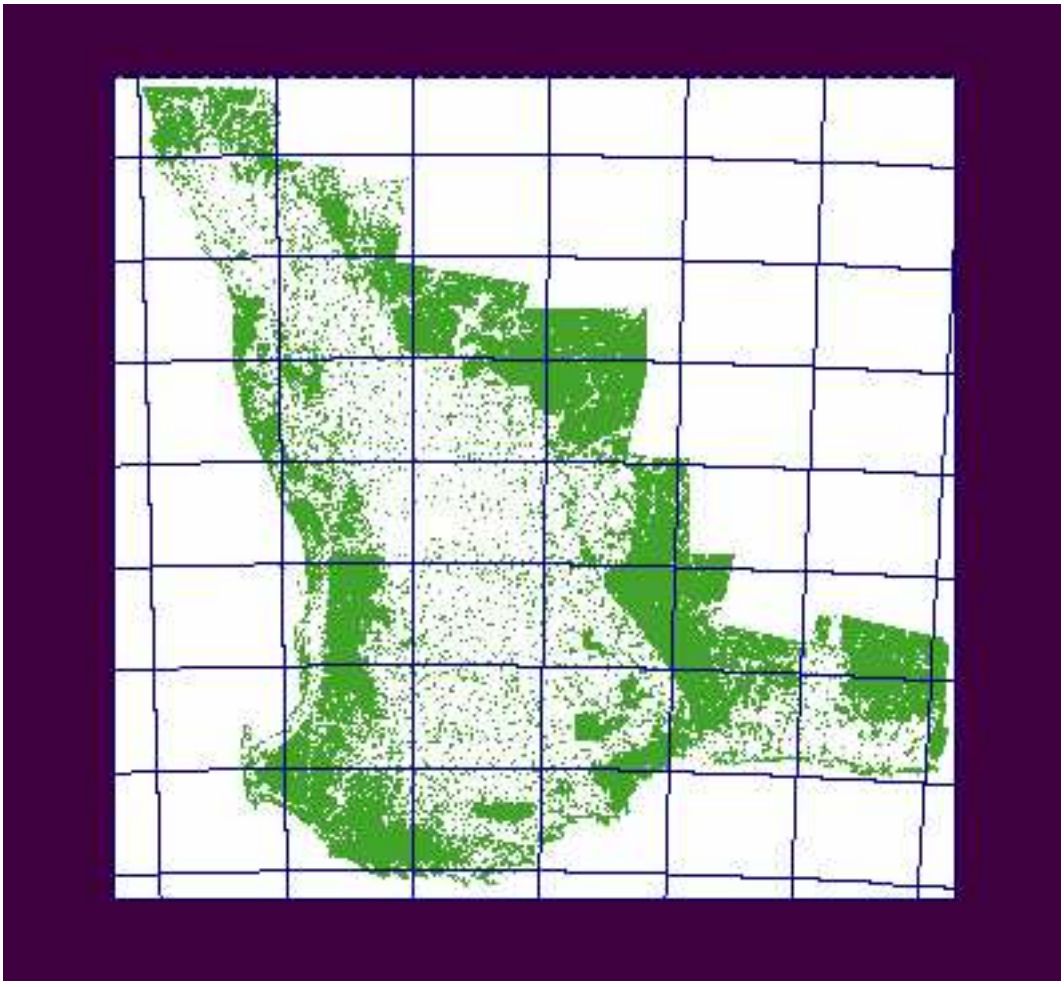
Vegetation Extent and Change 1988-2007

South West Agricultural Region of Western Australia

2007 Update of the Land Monitor II Project

Product #1 - Vegetation Change



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This report briefly describes the image data files, and the methodology that have been used to produce the vegetation monitoring product known as “Vegetation Change 1988-2007” for the Land Monitor II Project. The data product is an update of the ‘Vegetation Extent and Change Product 1988-2006’ using summer 2007 imagery.

This product is a series of classifications of the extent of perennial vegetation provided as thirteen 1-band raster files, one for each time period. The time periods are 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2003, 2004, 2005, 2006 and 2007. A list of the image dates within each time period can be found in the “Scene Dates” document.

This report summarises the methodology used to produce this product and its limitations.

The file contents of the standard data product DVDs are described in section 6.

1. The Area

The are covered by the products is shown in figure 1. 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.

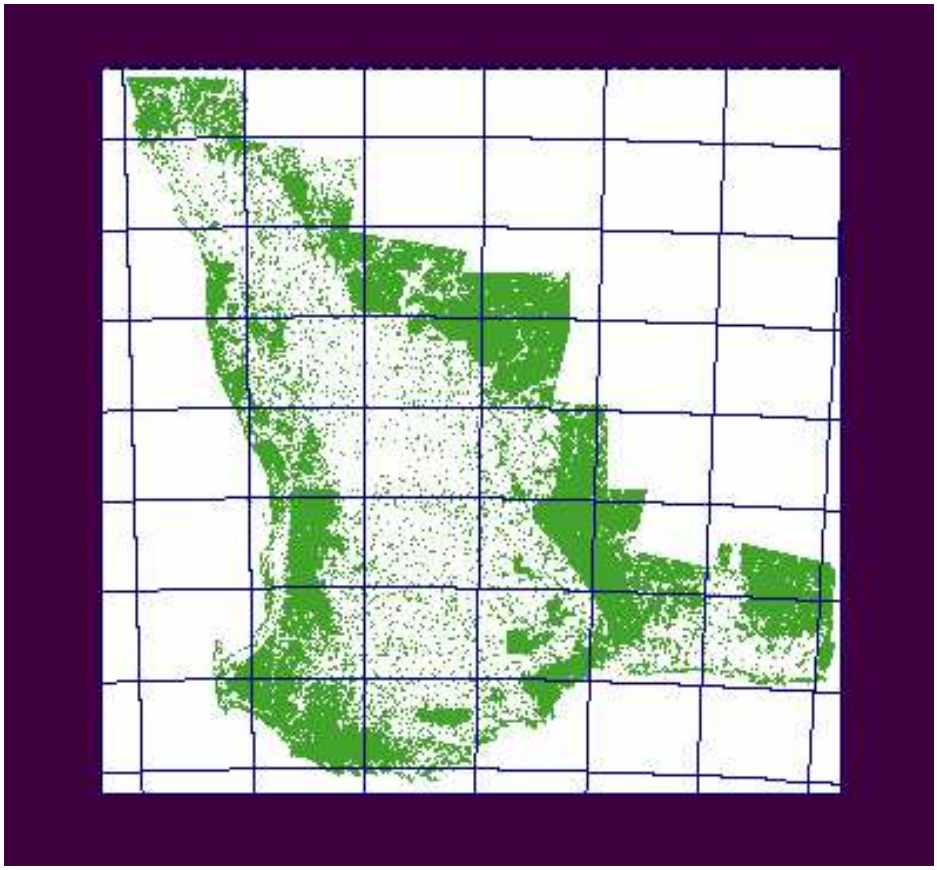

Figure 1: Coverage of vegetation products of the south west region of WA.
The grid represents standard 1:250000 map sheets over the region.

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
rvesp:	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. Methodology

The steps used to produce the series of vegetation maps are listed below. This is the standard methodology used for Land Monitor vegetation change.

1) Co-register the images to a common map. This allows ground sites to be traced through time and the satellite data to be compared with ancillary map data. Details are provided in the individual scene rectification and calibration reports.

2) Calibrate the ortho-rectified images to the common radiometric base (1994 summer base). Details are provided in the individual scene rectification and calibration reports.

3) Mask all areas of cloud/shadow and other data noise and irregularities.

4) Produce individual 'perennial vegetation probability' maps from each date of the masked Landsat TM imagery using the CMIS index-threshold approach that produces measures of confidence of 'perennial' and 'non-perennial' vegetation at each date. The approach uses two indices, TM band3+band5 (index 1), and a band4-band3 'greenness' index (index 2). The threshold values for these indices are known to vary spatially.
    - For the 1988 to 1998 data: For Index1, smoothed threshold surfaces which defined upper and lower 'certain-perennial' and 'certain-nonperennial' cover types were fitted to the whole south-west region. For Index 2, a fixed set of thresholds was defined for each scene. Data values falling between the thresholds are given a probability (0-100%), scaled linearly with distance relative to the thresholds.
    - For the 2000 to 2007 data: A CMIS program was used to derive thresholds to match the probabilities within image date and stratification zone boundaries using the 1998 perennial vegetation probabilities as the base. Data values that fall between the thresholds were given a probability (0-100%), and scaled linearly with distance relative to the thresholds.

5) Process the sequence of cover class probabilities from all dates (1988–2007) using "Conditional Probability Network" (CPN) approach (Caccetta 1997, Kiiveri and Caccetta 1998). This approach uses the probabilities from neighbouring dates to modify the probabilities of each pixel. The effect of the method is that it 'smoothes out' sudden changes (e.g. from cultivation), and reduces uncertainty and errors in the individual dates. The result is a series of modified probability images for each date.

6) From the probability images produced in step 5, "yes/no bush masks' for each date were formed, using probability thresholds of 50% for each year.

7) Produce a separate 'water-mask' mosaic from existing data for overlay and map production.

4. Accuracy and Limitations of the data

The perennial vegetation masks are derived from reflectance signals detected by Landsat TM, and depend on a contrast between vegetation and other cover types (soil, crops, bare rocks etc). The thresholds for classification of bush have been derived from interpretation and comparison with earlier maps where detailed air photography was used.

This classification as 'perennial vegetation' relies on the spectral contrasts of cover types resulting from physical differences on the ground, and effectively requires a certain density of vegetation. Hence thin, scattered vegetation with a high proportion of soil background may be omitted. Certain dense but highly reflective vegetation types may also be omitted, but no cases of such omissions are known.

In particular, bare or very thin areas within bush remnants will not be classified as 'perennial vegetation cover'. Common examples are tracks, rocks, fire-scars, and salt-affected vegetation. Hence the areas mapped as vegetation at particular dates will not necessarily correspond to administrative definitions of reserves etc.

There is a time lag in detection 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.

Errors of commission may occur when other land covers give a similar spectral response to perennial vegetation. The temporal smoothing of the CPN removes most of the transient cultivation effects that might cause these errors. However, there are cases where errors of commission may remain after the CPN processing. Examples include cleared areas with persistent dark soil, and in also lake fringes and normally dry lake surface where changes in water level have dramatic effects on the cover and reflectance. Errors that are incurred in these areas may result in incorrect mapping of change in lake edge vegetation. However, these errors have not been removed by manual digitising as some may be real vegetation change.

Since the 2004 time period, the area of data processed has been extended to the north and east of Esperance. Results east of 513800E and north of 6416600N in zone 51 are based on data from 2004 onwards only, hence the apparent 'edges' in the change maps from 1988.

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, Department of Land Administration, and the 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 #1 – Vegetation Change

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 1. 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 extent files:

lm50_nwest_VegMask_(1988, …, 2007)_mga.ers [ERMapper header file]
lm50_nwest_VegMask_(1988, …, 2007)_mga.hdr [ARC header file]
lm50_nwest_VegMask_(1988, …, 2007)_mga.bil [BIL format image file]

lm50_neast_VegMask_(1988, …, 2007)_mga.ers [ERMapper header file]
lm50_neast_VegMask_(1988, …, 2007)_mga.hdr [ARC header file]
lm50_neast_VegMask_(1988, …, 2007)_mga.bil [BIL format image file]

lm50_south_VegMask_(1988, …, 2007)_mga.ers [ERMapper header file]
lm50_south_VegMask_(1988, …, 2007)_mga.hdr [ARC header file]
lm50_south_VegMask_(1988, …, 2007)_mga.bil [BIL format image file]

lm51_rvesp_VegMask_(1988, …, 2007)_mga.ers [ERMapper header file]
lm51_rvesp_VegMask_(1988, …, 2007)_mga.hdr [ARC header file]
lm51_rvesp_VegMask_(1988, …, 2007)_mga.bil [BIL format image file]

Thirteen 1-band raster files for each region, each image corresponding to one of the time periods between 1988 and 2007.

CLASSIFICATION CODES:

0= not processed
1= not perennial vegetation (includes cleared land, rocks, roads, wet areas)

2= perennial vegetation

2) Combined 'Ever Bush' mask:

LM50_NWEST_EverbushMask_1990-2007.ers [ERMapper header file]
LM50_NWEST_EverbushMask_1990-2007 [BIL format image file]
LM50_NEAST_EverbushMask_1990-2007.ers [ERMapper header file]
LM50_NEAST_EverbushMask_1990-2007 [BIL format image file]
LM50_SOUTH_EverbushMask_1990-2007.ers [ERMapper header file]
LM50_SOUTH_EverbushMask_1990-2007 [BIL format image file]
LM51_RVESP_EverbushMask_1990-2007.ers [ERMapper header file]
LM51_RVESP_EverbushMask_1990-2007 [BIL format image file]

This image product combines the outputs from 1990 to 2007 to identify areas that have ever been bush (or conversely never been bush). The data for the initial 1988 is considered too unreliable to include in the processing. This mask is used to exclude the 'never' bush area from displays of the vegetation trends products supplied as product 4.

CLASSIFICATION CODES:

0= not processed
1= never bush
2= mapped as bush in at least one time period

3) Water mask files:

LM50_NEAST_WaterMask.ers [ERMapper header file]
LM50_NEAST_WaterMask [BIL format image file]
LM50_NWEST_WaterMask.ers [ERMapper header file]
LM50_NWEST_WaterMask [BIL format image file]
LM50_SOUTH_WaterMask.ers [ERMapper header file]
LM50_SOUTH_WaterMask [BIL format image file]
LM51_RVESP_WaterMask.ers [ERMapper header file]
LM51_RVESP_WaterMask [BIL format image file]

The 'water mask' files for the regions are derived from various dates of TM imagery (generally 1998 and 2005). These files are intended for display purposes only to exclude usually inundated areas from the trends displays; they do not represent a definitive mapping of the extent of water bodies at any particular time. Each water mask is a single-band raster file

CLASSIFICATION CODES:

0 = not water
1 = water

4) ERMapper algorithms:

LM50_NWEST_VegChange_1990_2007.alg
LM50_NEAST_VegChange_1990_2007.alg
LM50_SOUTH_VegChange_1990_2007.alg
LM51_RAVESP_VegChange_1990_2007.alg

These algorithms are based on the virtual datasets LM50_NEAST_VegMask_1988-2007_mga.ers, LM50_NWEST_VegMask_1988-2007_mga.ers, LM50_SOUTH_VegMask_1988-2007_mga.ers and LM50_RVESP_VegMask_1988-2007_mga.ers respectively. Each virtual dataset points to the thirteen vegetation extent

files in the corresponding region. These algorithms are used to produce colour displays of vegetation and change for the period 1988-2007. They can be readily modified by ERMapper users to alter the dates for display:

5) Ancillary Files:

LM50_DateBound_(1988,…,2007).erv [ERMapper vector header file]
LM50_DateBound_(1988,…,2007) [ERMapper vector file]
LM51_DateBound_(1988,…,2007).erv [ERMapper vector header file]
LM51_DateBound_(1988,…,2007) [ERMapper vector file]

LM50_ (1988,…,2007)_[region]_cloudmsk.erv [ERMapper vector header file]
LM50_ (1988,…,2007)_[region]_cloudmsk [ERMapper vector file]
LM51_ (1988,…,2007)_[region]_cloudmsk.erv [ERMapper vector header file]
LM51_ (1988,…,2007)_[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. 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 ‘Notprocessed’ vector files show areas excluded from the processing, usually because there are two or less image dates in the sequence. hese did not need to be changed from the previous update.

All these vectors are in the ‘ancillary’ directory on the DVD.

6) Documentation:

LM2007_VegMask_1988_2007.pdf [this report]
Land_Monitor_scene_dates.pdf [summary of images dates]
Scene_Reports_2007 [Directory]

The ‘Scene Reports’ directory contains the individual rectification and calibration reports for the 2007 imagery.

References

Caccetta P.A. (1997), Remote Sensing, Geographic Information Systems (GIS) and Knowledge-Based Methods for Monitoring Land Condition, PhD Thesis, School of Computing, Curtin University of Technology.

Kiiveri, H.T. and Caccetta, P.A. (1998), Image fusion with conditional probability networks for monitoring salinisation of farmland, Digital Signal Processing, October, 8:4, 225-230.

Renzullo, L.J. (2000) Bush masks for 1988 and 2000 imagery using conditional probability networks, CSIRO Mathematical and Information Sciences, Task Report.

Acknowledgements

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