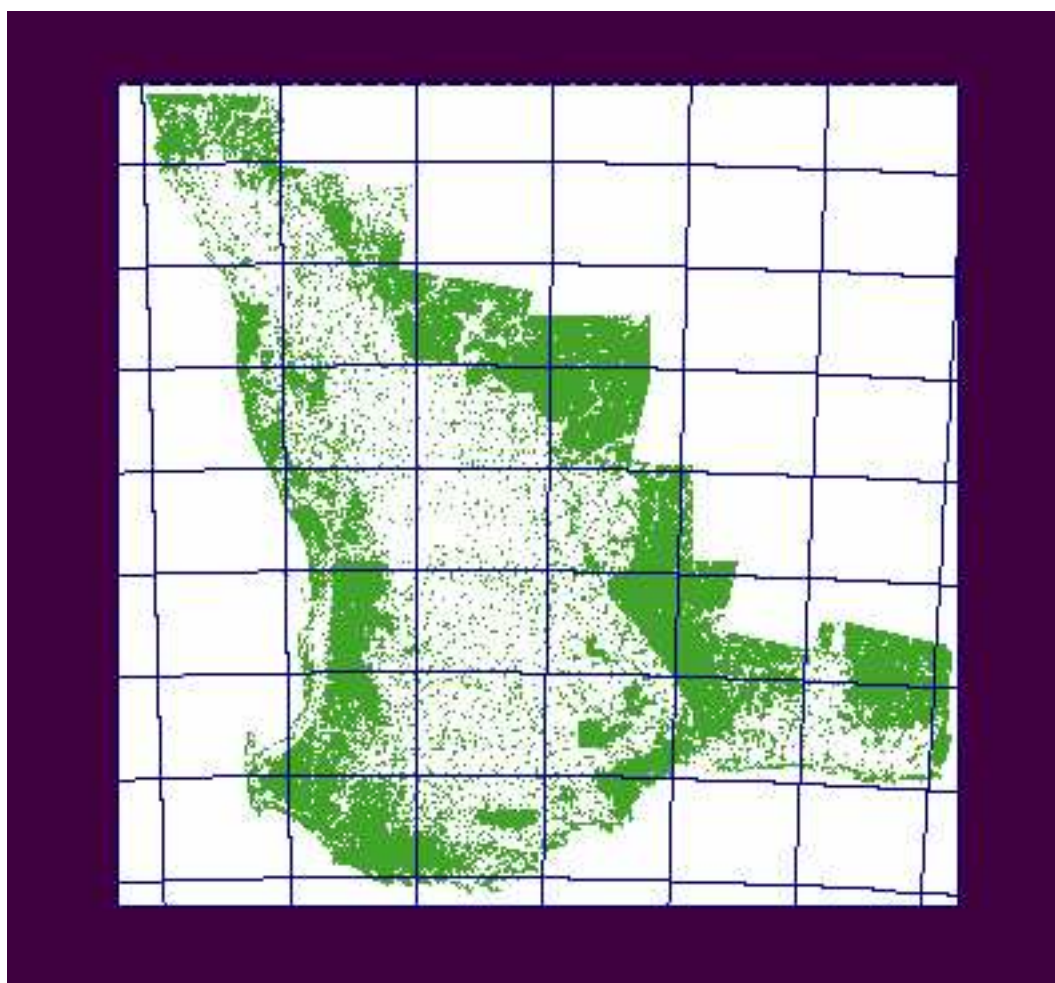


Vegetation History and Index Sequence 1988-2008

South West Agricultural Region of Western Australia

2008 Update of the Land Monitor II Project

Product #4 – Vegetation Index Sequence
(Also includes former Vegetation Product #2 – Vegetation History)



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Vegetation Index Sequence 1988-2008

South West Agricultural Region of Western Australia

This report describes the 'Vegetation Index Sequence' product and the "Vegetation History" product (the former Vegetation Product #2) for the southwest region of Western Australia. These two products represent one component of a suite of vegetation change products produced by the Land Monitor II Project.

The 'Vegetation Index' product is a sequence of single band image files, where each the same spectral 'woodiness' index. The index values are $(TM \text{ band3} + TM \text{ band5})/2$, calculated from fourteen summer dates of calibrated TM data, namely 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2003, 2004, 2005, 2006, 2007 and 2008. Where an area is cloud covered on a particular date, the data have been masked and replaced with a value of zero. This data is one input used to create the 'Trend Summary' Product #3.

The Index Sequence file can be used to produce 'time-trend' graphical plots for the index at a range of scales. These can be used in association with the various change map products to reveal and compare the patterns of response for areas of interest or concern.

The file can also be used, with image processing software, to produce colour image displays of changes in vegetation index from selected dates – the 'Vegetation History' Product. It provides visual displays which highlight areas of change in vegetation density over time. The product is suitable for visual interpretation of changes over the period.

Details of the filenames and contents of the standard data products can be found in section 6.

1. The Area

The region considered is shown in figure below. The region includes the area covered by the Landsat scenes of Kalbarri, Geraldton, Mullewa, Moora, Bencubbin, Jackson, Jurien Bay, Leeuwin, Perth, Kellerberrin, Southern Cross, Collie, Dumbleyung, Newdegate, Pemberton, Mount Barker, Bremer Bay, Ravensthorpe, Esperance and Malcolm.

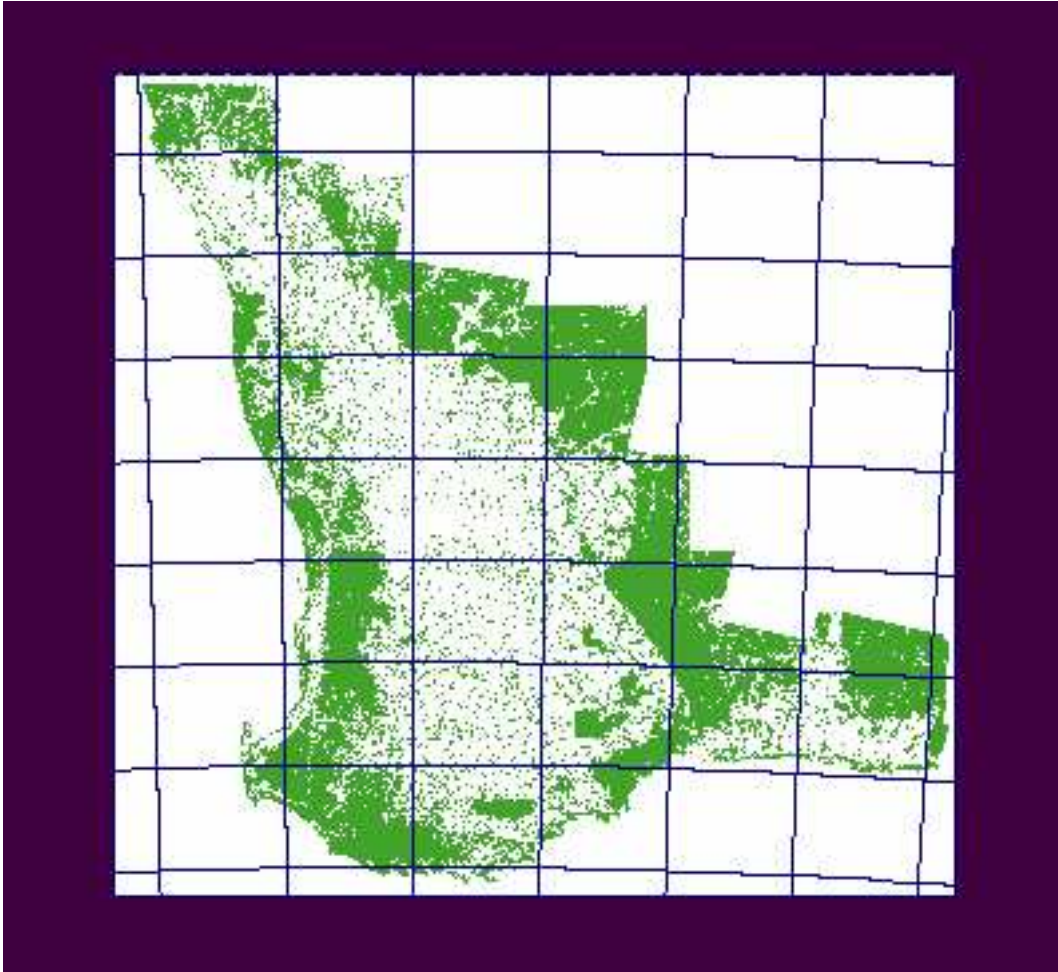


Figure 1: Coverage of vegetation products of the south west region of WA.
The grid represents standard 1:250000 map sheets over the region.

To keep files sizes within convenient storage and processing limits, each product is formed in four regions:

- north-west: 300km wide coastal strip from Kalbarri to just north of Perth
- north-east: 350km wide strip east of the above region
- south: from just north of Perth to the south coast, east to Ravensthorpe
- vesp: from Ravensthorpe east to the edge of the cleared agricultural area

2. The Satellite Image Data

The satellite data used to form these products is listed in the “Land Monitor Vegetation Scene Dates” document.

All data were ortho-rectified using Land Monitor DEM and calibrated to the Land Monitor Landsat TM Summer 1994 base prior to processing.

Final products are provided in datum GDA94, UTM zones MGA50 or MGA51 (for ‘rvesp’ region).

3. Outline of data processing methodology for “Vegetation Index”

- Co-register the sequence of images to a common map base.
- Calibrate the images to a common radiometric base so that the numerical values through time may be compared. The land monitor summer 1994 base has been used.
- Mask all areas of cloud/shadow and other data noise and irregularities.
- Calculate the chosen index $(b3+b5)/2$ for each time period.

4. ‘Vegetation History’: description and guide to display and interpretation

The ‘Vegetation History’ product is a visual display produced from the index image for three dates. It provides visual displays that highlight areas of change in vegetation density over time. From the twelve index image dates in the sequence, numerous choices of three dates are possible, depending on the period of interest. The product is suitable for visual interpretation of changes over the period only. Other products provide maps and data sets that are more suitable for numerical summary and analysis.

The recommended display of the 3 indices is in red (most recent date), green (middle date) and blue (oldest date) with a similar enhancement for all dates to suit display of perennial vegetated areas. When displayed in this way the colours over vegetated areas may be interpreted, with some caution, as described below.

ERMMapper algorithms and ‘ECW’ format raster files are provided on the data DVD as examples for selected periods. For these examples, cloud affected (and missing) data are replaced with data from an adjacent date in the sequence.

Table 1: Examples of colours and interpretation – Applicable to perennial vegetation*

| Colour | Brightness history | Interpretation for perennial vegetation |
|-------------|--|--|
| Black, Grey | Stable, consistently dark on all 3 dates | Unchanged vegetation |
| White | Bright on all dates | Cleared land on all dates |
| Red | Dark 1st and 2 nd dates, Changed to bright in 3 rd date. | Vegetation loss or clearing between 2 nd and 3 rd date |

| | | |
|-------------------|---|---|
| Green | Dark 1 st date, bright 2 nd , dark 3 rd date | Vegetation loss between first and second date, recovery by third date |
| Yellow | Dark 1 st , bright in 2 nd and 3 rd dates | Vegetation loss or clearing between 1 st and 2 nd date, without recovery by final date (or repeated fires effects on 2 nd and 3 rd dates) |
| Blue | Bright 1 st date, dark in 2 nd and 3 rd . | Re-vegetation between 1 st and 2 nd dates |
| Cyan (light blue) | Bright 1 st & 2 nd , dark 3 rd date. | Re-vegetation between 2 nd and 3 rd dates |
| Purple | Bright 1 st , dark 2 nd , bright 3 rd date | Repeated fire effects in 1 st and 3 rd dates. |

* Note: These interpretations are applicable to perennial vegetated areas only. Other changes on the ground may result in similar brightness changes in the vegetation index, and hence result in similar image colours. Examples are drying or filling lakes, or unseasonably dense flushes of annual growth, in particular in the wet summer of 2000 or in the very green Mt Barker scene in 2005. No attempt has been made in the examples to identify or remove such effects.

4.1 Interpretations and limitations of the data

The vegetation index product is numerically derived directly from the TM satellite data. It is provided for vegetated and cleared areas in the region. Interpretation and use of these data requires other data or knowledge. As noted above, the example vegetation history products are suitable for interpretation only. Since they summarise only three dates of the index with a particular enhancement, they do not summarise all the information on change in the index sequence. Some specific limitations can be listed as examples. There is a time lag in physical response of re-vegetated areas, which varies with region and vegetation type. Re-vegetated areas will not be mapped until the vegetation achieves a sufficient density. Hence some recent, slow-growing or sparse re-vegetated areas will not be detected. Similarly, some thin or highly reflective perennial vegetation may not be detected with a particular enhancement. Cloud-affected areas are masked out in the index sequence. If not masked in visual displays, cloud-affected areas will provide dramatic and misleading colour effects. In the example products (algorithms and ECW format mosaics), cloud-affected areas have been replaced with data from an adjacent date.

It has been noted that the index used – the sum of bands 3 and 5 – is less sensitive to fires in the green forests (on the scarp and the karri and jarrah forest in the south-west). Recently burnt areas in these forest regions are usually very dark in the image data (more dense) and appear to recover very quickly to an equivalent greenness to before the fire. Burnt areas in less green forest tend to appear brighter (less dense) and persist for much longer. A disturbance due to fire in green forests may not show up in the trend data.

5. Limitations and Liabilities

The information contained in these vegetation maps is necessarily based in part upon various assumptions and predictions. The Land Monitor II Project (comprising the

Western Australian State Government agencies, Department of Land Administration, Department of Environment Water and Catchment Protection, Department of Agriculture, Department of Conservation and Land Management, Department of Environmental Protection, Ministry of Planning and Infrastructure, the Water Corporation of WA, and the Commonwealth agency CSIRO Mathematical and Information Sciences) accepts no responsibility for any inaccuracies in these vegetation maps, and persons relying on these maps do so at their own risk.

6. DVD Contents: Land Monitor Product #2 and #4 – Vegetation Index Sequence and History

All geo-referenced files are provided in map projection MGA50 or MGA51 with datum GDA94. The pixel resolution is 25 metres.

Raster Files are provided in ERMapper raster format with standard header files (.ers).

For reasons of convenience, data products are provided as mosaics, each of which covers several complete 1:250000 map sheets. Due to data storage limitations, separate mosaics are provided for the North-West, North-East and South portions of MGA50. A separate file is provided for the region in MGA51. Table 1 describes the region covered by each mosaic.

Table 2. 1:250,000 Map sheets in each mosaic region.

| Mosaic files | 1:250000 map sheets covered Note: The data cover either the full land mapsheet area, or (for mapsheets on the northern and eastern edges of the agricultural region) the agricultural areas within the mapsheet. |
|--|--|
| LM50_NWEST_VegMask LM50_NEAST_VegMask | Ajana, Geraldton, Yalgoo, Dongara, Perenjori, Ninghan, Hill River, Moora, Bencubbin, Jackson, Perth, Kellerberrin, Southern Cross |
| LM50_SOUTH_VegMask | Pinjarra, Corrigin, Hyden, Busselton, Collie, Dumbleyung, Newdegate, Augusta, Pemberton, Mt Barker, Bremer Bay, Irwin Inlet, Albany |
| LM51_RAVESP_VegMask | Ravensthorpe*, Esperance, Lake Johnston*, Norseman (* portions also in the south mosaic) |

The DVD contents for each region are:

1. Vegetation index sequence files:

lm50_nwest_Index_(1988, ..., 2008)_mga.ers [ERMapper header file]
lm50_nwest_Index_(1988, ..., 2008)_mga [BIL format image file]
lm50_neast_Index_(1988, ..., 2008)_mga.ers [ERMapper header file]
lm50_neast_Index_(1988, ..., 2008)_mga [BIL format image file]
lm50_south_Index_(1988, ..., 2008)_mga.ers [ERMapper header file]
lm50_south_Index_(1988, ..., 2008)_mga [BIL format image file]
lm51_rvesp_Index_(1988, ..., 2008)_mga.ers [ERMapper header file]
lm51_rvesp_Index_(1988, ..., 2008)_mga [BIL format image file]

These are 12 single-band raster files for each region. File contents for each date ((TM3+TM5)/2) from the calibrated Landsat TM images. Cloud-affected and missing data are set to value zero.

2. Vegetation history products (examples) as ECW raster files

LM50_NWEST_90-98-08_VegHistory.ecw
LM50_NEAST_90-98-08_VegHistory.ecw
LM50_SOUTH_90-98-08_VegHistory.ecw
LM51_RVESP_90-98-08_VegHistory.ecw

LM50_NWEST_00-04-08_VegHistory.ecw
LM50_NEAST_00-04-08_VegHistory.ecw
LM50_SOUTH_00-04-08_VegHistory.ecw
LM51_RVESP_00-04-08_VegHistory.ecw

LM50_NWEST_06-07-08_VegHistory.ecw
LM50_NEAST_06-07-08_VegHistory.ecw
LM50_SOUTH_06-07-08_VegHistory.ecw
LM51_RVESP_06-07-08_VegHistory.ecw

These files present particular RGB enhancements of the index data as described in section 4 above. Three examples have been produced, for three-date sequences spanning 1990-1998-2008 (the complete period), 2000-2004-2008 (the most recent eight years) and 2006-2007-2008 (the most recent three dates). Missing and cloud-affected data is replaced by an adjacent date in the sequence.

3. Vegetation history display algorithms- examples

LM50_NWEST_90-98-08_VegHistory.alg
LM50_NEAST_90-98-08_VegHistory.alg
LM50_SOUTH_90-98-08_VegHistory.alg
LM51_RVESP_90-98-08_VegHistory.alg

LM50_NWEST_00-04-08_VegHistory.alg
LM50_NEAST_00-04-08_VegHistory.alg
LM50_SOUTH_00-04-08_VegHistory.alg
LM51_RVESP_00-04-08_VegHistory.alg

LM50_NWEST_06-07-08_VegHistory.alg
LM50_NEAST_06-07-08_VegHistory.alg
LM50_SOUTH_06-07-08_VegHistory.alg
LM51_RVESP_06-07-08_VegHistory.alg

ERMapper algorithms for display of the Index Data as 'Vegetation History' raster displays. These are provided for users of ERViewer or ERMapper. ERMapper users may readily alter the enhancements or the input dates to provide alternative displays. The following examples are provided:

4. Ancillary Files:

LM50_DateBound_(1988,...,2008).erv [ERMapper vector header file]
LM50_DateBound_(1988,...,2008) [ERMapper vector file]
LM51_DateBound_(1988,...,2008).erv [ERMapper vector header file]
LM51_DateBound_(1988,...,2008) [ERMapper vector file]

LM50_(1988,...,2008)_[region]_cloudmsk.erv [ERMapper vector header file]
LM50_(1988,...,2008)_[region]_cloudmsk [ERMapper vector file]
LM51_(1988,...,2008)_[region]_cloudmsk.erv [ERMapper vector header file]
LM51_(1988,...,2008)_[region]_cloudmsk [ERMapper vector file]

LM50_NEAST_Notprocessed_2006.erv [ERMapper vector header file]
LM50_NEAST_Notprocessed_2006 [ERMapper vector file]
LM50_NWEST_Notprocessed_2006.erv [ERMapper vector header file]
LM50_NWEST_Notprocessed_2006 [ERMapper vector file]
LM50_SOUTH_Notprocessed_2006.erv [ERMapper vector header file]
LM50_SOUTH_Notprocessed_2006 [ERMapper vector file]
LM50_RVESP_Notprocessed_2006.erv [ERMapper vector header file]
LM50_RVESP_Notprocessed_2006 [ERMapper vector file]

The 'DateBound' vector files contain the polygons which show the boundary of individual image scenes in the mosaic image for each time period.

The 'cloudmsk' vector files contain the polygons which show the boundaries of masked cloud and noise in each time period from 1988 to 2007. If a region name is included in the file name, the data applies to just that mosaic region. If no region is included it applies to the whole of the MGA zone. These two vector file contain the polygons which show the boundary of mosaics. The directory 2008_cloud contains the cloud masks for the 2008 data. These were created for individual images rather than whole mosaics.

The 'Notprocessed' vector files show areas excluded from the processing, usually because there are two or less image dates in the sequence.

All these vectors are in the 'ancillary' directory on the DVD.

5. Documentation:

LM2008_IndexSeq_History_1988_2008.pdf [this report]
Land_Monitor_scene_dates.pdf [summary of images dates]
Scene_Reports_2008 [Directory]

Acknowledgements

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