Community DustWatch Expansion Project (CDW)
Appendix to Milestone Report No. 6

Using DustWatch to Report on Changes in Ground Cover and Land Management Practices in Natural Resource Management Regions

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CARING FOR OUR COUNTRY

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Abbreviations

BoM	Bureau of Meteorology
CfoC	Caring for our Country
CoDii	Community DustWatch Information Interface
CMA	Catchment Management Authority, and Catchment Management Area
DAFWA	Department of Food and Agriculture Western Australia
DSY	Dust Storm Year
DWN	DustWatch Node
IPCC	Intergovernmental Panel on Climate Change
NRM	Natural Resource Management, and Natural Resource Management region
OEH	Office of Environment and Heritage, NSW Department of Premier and Cabinet

Executive summary

State governments and the Australian Government are co-investing with land managers and industry to address wind and water erosion by improving the adoption of best practice land management. The driver for this investment is to protect and enhance our natural, social and economic assets.

Even in today's climate and under current land management practices, wind erosion continues to remove millions of tonnes of valuable topsoil from the agricultural and pastoral lands of Australia; for example, the dust storm that engulfed Sydney on 23 September 2009.

As outlined in the 2013 final synthesis DustWatch project report to the federal funding body by Leys *et al.*, wind erosion has a wide range of negative impacts on the climate (Shao *et al*. 2011), biodiversity (McTainsh and Strong 2007), carbon stores (Chappell *et al.* 2013) and the capacity for food and fibre production (Leys 2002). Wind erosion also decreases air quality in our cities (Chan *et al*. 2005) and water quality in rivers (Leys and McTainsh 1999). The economic impact of a single dust event on 23 September 2009 on the NSW economy alone is reported to be $299 million (Tozer and Leys 2013).

In the near future, Australian land management will likely have to deal with more erratic and variable climate with more severe droughts predicted (IPCC report, Hennessy *et al.* 2007). The implementation of these land management changes will largely be undertaken by land managers working with regional natural resource management (NRM) bodies.

To quantify the benefit of government investment, the Auditor General (2008) stated that: *"improved monitoring of the environment is required to identify priorities, monitor the consequences of investments, policies and actions and evaluate if on-ground outputs contribute to the outcomes sought by government."*

In 2008, the *Caring for our Country Business Plan 2009–10* further identified the need for standardised accurate quantitative monitoring of land resources across all states to evaluate the success of funding, policies and outcomes of environmental investments, and provide planning for future investments.

Dust is a key indicator of landscape condition. It can reveal if land management practices are maintaining adequate ground cover and delivering the desired ecosystems services of healthy soils, clean air, functioning ecosystems and agricultural production as outlined in Figure 1. Dust and ground cover provide measurable monthly results against land management targets as demonstrated by the Community DustWatch project.

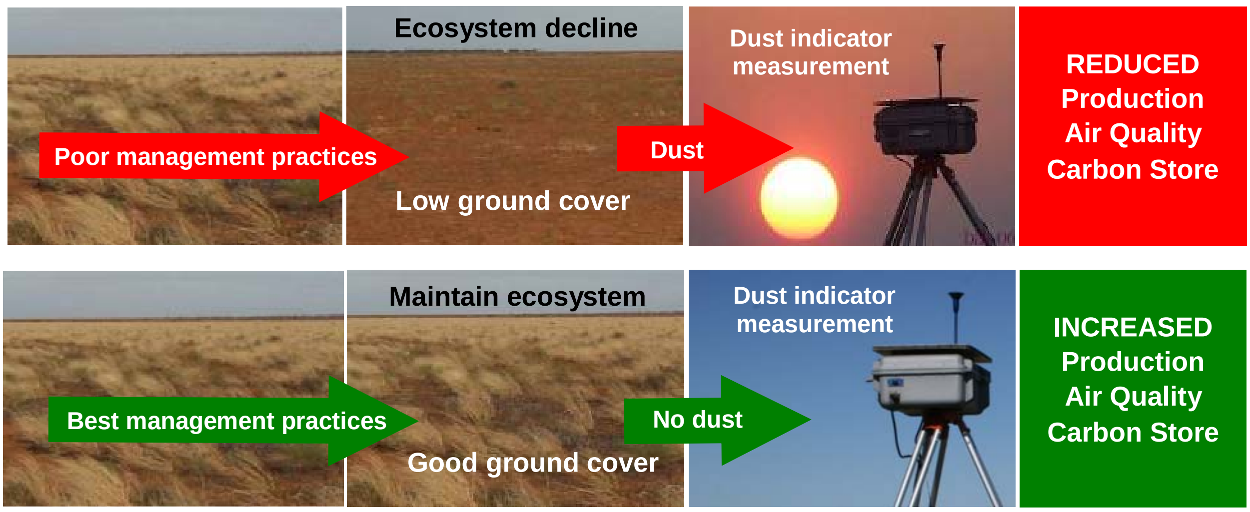


Figure 1. Using dust and ground cover as indicators of ecosystem health.

The success of Community DustWatch in NSW led to the Caring for our Country-funded expansion of this project across Australia in 2010. DustWatch Nodes (DWNs) were established in priority areas where improvements in land management practices would have the greatest benefits.

In partnership with NRM regions, state agencies and the community, the Community DustWatch network now operates in 41 sites across 16 NRM regions and five states. It is the only network of instrumented measurements of dust activity across Australia providing daily high-quality data for landscape condition assessment. The data is also highly valuable for the calibration of modelling and remote sensing products.

This report provides those NRMs who have collaborated over the past three years in the Community DustWatch project with individual reports on where and when dust activity has occurred in their region. This information is being used as a performance indicator of land management and to report against NRM targets. It identifies the drivers behind significant individual dust events as being either land management or climate. It also identifies sources of dust as being either local to the NRM region or long-range transported dust that can have significant impact on a statewide scale.

This report highlights priority locations for future DustWatch Nodes near and downwind of ongoing source areas. There are opportunities for co-investment for already participating as well as new NRM regions.

This project is coordinated by the NSW Office of Environment and Heritage (OEH), with contributions from participating NRMs and state agencies, and in-kind support from local DustWatchers in the community. Cost savings as a result of this collaboration, in both salaries and infrastructure, are estimated to be in excess of $250,000 a year.

The Community DustWatch Information Interface (CoDii) has been developed by OEH to automate the data collection from the individual DustWatch Nodes and corresponding Bureau of Meteorology (BoM) Automatic Weather Stations (AWS). It is used to examine minute, hourly and exceedence trends for dust, wind speed and direction, temperature and humidity at each operational DustWatch Node. When coupled with BoM gridded rainfall and ground cover information (derived from MODIS using the Guerschman *et al.* 2012 methodology), roadside surveys (where available) and local observations from DustWatchers, the interactions of climate and land management can be recognised.

NRMs can now identify which parts of the catchment are experiencing problems; use near real-time reporting to quickly identify problems areas and make appropriate changes to investment plans. The effectiveness of investments or plans can then be rapidly evaluated because all NRMs have independent access to their information via a web portal.

Over the past three years Community DustWatch has established a partnership with landholders, the community, NRMs, state and Australian Government agencies. The next step is to continue to maintain this partnership through co-investment so we can continue to *"monitor the consequences of investments, policies and actions and evaluate if on-ground outputs contribute to the outcomes sought by government"* (Auditor General (2008)) and the community.

1 Introduction to DustWatch

DustWatch is a community-based wind erosion monitoring program that was established in NSW and Queensland in 2002 in response to widespread dust storm activity across eastern Australia at that time. The aim of the program is to obtain data and information from community observers and bring it together with modelled products and data from the Bureau of Meteorology, satellites and other sources to provide information on the causes of dust storms, their extent and severity.

The program has three components:

1. **Community DustWatch network**. Dust is measured via a network of instruments at DustWatch Nodes (DWN), which are owned by either OEH, the participating NRM or other state agency. All DWNs are maintained by community volunteers and agency staff and coordinated by OEH.

2. **Wind erosion modelling**. This is undertaken by the University of Southern Queensland.

3. **Wind erosion information for regional monitoring**. Dust and meteorological data sourced from the Bureau of Meteorology is compiled and analysed at Griffith University.

This report focuses on the role **Community DustWatch** can play in NRM reporting.

Initially, Catchment Management Authorities (CMAs) in NSW with high risk of wind erosion (light brown and brown areas in Figure 2) provided funding to establish DWNs within their regions to measure dust activity. These instrumented sites take objective measurements of dust activity 24 hours a day. This data is processed with ground cover and climate data to form weekly and/or monthly reports. CMAs use this information to make land management decisions reducing dust emissions from their region.

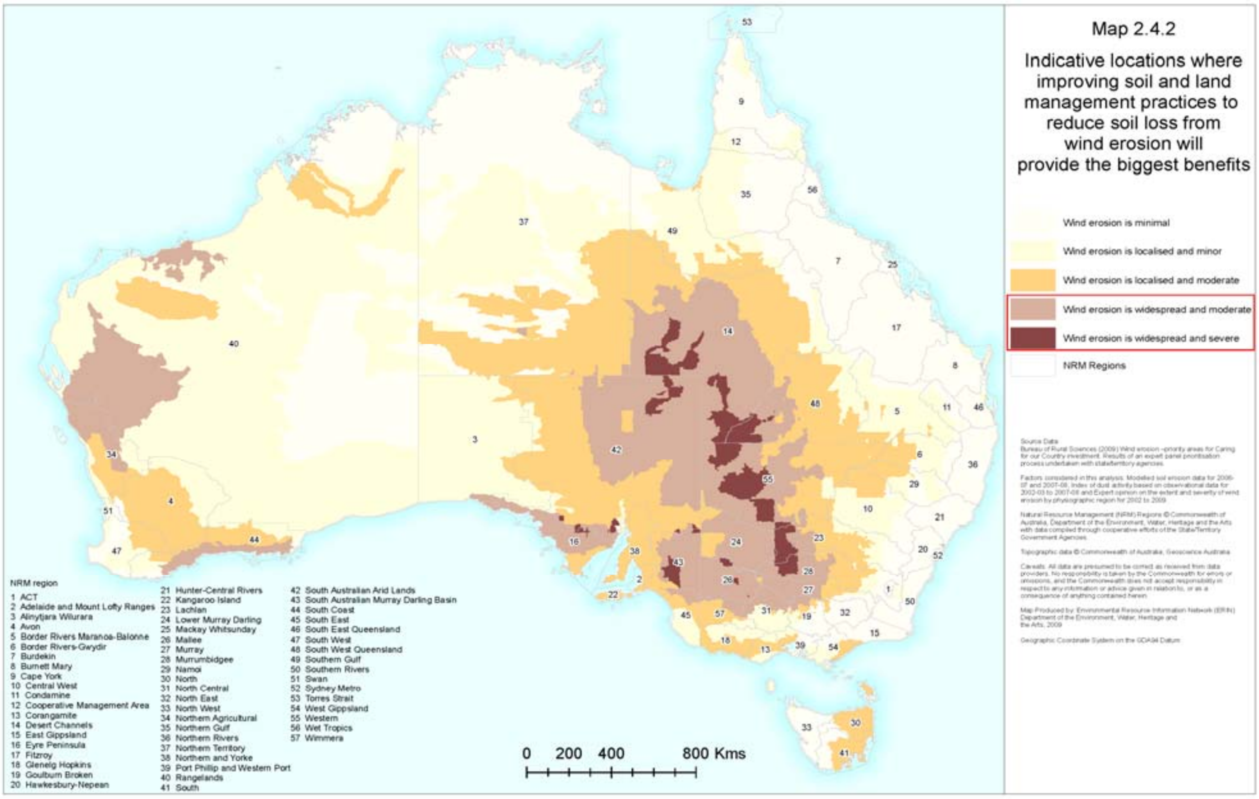


Figure 2. Map of wind erosion severity, from *Caring for our Country Business Plan 2010–11*.

Commencing in 2009, the Australian Government supported this approach and provided funding to establish a national, uniform measurement of dust activity identified in the Caring for our Country Business Plan (2008).

Led by OEH, NRM regions and state agencies are working collaboratively to install equipment, gather data and report trends in dust activity to NRM agencies and the community. As a result of this project expansion in 2009, there are currently 41 active DWNs in 16 NRM regions in five states across the southern half of Australia, with the most recent addition at Birdsville in Queensland in June 2013. It is the only network of instrumented measurements of dust activity across Australia providing high-quality data for landscape condition assessment. Installation of DWNs is prioritised by the severity of wind erosion in the particular regions (Figure 2). Future opportunities exist for co-investments between agencies, NRM regions and communities in and downwind of source areas. This includes installation of equipment in new NRM regions.

The collaborative approach between OEH, the NRM region, other state agencies and the local community, and the utilisation of existing BoM infrastructure and data, makes DustWatch a very cost effective approach to NRM monitoring. Costs for developing and maintaining IT infrastructure and software can be shared between NRM regions, dramatically reducing individual NRM costs. Cost savings as a result of these collaborations, in both salaries and infrastructure, are estimated to be in excess of $250,000 a year. Using existing BoM infrastructure and monitoring equipment has saved considerable amounts of time and money.

This collaborative approach also ensures consistency in data quality and parameters measured between NRM regions. This enables a nationwide picture of landscape condition and a direct comparison between landscapes, NRM regions or individual sites.

1.1 Questions DustWatch tries to answer

Dust is a key indicator that can reveal if land management has maintained adequate ground cover and has delivered the desired ecosystem services of healthy soils, clean air, functioning ecosystems and agricultural production. It provides measurable results against land management targets, as demonstrated by the NSW DustWatch project and as required by the Auditor General (2008) and Caring for our Country Business Plan (2008).

DustWatch was established to answer the following questions:

1. *Are the currently used land management practices maintaining or improving our soils?*

If there is soil erosion, the answer to question 1 is “no” and soil resources are being negatively impacted.

2. *What is the erosion’s impact on communities?* For example, air quality decline, decline in water quality in rivers, and increased operational costs in urban areas to clean up after a storm.

The second question deals with ecosystem services. Good land management and no dust results in positive ecosystem services. Erosion control on-farm is justified because it benefits people off-farm, especially in urban areas.

Dust is the product of wind erosion. It occurs when winds are stronger than about 30 km/h, the soil has low ground cover, and the soil is loose. The latter two are generally closely linked to land management and climate.

The next three questions focus on the spatial extent, severity and temporal nature of the erosion that threatens our soils and community. In the near future it is predicted that land managers and NRM bodies will have to deal with a more erratic and variable climate and more severe droughts (Hennessy *et al.* 2007).

3. *Where is the erosion occurring?*

4. *How often does it occur?*, and

5. *How severe is that erosion?*

To control the erosion we need to know what we can do to minimise it. So knowing the cause, e.g. low ground cover caused by disc ploughing or overgrazing, will help formulate the land management response.

6. *What is the cause of the erosion?*

Finally, if changes are made to land management practices or the climate is changing, then information is required about the trends in erosion and its causes.

7. *Are the levels of erosion changing with time in different landscapes?*

So, understanding the temporal trends in the extent and severity of erosion and the causes of the erosion allows us to answer many questions about land management practices, ground cover, the status of the soil resource condition and to document the benefits that good land management provides to the wider community.

1.2 Why measure dust?

Dust is a good indicator of soil and landscape health. If there is dust in the air then ground cover is below target levels and soil erosion due to wind is occurring.

Several studies have examined the impact of wind erosion on the community and ecosystem services. Effects of wind erosion reach broadly across the economy and environment and include:

- climate impacts (Shao *et al*. 2011)
- poorer air quality (Chan *et al.* 2005)
- declining biodiversity (McTainsh and Strong 2007)
- reduced carbon stores (Chappell *et al.* 2013)
- declining agricultural production (Leys 2002)
- reduced water quality in rivers (Leys and McTainsh 1999), and
- economic costs (Tozer and Leys 2013).

Across Australia nearly 25% of the land has been identified as having moderate to severe risk of widespread wind erosion (Figure 2). In times of low rainfall, ground cover on the soil surface may be reduced and the soil becomes loose and dry. Land management practices can have a huge impact on ground cover and soil surface disturbance and can contribute towards the potential for wind erosion.

Catchment targets have been set by Australian Government, state and regional agencies to maintain or improve the soil health of agricultural land. Most targets encompass some sort of soil health or ground cover target or concept. DustWatch uses a measurable indicator, such as the frequency and concentration of dust in the air, to indicate progress towards soil health targets and levels of ground cover (Figure 3).

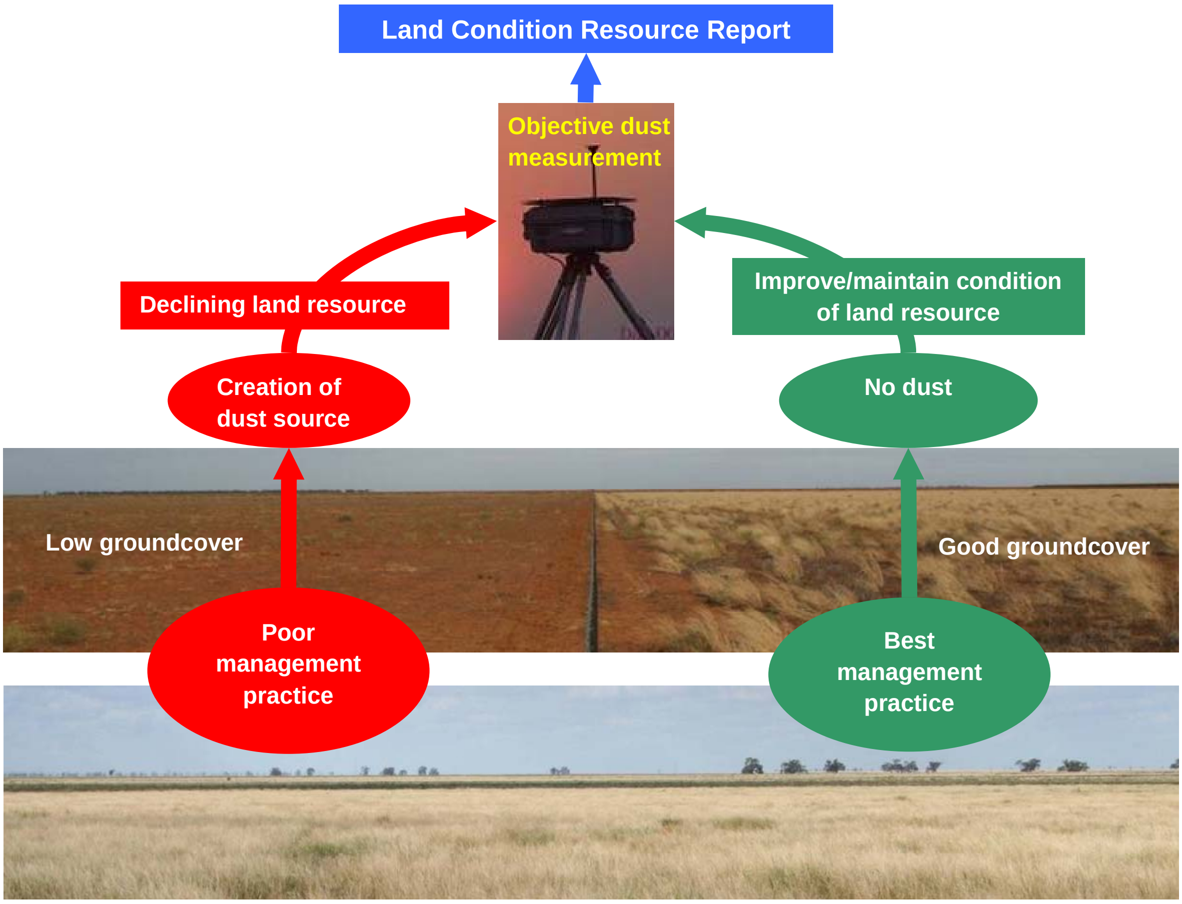


Figure 3. Using dust as an indicator to report soil health.

Wind erosion has local impacts because it affects individual farms by removing soil nutrients from fertile topsoil resulting in lower soil productivity, loss of carbon to the atmosphere and soil degradation. When dust carried in suspension, sometimes for many thousands of kilometres from the source, off-site impacts including poor air quality, increased health costs, disruptions to business and transport, and changes to ocean chemistry can occur. During the 2009 dust storms in September and October, including the infamous “Red Dawn” in Sydney, over 4 million tonnes of topsoil was lost from source areas in South Australia, south-western Queensland and north-western NSW off the east coast. The cost of the “Red Dawn” dust event to the NSW economy alone was just under $300 million (Tozer and Leys 2013).

2 Community DustWatch program across Australia

Caring for Our Country supports the concept of monitoring soil and landscape condition using DustWatch. This is because:

- Dust as measured by Community DustWatch has been demonstrated to be a good indicator of ground cover and land management practice outcomes.
- Community DustWatch is collaborative and requires NRM involvement and support to deliver its reports.
- Community DustWatch measurements are consistent between all sites and so comparisons and prioritisations can be made.
- Results are timely – when a major dust event occurs information is available within hours via the Community DustWatch Information Interface (CoDii) or within a few days via DustWatch reports.

Community DustWatch measures dust activity at 41 DWNs across Australia. The location of the DWNs and the NRMs that support them are shown in Figure 4.

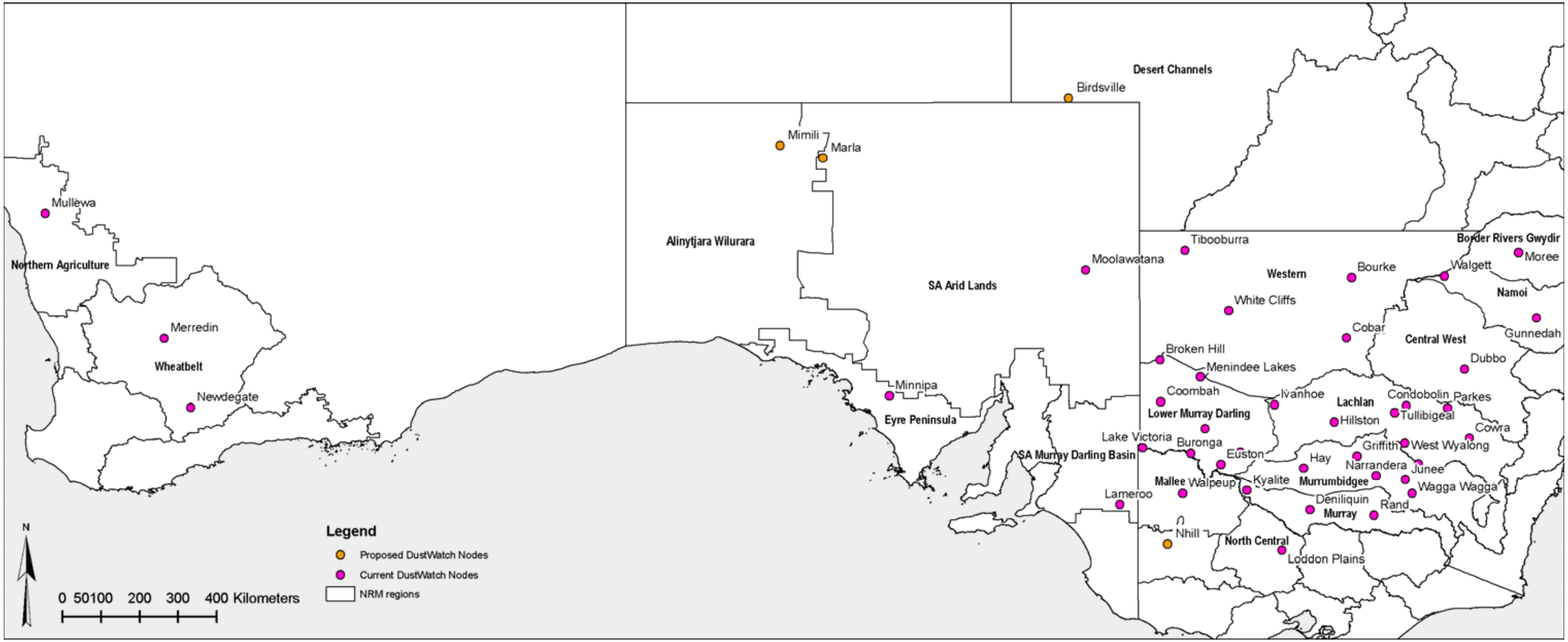


Figure 4. Location of participating NRM regions and DWNs in southern Australia.

The 41 DWNs have been established over the past seven years. The installation dates and the number of DWNs per NRM region are given in Table 1.

Table 1. Location, NRM region and installation date of DWNs across Australia.

Site ID	Location	NRM	State	Installed
DW 30	Moree	Border Rivers Gwydir	NSW	29/09/2008
DW 17	Dubbo	Central West	NSW	02/08/2007
DW 03	Condobolin	Lachlan	NSW	15/09/2004
DW 18	Cowra	Lachlan	NSW	13/11/2007
DW 21	Hillston	Lachlan	NSW	14/11/2007
DW 04	Ivanhoe	Lachlan	NSW	17/09/2004
DW 24	Parkes	Lachlan	NSW	15/11/2007
DW 20	Temora	Lachlan	NSW	13/11/2007
DW 33	Tullibigeal	Lachlan	NSW	29/10/2010
DW 19	West Wyalong	Lachlan	NSW	14/11/2007
DW 27	Broken Hill	Lower Murray–Darling	NSW	2/10/2008
DW 11	Buronga	Lower Murray–Darling	NSW	4/04/2003
DW 05	Coombah	Lower Murray–Darling	NSW	14/10/2004
DW 14	Euston	Lower Murray–Darling	NSW	24/10/2005
DW 09	Lake Victoria	Lower Murray–Darling	NSW	23/12/2004
DW 31	Menindee Lakes	Lower Murray–Darling	NSW	4/05/2009
DW 07	Penarie	Lower Murray–Darling	NSW	13/10/2004
DW 01	Pooncarie	Lower Murray–Darling	NSW	15/10/2004
DW 22	Deniliquin	Murray	NSW	29/07/2007
DW 23	Kyalite	Murray	NSW	5/10/2007
DW 32	Rand	Murray	NSW	23/12/2010
DW 35	Griffith	Murrumbidgee	NSW	9/05/2012
DW 02	Hay	Murrumbidgee	NSW	16/09/2004
DW 37	Junee	Murrumbidgee	NSW	4/02/2010
DW 36	Narrandera	Murrumbidgee	NSW	13/06/2012
DW 34	Wagga Wagga	Murrumbidgee	NSW	4/02/2010
DW 10	Gunnedah	Namoi	NSW	10/10/2003
DW 28	Walgett	Namoi	NSW	29/09/2008
DW 16	Bourke	Western	NSW	31/07/2007
DW 15	Cobar	Western	NSW	31/07/2007
DW 06	Tibooburra	Western	NSW	17/10/2004
DW 29	White Cliffs	Western	NSW	1/10/2008
DW 62	Minnipa	Eyre Peninsula NRM	SA	15/02/2012
DW 26	Moolawatana	SA Arid Lands	SA	17/07/2008
DW 61	Lameroo	SA Murray–Darling Basin	SA	14/02/2012
DW 41	Walpeup	Mallee	VIC	22/09/2011
DW 40	Loddon Plains	North Central	VIC	29/07/2011
DW 50	Mullewa	Northern Agricultural	WA	8/07/2008
DW 51	Merredin	Wheatbelt	WA	22/10/2009
DW 52	Newdegate	Wheatbelt	WA	19/12/2011
DW71	Birdsville	QLD Desert Channels	QLD	30/06/2013

3 DustWatch and your NRM region

How much dust is emanating from your region is a good indicator of soil health and ground cover levels. DustWatch provides an early indicator of changing weather, ground cover and land management actions because it is monitoring dusty activity 24 hours a day, 7 days a week. The data is available to collaborating NRMs and state agencies via the CoDii website.

3.1 Community DustWatch workflow

Community DustWatch is a collaborative program between OEH, NRM regions and other state agencies. The diagram in Figure 5 explains the operation, responsibilities and workflow of DustWatch.

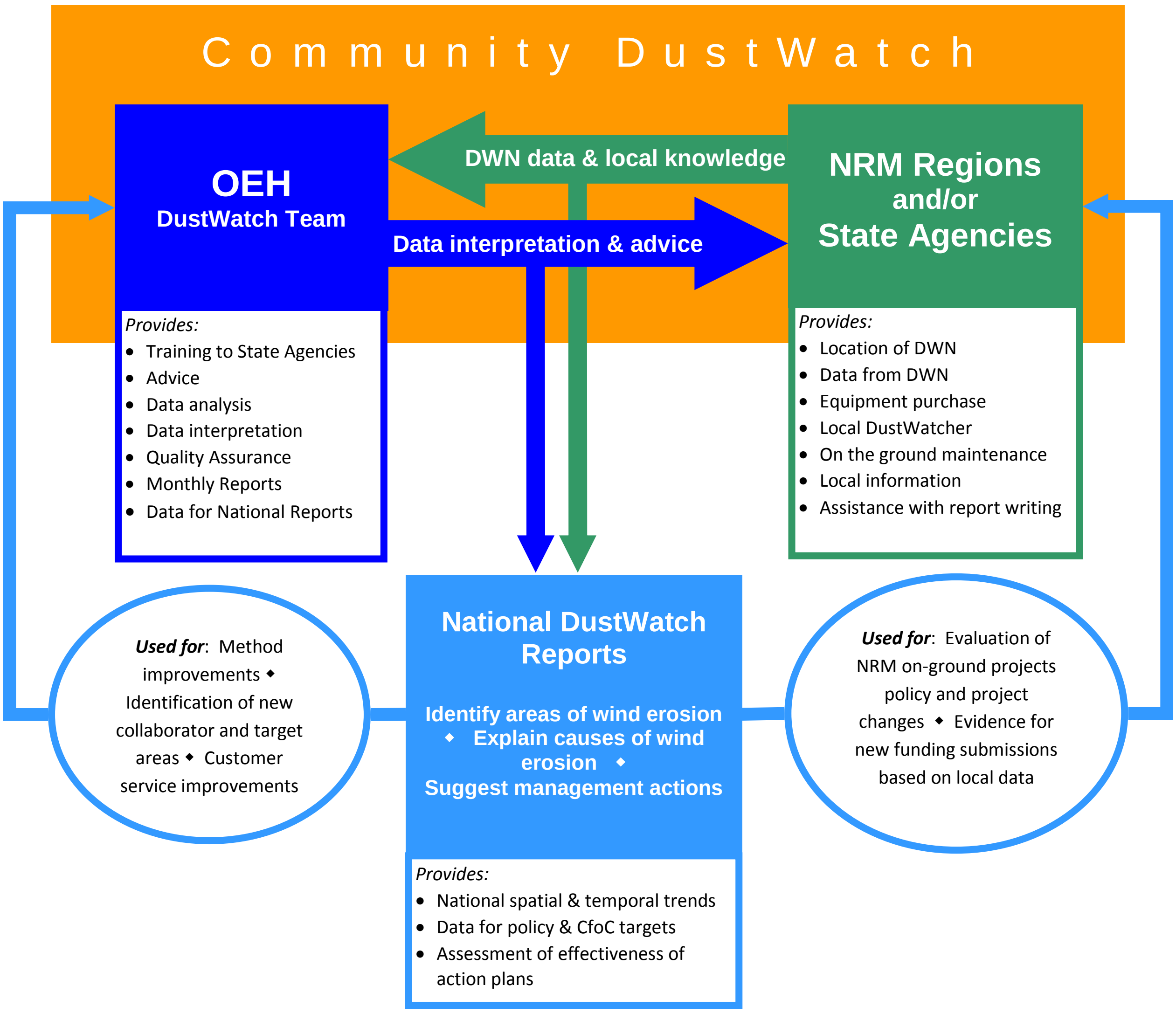


Figure 5. Community DustWatch operations and partnerships.

3.2 Site set-up and communication in Community DustWatch

DustWatch relies on the NRM/state agencies for equipment, local support and information regarding the landscape. Without this collaboration there would be no “community” input, no data, and so no real information flow or likely adoption of findings.

In the current model, each NRM organisation (or other participating state agency) is responsible for purchasing the equipment for the DWN and providing a local DustWatcher to maintain the equipment and site. The local DustWatcher and NRM/agency staff also provide feedback on landscape condition (e.g. “there was a fire 100 km north of the site”) and management actions being undertaken (e.g. “the winter harvest is on and so there is lots of dust from headers and trucks”). Information about where NRM investments are made is also critical as they become areas to monitor closely.

OEH provides the CoDii portal for downloading the data, the data quality assurance (QA) and storage, and makes the data available on the web to collaborating NRMs. OEH also supports the NRM by assisting with site location, training, and local, regional and national reporting. Ideally, in the future, the data QA will be done by a trained DustWatcher in each NRM because they know the area best.

A typical DWN is shown in Figure 6. Each DWN consists of an aerosol monitor (DustTrak®) that measures the aerosol concentration in the air of particulate matter less than 10 µm (micrometers) in diameter (PM_{10}). The air is sampled every 15 minutes and if the PM_{10} concentration exceeds 25 µg/m^3 (equivalent to a visibility reduction to less than 10 km) then samples are taken every minute until the concentration drops below the threshold. The instrument is mounted on a standard surveyor tripod, and is connected to a data logger. It is powered by a solar panel with a battery. Data is sent via the Next G mobile phone network or satellite modem to the DustWatch team. The instruments are enclosed with suitable fencing.

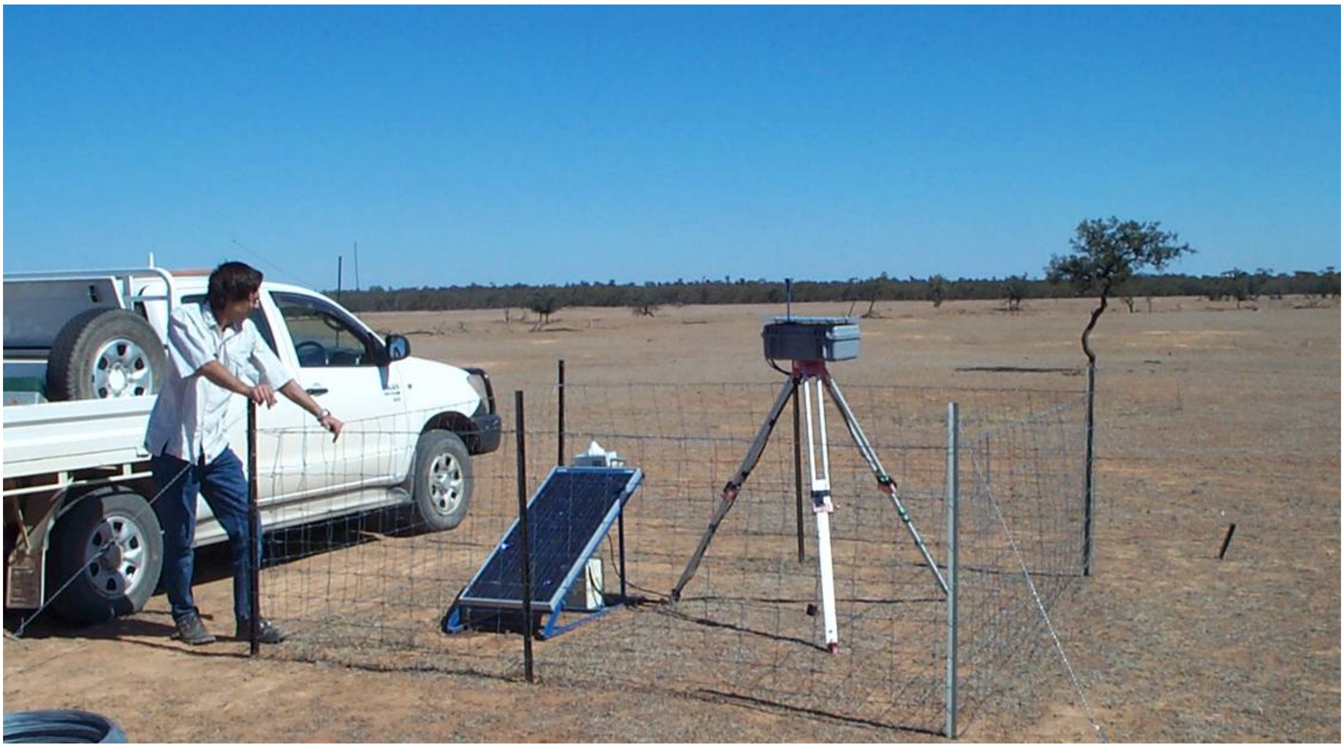


Figure 6. Layout of a typical DWN (Photo M. Case).

3.3 Reporting

The most important factor in DustWatch reporting is the local knowledge. While the instruments can identify that there is dust, and it is fair to assume that there is therefore low ground cover somewhere, the measurements do not reveal the ‘why’ i.e. why the dust is occurring. A critical part of the reporting process involves synthesising this local knowledge with the monitoring data in order to create a useful report.

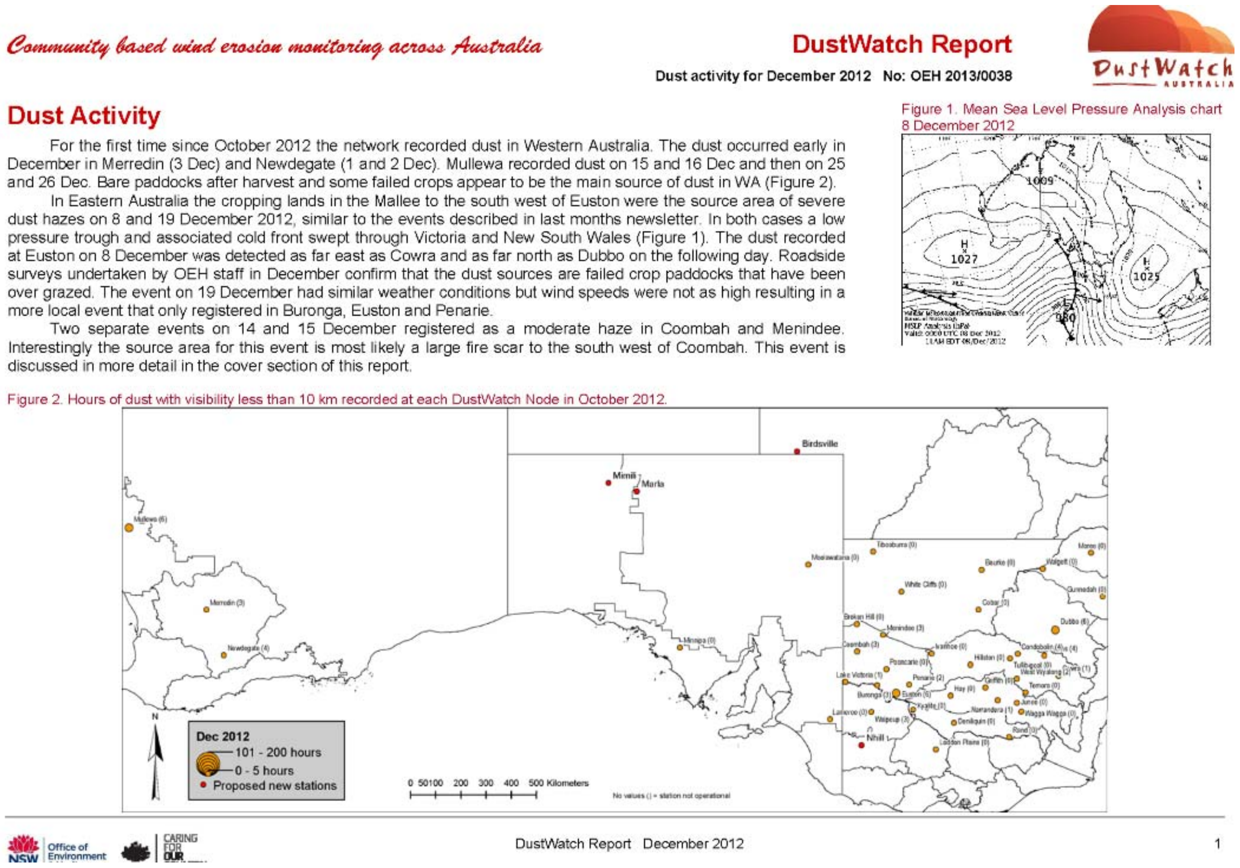
This local information, combined with meteorological and ground cover data sourced by DustWatch each week and month, is compiled to provide DustWatch alerts and weekly and monthly reports on dust events. These reports are publicly available on the OEH website (Figure 7, Figure 8).

- Salinity
- Wind erosion
  - DustWatch
    - DustWatch reports
- Gully erosion

DustWatch reports

Year	Newsletter for	Tick indicates highest dust level detected in that period.				PDF
		No dust	Dust haze	Local dust storm	Regional dust storm	
2013	January 2013			✓		130116DWNL.pdf (1.26mb)
2012	December 2012			✓		130038DWNL.pdf (1.17mb)
	November 2012				✓	121000DWNL.pdf (783kb)
	October 2012		✓			120865DWNL.pdf (1.2mb)
	September 2012		✓			120835DWNL.pdf (980kb)
	August 2012		✓			DWNL120831.pdf (432kb)
	July 2012		✓			DWNL120731.pdf (497kb)
	June 2012		✓			DWNL120630.pdf (516kb)
	May 2012		✓			DWNL120531.pdf (661kb)
	April 2012				✓	DWNL120430.pdf (600kb)
	March 2012	✓				DWNL120331.pdf (602kb)
	February 2012	✓				DWNL120229.pdf (4.49mb)
2012	January 2012			✓		DWNL120131.pdf (926kb) - NSW
2011	December 2011	✓				under review
	November 2011		✓			DWNL111101.pdf (1.38mb)

Figure 7. DustWatch reports webpage on the OEH website at www.environment.nsw.gov.au/dustwatch/dwreports.htm.



Community based wind erosion monitoring across Australia

DustWatch Report

Dust activity for December 2012 No: OEH 2013/0038

Dust Activity

For the first time since October 2012 the network recorded dust in Western Australia. The dust occurred early in December in Merredin (3 Dec) and Newdegate (1 and 2 Dec). Mullewa recorded dust on 15 and 16 Dec and then on 25 and 26 Dec. Bare paddocks after harvest and some failed crops appear to be the main source of dust in WA (Figure 2).

In Eastern Australia the cropping lands in the Mallee to the south west of Euston were the source area of severe dust hazes on 8 and 19 December 2012, similar to the events described in last months newsletter. In both cases a low pressure trough and associated cold front swept through Victoria and New South Wales (Figure 1). The dust recorded at Euston on 8 December was detected as far east as Cowra and as far north as Dubbo on the following day. Roadside surveys undertaken by OEH staff in December confirm that the dust sources are failed crop paddocks that have been over grazed. The event on 19 December had similar weather conditions but wind speeds were not as high resulting in a more local event that only registered in Buronga, Euston and Penarie.

Two separate events on 14 and 15 December registered as a moderate haze in Coombah and Menindee. Interestingly the source area for this event is most likely a large fire scar to the south west of Coombah. This event is discussed in more detail in the cover section of this report.

Figure 1. Mean Sea Level Pressure Analysis chart 8 December 2012

Figure 2. Hours of dust with visibility less than 10 km recorded at each DustWatch Node in October 2012.

DustWatch Report December 2012 1

Figure 8. December 2012 DustWatch report. These reports are downloadable as PDF files from the OEH DustWatch webpage.

3.4 Planning

Using tools within Community DustWatch, such as CoDii and the weekly and monthly reports, the effectiveness of on-ground activities, investments or plans can be rapidly evaluated by NRMs, the community, state agencies and funding bodies. In particular, the weekly or monthly reports derived from Community DustWatch form a record of the region's performance and can be used to:

- **underpin** operational decisions – e.g. Area A now has low ground cover and dust emissions; time to focus projects there
- **describe** progress towards targets. Used by funding bodies, state agencies and the community to *"monitor the consequences of investments, policies and actions and evaluate if on-ground outputs contribute to the outcomes sought by government"* and the community (Auditor General 2008)
- **raise** awareness of NRM soils issues by highlighting the dust and its causes to the community
- **form** the evidence for adaptive management within DustWatch and the NRM. NRMs can now identify which parts of the catchment are experiencing problems; use near real-time reporting to quickly identify problem areas and make appropriate changes to investment plans
- **provide** evidence for strategic planning and co-investment. Priority locations for future DustWatch Nodes near and downwind of ongoing source areas can be identified.

4 DustWatch rankings

Since 2005–06, DustWatch Nodes have been ranked according to the amount of dust activity (hours of dust activity with PM_{10} concentration > 25 µg/m^3) for that Dust Storm Year (DSY). Table 2 lists the DustWatch Nodes in ranked order from greatest to least dust activity for each DSY. The list of participating stations has increased over the years because stations were installed gradually. Some DWNs have incomplete datasets for the year they were installed, or, in some cases, if instrument malfunction occurred. This has an impact on the reliability of the ranking, and data completeness is noted where applicable.

This ranking gives an indication of

- where an individual station sits within the network
- how a particular group of sites has performed e.g.:
  - rangelands/cropping
  - east/west
  - north/south.

These different rankings can give NRM regions an indication of sites that performed above average (what have they done better?) or below average (what went wrong?). This is a very good starting point to consult other site-specific information such as ground cover data, roadside surveys and local knowledge to explore the reasons for the above or below average performance of a site.

Table 2. DWN ranking by Dust Storm Year (DSY); h = hours of dust activity with PM_{10} concentration > 25µg/m^3; % = percentage of data completeness (100% unless otherwise noted).

2005–06			2006–07			2007–08			2008–09			2009–10			2010–11			2011–12		
DWN	**h**	**%**	**DWN**	**h**	**%**	**DWN**	**h**	**%**	**DWN**	**h**	**%**	**DWN**	**h**	**%**	**DWN**	**h**	**%**	**DWN**	**h**	**%**
Euston	114	70	Tibooburra	120		Pooncarie	210		Moolawatana	264	95	Tibooburra	413		Mullewa	16		Walpeup	45	80
Tibooburra	113		Euston	76		Ivanhoe	131		Pooncarie	195		White Cliffs	320		Temora	10		Buronga	30	
Ivanhoe	53		Pooncarie	73		Tibooburra	117		Ivanhoe	168		Moolawatana	301		Menindee Lakes	9		Bourke	22	
Coombah	50		Buronga	71		Temora	113	60	Hillston	138		Moree	270		Buronga	7		Tibooburra	16	
Buronga	48		Lake Victoria	66		Hillston	98	60	Euston	135		Menindee Lakes	256		Pooncarie	6		Euston	15	
Condobolin	47		Coombah	49		Condobolin	95		Tibooburra	121		Broken Hill	227		Cobar	5		Kyalite	15	
Lake Victoria	40		Penarie	48		Bourke	86	90	White Cliffs	92	75	Ivanhoe	216		Lake Victoria	5		Deniliquin	14	
Penarie	32		Ivanhoe	45		Euston	85		Hay	84		Bourke	201		Hillston	4		Hillston	14	
Gunnedah	26		Hay	38		Cobar	85	90	Temora	82		Coombah	155		Ivanhoe	3		Cobar	13	
Hay	23		Condobolin	30		Parkes	77	60	Broken Hill	77	75	Walgett	151		Condobolin	3		Ivanhoe	11	
Pooncarie	13		Gunnedah	10		West Wyalong	75	60	Cobar	77		Pooncarie	143		West Wyalong	3		Lake Victoria	10	
						Kyalite	65	70	Condobolin	77		Euston	141		Tullibigeal	3	75	Penarie	9	
						Penarie	63		Kyalite	75		Cowra	135		Walgett	3		Mullewa	9	
						Deniliquin	57	80	Buronga	74		Cobar	128		Bourke	2		Menindee Lakes	8	
						Buronga	54		Penarie	67		Buronga	113		Euston	2		Lameroo	7	35
						Gunnedah	52		Dubbo	62		Gunnedah	113		Kyalite	2		Loddon Plains	7	90
						Hay	47		Deniliquin	64		Hillston	113		Deniliquin	2		White Cliffs	5	
						Coombah	46		Bourke	49		Dubbo	110		Penarie	2		Wagga Wagga	5	
						Cowra	44	60	Coombah	49		Lake Victoria	108		Parkes	2		Junee	5	
						Lake Victoria	43		West Wyalong	47		Parkes	95		Dubbo	2		Rand	5	
						Dubbo	34	85	Parkes	46		Temora	85		Broken Hill	2		Condobolin	4	
									Cowra	43		West Wyalong	82		White Cliffs	1		Temora	4	
									Lake Victoria	35		Hay	61		Cowra	1		West Wyalong	4	
									Moree	27	75	Condobolin	50		Hay	1		Minnipa	3	35
									Walgett	26	75	Kyalite	46		Coombah	1		Pooncarie	3	
									Gunnedah	19		Deniliquin	36		Moree	1		Tullibigeal	3	
									Menindee Lakes	13	10	Penarie	35		Gunnedah	1		Merredin	3	
									Mullewa	0	95	Mullewa	27		Tibooburra	0		Parkes	2	
												Wagga Wagga	3	40	Wagga Wagga	0		Cowra	2	
												Merredin	0	70	Junee	0	40	Dubbo	2	
															Merredin	0		Hay	1	
															Moolawatana	0		Coombah	0	
															Rand	0	50	Moree	0	
																		Moolawatana	0	
																		Gunnedah	0	
																		Broken Hill	0	
																		Walgett	0	
																		Newdegate	0	55
																		Griffith	0	
																		Narrandera	0	

5 NRM summaries

The NRM summaries presented on the following pages contain multiple streams of information. They are in most cases summarised by the Dust Storm Year (1 July to 30 June). This is done to avoid inaccuracies by splitting the records at their maximum (December, January and February are the dustiest times in Australia).

All gridded files, such as rainfall, ground cover and land use, are analysed in a 25 km circle around the DWN. This area is regarded as the primary area of influence directly related to the DWN, i.e. the DWN measures dust at the source. There is obviously dust measured at the DWN that is from further afield and therefore medium or long-distance transport. Distinguishing between the two is a major challenge but becomes easier as the DustWatch network grows and individual NRMs are covered with multiple DWNs.

The information summaries include:

1. the hours of dust activity exceeding 25 $\mu g/m^3$ (equivalent to a visibility reduction to less than 10 km) per month and/or Dust Storm Year (DSY)

2. monthly and/or 12-monthly rainfall records, extracted from a 25 km circle around the DWN and based on BoM gridded monthly rainfall files

3. Dust Storm Year rainfall deviation from the mean – to explain ground cover anomalies caused by climate

4. monthly satellite-based ground cover images where appropriate, based on MODIS[1] images – using the bare ground methodology by Guerschman *et al.* (2012)

5. monthly trends in ground cover where appropriate, extracted from a 25 km circle around the DWN.

5.1 New South Wales

5.1.1 Border Rivers–Gwydir CMA

Catchment description

The Border Rivers–Gwydir CMA region covers approximately 50 000 km^2 and is located in north-western NSW, covering the Gwydir catchment and the NSW portion of the Border Rivers catchment. The main towns are Moree, Inverell, Glen Innes, Tenterfield and Boggabilla. Grazing is the main enterprise on the tablelands in the east of the catchment. Mostly dryland cropping occurs on the slopes, with an increasing use of irrigation on the plains in the west of the catchment.

Data at the DWNs

At all DWNs data is updated weekly and is current. Rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 $\mu g/m^3$. Land use, rainfall and ground cover of DWNs refer to the surrounding 25 km (yellow circles in Figure 9).

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[1] MODIS (or Moderate Resolution Imaging Spectroradiometer) is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites.

DWNs in the Border River–Gwydir CMA region

There is one DWN in the CMA located at Moree (Figure 9). The Moree DWN was installed in September 2008. This DWN is owned and maintained by OEH with in-kind contributions from the Border Rivers–Gwydir CMA and Bureau of Meteorology.

The land use surrounding the Moree DWN is mixed irrigation and dryland farming. The Moree DWN is located well within the boundaries of the catchment and can receive local dust from all directions. The Moree DWN can also receive dust from regional events that have blown from distant sources.

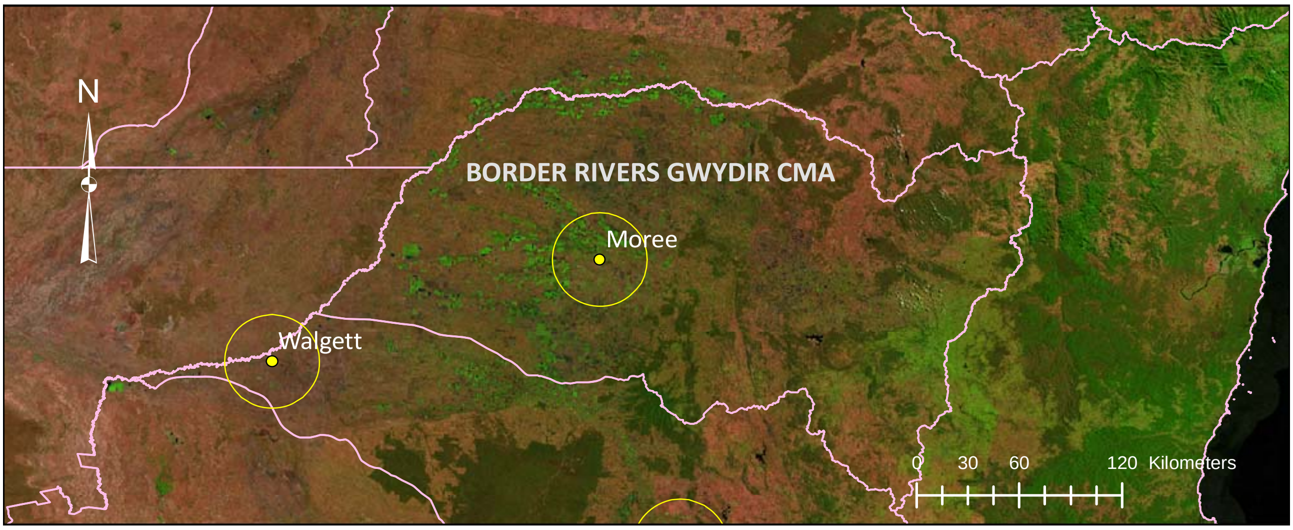
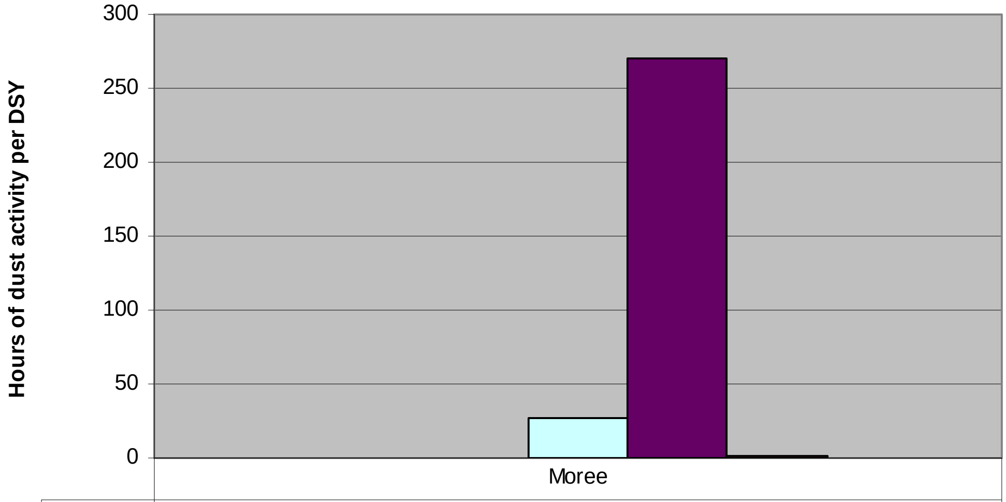


Figure 9. LandSat 7 image: location and ground cover assessment area of the Moree DWN in the Border Rivers–Gwydir CMA, and other nodes in neighbouring CMAs.

Dust activity – annual trends

Dust activity increased to exceptional levels at the Moree DWN in the 2009–10 DSY (270 hours). Dust activity fell dramatically in 2010–11 (1 hour) and ceased in 2011–12 (Figure 10).



	Moree
2005/06	
2006/07	
2007/08	
2008/09	27
2009/10	270
2010/11	1
2011/12	0

Figure 10. Annual hours of dust activity for the Moree DWN.

Dust activity – directional component

The Moree DWN is located well within the boundary of the CMA, where it can receive dust from local sources from all directions and dust from regional events that have blown from distant sources. In 2008–09 Moree received dust from the east to south-west. During 2009–10 dust activity was from the west and north. Substantial long-range transport of dust was recorded in 2009–10.

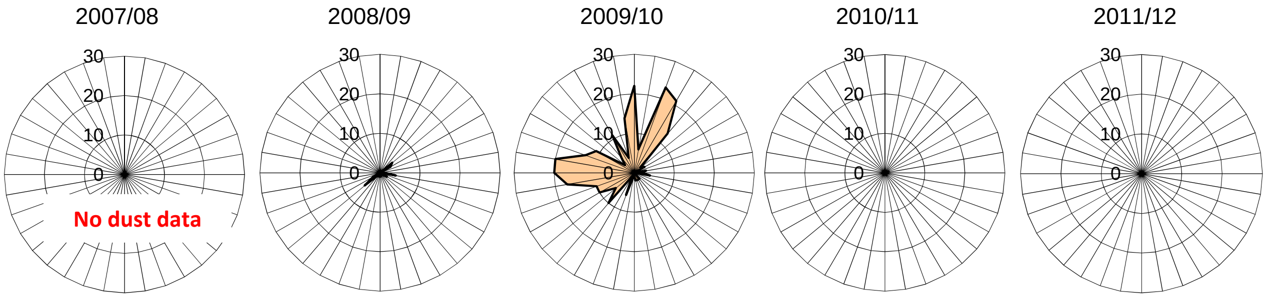


Figure 11. Annual dust roses (showing hours of dust and direction) for the Moree DWN.

Causes of recent dust activity in the Border Rivers–Gwydir catchment

In 2009–10 dust activity came from sources both within and outside the catchment. Prolonged drought, strong winds and extensive areas with less than 50% cover in the Lake Eyre Basin, Channel Country of south west Queensland and north-west of NSW led to widespread wind erosion and were the major components of dust considered to have come from outside the Border Rivers–Gwydir catchment. Multiple dust events from these sources were recorded at the Moree DWN in September, October, November and December 2009. This included the widely publicised “Red Dawn” dust event that swept across NSW in September. In the 2009–10 DSY, the Moree DWN was ranked fourth highest for the hours of dust (270 hours) (Table 2). On a local scale during 2009–10 there were high winds, low ground cover and dry soils that predisposed the CMA to erosion. Land management practices such as cultivated fallows in irrigation areas, grazing of failed crops, overgrazing of pasture and rangelands, could not maintain what little cover there was and this resulted in the country to the west of Moree being susceptible to wind erosion. Although generally there is low ground cover in March, the soil is saved from erosion due to the hours of wind > 30 km/h also being low. Since January 2010 there has virtually been no dust at Moree indicating cover levels have recovered above the level required to control wind erosion.

Only 1 hour of dust was measured in 2010–11.

In 2012–13 dust activity has recommenced. In September 2012 there were 11 hours of dust following 23 months of no dust. Two events were recorded in September. The first event was attributed mainly to a regional event that affected most of NSW. Some local dust from paddocks being prepared for summer crops would have also contributed to the dust measured during this event. Dust was driven by strong (40–50 km/h) to very strong (50–60 km/h) westerly and pre-frontal northerly winds. Dust levels were around the moderate haze limit (visibility 10–5 km). A more localised event occurred later in the month driven by moderate northerly winds. These winds generated the dust which came from paddocks being prepared for summer crops such as cotton. The combination of dry soils due to the low rainfall in August and September and the low cover from the cultivation resulted in the dust (Figure 12).

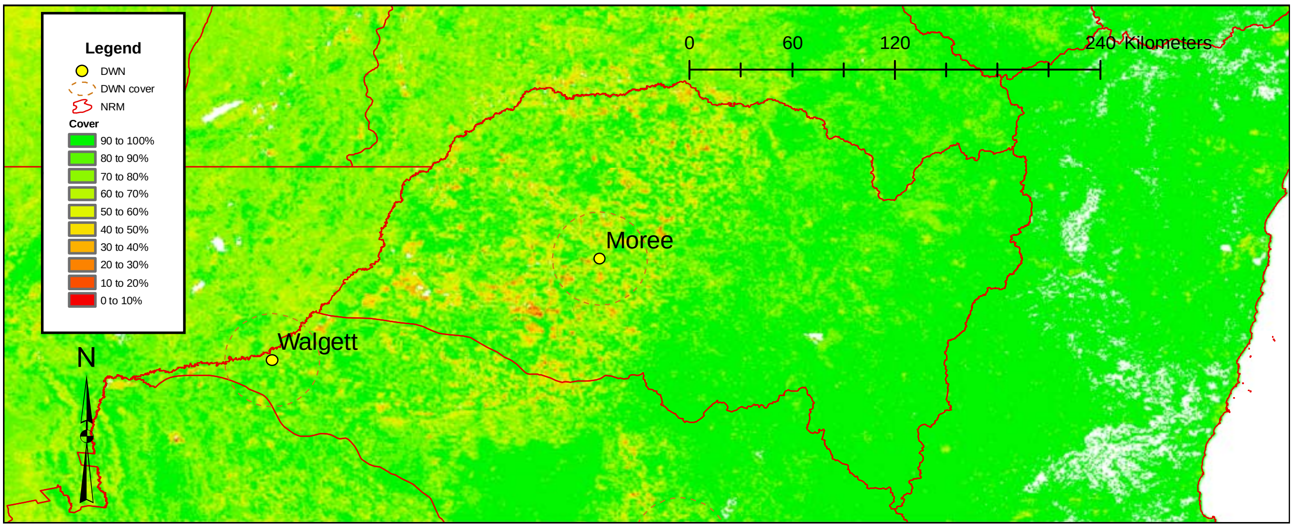
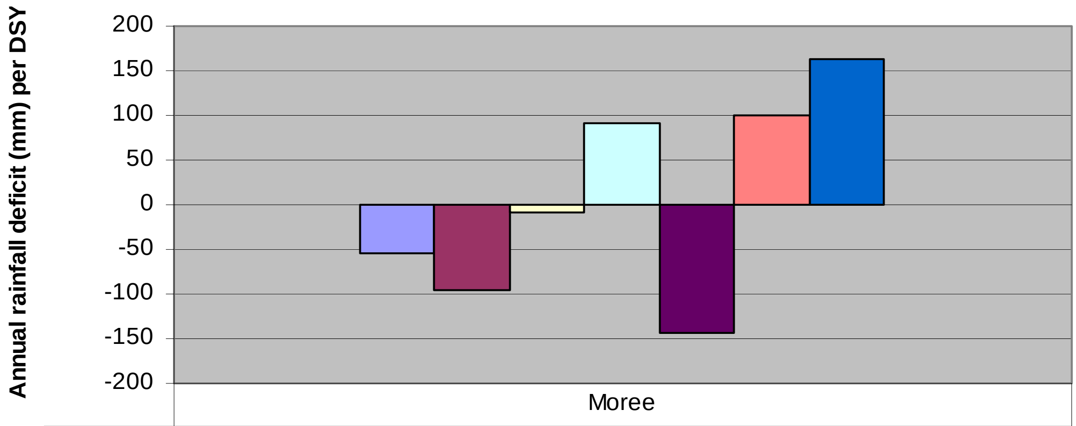


Figure 12. Cover (%) in the Border Rivers–Gwydir CMA in September 2012.

Rainfall

The Moree DWN averages 583 mm per DSY. The annual rainfall deficits show the deviation from average at the Moree DWN since 2005–06 (Figure 13). Since 2005–06, Moree has received above average rainfall in 2008–09, 2010–11 and 2011–12. In 2010–11 most areas of eastern Australia, including the Border Rivers–Gwydir CMA region, were exceptionally wet, receiving above average or record rainfall. The Moree DWN recorded 683 mm in that DSY. Following very good falls in early 2010, ground cover recovered to levels that prevented wind erosion. In 2011–12 rainfall levels at Moree were higher still (746 mm) due to an exceptionally wet February.



	Moree
2005/06	-54
2006/07	-95
2007/08	-9
2008/09	92
2009/10	-144
2010/11	100
2011/12	163

Figure 13. Annual rainfall deficit (mm) for the Moree DWN.

Summary

There are two distinctive parts to the Border Rivers–Gwydir CMA region, with different landforms and associated land uses. The eastern half, due to its geography, land use and rainfall has a low wind erosion risk. The western half has a moderate wind erosion risk during fallow periods in broadacre cropping and during drought in western rangeland grazing. Both risks can be minimised with appropriate land management practices.

Dust from wind erosion outside the region can reach the Border Rivers–Gwydir CMA region during extended droughts when the rangelands to the west and north drop below critical cover and become major dust sources for NSW. Moree is in a major dust transport pathway and can experience extended periods of dust originating from west and north of the Border Rivers–Gwydir catchment.

5.1.2 Central West CMA

Catchment description

The Central West CMA region covers an area 84 842 km^2 in central western NSW. It includes the Castlereagh, Bogan and Macquarie River valleys. Major centres include Orange, Bathurst, Dubbo and townships of Mudgee and Nyngan. Grazing is the major land use, followed by broadacre winter cereal production.

Data at DWNs

At all DWNs data is updated weekly and is current. Rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration >

25 µg/m³. Land use, rainfall and ground cover of DWNs refer to the surrounding 25 km (yellow circle in Figure 14).

DWNs in the Central West CMA region

There is one DWN in the CMA region located at Dubbo (Figure 14). The Dubbo DWN was installed in August 2007 and is owned and maintained by OEH.

Land uses surrounding the DWN are mainly mixed dryland cropping with irrigation along rivers, grazing and forests in the south-west and north-east. The Dubbo DWN is located well within the boundaries of the catchment and can receive local dust from all directions. The Dubbo DWN can also receive dust from regional events that have blown from distant sources.

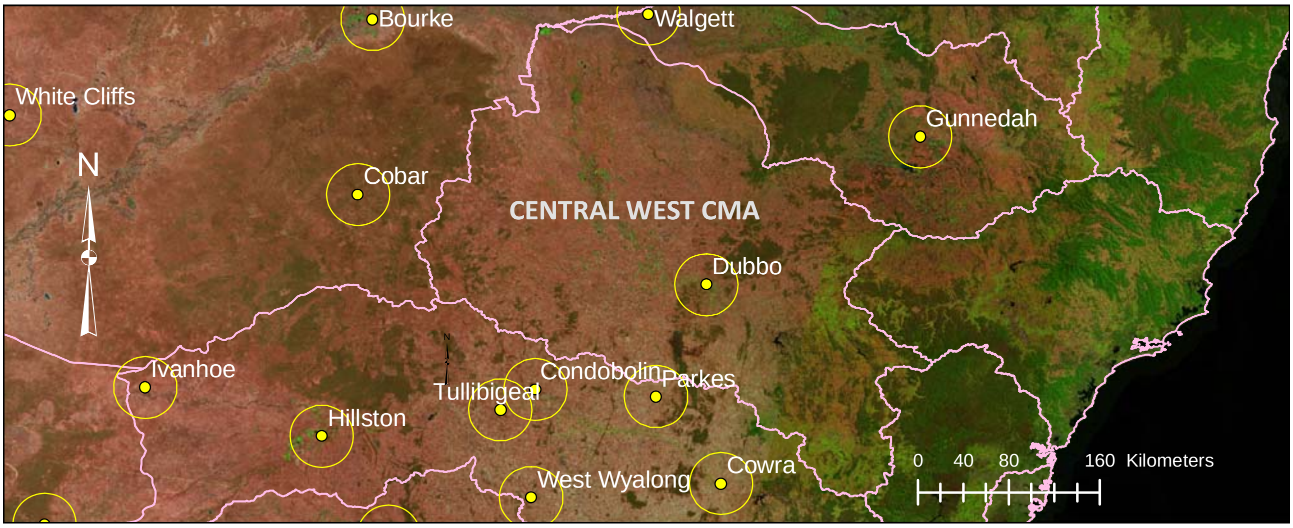


Figure 14. LandSat7 image: location and ground cover assessment area of the Dubbo DWN in the Central West CMA and other nodes in neighbouring CMAs.

Dust activity – annual trends

At the Dubbo DWN the trend of dust activity was upward from 34 hours in 2007–08 to its peak of 110 hours in 2009–10. In 2010–11 and 2011–12, dust activity almost completely ceased, with 2 hours measured in both years (Figure 15).

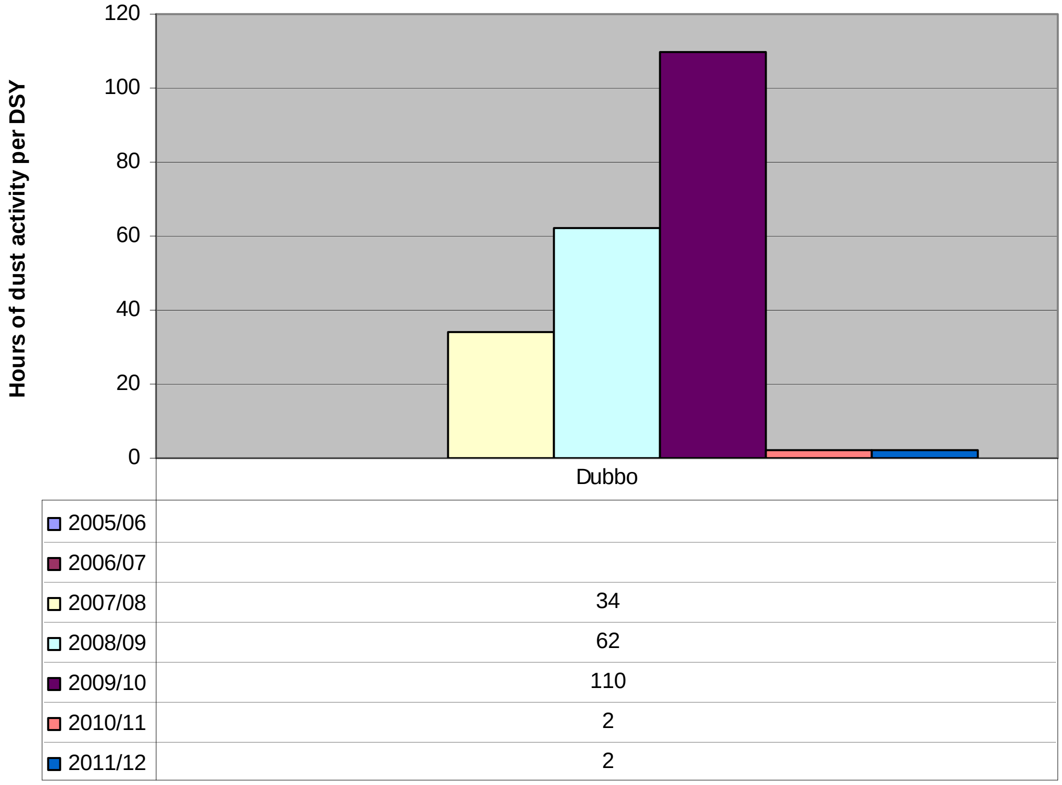


Figure 15. Annual hours of dust activity for the Dubbo DWN.

Dust activity – directional component

The Dubbo DWN is located well within the boundary of the CMA, where it can receive dust from local sources from all directions and dust from regional events that have blown from distant sources. Dust at Dubbo originates predominantly from the east to south-east, but in 2009–10 there was significant dust from the north and west (Figure 16).

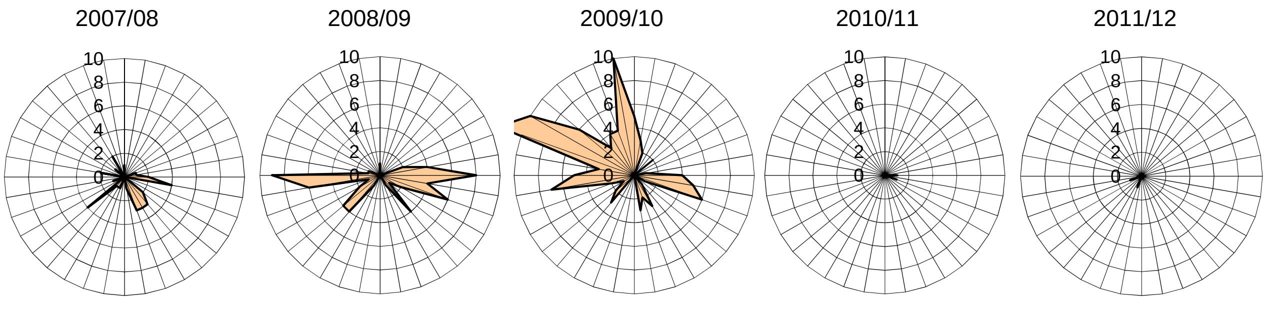


Figure 16. Annual dust roses (showing hours of dust and direction) for Dubbo DWN.

Causes of recent dust activity in the Central West CMA

In 2009–10 the Central West CMA region received significant dust from several widespread dust events that swept across NSW, including the widely publicised “Red Dawn” dust event in September. In 2009–10 the Dubbo DWN was ranked 18th with 110 hours of dust (Table 2). The dust measured at the Dubbo DWN during 2009–10 occurred in September (25 hours), October (26 hours) and November 2009 (41 hours) and was mainly attributed to sources in the Lake Eyre Basin, Channel Country of south-west Queensland and north-west of NSW. During this period, ground cover levels in the CMA remained high, with less than 2% of the ground cover assessment area below 50% cover at Dubbo (Figure 17). However, some mixed farming areas near the western border approached critical levels of ground cover at this time.

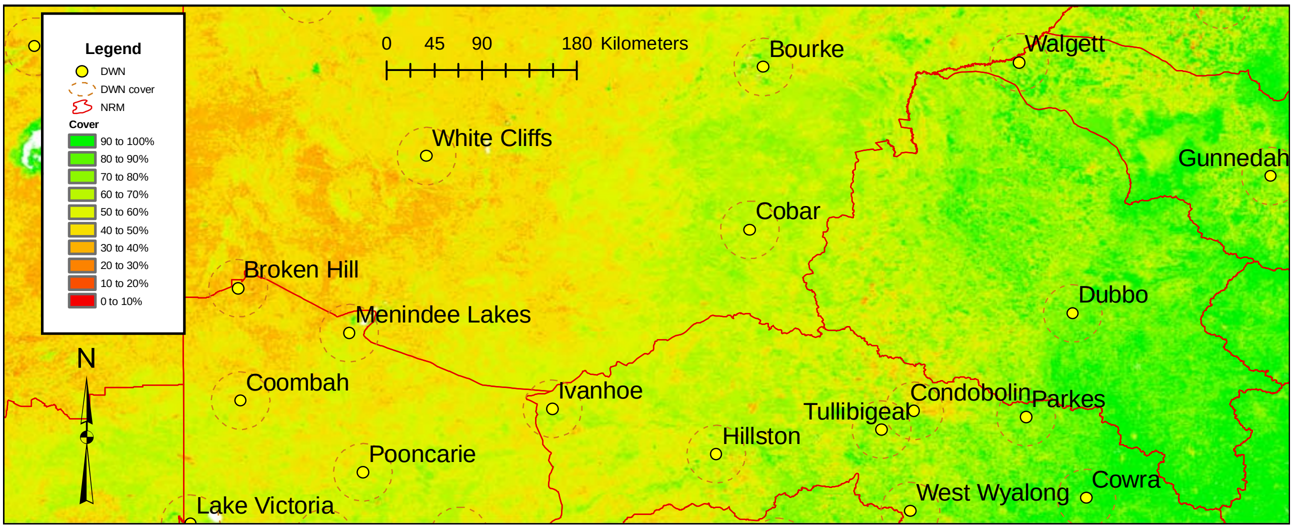


Figure 17. Widespread areas of low ground cover to the north-west of the Central West CMA in September 2009.

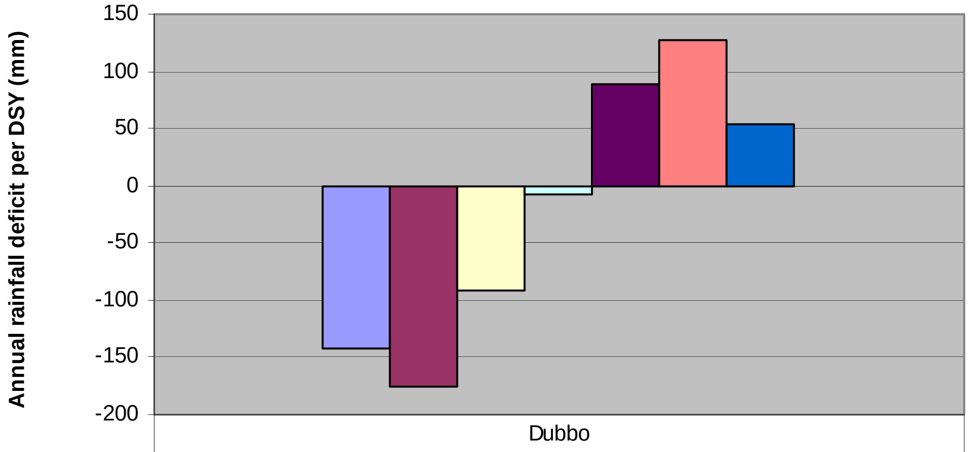
In 2010–11 most areas in Australia, including the Central West CMA region, were exceptionally wet, receiving above average or record rainfall. Following very good falls in early 2010, ground cover recovered to levels that prevented wind erosion. The overall magnitude of the recorded dust fell by two orders of magnitude, with Dubbo recording 110 hours in 2009–10 to 2 hours in 2010–11. This pattern is largely a function of the rainfall, i.e. in drought conditions there is dust and in wetter years there is not. However, land management also plays an important part in the erosion levels. From June 2010 mostly good cover levels were maintained in the assessment area, apart from a slight increase in the area at risk of erosion around autumn due to harvest of summer crops.

In 2011–12 rainfall levels were generally lower in eastern Australia than in 2010–11 but still above average. Only 2 hours of dust activity were recorded that year in February at Dubbo. This was attributed to a widespread regional event from dust activity in the Victorian Mallee region resulting from land management practices associated with fallowing, i.e. burning and cultivation. The dust was picked up by strong south-westerly winds that approached 60 km/hour – double the speed required to lift loose, bare soil. The dust travelled as far east as Cowra and as far north as Dubbo.

Until January 2013, in 2012–13 dust has been recorded in September 2012 at Dubbo (3 hours), driven by strong to very strong west to north winds. Dust measured at Dubbo was part of a regional event that affected most of NSW. Dust was driven by strong (40–50 km/h) to very strong (50–60 km/h) westerly and pre-frontal northerly winds. Dust levels were around the moderate haze limit (visibility 10–5 km) for most DWNs. Dubbo also recorded dust in December (6 hours) as part of widespread events covering many parts of NSW which were attributed to sources in the Mallee.

Rainfall

On average, Dubbo receives 587 mm of rain per DSY. The annual rainfall deficits show the deviation from average at the Dubbo DWN since 2005–06 (Figure 18). From the largest deficit in 2006–07 (-175 mm), rainfall at Dubbo steadily increased to record 128 mm above average rainfall in 2010–11 (receiving 714 mm in total). Following very good falls in early 2010, ground cover recovered to levels that prevented wind erosion. In 2011–12 rainfall levels (640 mm) were lower than in 2010–11 but still remained above average for this DWN, and also across eastern Australia.



	Dubbo
2005/06	-141
2006/07	-175
2007/08	-92
2008/09	-8
2009/10	88
2010/11	128
2011/12	54

Figure 18. Annual rainfall deficit (mm) for the Dubbo DWN.

Summary

Dust in the Central West CMA is highly variable between the western areas towards Cobar and the eastern parts into the ranges. The Dubbo DWN only captures a small proportion of the western CMA dust activity and cannot be interpreted to represent the entire catchment.

Dust around the Dubbo DWN is partly related to long-range dust transport from rangelands to the west and north in times of severe drought. Regional dust, predominantly from the east, is more related to cropping activities within the catchment and around the DWN. This dust is not as dependant on climate and more related to cropping management.

The rangeland dust activities occur in early summer whereas the cropping-related dust tends to occur in late summer/early autumn.

5.1.3 Lachlan CMA

Catchment description

The Lachlan CMA region is located in central western NSW and covers an area of approximately 84 700 km^2. It includes the Lachlan River catchment. Major townships in the CMA region are Parkes, Forbes, Cowra, West Wyalong and Ivanhoe. Dryland cereal production and livestock are the major land uses on the slopes and near plains, with grazing as the major land use on the tablelands and western plains.

Data at DWNs

At all DWNs data is updated weekly and is current. Rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. The annual reporting period is called a Dust Storm Year

(DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 µg/m^3. Land use, rainfall and ground cover of DWNs refer to the surrounding 25 km (yellow circles in Figure 19).

DWNs in the Lachlan CMA region

The Lachlan CMA region has 8 DWNs (Figure 19). These are located at Condobolin (installed in September 2004), Cowra (installed in November 2007), Hillston (installed in November 2007), Ivanhoe (installed in September 2004), Parkes (installed in November 2007), Temora installed in (November 2007), Tullibigeal (installed in October 2010) and West Wyalong (installed in November 2007). All DWNs in the Lachlan CMA region are owned and maintained by the Lachlan CMA with in-kind contributions from Lower Murray–Darling CMA (Ivanhoe only), OEH and the local community.

The Ivanhoe DWN is surrounded by rangelands. Hillston has mixed dryland farming and also grazing land to the north-west of the DWN. Land use near Condobolin, Cowra and Hillston DWNs is mixed irrigation and dryland farming. Land use surrounding the Parkes, Tullibigeal, Temora and West Wyalong DWNs is mixed dryland farming.

Four DWNs are located near the boundaries to other CMAs. Table 3 below shows the directions from which dust is considered to originate from outside the catchment for these DWNs.

Table 3. DWNs with local dust sources from outside the Lachlan CMA region.

Site	Origin of dust	Degrees (°)		Direction		Neighbouring CMAs
		From	To	From	To	
Ivanhoe	Outside	170	30	S	NNE	LMD*, Western
West Wyalong	Outside	140	330	SE	NNW	Murrumbidgee
Temora	Outside	90	310	E	NW	Murrumbidgee
Parkes	Outside	300	90	WNW	E	Central West

* LMD = Lower Murray–Darling

Hillston, Tullibigeal, Condobolin and Cowra DWNs are all located well within the catchment and can receive local dust from all directions.

All DWNs can receive dust from regional events that have blown from distant sources.

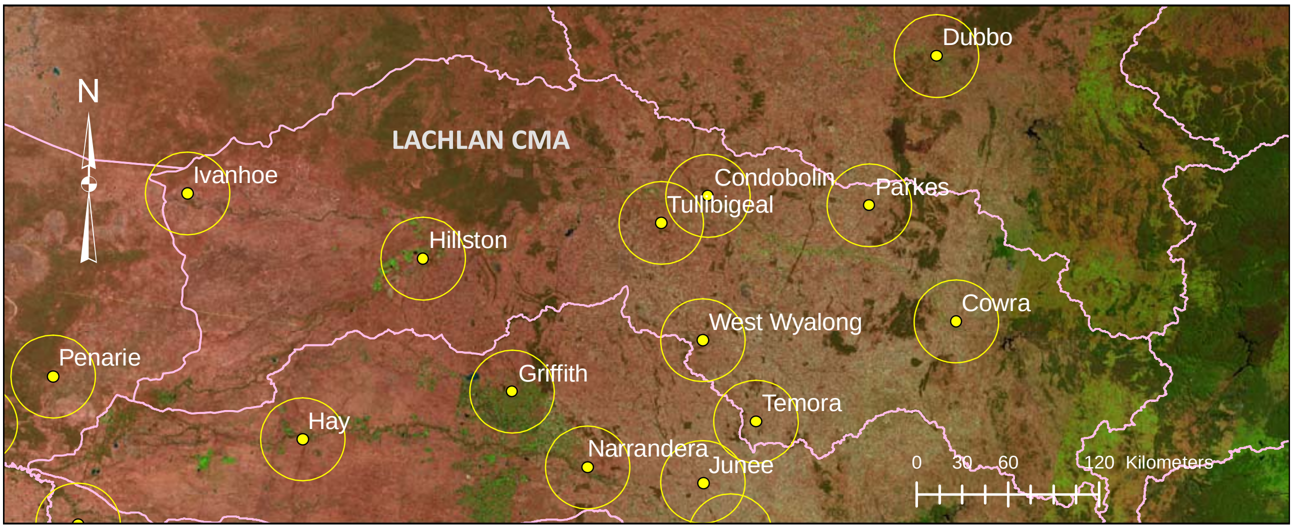
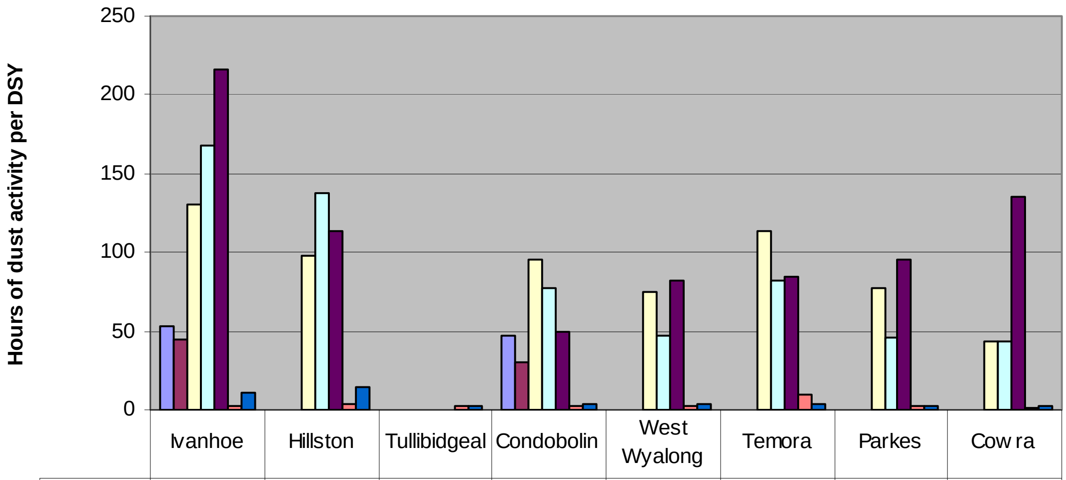


Figure 19. LandSat7 image: location and ground cover assessment areas of DWNs in the Lachlan CMA region and neighbouring CMAs.

Dust activity – annual trends

Prior to 2010–11, extended periods of high dust activity were recorded across the CMA region (Figure 20). Between 2007–08 to 2009–10 all DWNs recorded annual values near or above 50 hours. Maximum values of dust activity were recorded at Ivanhoe in 2009–10 with 216 hours. Hillston's peak (138 hours) was recorded in 2008–09. Condobolin and Temora recorded greatest dust activity in 2007–08 (95 hours and 113 hours respectively). In 2010–11 dust activity reduced by up to two orders of magnitude across the catchment. Ivanhoe recorded only 3 hours of dust in 2010–11. In 2011–12 dust was measured at all DWNs with Hillston recording a maximum value of 14 hours.

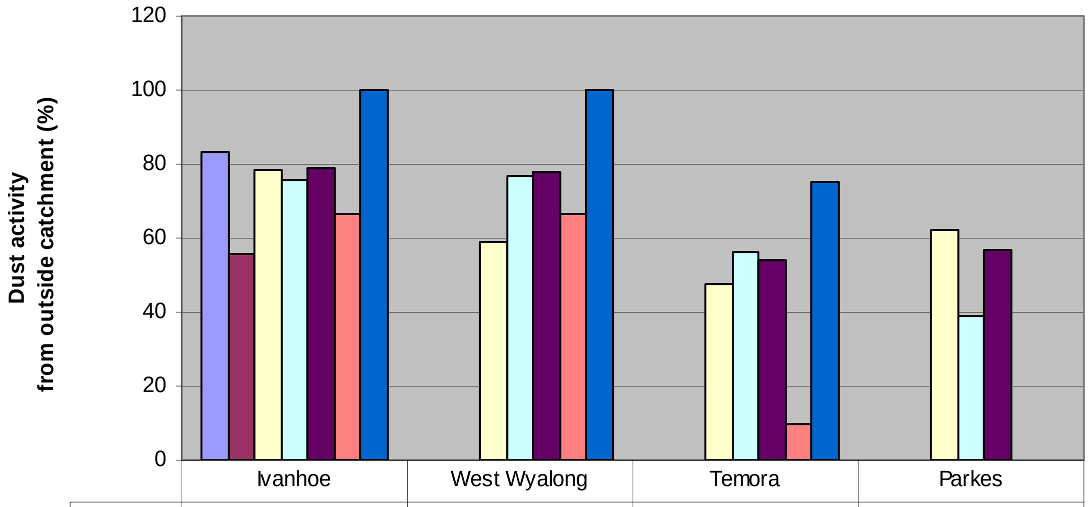


	Ivanhoe	Hillston	Tullibidgeal	Condobolin	West Wyalong	Temora	Parkes	Cow ra
2005/06	53			47				
2006/07	45			30				
2007/08	131	98		95	75	113	77	44
2008/09	168	138		77	47	82	46	43
2009/10	216	113		50	82	85	95	135
2010/11	3	4	3	3	3	10	2	1
2011/12	11	14	3	4	4	4	2	2

Figure 20. Annual hours of dust activity for all DWNs in the Lachlan CMA.

Dust activity – directional component

DWNs located near boundaries of the catchment can measure a significant component of dust from sources deemed to be outside the catchment (Table 3, Figure 21). In Ivanhoe's year of peak dust activity in 2009–10, 79% of recorded dust came from sources outside the catchment, with a strong dust signal from the north-west (Figure 22). In 2011–12, 100% of dust recorded at Ivanhoe (11 hours) was deemed to have originated from sources outside the catchment to the south-west. Temora recorded the highest level of dust activity in 2010–11 (10 hours), with only 10% considered to have come from sources outside the catchment.



	Ivanhoe	West Wyalong	Temora	Parkes
2005/06	83			
2006/07	56			
2007/08	79	59	48	62
2008/09	76	77	56	39
2009/10	79	78	54	57
2010/11	67	67	10	0
2011/12	100	100	75	0

Figure 21. Dust activity originating from outside the Lachlan CMA catchment (%) for DWNs near the catchment boundaries.

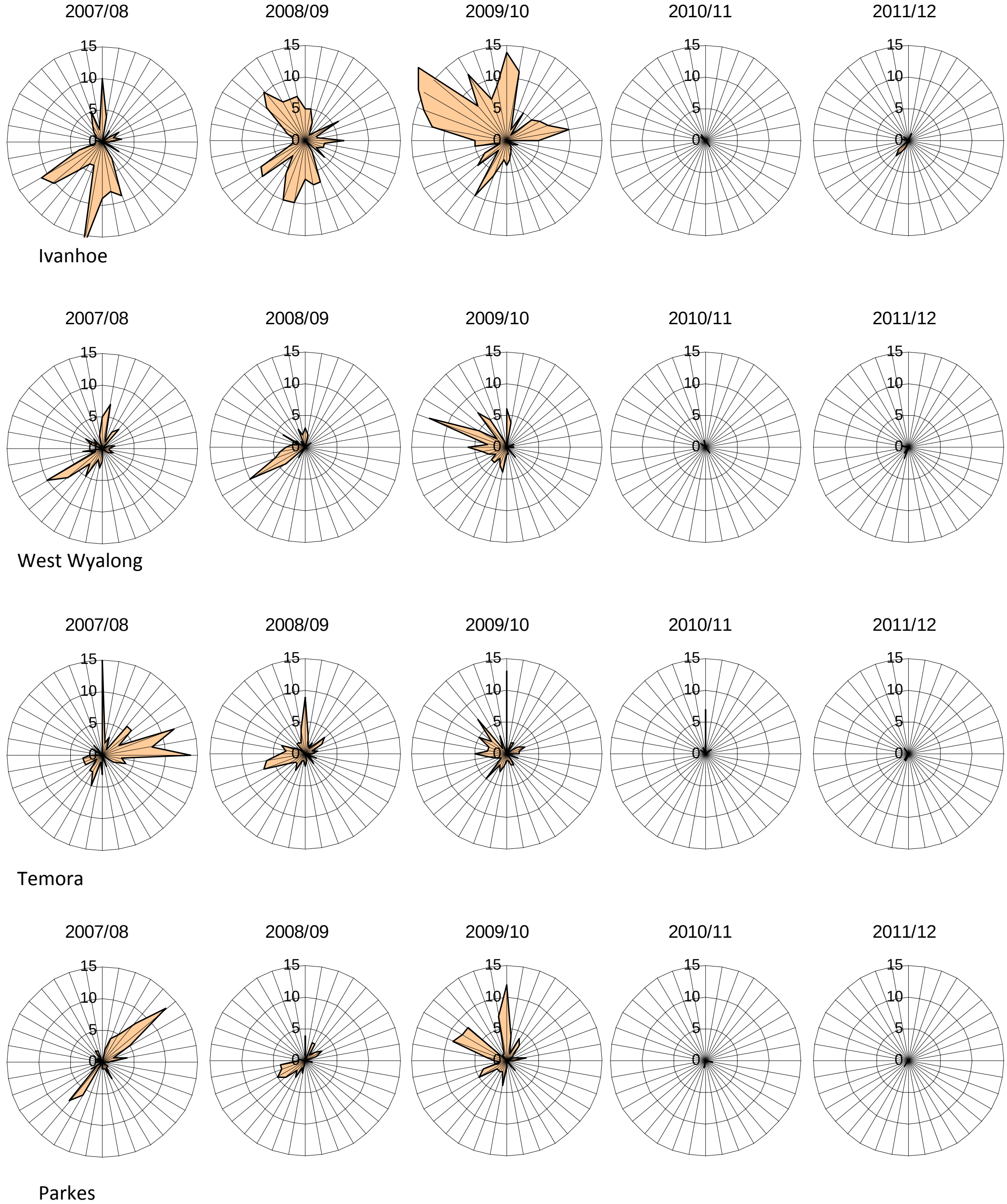


Figure 22. Dust roses showing hours of annual dust activity according to direction at DWNs near the Lachlan CMA catchment boundaries since 2007–08.

Causes of recent dust activity in the Lachlan CMA region

In 2009–10 dust activity came from sources both within and outside the CMA region. Prolonged drought, strong winds and extensive areas with less than 50% ground cover in the Lake Eyre Basin, Channel Country of south-west Queensland and north-west of NSW led to widespread wind erosion and were the major components of dust considered to have come from outside the Lachlan catchment. Multiple dust events from these sources were recorded in the Lachlan catchment in September, October and November, December and January. This included the widely publicised “Red Dawn” dust event that swept across NSW in September 2009. Local dust activity within the catchment was associated with increased fallow areas and failed crops in farming areas, loose silt in creek line washouts and on the surface of some clay soils, and low ground cover in rangelands due to the drought conditions (Figure 23). November 2009 recorded the highest dust activity at most DWNs in the catchment that DSY, with Ivanhoe recording a maximum of 58 hours. The exception was Condobolin whose 2009–10 maximum was 21 hours in September.

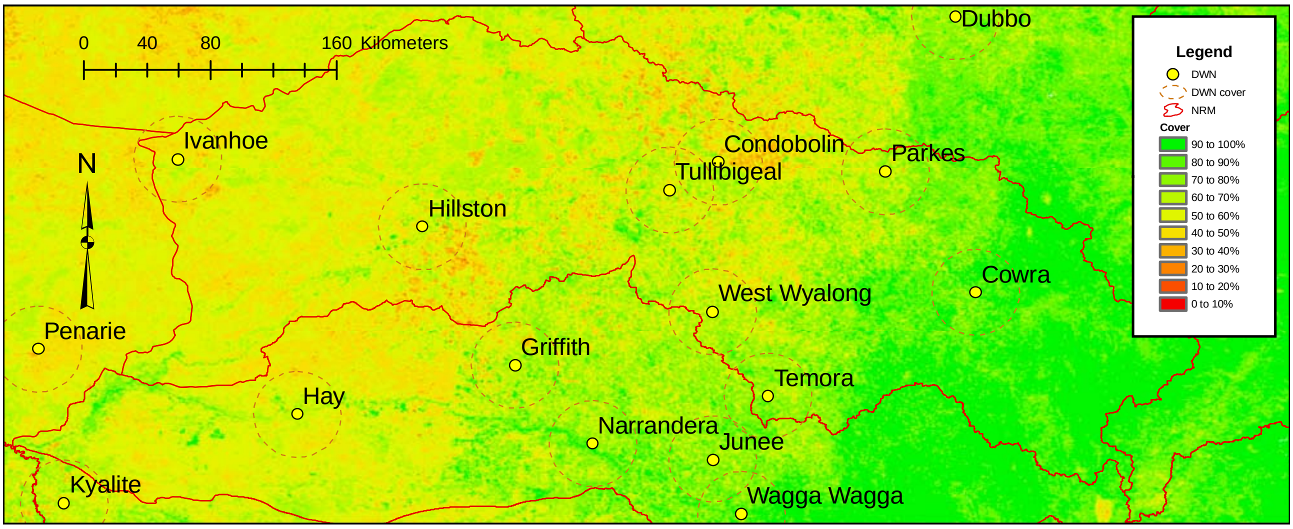


Figure 23. Widespread areas of low ground cover in the Lachlan catchment in November 2009.

In 2010–11 most areas in Australia, including the Lachlan CMA region, were exceptionally wet, receiving above or record rainfall. Following very good falls in early 2010, ground cover recovered to levels that prevented wind erosion. The overall magnitude of the recorded dust in the catchment fell from values of 50–216 hours in 2009–10 to 1–10 hours in 2010–11. The highest recorded dust activity in the CMA region that year was 10 hours at Temora, placing it 2nd on the rankings behind Mullewa in Western Australia (Table 2).

In 2011–12 rainfall levels were lower than in 2010–11 but still above average for eastern Australia. Recorded dust activity in the catchment was highest at Hillston with 14 hours, ranking it at overall 8th, to Parkes and Cowra with 2 hours, placing them 28th and 29th of 40 DWNs (Table 2). In February widespread dust was recorded at all DWNs in the catchment, carried on strong south-westerly winds from the Victorian Mallee region. Additionally, Ivanhoe and Hillston recorded dust from widespread events in April and May, also emanating from the Victorian Mallee region. Other dust activity in the catchment in this DSY occurred at a local scale near Cowra, Temora and Hillston in preparation for winter crops.

Until January 2013, in 2012–13 the Lachlan CMA region has recorded dust activity as part of widespread events that covered many parts of NSW. In September Cowra (5 hours) and Parkes (3 hours) recorded severe hazes carried on strong north-west to northerly winds. This dust was sourced from rangeland areas of South Australia that were experiencing low rainfall and critical ground cover levels. Dust from paddocks of low cover near Hillston may have contributed to this haze as the dust event progressed across the region (Figure 24). The central and western region of the catchment recorded dust activity resulting in severe haze in November and January. This was attributed to strong winds, low rainfall, thinning stubble and overgrazing in the Victorian Mallee.

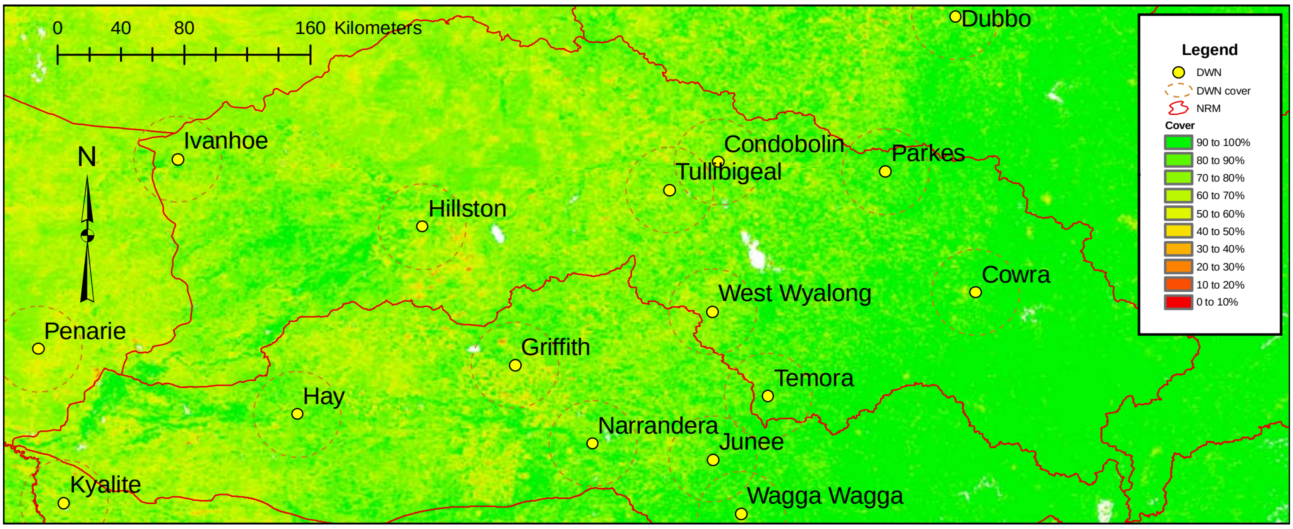
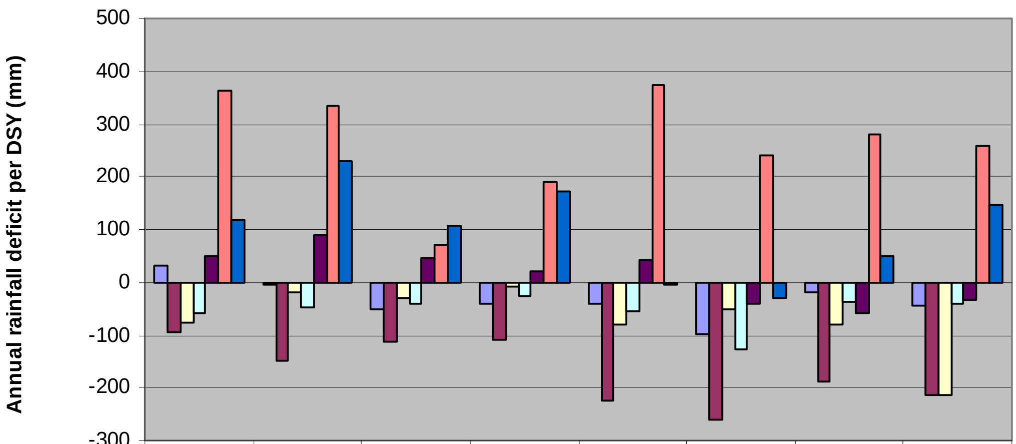


Figure 24. Low ground cover to the east and south-east of Hillston DWN in September 2012.

Rainfall

The long-term average annual rainfall per DSY varies in the Lachlan CMA region with rainfall increasing from west to east. Average annual rainfalls are: Ivanhoe 304 mm, Hillston 368 mm, Condobolin 440 mm, Tullibigeal 422 mm, West Wyalong 458 mm, Temora 541 mm, Parkes 586 mm and Cowra 607 mm.

The annual rainfall deficits show the deviation from average at each DWN since 2005–06 (Figure 25). In 2010–11 the CMA region exited from up to five years of below average rainfall when exceptional rain fell across the region. DWNs in the western part of the catchment and West Wyalong received close to double their annual rainfall, with the other DWNs receiving up to 1½ times their annual rainfall. Condobolin received only 16% extra rainfall during this period. In 2011–12 all stations except West Wyalong, Temora and Parkes remained well above average conditions.



	Ivanhoe	Hillston	Condobolin	Tullibigeal	West Wyalong	Temora	Parkes	Cowra
2005/06	32	-5	-51	-41	-41	-99	-19	-43
2006/07	-95	-148	-112	-108	-224	-260	-187	-213
2007/08	-77	-21	-28	-9	-80	-53	-80	-212
2008/09	-60	-50	-40	-27	-56	-127	-37	-41
2009/10	49	87	45	19	43	-41	-57	-35
2010/11	363	333	73	191	375	240	281	258
2011/12	118	229	106	172	-4	-30	49	148

Figure 25. Annual rainfall deficit (mm) for DWNs in the Lachlan CMA.

Summary

The modelled risk to wind erosion ranges from widespread moderate to severe in the western portion, and moderate to minor and more localised in the central to eastern portion of the CMA region (Figure 2). Located near the boundaries to other CMAs, Ivanhoe, West Wyalong, Temora and Parkes receive dust from outside the catchment.

In times of widespread drought, dust within the Lachlan catchment is partly transported into the catchment from further west. However, the western rangelands of the Lachlan CMA, if overstocked, can become significant dust sources in their own right during those times.

Cropping around the eastern DWNs in particular does create dust sources if managed incorrectly. The majority of dust recorded in the Lachlan CMA region last year is attributed to the northern Mallee and Lower Murray–Darling CMA regions.

5.1.4 Former Lower Murray–Darling CMA

Catchment description

The former Lower Murray–Darling CMA region covers an area of approximately 63 000 km^2 in the south-western border region of NSW. The Darling River and the Great Darling Anabranch run through the centre of the CMA and its southern border is the Murray River. Major centres are Broken Hill, Menindee and Buronga. Natural features include Menindee Lakes and Lake Victoria. Land uses are irrigated horticulture including grapes and citrus along the rivers, and generally dryland cereal and mixed farming in the southern half of the CMA, and rangeland farming of cattle and sheep in the northern half of the CMA.

Data at DWNs

At all DWNs data is updated weekly and is current. Rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 µg/m^3. Land use, rainfall and ground cover of DWNs refer to the surrounding 25 km (yellow circles in Figure 26).

DWNs in the former Lower Murray–Darling CMA region

The former Lower Murray–Darling CMA region has eight DWNs (Figure 26). These are located at Broken Hill (installed in October 2008), Buronga (installed in April 2003), Coombah (installed in October 2004), Euston (installed in October 2005), Lake Victoria (installed in December 2004), Menindee Lakes (installed in May 2009), Penarie (installed in October 2004), and Pooncarie (installed in October 2004). These DWNs are owned and maintained by the former Lower Murray–Darling CMA with in-kind contributions from Western CMA (Broken Hill only), Bureau of Meteorology, State Water and the local community.

The land use surrounding the Coombah DWN is rangelands. The land use surrounding the Pooncarie, Lake Victoria and Penarie DWNs is primarily rangelands with mixed dryland farming. Broken Hill has rangelands, urban development and mining in the assessment area. Because the actual lake beds of Lake Menindee and Lake Cawndilla are located within the Menindee Lakes DWN ground cover assessment area, the area of land available for ground cover assessment will vary depending on the volume of water in the lakes. The land use surrounding the Menindee Lakes DWN is mainly rangelands, conservation reserves and small amounts of irrigation areas. The Euston DWN is surrounded by mixed dryland farming. Buronga DWN has irrigation, mixed farming and forestry within its assessment area.

Five DWNs are located near the boundaries to other CMA regions. Table 4 below shows the directions from which dust is considered to originate from sources outside the former Lower Murray–Darling CMA region for these DWNs.

Table 4. DWNs with local dust sources from outside the former Lower Murray–Darling (LMD) CMA region.

Site	Origin of dust	Degrees (°)		Direction		Neighbouring CMAs
		From	To	From	To	
Lake Victoria	Outside	110	0	ESE	N	Mallee, SA LMD Basin
Broken Hill	Outside	250	120	WSW	ESE	Western
Buronga	Outside	150	270	SE	W	Mallee
Menindee Lakes	Outside	300	120	WNW	ESE	Western
Euston	Outside	310	130	NW	SE	Mallee

Coombah, Penarie and Pooncarie DWNs are all located well within the CMA region and can receive local dust from all directions. All DWNs can receive dust from regional events that have blown from distant sources.

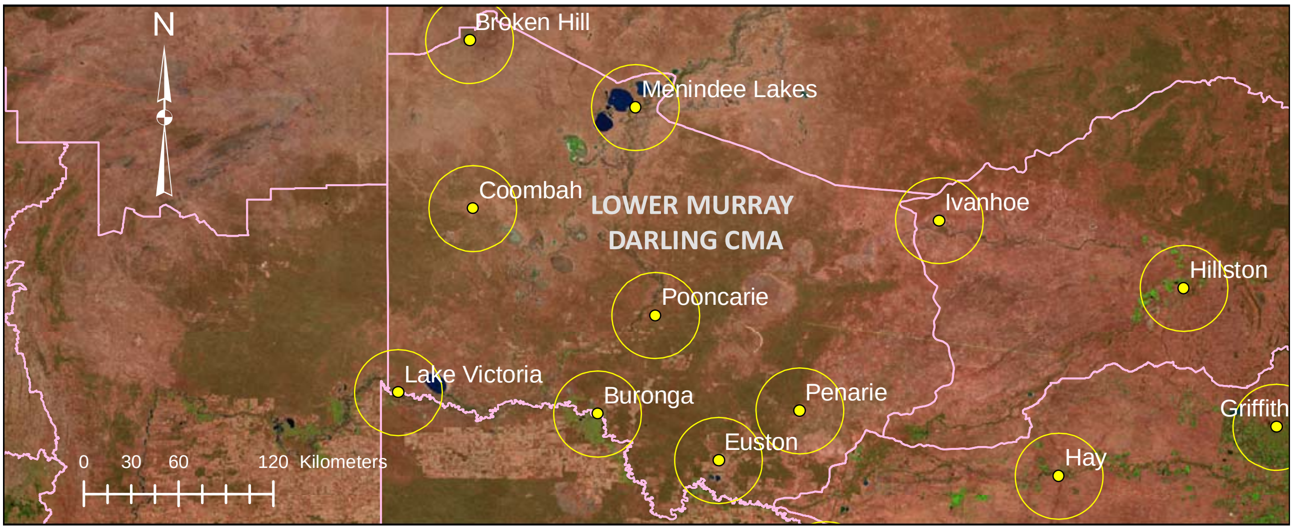
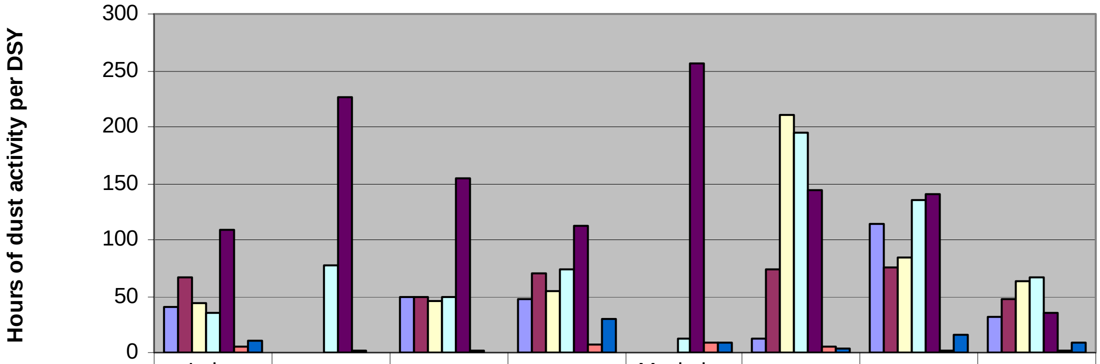


Figure 26. Lansat 7 image: location and ground cover assessment areas of DWNs in the former Lower Murray–Darling Basin CMA region and neighbouring CMAs.

Dust activity – annual trends

At Lake Victoria, Broken Hill, Coombah, Buronga, Menindee Lakes and Euston, maximum values for dust activity were recorded in 2009–10 (Figure 27). Pooncarie’s maximum (210 hours) was recorded in 2007–08 and Penarie’s (67 hours) in 2008–09. Lake Victoria, Coombah and Buronga remained relatively steady from 2005–06, before reaching their peak in 2009–10. In 2010–11 dust activity at nearby DWNs reduced by two orders of magnitude. Dust activity increased to modest levels in 2011–12 at Lake Victoria, Buronga, Euston and Penarie.

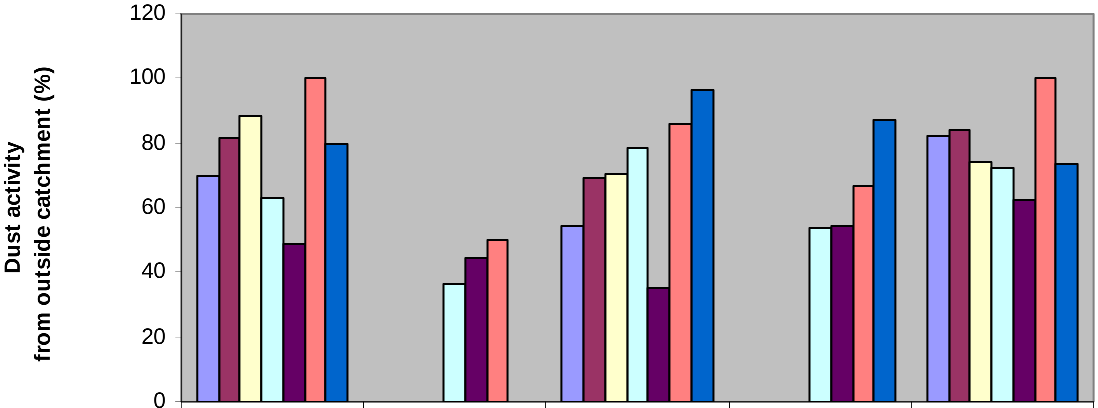


	Lake Victoria	Broken Hill	Coombah	Buronga	Menindee Lakes	Pooncarie	Euston	Penarie
2005/06	40		50	48		13	114	32
2006/07	66		49	71		73	76	48
2007/08	43		46	54		210	85	63
2008/09	35	77	49	74	13	195	135	67
2009/10	108	227	155	113	256	143	141	35
2010/11	5	2	1	7	9	6	2	2
2011/12	10	0	0	30	8	3	15	9

Figure 27. Annual hours of dust activity for all DWNs in the former Lower Murray–Darling CMA.

Dust activity – directional component

For the exceptional values of dust activity measured in 2009–10 at Lake Victoria, Broken Hill, Buronga, Menindee Lakes and Euston, around 50% came from sources deemed to be outside the catchment (Figure 28, Figure 29). The remaining dust activity in the former Lower Murray–Darling catchment during this year came from sources within its boundaries.



	Lake Victoria	Broken Hill	Buronga	Menindee Lakes	Euston
2005/06	70		54		82
2006/07	82		69		84
2007/08	88		70		74
2008/09	63	36	78	54	73
2009/10	49	44	35	54	62
2010/11	100	50	86	67	100
2011/12	80	0	97	88	73

Figure 28. Dust activity originating from outside the catchment (%) at DWNs near catchment boundaries.

In 2010–11, for DWNs near the southern boundary (Lake Victoria, Buronga and Euston), nearly all dust received (80 to 100%) was deemed to have come from sources outside the catchment. Dust blown towards these DWNs came from the south-west, with the likely sources of this dust in the Mallee.

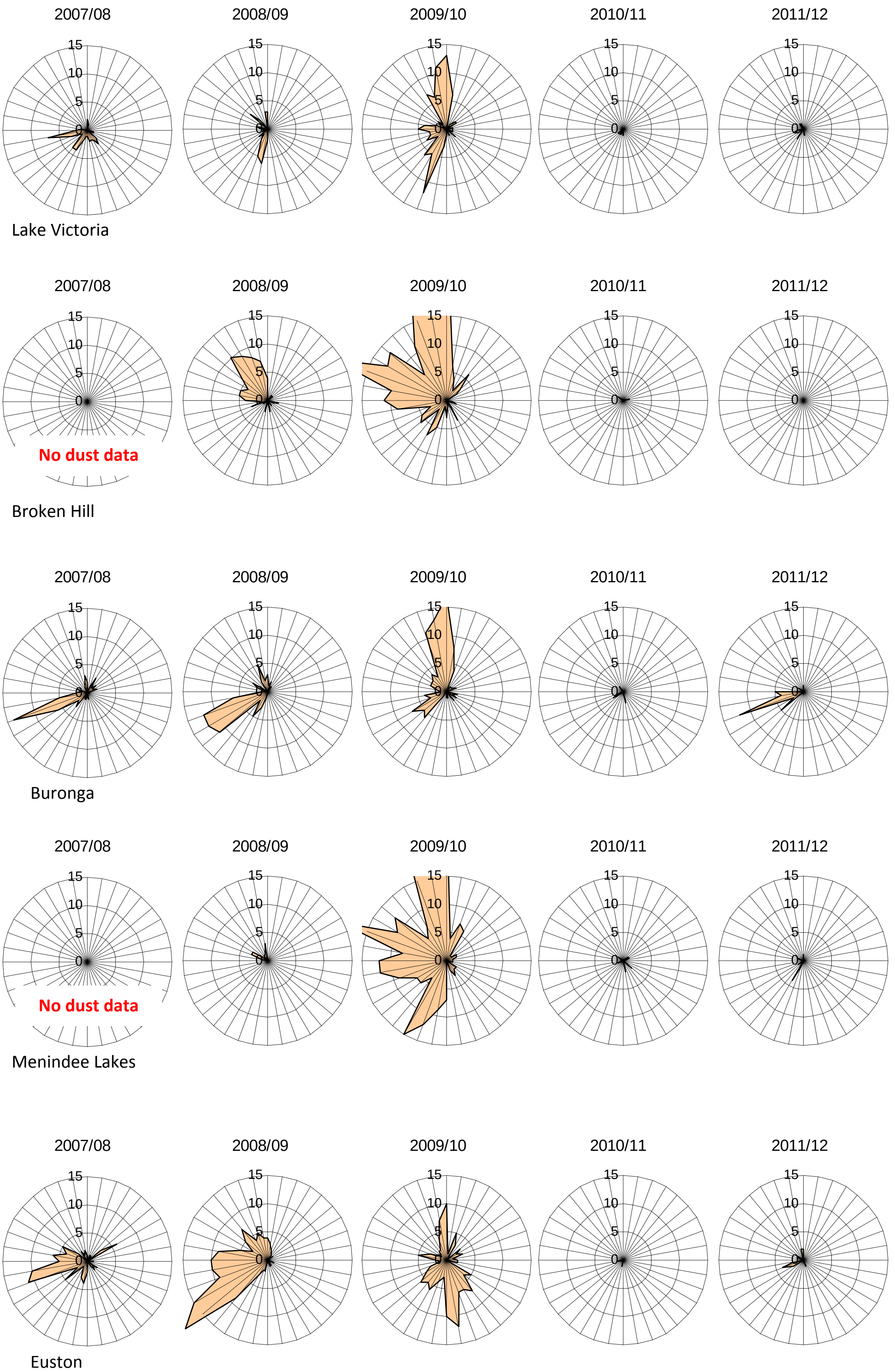


Figure 29. Dust roses showing hours of annual dust activity according to direction at selected DWNs in the former Lower Murray–Darling CMA region since 2007–08.

Causes of recent dust activity in the former Lower Murray–Darling CMA region

In 2009–10 dust activity came from sources both within and outside the catchment. Prolonged drought, strong winds and extensive areas with less than 50% ground cover in the Lake Eyre Basin, Channel Country of south-west Queensland and north-west of NSW led to widespread wind erosion. This included the widely publicised "Red Dawn" dust event that swept across NSW in September 2009. Dust activity within the CMA region was associated with increased fallow areas in farming areas, and low ground cover in the rangelands due to the drought conditions. September 2009 recorded the highest dust activity at most DWNs in the CMA since July 2005. The exceptions were at Euston (which was highest in February 2010 with 36 hours) and Penarie (which was highest in March 2008 with 17 hours).

In 2010–11 most areas in Australia, including the former Lower Murray–Darling CMA region, were exceptionally wet, receiving above or record rainfall. At all DWNs dust activity fell by two orders of magnitude and was less than 10 hours at any DWN for that DSY. This is largely a function of the rainfall, i.e. in drought conditions there is dust and in wetter years there is not. However, land management also plays an important part in the erosion levels. Menindee Lakes recorded 9 hours of dust activity, with 6 hours in January, attributed to localised strong winds and agricultural activity or road works near that DWN.

In 2011–12 no dust was recorded at Broken Hill and Coombah. At these DWNs, although low ground cover levels were evident in spring to autumn, adequate rain at that time ensured no dust was recorded. Regional dust events occurred in February and April. The February event was recorded at Buronga, Euston, Pooncarie and Penarie and originated in the Victorian Mallee region (**Error! Not a valid bookmark self-reference.**). The dust was picked up by strong south-westerly winds that approached 60 km/h – double the speed required to lift loose bare soil. Visibility at the DWNs in the source area dropped to between one and five kilometres. The dust travelled as far east as Cowra and as far north as Dubbo. The April event was also recorded in the southern DWNs in the CMA region. It was driven by strong south-westerly winds (40–50 km/h) and low ground cover to the south-west of the CMA region, particularly in the Mallee and former Lower Murray–Darling CMA regions. The prevailing winds transported the dust as far north as Tibooburra and Bourke.

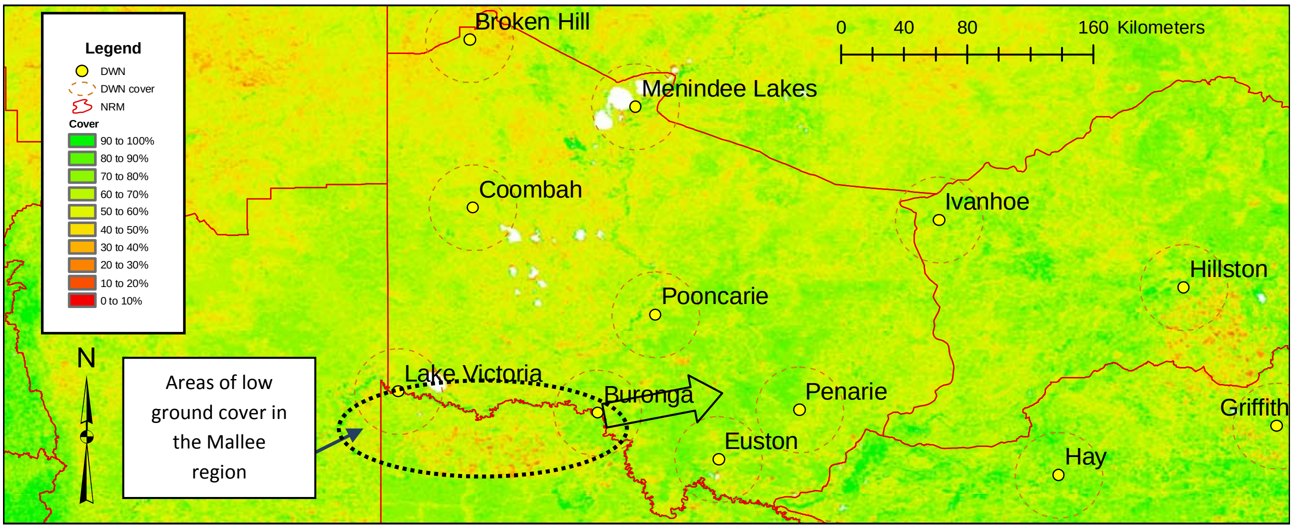


Figure 30. Low ground cover in the Mallee region resulting in dust recorded in the southern part of the LMD in February 2012.

For the 2012–13 DSY (4 months to November only), dust was recorded in August (Euston, Buronga and Broken Hill only) and September (all sites except Lake Victoria). Except for near the Broken Hill DWN, ground cover in the former Lower Murray–Darling CMA region was generally maintained during this period. During September dust entered the CMA from the arid rangelands in South Australia to the north-west of the CMA boundary (Figure 31). Dust was driven by low ground cover, moderate to strong winds and low rainfall in that area with Menindee Lakes and Coombah recording 11 hours and 12 hours respectively.

Dust activity at Buronga (3 hours) was attributed to low ground cover following little rain and failed winter crops.

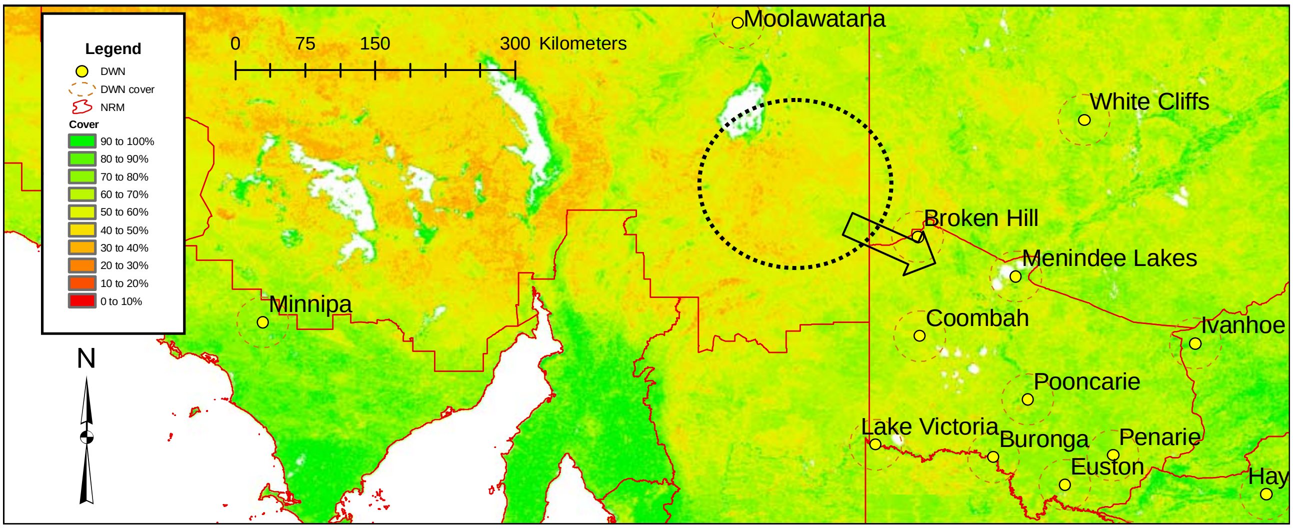
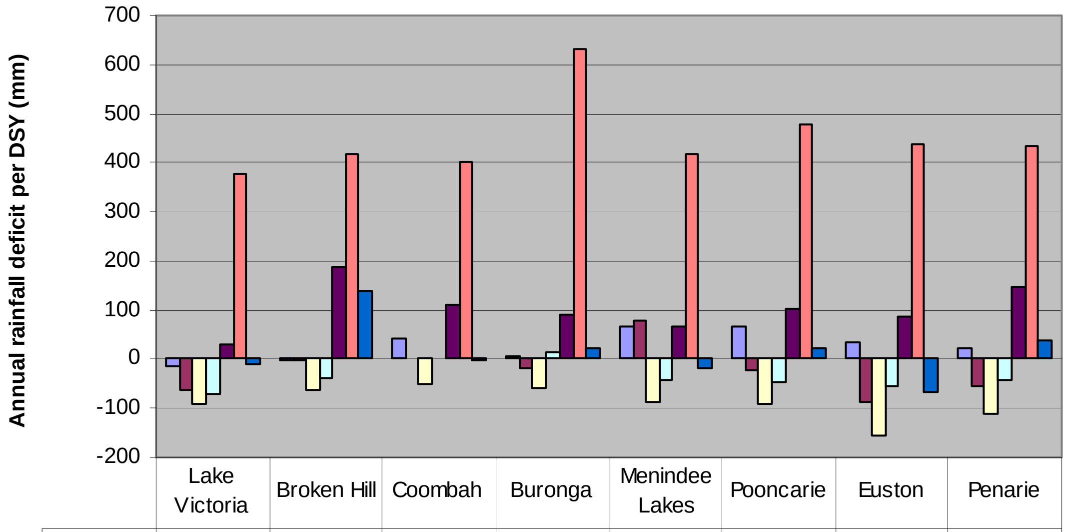


Figure 31. Low ground cover in the arid rangelands of South Australia resulting in dust received in the north-west Lower Murray–Darling CMA in September 2012.

Rainfall

The long-term average annual rainfall (mm) per DSY at DWNs in the CMA region are: Lake Victoria 261 mm, Broken Hill 254 mm, Coombah 206 mm, Buronga 276 mm, Menindee Lakes 226 mm, Pooncarie 261 mm, Euston 316 mm, and Penarie 281 mm.

The annual rainfall deficits show the deviation from average at each DWN since 2005–06 (Figure 32). The rainfall is winter dominant and the majority of plant growth occurs between May and October. If the autumn rainfall break is late and the spring is poor, then wind erosion is likely in the following summer/autumn. The area is subject to frequent droughts, and, since 1895, there have been ten major droughts with duration greater than 24 months, the latest being November 2005 to May 2009. Exceptional rain fell across the catchment in the 2010–11 DSY, more than double the annual rainfall at all DWNs in the CMA. In 2011–12 all stations except Broken Hill, Penarie and Pooncarie returned to near or slightly below average annual rainfall.



	Lake Victoria	Broken Hill	Coombah	Buronga	Menindee Lakes	Pooncarie	Euston	Penarie
2005/06	-14	-2	41	7	67	65	34	22
2006/07	-62	-2	2	-17	79	-22	-87	-55
2007/08	-89	-64	-53	-58	-89	-91	-156	-109
2008/09	-73	-40	0	13	-41	-46	-55	-41
2009/10	29	189	110	90	65	103	85	148
2010/11	376	419	401	631	418	480	440	433
2011/12	-9	138	-2	21	-17	23	-66	39

Figure 32. Annual rainfall deficit (mm) for DWNs in the former Lower Murray–Darling Catchment.

Summary

According to the modelling, the risk of wind erosion of land within the former Lower Murray–Darling Catchment is mostly widespread and moderate. In some rangelands areas to the west near Coombah and Broken Hill the risk is localised and moderate (Figure 2).

Dust sources within the former Lower Murray–Darling CMA region during times of drought are the rangelands in the north and west of the CMA region. These can become very substantial regional dust sources if drought conditions prevail for too long and land management is unable to preserve the protective vegetation, cryptogam and chenopod cover. During those times the CMA region also receives dust from the South Australian arid rangelands to the west and north.

In average to good years, the rangelands generally have good cover and do not emit significant dust. The cropping areas in the south, if managed inadequately, can become substantial local dust sources during those times. The cropping areas in the northern Mallee region to the south contribute to the dust from the former Lower Murray–Darling cropping areas. These are the areas where change in land management can make the biggest difference in the former Lower Murray–Darling CMA region.

5.1.5 Murray CMA

Catchment description

The NSW Murray CMA region is located on the southern border of NSW and covers an area of 35 170 km^2. It includes the Murray, Edward–Wakool River and Billabong Creek catchments. Major towns and centres are Albury, Deniliquin, Corowa, Jerilderie and Tumbarumba. Major land uses include forestry in the steep terrain of the Upper Murray region in the east, and pastures and irrigated and dryland cropping which has replaced shrubland and woodland on the South West Slopes in the east and Riverina Plain to the west. Rainfall across the CMA ranges from 300 mm on the western boundary to 1600 mm in the east.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25µg/m^3. Land use, rainfall and ground cover data presented refer to the 25 km surrounding the individual DWNs (yellow circles in Figure 33).

DWNs in the Murray CMA region

The Murray CMA region has three DWNs. These are located at Deniliquin (installed in July 2007), Kyalite (installed in October 2007) and Rand (installed in December 2010). These DWNs are owned and maintained by the Murray CMA with in-kind contributions from OEH and the local community.

Land use surrounding Deniliquin and Rand DWNs is mixed irrigation and dryland farming. Land use surrounding the Kyalite DWN is mixed dryland farming.

The Kyalite DWN is located on the north-western boundary of the catchment. Dust considered to originate from within the catchment comes from east (90°) to south-south-east (160°) directions. Dust from all other directions is considered to originate from outside the catchment (Figure 33). Deniliquin and Rand lie well within the catchment and can receive local dust from all directions.

All DWNs can receive dust from regional events that have blown from distant sources.

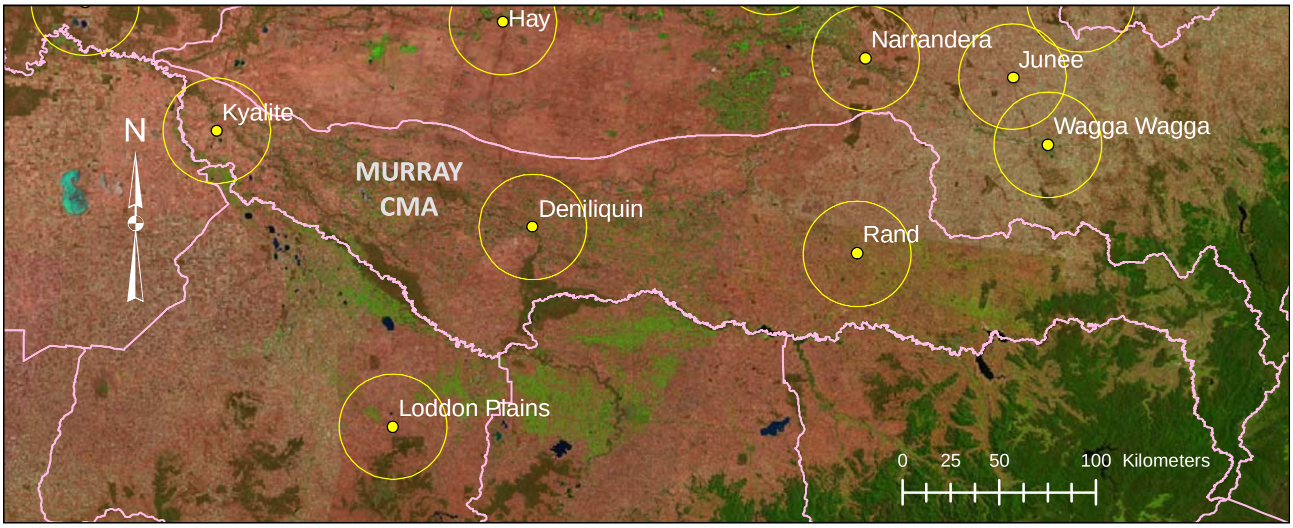
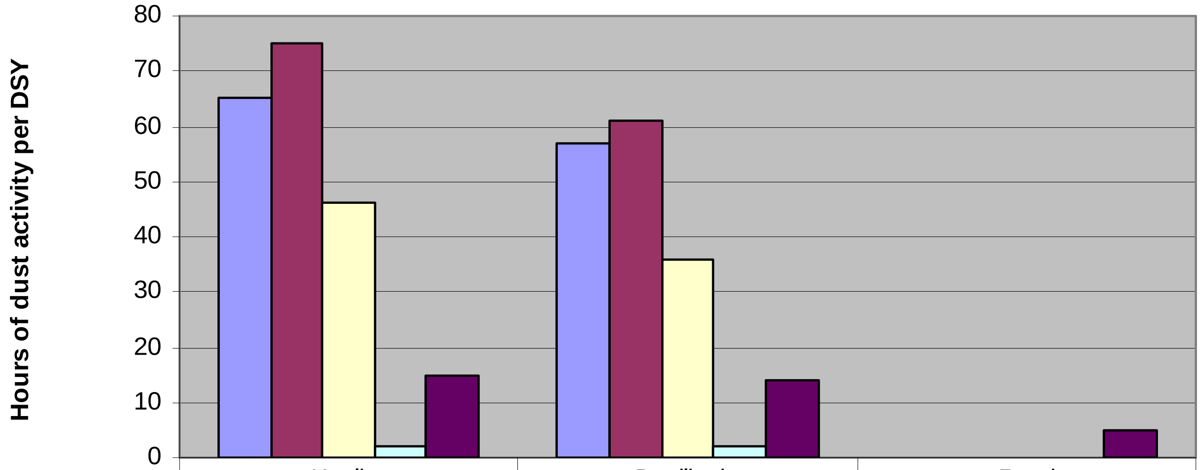


Figure 33. LandSat7 image: location and ground cover assessment areas of DWNs in the Murray CMA and neighbouring CMAs.

Dust activity – annual trends

High dust activity was recorded at Kyalite (65 hours) and Deniliquin (57 hours) in 2007–08 (Figure 34). Dust activity peaked at both DWNs in 2008–09 with Kyalite recording 75 hours and Deniliquin recording 61 hours. Dust activity declined in 2009–10, and almost completely ceased in 2010–11. Increased dust activity was recorded at all DWNs in 2011–12.

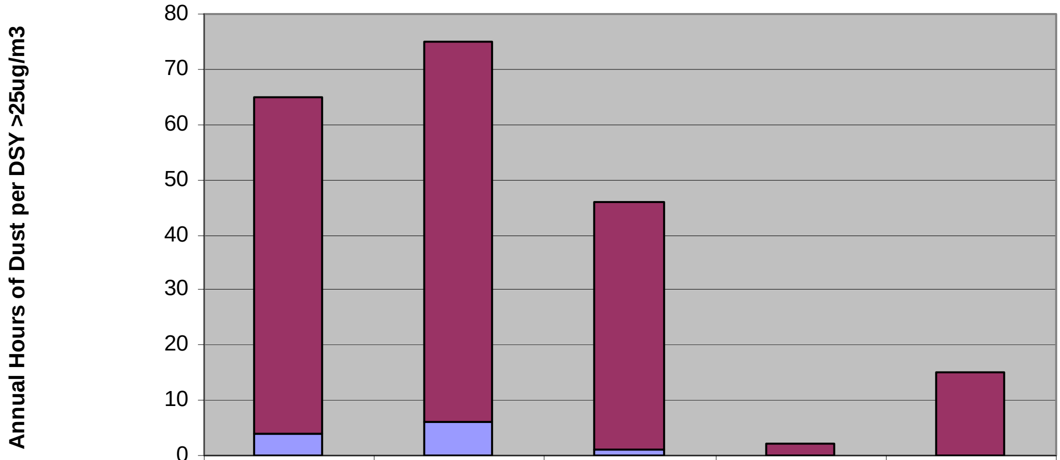


	Kyalite	Deniliquin	Rand
2007/08	65	57	
2008/09	75	61	
2009/10	46	36	
2010/11	2	2	0
2011/12	15	14	5

Figure 34. Annual hours of dust activity for DWNs in the Murray CMA region.

Dust activity – directional component

Because of its location in the north-western corner of the CMA region, the Kyalite DWN has the potential to receive dust from within and outside the Murray CMA region. Since its installation in July 2007, over 90% of dust measured at Kyalite has come from outside the CMA boundaries (Figure 35). The predominant directions are from the west-south-west and north (Figure 36) in all years. However, there was also dust detected from within the catchment indicating that there was not always adequate ground cover.



	2007/08	2008/09	2009/10	2010/11	2011/12
Outside CMA	61	69	45	2	15
Within CMA	4	6	1	0	0

Figure 35. Hours of dust activity measured at Kyalite from within and outside the CMA.

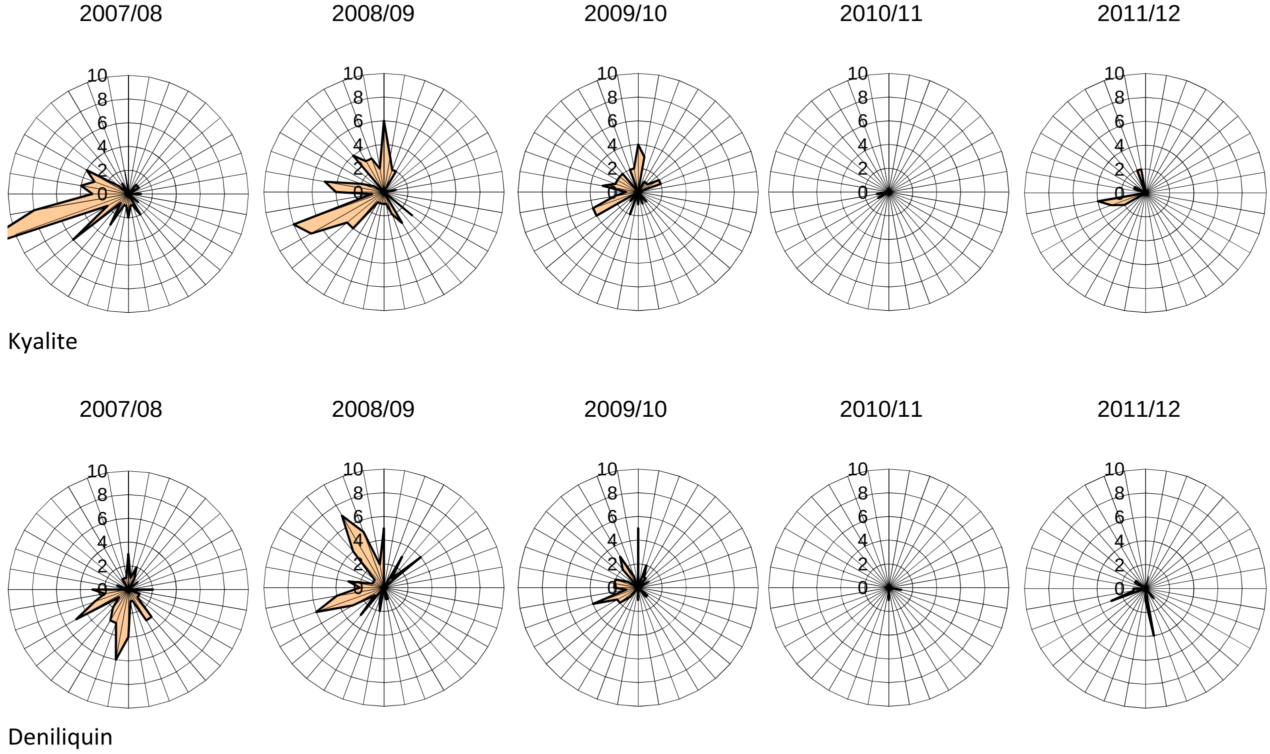


Figure 36. Dust roses showing hours of annual dust activity according to direction at Kyalite and Deniliquin DWN since 2007–08.

Causes of recent dust activity in the Murray CMA region

In 2009–10 the Murray CMA region received some pre-event dust activity from the September 2009 “Red Dawn” dust event that swept across NSW, although missed out on the major event itself.

In 2010–11 most areas in Australia, including the Murray CMA region, were exceptionally wet, receiving above or record rainfall. Deniliquin and Kyalite recorded 2 hours of dust activity. This is largely a function of the rainfall; i.e. in drought conditions there is dust and in wetter years there is not. However, land management also plays an important part in the erosion levels.

In the 2011–12 DSY Deniliquin recorded dust activity in February (3 hours) associated with the first widespread dust event following September 2009. In April a widespread dust event entered the CMA from the Mallee area to the south-west of the Murray CMA region. Dust was recorded at Kyalite (5 hours) and Deniliquin (4 hours). The dust emissions were a result of the many bare paddocks in the Mallee region and very strong winds (Figure 37). Low level dust activity was also recorded in May at Kyalite (4 hours) and Deniliquin (1 hour) from the north-west. Cover levels in mixed farming areas to the west and north-west of Kyalite fell due to fallow preparations for winter cereal production. The lack of strong winds at this time prevented more dust being released.

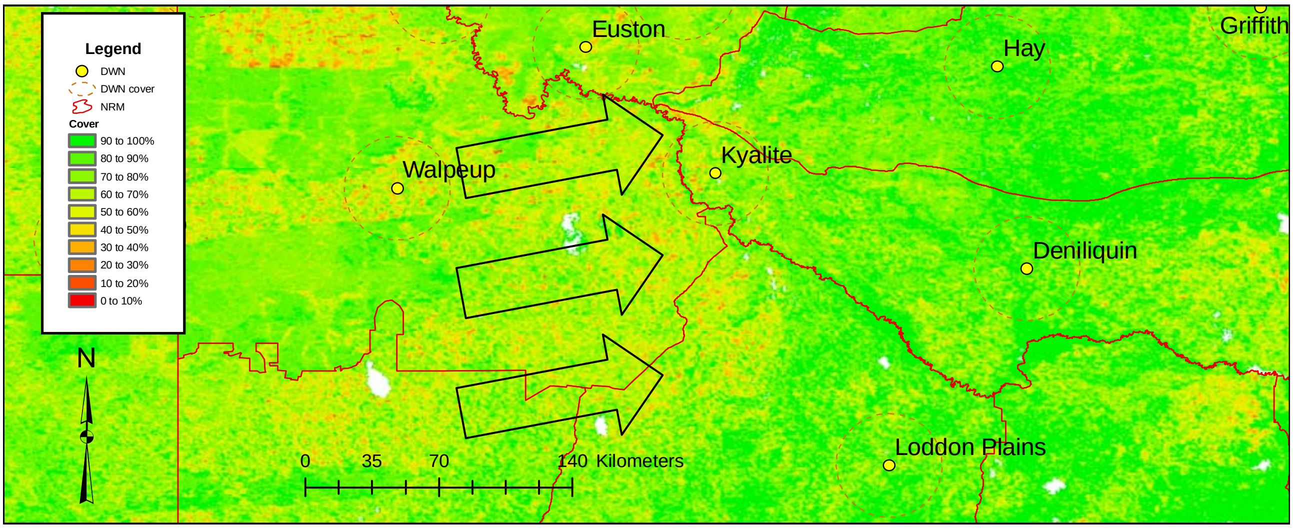
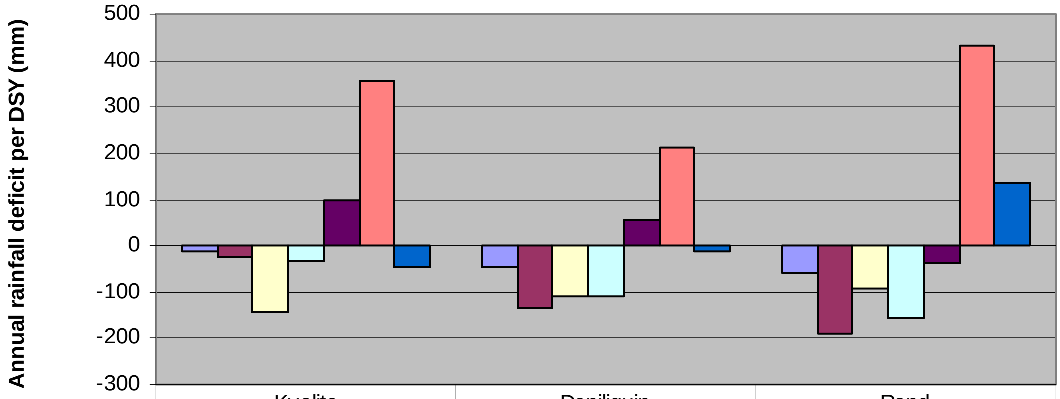


Figure 37. Widespread areas of low ground cover in the Mallee and strong winds in April 2012 resulting in dust recorded in the Murray CMA.

In the 2012–13 DSY dust activity was measured in September at Kyalite (4 hours) and Deniliquin (7 hours). In Deniliquin dust appeared to come from irrigation paddocks being prepared for rice. Events that caused this dust activity were driven by strong northerly winds and this dust was recorded across most of NSW. Although substantial ground cover resulted from the extensive rain in 2010 and 2011, these dust events indicate that threshold levels for dust production are being approached in some areas.

Rainfall

Average annual rainfall for Kyalite is 321 mm, Deniliquin 405 mm and Rand 511 mm. The annual rainfall deficits (Figure 38) show the deviation from average at each DWN since 2005–06 (Figure 38). In the 2009–10 DSY rainfall started to increase following several years of widespread drought conditions. Exceptional rain fell in the 2010–11 DSY, with both Kyalite and Rand receiving twice their average annual rainfall. The 2011–12 period saw a return to below average conditions for Kyalite and Deniliquin, although Rand in the east of the catchment remained wetter than average (647 mm).



	Kyalite	Deniliquin	Rand
2005/06	-11	-46	-60
2006/07	-26	-135	-191
2007/08	-141	-109	-93
2008/09	-35	-108	-158
2009/10	97	57	-39
2010/11	355	214	433
2011/12	-47	-12	136

Figure 38. Annual rainfall deficit (mm) for DWNs in the Murray CMA.

Summary

Dust emissions within the Murray CMA region are predominantly related to crop management in the irrigated and dryland areas in the western part of the catchment. At times only the absence of strong winds prevents larger dust emissions from those areas.

Some of the rangelands on the northern border can drop below critical ground cover in times of severe drought and add to the dust blowing into the CMA from the north and west.

The other source of dust measured within the Murray CMA is dust that has been transported into the catchment from the west and north. At times this can account for the majority of dust in the CMA. The Mallee CMA in particular has contributed significantly to dust measured in the far western end of the Murray CMA.

5.1.6 Murrumbidgee CMA

Catchment description

The Murrumbidgee CMA covers an area of approximately 84 000 km^2, with the Murrumbidgee River traversing the catchment from east to west. Cities and towns include, Wagga Wagga, Cooma, Cootamundra and Hay. Major land uses include grazing and cereal production on the south-west slopes and plains, and grazing on the shrublands and grasslands of the western Riverina. Rainfall across the CMA ranges from 300 mm on the western boundary to 1600 mm in the south-east.

Data at DWNs

At all DWNs data is updated weekly and is current. Rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. The annual reporting period is called a Dust Storm Year

(DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25µg/m^3. Land use, rainfall and ground cover of DWNs refer to the surrounding 25 km (yellow circles in Figure 39).

DWNs in the Murrumbidgee CMA region

The Murrumbidgee CMA region has five DWNs. These are located at Griffith (installed in May 2012), Hay (installed in September 2004), Junee (installed in February 2012), Narrandera (installed in September 2012) and Wagga Wagga (installed in July 2011). Griffith, Junee, and Narrandera DWNs are owned and maintained by the Murray CMA. Hay and Wagga Wagga DWNs are owned and maintained by OEH. In-kind support comes from the local community.

Land use surrounding the Griffith, Junee, Narrandera and Wagga Wagga DWNs is mixed irrigation and dryland farming. Land use surrounding the Hay DWN is mixed irrigation and dryland farming and rangelands.

All DWNs lie well within the catchment and receive local dust from all directions. All DWNs can receive dust from regional events that have blown from distant sources.

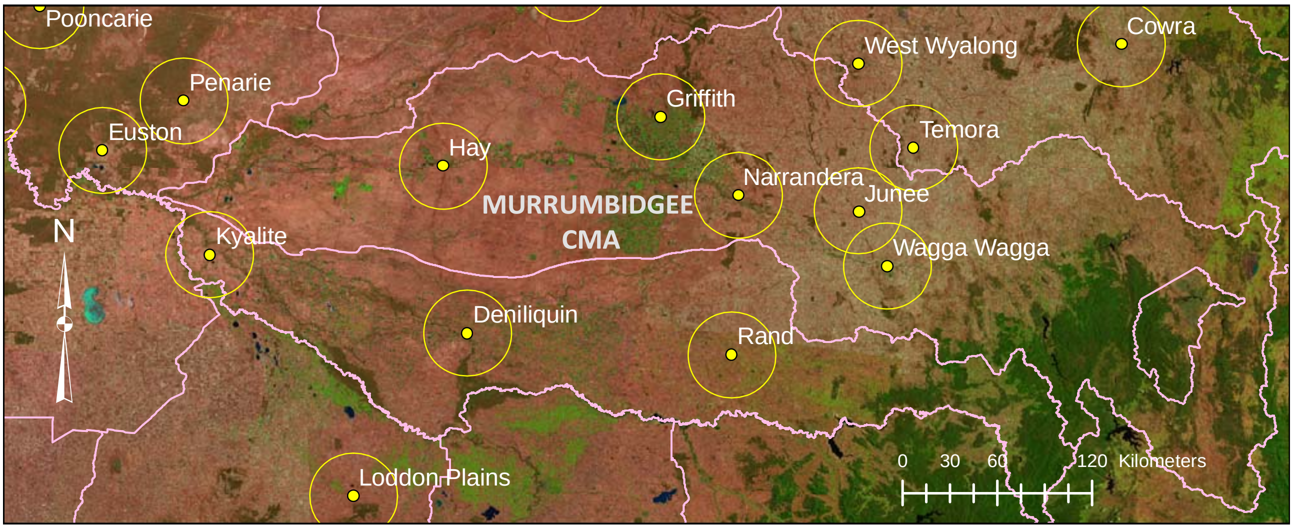
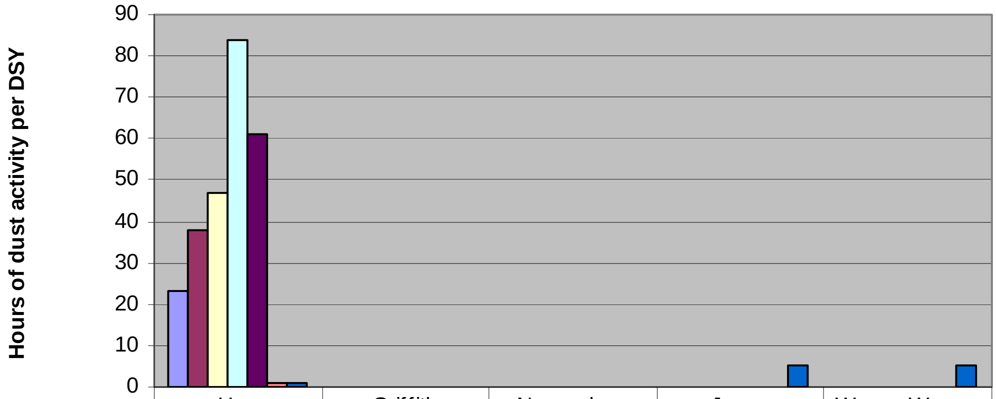


Figure 39. LandSat7 image: location and ground cover assessment areas of DWNs in the Murrumbidgee CMA and neighbouring NRM regions.

Dust activity – annual trends

Annual trends are discussed for the Hay DWN only, because the remaining DWNs in the CMA region have one year or less of recorded dust data (Figure 40). At Hay the trend of dust activity was upward from 2005–06 to its peak in 2008–09 (84 hours). Dust activity decreased in 2009–10 but still remained high (61 hours). Dust activity decreased and almost completely ceased in 2010–11 (1 hour) and 2011–12 (1 hour).



	Hay	Griffith	Narrandera	Junee	Wagga Wagga
2005/06	23				
2006/07	38				
2007/08	47				
2008/09	84				
2009/10	61				
2010/11	1				
2011/12	1	0		5	5

Figure 40. Annual hours of dust activity for all DWNs in the Murrumbidgee CMA.

Dust activity – directional component

The highly variable directional component of the dust measured at the Hay DWN is shown in Figure 41. In 2008/09 there was a strong directional component from the west south west, responsible for most of the dust recorded in Hay that DSY. Hay recorded dust from multiple directions in 2007/08 and 2009/10 DSYs.

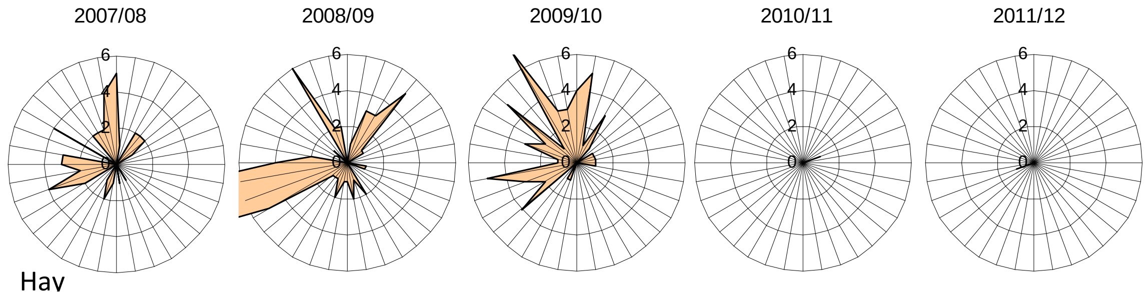


Figure 41. Dust roses showing hours of annual dust activity according to direction at Hay DWN since 2007–08.

Causes of recent dust activity in the Murrumbidgee CMA

In 2009–10 dust activity came mostly from sources outside the CMA region. Prolonged drought, strong winds and extensive areas with less than 50% ground cover in the Lake Eyre Basin, Channel Country of south-west Queensland and north-west of NSW led to widespread wind erosion. Dust activity within the catchment was associated with increased fallow areas due to the drought conditions. Hay was ranked 23rd of 29 DWNS with 61 hours of dust with PM_{10} concentration > 25 µg/m^3 (Table 2). During this period high winds and dry soils predisposed the CMA region to erosion. Generally at that time, land management practices such as overgrazing of pasture and rangelands could not maintain what little ground cover there was and this resulted in the country being susceptible to wind erosion.

In 2010–11 most areas in Australia, including the Murrumbidgee CMA region, were exceptionally wet, receiving above or record rainfall. Following very good falls in early 2010, ground cover recovered to levels that prevented wind erosion. The overall magnitude of the recorded dust at Hay DWN fell by an order of magnitude, from values of 61 hours in 2009–10 to 1 hour in 2010–11. Wagga Wagga recorded no dust in that DSY.

In 2011–12 rainfall levels were lower than in 2010–11 but still above average for eastern Australia. Recorded dust activity in the CMA region was highest at Wagga Wagga and Junee with 5 hours, ranking them at overall 18th, and Hay with 1 hour, placing it overall 31st of the 40DWNs (Table 2). Dust measured at Wagga Wagga and Hay was mainly due to a February event emanating from the Victorian Mallee region associated with fallow management practices such as burning and cultivation (Figure 42). This reflected increasing areas of low ground cover in north-west Victoria and far south-west NSW. Dust measured in Junee in April was also associated with a regional event emanating from the Mallee and Lower Murray–Darling region associated with burning and cultivation. The west-south-westerly winds transported this dust as far north as Tibooburra and Bourke and east to Temora.

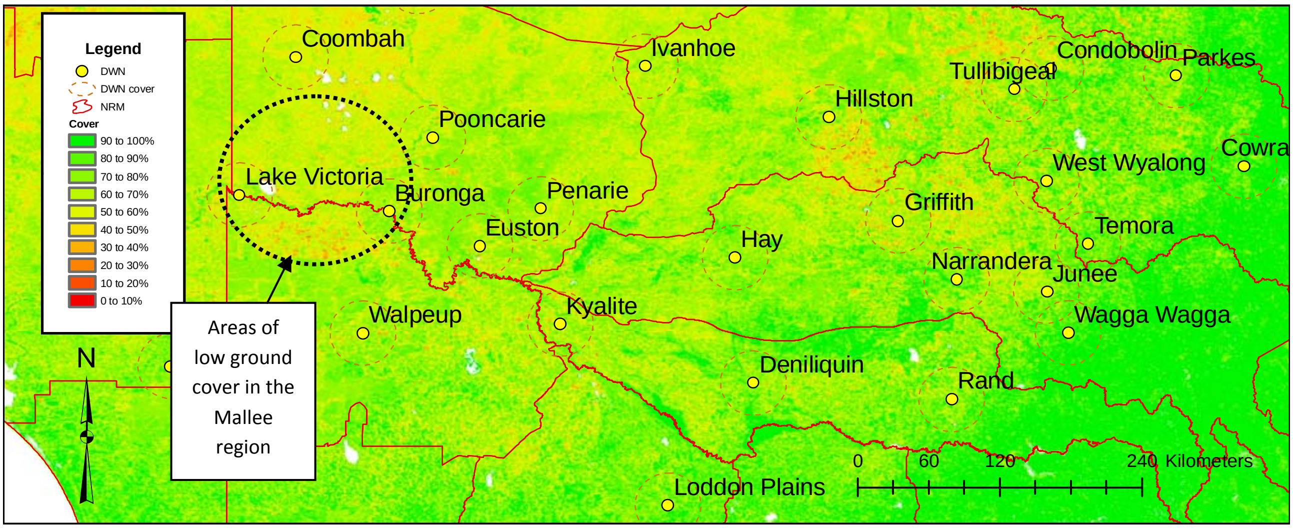


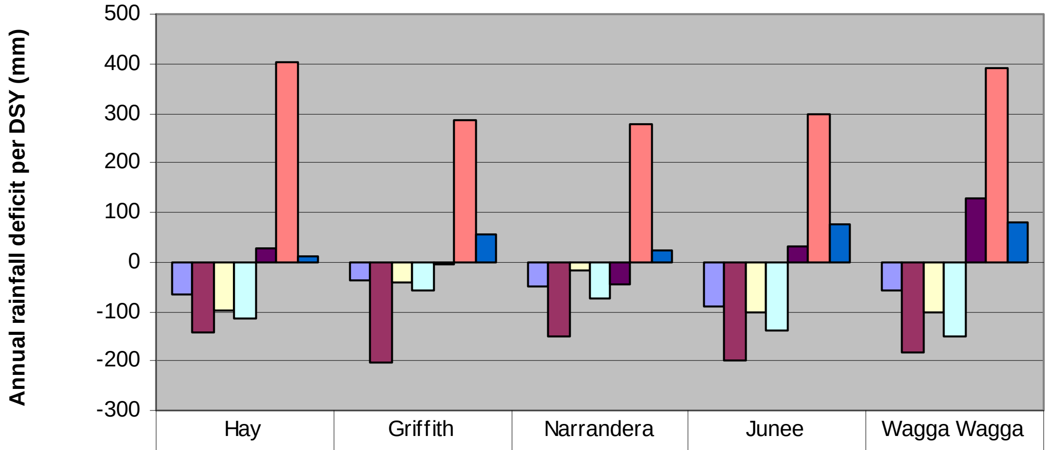
Figure 42. Low ground cover in the Mallee region in February 2012 resulting in dust measured at Hay and Wagga Wagga DWNs.

In the 2012–13 DSY (until November 2012 only) the Murrumbidgee CMA recorded dust from regional and local events. In September 2012 dust was measured at the Wagga Wagga DWN (2 hours). Other DWNs across NSW measured dust during this event including White Cliffs, Menindee, Cobar and Parkes DWNs. In November, Hay (2 hours), Griffith (2 hours) and Wagga Wagga (4 hours) recorded widespread dust haze, from sources in the Victorian Mallee region and additional sources to the west of Wagga Wagga.

Rainfall

The long-term average annual rainfall at each DWN in the CMA is Hay 367 mm, Griffith 407 mm, Narrandera 418 mm, Junee 527 mm and Wagga Wagga 525mm.

The annual rainfall deficits show the deviation from average at each DWN since 2005–06 (Figure 43). Below average rainfall was experienced at all DWNs in the CMA from 2005–06 to 2008–09. Near average rainfall was received in 2009–10 with only Wagga Wagga receiving significantly above average rainfall. In 2010–11 exceptional rainfall was experienced across eastern Australia. Within the Murrumbidgee CMA region all stations received at least 1½ times their long-term average rainfall, with Hay receiving double its average rainfall. The 2011–12 period saw a return to near average conditions, with all DWNs receiving slightly above average rain.



	Hay	Griffith	Narrandera	Junee	Wagga Wagga
2005/06	-64	-36	-48	-91	-57
2006/07	-142	-203	-150	-199	-185
2007/08	-98	-39	-15	-100	-103
2008/09	-113	-56	-72	-140	-152
2009/10	25	-7	-44	33	129
2010/11	402	287	278	297	393
2011/12	11	57	22	77	81

Figure 43. Rainfall deficit for DWNs in the Murrumbidgee catchment.

Summary

There are several drivers for dust emissions within the Murrumbidgee CMA region.

During times of extreme drought, the shrublands and grasslands of the western Riverina can lose most of their ground cover if managed inadequately and become substantial regional dust sources. The irrigated and dryland cropping areas in the western and central parts of the Murrumbidgee can develop localised moderate dust emissions if managed incorrectly. Overgrazing on arable land during dry times is another source of the dust emissions in the central part of the Murrumbidgee. Long-range dust transport entering the Murrumbidgee CMA area from the south-west (predominantly related to cropping) and north-west (predominantly related to rangelands) adds to local dust sources. High rainfall overwrites land management east of Wagga Wagga and there is no wind erosion expected in these areas.

5.1.7 Namoi CMA

Catchment description

The Namoi catchment covers an area of approximately 42 000km^2 in north-western NSW. Major townships include Tamworth, Gunnedah, Narrabri and Walgett. Land use includes grazing of natural pastures, broad acre dryland and irrigation cropping on the slopes and plains, mixed cropping and grazing, and timber on the slopes. Long-term rainfall across the catchment ranges from 400 mm west of Walgett to 1000 mm east of Tamworth.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year

(DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25µg/m^3. Land use, rainfall and ground cover data presented refer to the 25 km surrounding the individual DWNs (yellow circles in Figure 44).

DWNs in the Namoi CMA region

The Namoi CMA region has two DWNs (Figure 44). These are located at Gunnedah (installed in October 2004) and Walgett (installed in September 2008). These DWNs are owned and maintained by OEH with in-kind support from the Namoi CMA.

Land use at Gunnedah DWN is mixed dryland and irrigation farming. Land use at the Walgett DWN is mixed dryland farming, with rangelands to the north-west of the DWN.

The Walgett DWN is located on the north-western boundary of the CMA region. At this DWN dust from the west-south-west (260°) to north-east (50°) is considered to originate from outside the CMA area (Figure 44). Gunnedah lies well within the catchment and receives local dust from all directions.

Both DWNs can receive dust from regional events that have blown from distant sources.

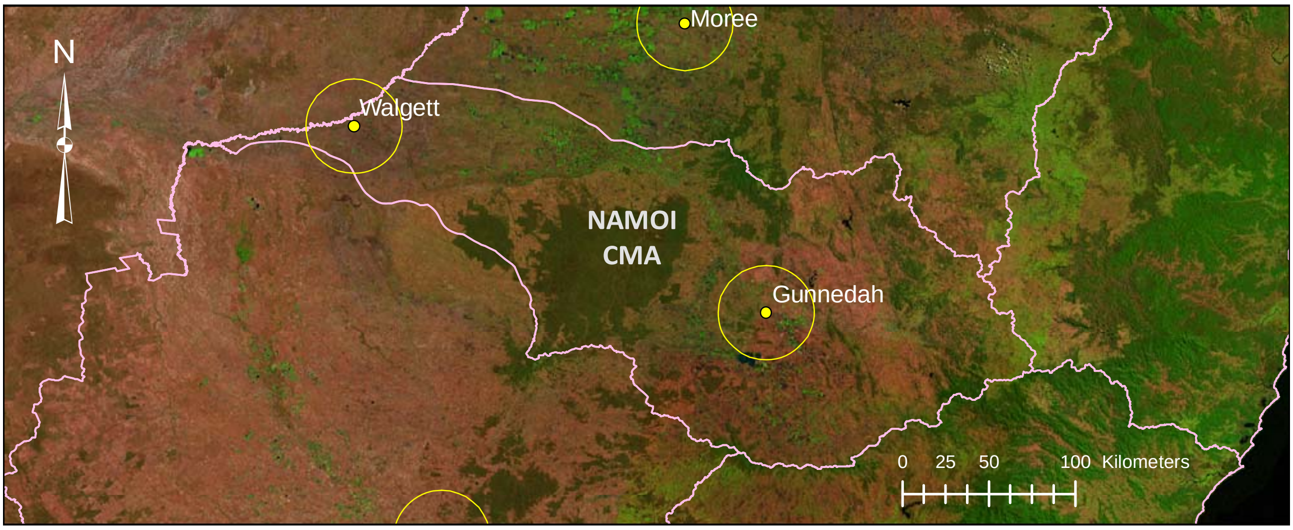
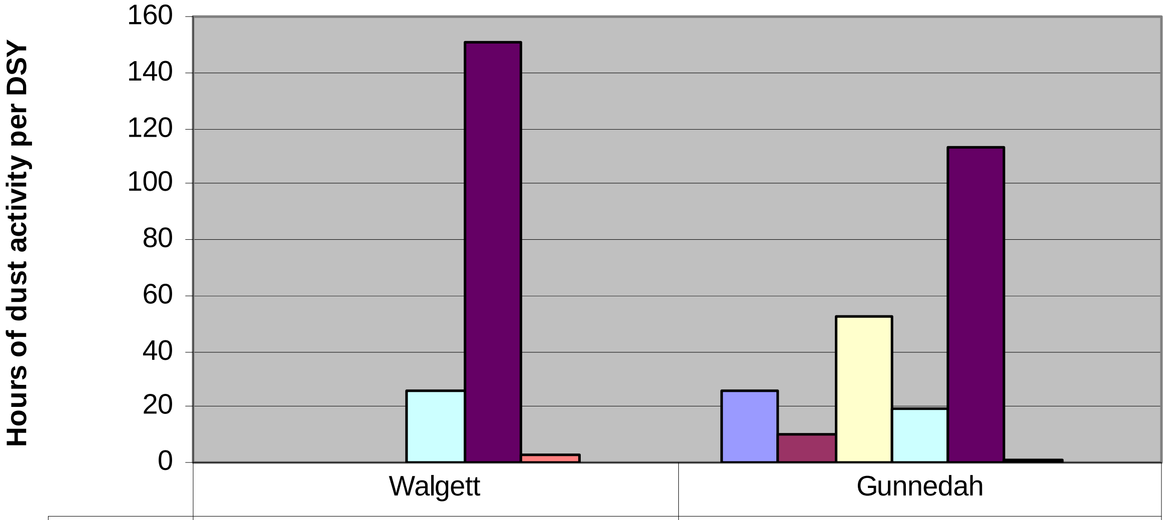


Figure 44: LandSat 7 image: location and ground cover assessment areas of DWNs in the Namoi catchment.

Dust activity – annual trends

At both DWNs the trend of dust activity was upward from 2008–09 to its peak in 2009–10 (151 hours in Walgett and 113 hours in Gunnedah). Dust activity decreased dramatically in 2010–11 and reached nil in 2011–12 at both DWNs (Figure 45).

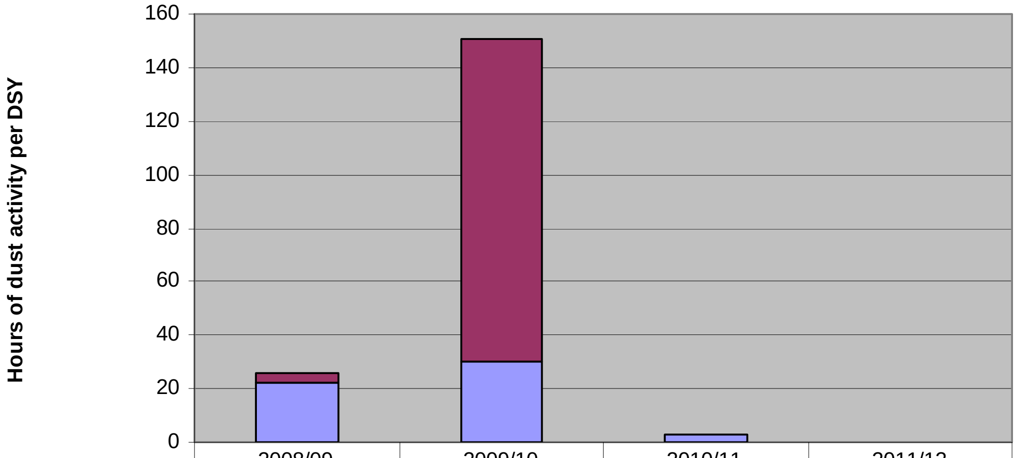


	Walgett	Gunnedah
2005/06		26
2006/07		10
2007/08		52
2008/09	26	19
2009/10	151	113
2010/11	3	1
2011/12	0	0

Figure 45. Annual hours of dust activity for DWNs in the Namoi CMA.

Dust activity – directional component

In 2009–10, 80% of measured dust activity came from sources deemed to be outside the catchment (Figure 46). Most dust received at the DWNs during 2009–10 occurred between September and November 2009 and came from sources in the Lake Eyre Basin, the Channel Country of south-west Queensland and the north-west of NSW. This included the widely publicised "Red Dawn" dust event that swept across NSW in September 2009. At the Walgett DWN, 90% of dust received during these months (31 hours in September and October, 48 hours in November) came from west-south-west to north-easterly directions (Figure 47). During this period, ground cover levels within the catchment remained high, with less than 6% of the ground cover assessment area below 50% ground cover at Walgett and Gunnedah (Figure 48).



	2008/09	2009/10	2010/11	2011/12
Outside CMA	4	121	0	0
Within CMA	22	30	3	0

Figure 46: Hours of dust measured at Walgett from within and outside the Namoi CMA.

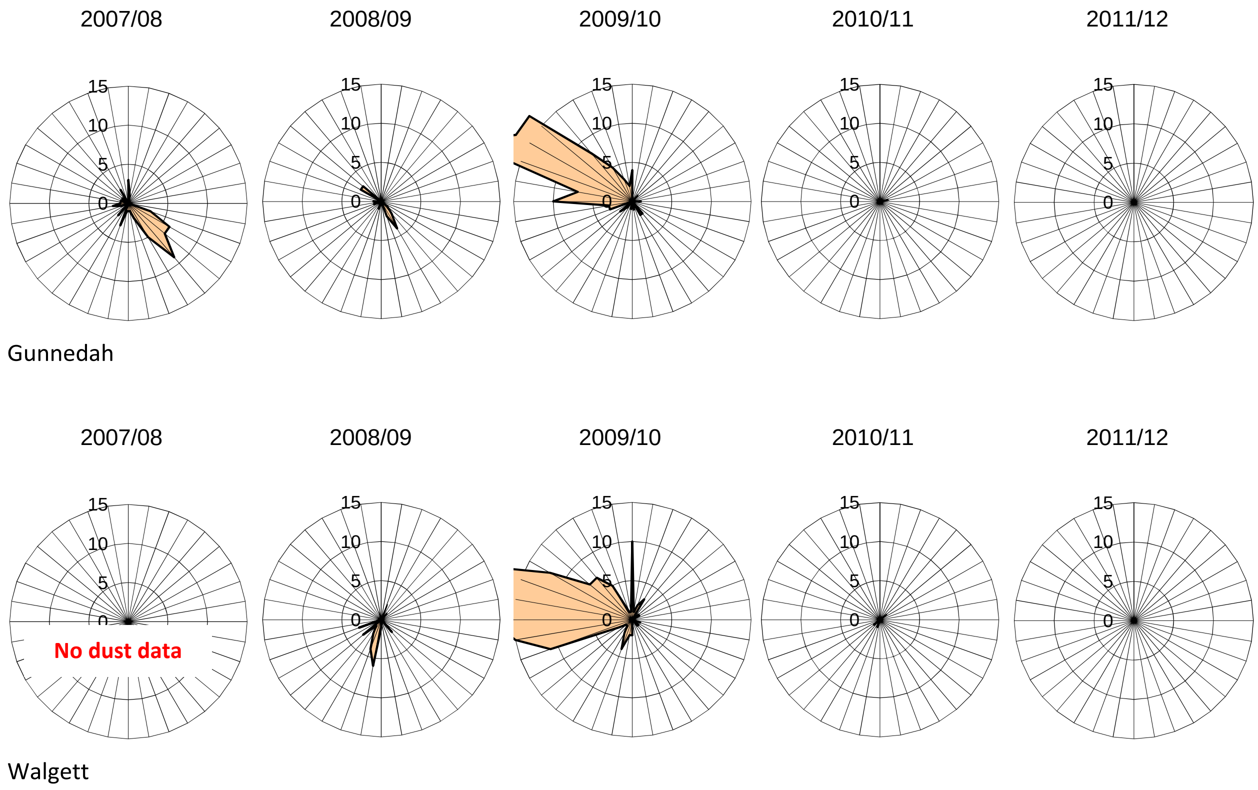


Figure 47. Dust roses showing hours of annual dust activity according to direction in the Namoi CMA since 2007–08.

Causes of recent dust activity in the Namoi CMA region

In 2009–10 dust activity came mostly from sources outside the catchment. Prolonged drought, strong winds and extensive areas with less than 50% ground cover in the Lake Eyre Basin, Channel Country of south-west Queensland and north-west of NSW led to widespread wind erosion (Figure 48). Dust activity within the catchment was associated with increased fallow areas due to the drought conditions.

In 2010–11 most areas in Australia, including the Namoi CMA region, were exceptionally wet, receiving above average or record rainfall. Following these good falls, ground cover recovered to levels that prevented wind erosion. Recorded dust levels fell by two orders of magnitude in the CMA region, with Walgett recording values of 151 hours in 2009–10 to 3 hours in 2010–11, and Gunnedah 113 hours in 2009–10 to 1 hour in 2010–11. This pattern is largely a function of the rainfall, i.e. in drought conditions there is dust and in wetter years there is not. However, land management also played an important part in the erosion levels.

In 2011–12 rainfall in eastern Australia was generally lower than in 2010–11 but still above average. No dust activity was recorded at Gunnedah or Walgett.

In 2012–13 (until February 2013 only) dust has been measured at both DWNs. Following 19 months of no dust activity the first dust was recorded in September 2012 at Gunnedah (4 hours), driven by strong north-westerly winds. Seedbeds in cropping areas in this region were too dry to sow dryland summer crops, leaving these areas at risk of erosion (Figure 49). In another event in September 2012 Walgett recorded 1 hour of dust activity from the north from local sources. Despite little rainfall, hot temperatures and reduced plantings and vigour of crops, there was no dust activity in the CMA until February 2013. Gunnedah recorded 1 hour of dust following moderate southerly winds, with dust most likely from local sources in cropping areas.

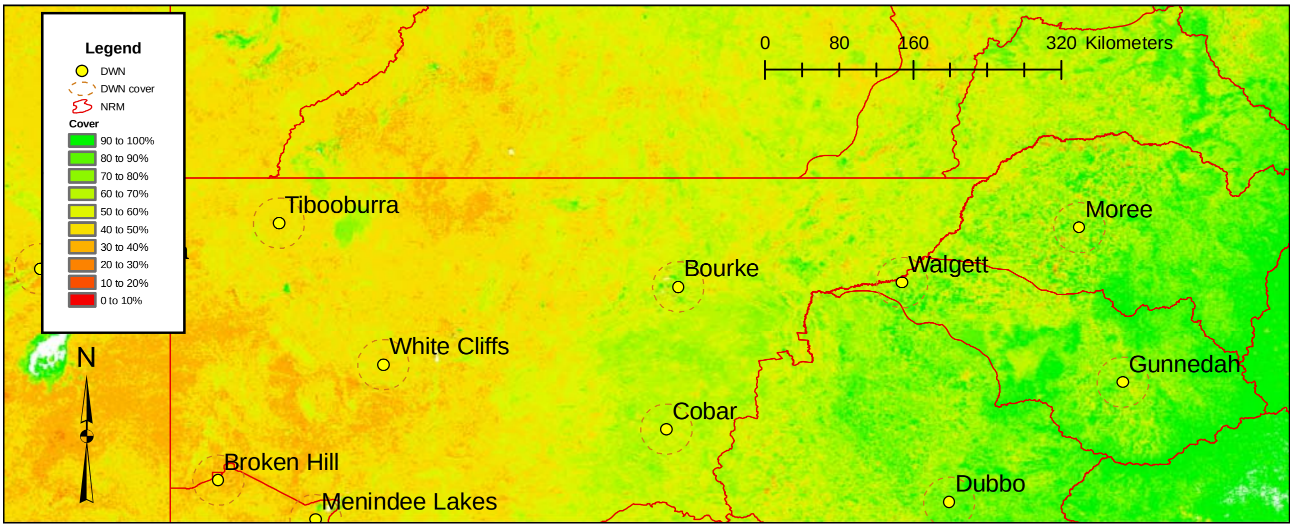


Figure 48: Widespread areas of low ground cover to the north-west of the Namoi CMA in September 2009.

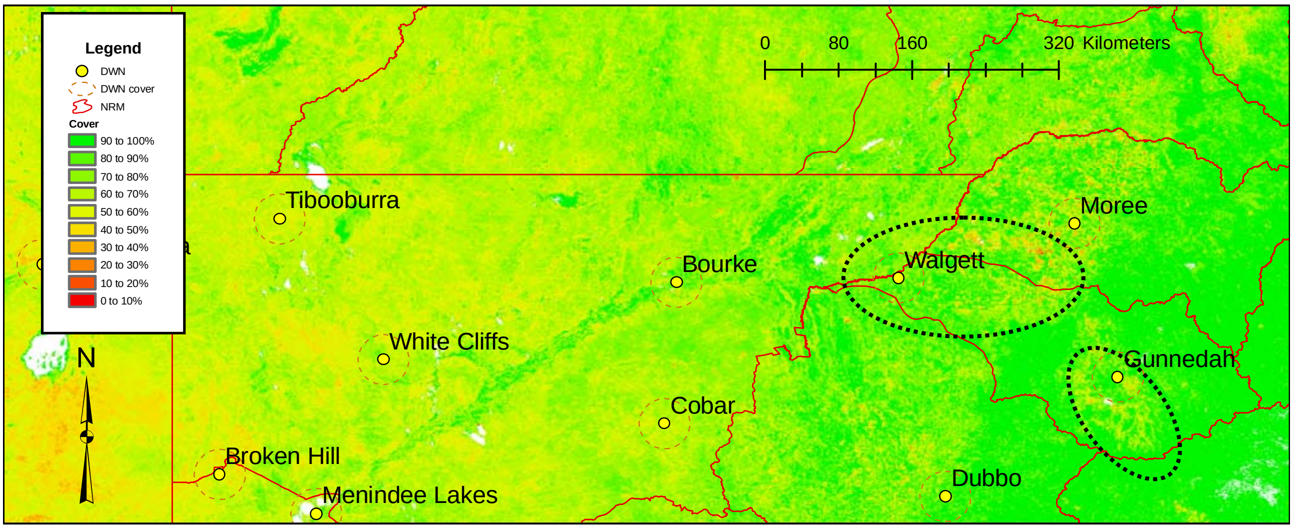
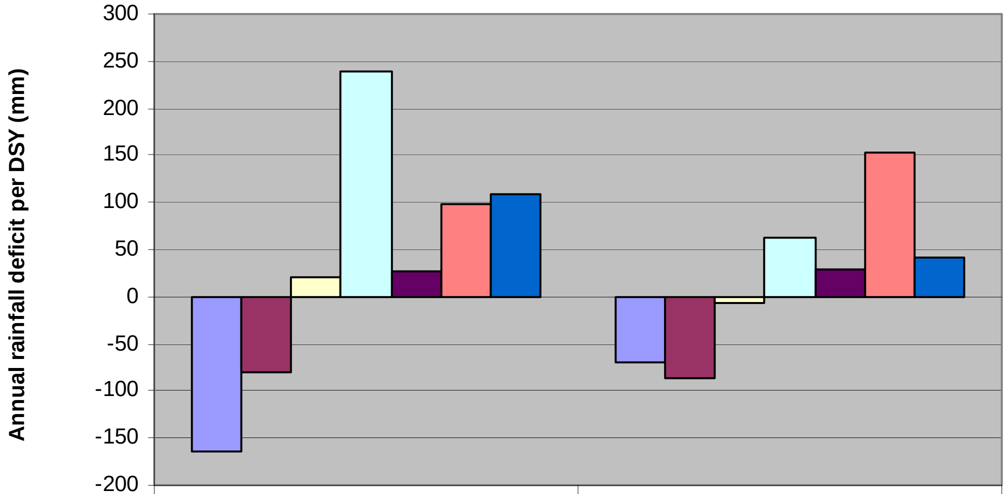


Figure 49: Ground cover recovery to the north-west of the Namoi CMA in September 2012, with areas of low ground cover in irrigated and dryland cropping areas in and near the Namoi CMA (circled).

Rainfall

The long-term average annual rainfalls for DWNs in this CMA region are Walgett 482 mm and Gunnedah 618 mm.

The annual rainfall deficits show the deviation from average at each DWN since 2005–06 (Figure 50). Below average rainfall was experienced at both DWNs in the CMA region in 2005–06 and 2006–07. Near average rainfall was received in 2007–08. In 2010–11 both Walgett and Gunnedah received above average rainfall, with Walgett receiving 1½ times its average (721 mm). Both Walgett and Gunnedah have received near or above average rainfall since 2008–09, but the trend has been decreasing, with a return to near average conditions in Gunnedah (660 mm) in 2011–12. The widespread drought affecting southern and western regions of eastern Australia was not as prolonged in the Namoi CMA region, with near or above average conditions returning in 2007–08.



	Walgett	Gunnedah
2005/06	-165	-70
2006/07	-81	-86
2007/08	21	-6
2008/09	239	62
2009/10	28	30
2010/11	98	152
2011/12	108	42

Figure 50. Annual rainfall deficit (mm) for DWNs in the Namoi catchment.

Summary

Disregarding dust that has blown into the catchment from regional dust events, the Namoi CMA region's DWNs rank in the best 10 for all years measured. The only exception is 2010–11 which was a very quiet year and rankings are not really comparable. The overall wind erosion risk in the Namoi CMA area is moderate to low. This is partly due to the reasonably good tree cover (e.g. Pilliga forest and timbered hills and slopes) and the heavy soils. These soils, when managed correctly, will provide good protection from wind erosion particularly in average to wet years. Nevertheless, in dry years and if managed incorrectly (e.g. disaggregating by raking or laser levelling), these soils can become significant dust sources within the Namoi catchment and in particular in the upper Namoi. The rangelands in the western part of the catchment are the other local dust source in dry times. In short, the reason for any dust created within the Namoi catchment is related predominantly to land management and not to climate.

Land management practices to reduce wind erosion would have the greatest impact in the north-western portion of the Namoi CMA region, where the risk of wind erosion is localised and moderate (Figure 2). Retaining soil aggregation and ground cover in cropping areas will minimise the risk of wind erosion associated with cropping activities. Stubble management, in particular the discouragement of fire as a cropping management tool, appears better in the Namoi CMA region in comparison to areas further south and west.

5.1.8 Western CMA

Catchment description

The Western CMA region is located in western NSW and covers an area of approximately 230 000 km^2. It is the largest CMA in NSW. It includes the Barwon–Darling, Culgoa, Paroo, Warrego, Narran, Bokhara and Birrie River catchments. Major townships include Bourke, Brewarrina, Cobar, Walgett, Lightning Ridge and Broken Hill. Land use is predominantly grazing on rangelands, with some dryland and irrigated cropping along river corridors. The CMA region is predominantly leasehold land which is administered under the *Western Lands Act 1901*. Rainfall across the CMA region ranges from 600 mm in the north-eastern corner to less than 250 mm in the far west.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 µg/m^3. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circles in Figure 51).

DWNs in the Western CMA region

The Western CMA region has four DWNs (Figure 51). These are located at Bourke (installed in July 2007), Cobar (installed in July 2007), Tibooburra (installed in October 2003) and White Cliffs (installed in October 2008). These DWNs are owned and maintained by OEH with in-kind contributions from the Western CMA, Bureau of Meteorology and the local community.

Land use at the Bourke DWN is mixed dryland and irrigation farming. Cobar, Tibooburra and White Cliffs DWNs are surrounded by rangelands. Additionally there are opal mining sites near the White Cliffs DWN.

All DWNs are located well within the CMA region’s boundary and can receive local dust from all directions in the CMA region. All DWNs can receive dust from regional events that have blown from distant sources.

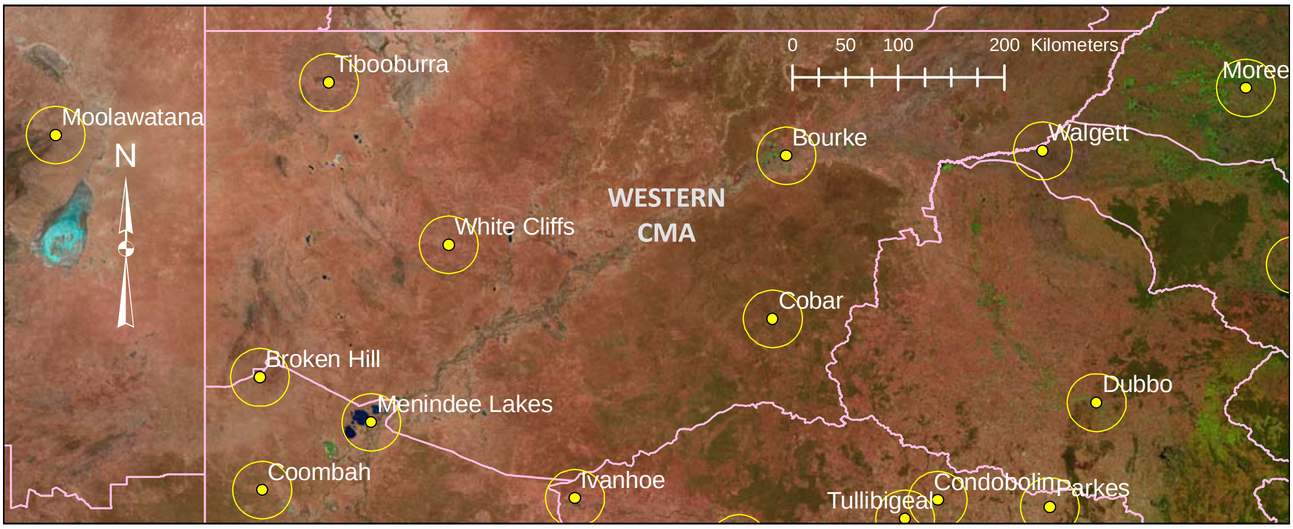
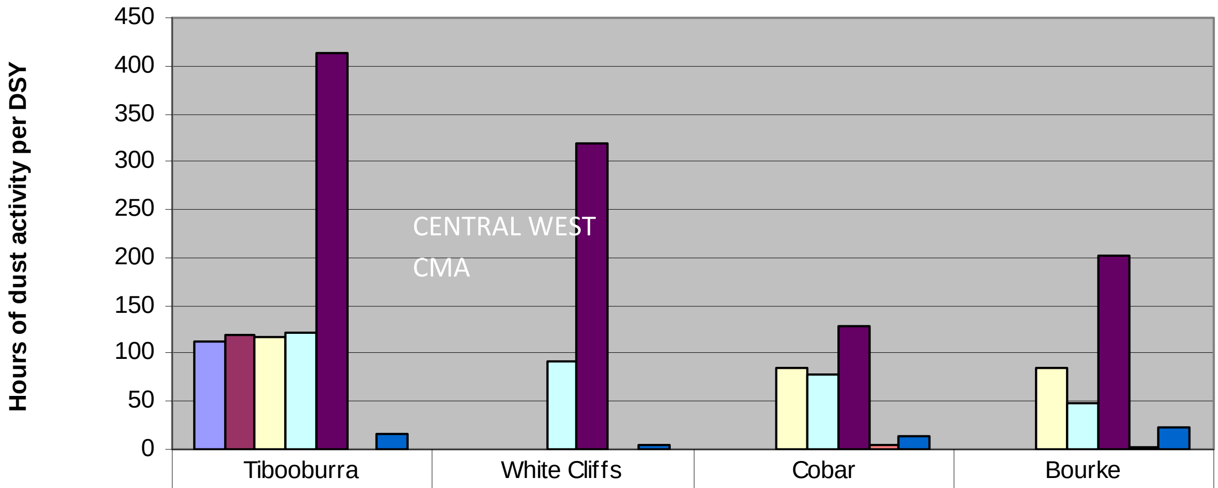


Figure 51. LandSat 7 image: location and ground cover assessment areas of DWNs in the Western CMA region and neighbouring NRM regions.

Dust activity – annual trends

From 2005–06 to 2007–08 very high annual dust activity was recorded at Tibooburra. Although records are not as long at other DWNs, a similar trend was recorded at Cobar from 2007–08 to 2008–09. White Cliffs and Cobar recorded similar dust activity in 2008–09. In 2009–10 dust emissions increased to record values at all DWNs. Dust activity decreased by two orders of magnitude in 2010–11 at all DWNs following drought breaking rain in late 2009/early 2010. Dust activity increased during 2011–12 at all DWNs (Figure 52).



	Tibooburra	White Cliffs	Cobar	Bourke
2005/06	113			
2006/07	120			
2007/08	117		85	86
2008/09	121	92	77	49
2009/10	413	320	128	201
2010/11	0	1	5	2
2011/12	16	5	13	22

Figure 52. Hours of dust activity for DWNs in the Western CMA region.

Dust activity – directional component

The strong directional component of the dust received at each of the DWNs in the CMA region is shown in Figure 53. In 2009–10, across the CMA region there was a strong directional component from the west at all DWNs. Tibooburra and White Cliffs also received dust from the south and west, from sources in the South Australian Arid Lands (SAAL) region.

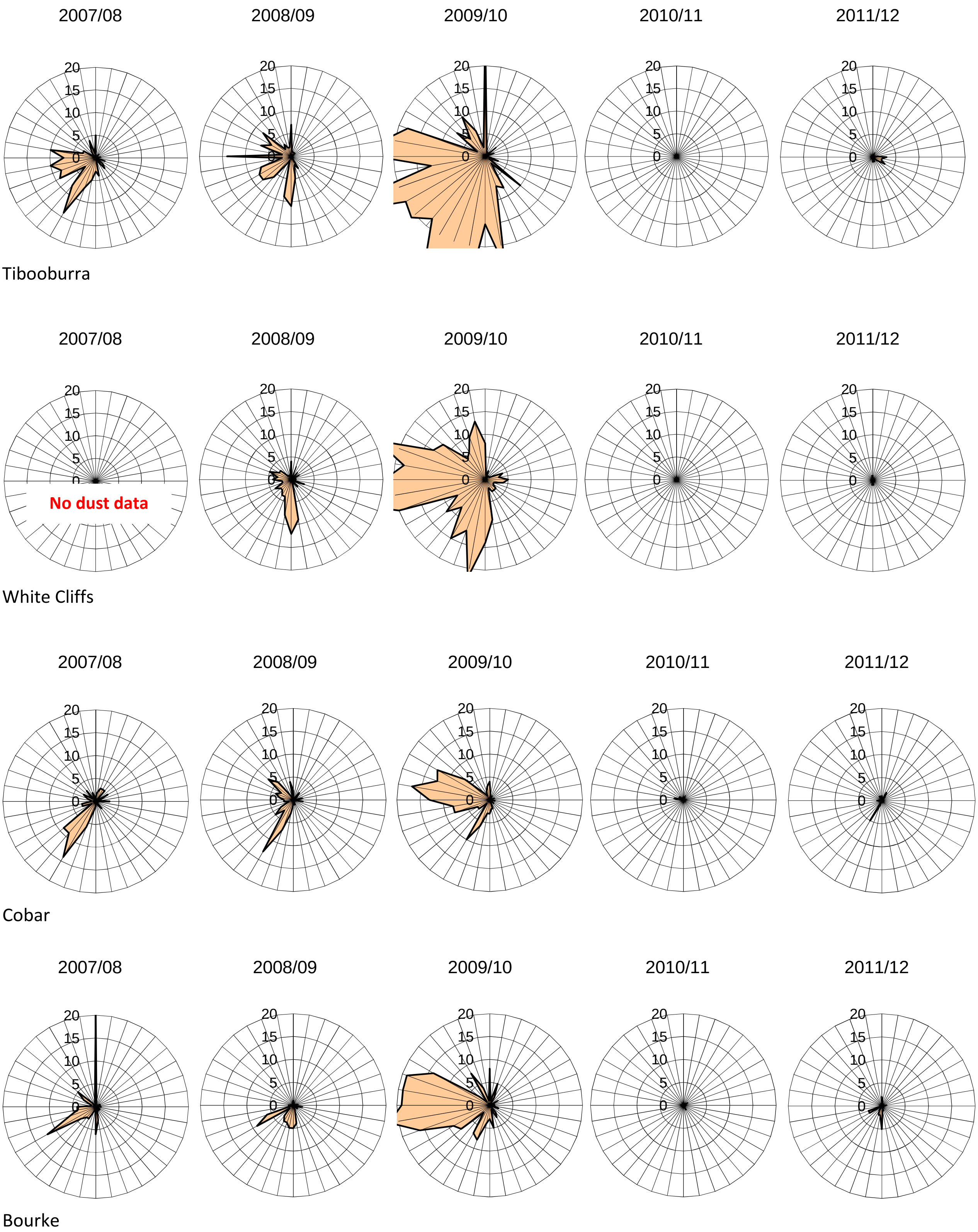


Figure 53. Dust roses showing hours of dust activity according to direction at each DWN since 2007–08.

Causes of recent dust activity in the Western CMA region

At Tibooburra annual dust recorded was consistently high from 2005–06 (113 hours) to 2008–09 (117 hours) due to the ongoing drought in the area. In 2009–10 ground cover levels decreased even further (Figure 54) in the CMA region and surrounding NRM areas which saw dust emissions increase to a peak (413 hours). In September 2009, Tibooburra, White Cliffs and Cobar averaged 75% of land in the ground cover assessment area with less than 50% cover (Figure 54). In 2009–10 Tibooburra recorded dust from several regional events sourced from Lake Eyre, north-west NSW and south-west Queensland. Since 2005–06 Tibooburra has ranked highest for the amount of dust recorded in 2006–07 and 2009–10, and has been listed within the top ten DWNs for six years for the amount of recorded dust. White Cliffs, Cobar and Bourke have also recorded similar trends since 2005–06, with White Cliffs recording a peak in 2009–10 (320 hours).

In 2010–11 most areas in Australia, including the Western CMA region, were exceptionally wet, receiving above average or record rainfall. Following very good falls in early 2010, ground cover recovered in the CMA region and the surrounding NRM areas to levels that prevented wind erosion (Figure 55). Dust emissions across the CMA region fell by two orders of magnitude, with Cobar recording the most hours of dust in the CMA (5 hours). Tibooburra recorded no dust in that DSY.

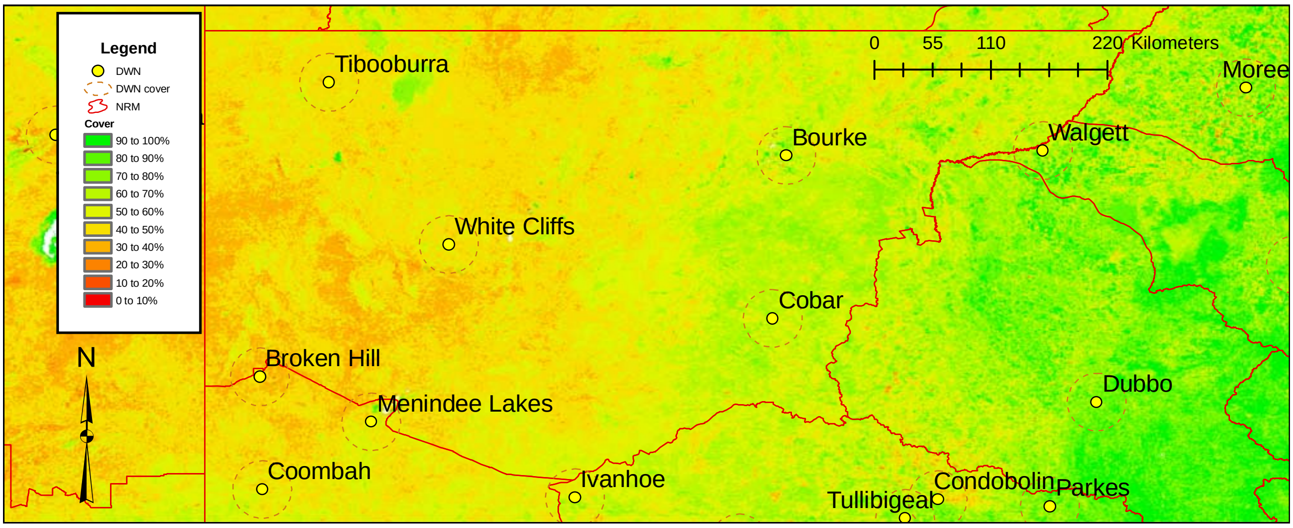


Figure 54. Widespread areas of low ground cover in the Western CMA region in September 2009.

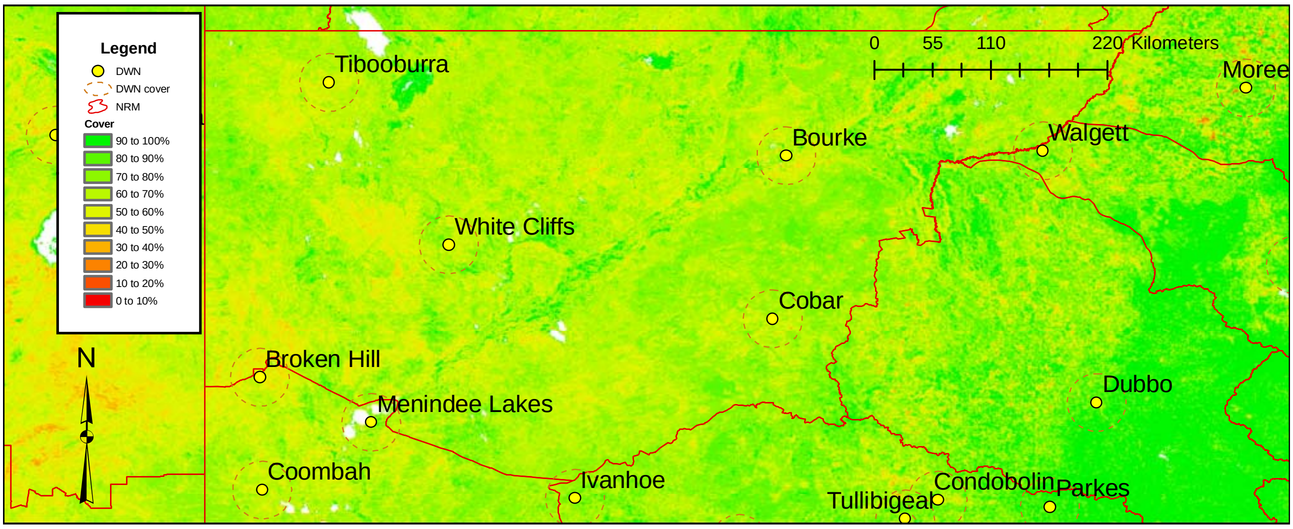


Figure 55. High ground cover in the Western CMA region in September 2011.

In 2011–12 rainfall levels were generally lower in eastern Australia than in 2010–11 but still above average. Dust activity was recorded at all DWNs. In August, Bourke and Cobar recorded dust in an event that swept down to Condobolin. Other regional events measured in the Western CMA region were in February and April, when dust was recorded from the Mallee region of NSW, Victoria and South Australia. The plume from the April event reached as far as Tibooburra. Local events were measured at Tibooburra and Bourke in January. A comparison of the ground cover level in September 2011 (Figure 55) with September 2009 (Figure 54) shows significant improvement, with the amount of land with ground cover levels less than 50% in the DWN assessment area in rangeland DWNs decreasing from 75% in September 2009 to 1% in September 2011.

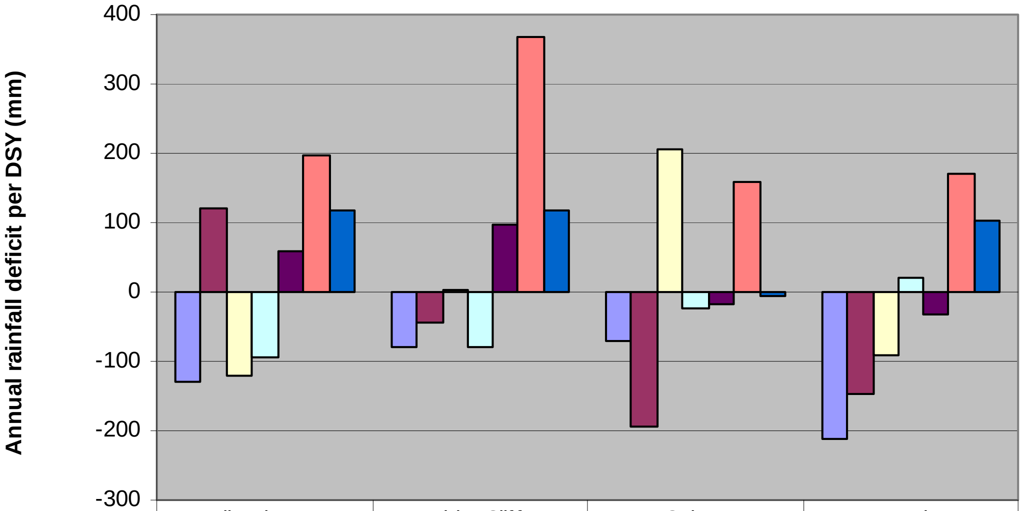
Although incomplete, until January 2013 in the 2012–13 DSY there have been several dust recordings at all DWNs in the CMA region. In August, a dust haze was recorded at Cobar (3 hours) and Tibooburra (2 hours) from local events. A regional dust event covering most of NSW occurred in September and was recorded in the CMA at White Cliffs, Cobar and Bourke. Low rainfall during this period, high winds, and ground cover levels approaching the threshold values in the rangelands were the drivers for this event. In November, local events were recorded at Bourke and White Cliffs. White Cliffs also recorded moderate haze (4 hours) as part of an extensive dust storm covering most of southern NSW and driven by southerly winds. In January, bare paddocks in the Victorian Mallee were the source of significant dust activity in south-eastern Australia with several events that month detected as far north as Bourke.

Bourke is the only DWN in the CMA whose land use includes irrigated and dryland cropping. Fallow management and harvest will impact on ground cover near this DWN.

Rainfall

The long-term average annual rainfall at each DWN in the CMA region is Tibooburra 226 mm, White Cliffs 249 mm, Cobar 401 mm and Bourke 351 mm.

The annual rainfall deficits show the deviation from average at each DWN since 2005–06 (Figure 56). Without some exceptional rainfall in January and May in the 2007–08 DSY at Cobar, and summer months in the 2006–07 DSY at Tibooburra, all DWNs would have experienced prolonged period of below average rainfall leading up to 2010–11. However, the good rainfall at Cobar in summer 2007–08 had no significant impact on overall ground cover. In 2010–11 exceptional rainfall was experienced across eastern Australia, and in the Western CMA region all stations received above average rainfall, with Tibooburra and White Cliffs receiving 1½ times their long-term average. Rainfall during the 2011–12 DSY remained above average at all DWNs except Cobar, which experienced slightly below average rainfall.



	Tibooburra	White Cliffs	Cobar	Bourke
2005/06	-129	-79	-71	-212
2006/07	121	-44	-193	-147
2007/08	-120	4	205	-93
2008/09	-93	-78	-23	20
2009/10	60	98	-18	-32
2010/11	196	367	158	170
2011/12	118	119	-7	102

Figure 56. Annual rainfall deficits for DWNs in the Western CMA region.

Summary

The rangelands of the Western CMA region, and in particular in the western part of the CMA, display a initial resilience to drought conditions, with chenopods and cryptogams playing a vital role in stabilising the sometimes fragile soils during dry times. Timing and the nature of the rainfall events is much more important in the Western CMA region than in other regions because it determines the amount of resulting pasture growth; in particular in areas already under pressure.

Nevertheless, if stock management is not pro-active and land management does not react promptly to climate conditions, ground cover will fail and the rangelands of the Western CMA region will become the major dust source of NSW.

In recent years numbers of feral animals, and goats in particular, have increased significantly and contributed to an abnormally high reduction in ground cover during summer in above average rainfall years. This contributed to dust within the catchment during 2011–12 even though rainfall was well above average.

Cropping along the river corridor and around Bourke can lead to bare and highly disturbed soils if managed incorrectly. This will create local dust if meteorological conditions are adverse.

5.2 Victoria

5.2.1 Mallee CMA

Catchment description

The Mallee CMA is located in north-western Victoria and covers 39 939 km^2, around one-fifth of Victoria. Major centres are Mildura, Birchip, Sea Lake, Ouyen, Robinvale, Red Cliffs and Merbein. Land uses include dryland cereal and pulse production mixed with livestock (mainly sheep) in the south, livestock production in the west and irrigated horticulture along the River Murray. Two large areas of remnant vegetation are located in the western portion of the CMA in the north and south.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 µg/m^3. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circles in Figure 57).

DWNs in the Mallee CMA region

The Mallee CMA has one DWN located at Walpeup (installed in September 2011). This DWN is owned by the Mallee CMA and maintained by OEH.

The land use surrounding the Walpeup DWN is dryland farming with bands of timbered country to the south and north (Figure 57).

The Walpeup DWN is located well within the CMA region's boundary and can receive local dust from all directions in the catchment. It can also receive dust from regional events that has blown from distant sources.

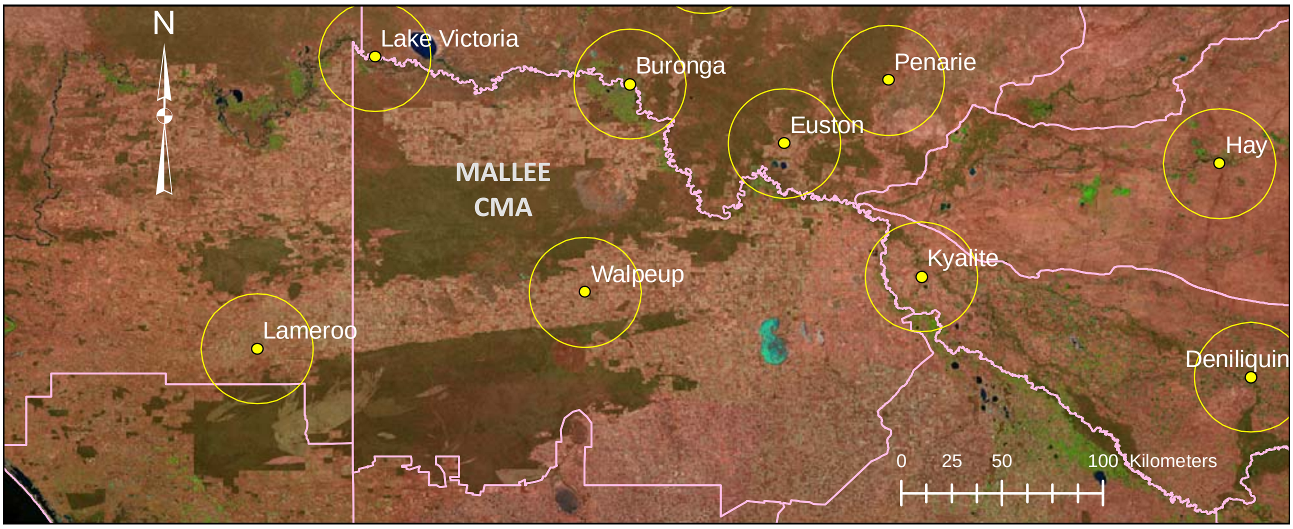


Figure 57. LandSat7 image: location and ground cover assessment area of the Walpeup DWN in the Mallee CMA and other DWNs in neighbouring CMAs.

Dust activity – annual trends

As this DWN has only been operational since September 2011, there is not enough long-term data to discuss annual trends. In the 10 months of operation in the 2011–12 DSY the Walpeup DWN measured 45 hours of dust activity. This was the highest record across the entire DustWatch network that year.

Dust activity – directional component

The directional component of the dust received at Walpeup is shown in Figure 58. In 2011–12 there was a strong directional component of dust from the south-south-east (in summer months) and the west-south-west (in autumn).

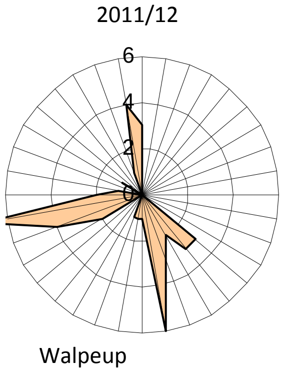


Figure 58. Annual dust rose for 2011–12 showing direction and hours of dust for the Walpeup DWN.

Neighbouring DWNs also show a strong signal of dust from the west-south-west. Both Buronga and Kyalite received dust from that direction, which can be attributed to sources in the Mallee CMA (Figure 59).

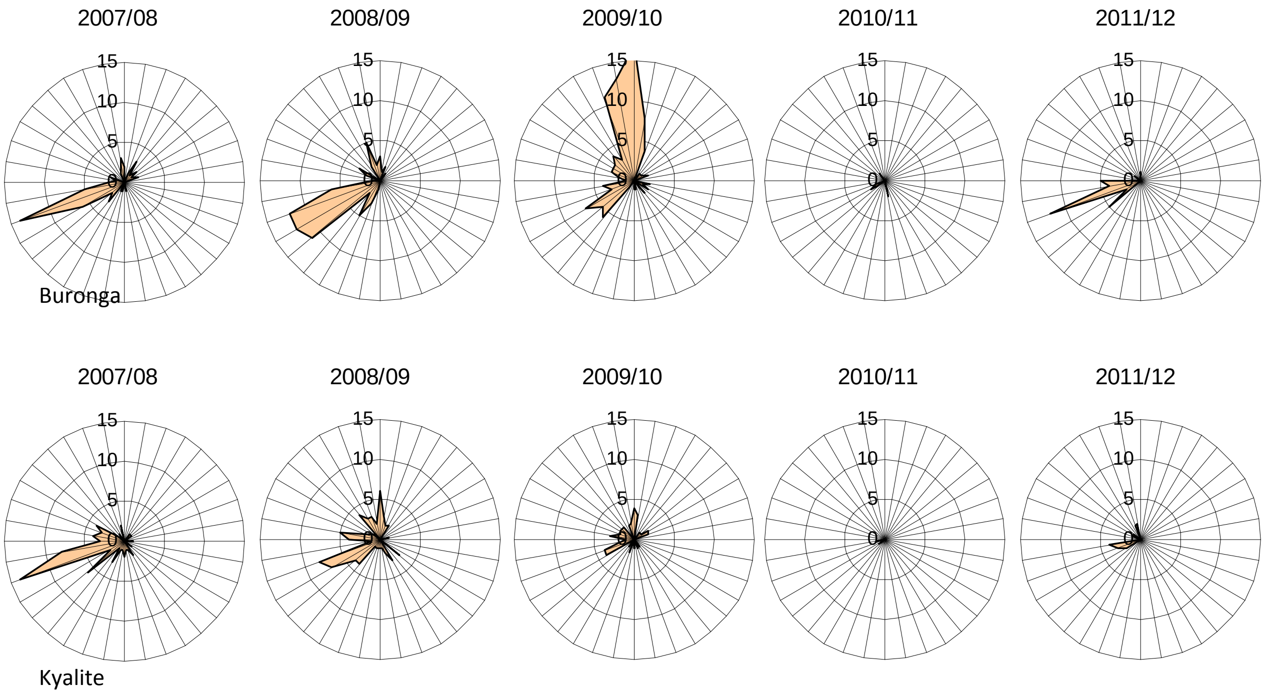


Figure 59. Annual dust roses for DWNs (Buronga and Kyalite) in neighbouring catchments.

Causes of recent dust activity in the Mallee CMA region

In 2011–12 rainfall levels were generally lower in eastern Australia than in 2010–11 but still above average with the exception of western Victoria, including the Mallee. Dust activity at Walpeup was recorded in all months (excluding March) from December until June, resulting in 45 hours for that DSY. During the summer months 29 hours of dust was recorded. In January, 5 hours of dust recorded at Buronga was attributed to bare paddocks in long fallow, located south-west of that DWN in the Mallee CMA region.

Regional dust events recorded in February and April 2012 affecting widespread areas of NSW were attributed to dust sources in the Victorian Mallee. This coincided with decreasing ground cover due to long fallowing practices including burning and cultivation. In February 2012, dust was generated from widespread areas of loose, dry soil from the Millewa region in the north-west. It was picked up by strong south-westerly winds and travelled into NSW as far as north as Dubbo and east as Cowra. Buronga's February total of 9 hours of dust activity came from this one event (Figure 60). In all years Buronga has a strong signal of dust from the south-west, i.e. the Millewa region in the Mallee CMA.

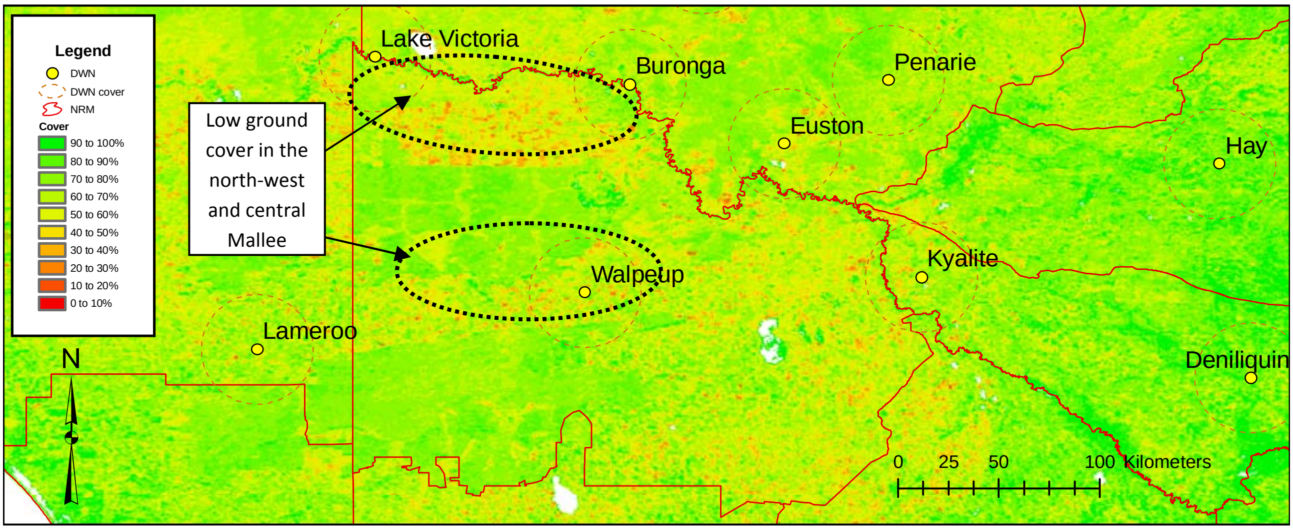


Figure 60. Low ground cover in the north-west and central region of the Mallee in February 2012 resulting in widespread regional dust.

Dust activity in 2011–12 was also recorded in April, May and June with 14 hours of dust in this period from sources in the west and north of the Buronga DWN. The April event, sourced from both the Mallee CMA region and former Lower Murray–Darling CMA regions, travelled on south-westerly winds as far north as Tibooburra and Bourke. In May (6 hours) and June (4 hours) dust activity was recorded at Walpeup, but a lack of strong winds prevented more widespread dust activity. During April, May and June 2012, on average 15% of land in the assessment area had ground cover < 50% (Figure 61). Although crops may have been sown on above average rainfall in March (53.4 mm), there was very little follow-up rain in April (2 mm) and May (4.5 mm) which may have led to crop failure or late plantings. There were also issues with canola establishment during this time.

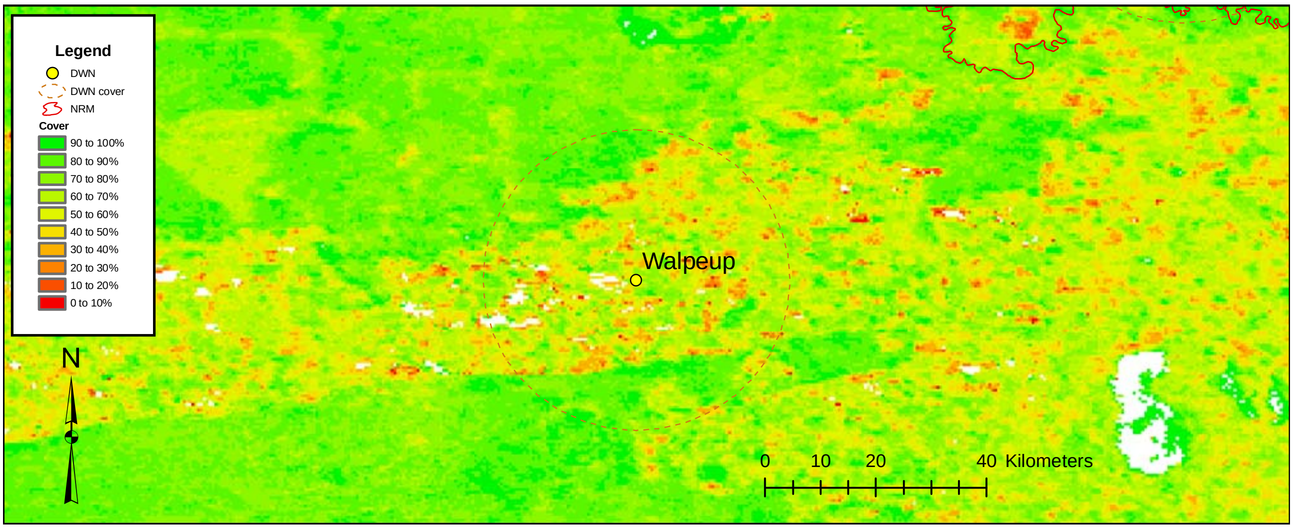


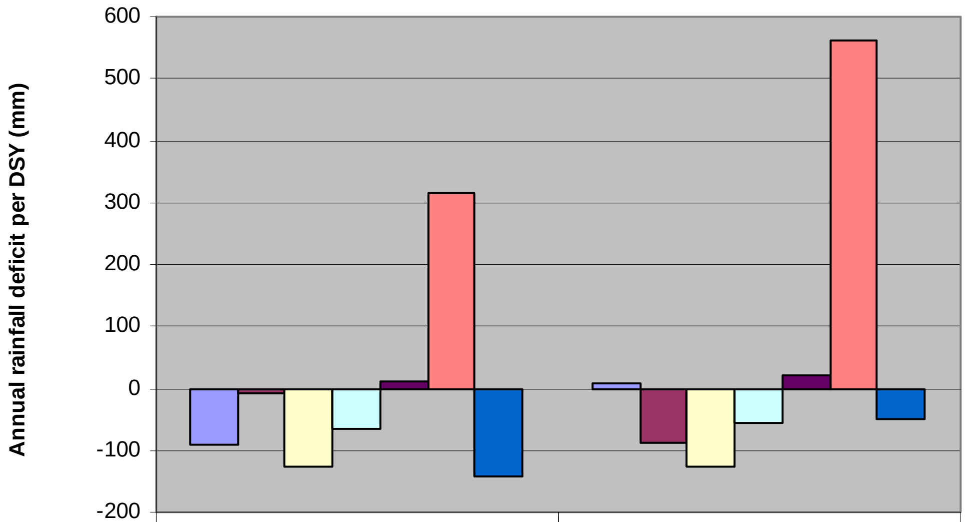
Figure 61. Areas of low ground cover in May 2012 near the Walpeup DWN.

In 2012–13 (until February 2013) the Walpeup DWN has recorded 6 hours of dust activity. In November 2012, 1 hour of dust activity was measured at Walpeup, with strong south-west winds driving a dust plume that resulted in moderate dust haze and extending to West Wyalong and Temora. For that event, the highest values of dust activity were recorded at Buronga and Kyalite suggesting the Millewa and Manangatang regions as the source, with a severe haze detected as far as north-east as Hillston. In December, 3 hours of dust activity at Walpeup were received from the west-north-west and south. Other dust emitted from the Millewa region in December 2012 was measured at Buronga and Euston, with plumes extending as far east as Cowra and Dubbo. Although no dust was measured in January at Walpeup, multiple events coming from the bare paddocks in the Millewa and Euston areas were carried north and north-east and registered as far north as Bourke and as far east as Cowra. In February 2 hours of dust activity were recorded at Walpeup.

Rainfall

The Walpeup DWN averages 340 mm per DSY which mainly falls in winter and spring.

The annual rainfall deficits show the deviation from average at the Walpeup DWN and the neighbouring Buronga DWN since 2005–06 (Figure 62). Since 2005–06, Walpeup has recorded near or below average rainfall in all years except 2010–11. In 2010–11 most areas of eastern Australia, including the Mallee CMA region, were exceptionally wet, receiving above average or record rainfall. The Walpeup DWN recorded 657 mm in that DSY, almost double its average annual rainfall. This fell mainly in the summer months (330 mm). In 2011–12 rainfall at Walpeup returned to below average levels, with only 198 mm recorded.



	Walpeup	Buronga
2005/06	-92	7
2006/07	-9	-87
2007/08	-127	-128
2008/09	-65	-57
2009/10	11	20
2010/11	317	561
2011/12	-142	-49

Figure 62. Annual rainfall deficits for the Walpeup and Buronga DWNs.

Summary

The modelled wind erosion risk in the Mallee CMA region is mainly moderate with some areas of severe risk in the north and central region (Figure 2). Many soils in the Mallee are sandy in texture and can be highly susceptible to wind erosion when loose, dry and without adequate ground cover.

The Millewa area in the north-west of the Mallee CMA is the largest dust source in the CMA. Erosion levels have been declining over recent decades as a result of improved land management practices in that area.

However, management practices still in place such as long fallowing, burning, repeated cultivation and over grazing of stubbles and pastures in dry years are strongly associated with a decline in ground cover and soil aggregation and are the major cause of erosion. Farming systems are at greatest risk of erosion after a failure in winter rains – the period of maximum vegetation growth. The 2013 autumn is an example of low ground cover produced by the very much below average winter rains of 2012 and has contributed to the dust emissions from the area during this DSY.

The other time of high erosion risk is when there are very much above average summer rains. This results in increased cultivation for summer weed control that leads to lower ground cover levels. Chemical weed control can mitigate this effect but is more difficult and expensive than winter weed control. The low ground cover levels in March 2011, which were preceded by excellent winter and summer rainfall (Figure 62), are an example of how fallow management can reduce ground cover and result in wind erosion when rainfall has been above average. The Walpeup site was not installed that year (2010–11) but the Buronga site recorded the 4th highest hours of dust activity across all sites that year, with only Mullewa in WA, Temora in the Lachlan CMA and Menindee Lakes in the Western CMA recording higher values.

The 2011–12 period was in the driest 10% of BoM records for most of the Mallee CMA. The average annual rainfall was almost 50% less than the mean at the Walpeup site. The Walpeup DWN topped the ranking table that year with a total of 45 hours of dust activity recorded during the year (Table 2). The 2012–13 period is shaping up the same way. Walpeup in the central area of the CMA, and Buronga and Euston, the two DWNs downwind from the Millewa region, have received dust as a result of the reduced rainfall and the inadequate management of soil cover. All three DWNs are ranked in the top five dust measurements for 2011–12 and a similar result is anticipated for 2012–13.

5.2.2 North Central CMA

Catchment description

The North Central CMA region is located in the central part of Victoria and covers approximately 22 000 km^2. It includes the Loddon, Campaspe, Avoca and River Murray river systems. Major centres are Bendigo, Swan Hill, Daylesford and Heathcote. Land uses include broadacre dryland cereal production with grazing and irrigated mixed farming in the riverine plains of the Loddon and Campaspe rivers, and timber production in the south. Rainfall ranges from 400 mm in the north of the catchment to over 1000 mm in the south-east.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 $\mu g/m^3$. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circles in Figure 63).

DWNs in the North Central CMA region

The North Central CMA region has one DWN located at Loddon Plains (installed in July 2011) (Figure 63). This DWN is owned by the North Central CMA and maintained by OEH.

The land use surrounding the Loddon Plains DWN is mixed irrigation and dryland farming and a timbered area to the south.

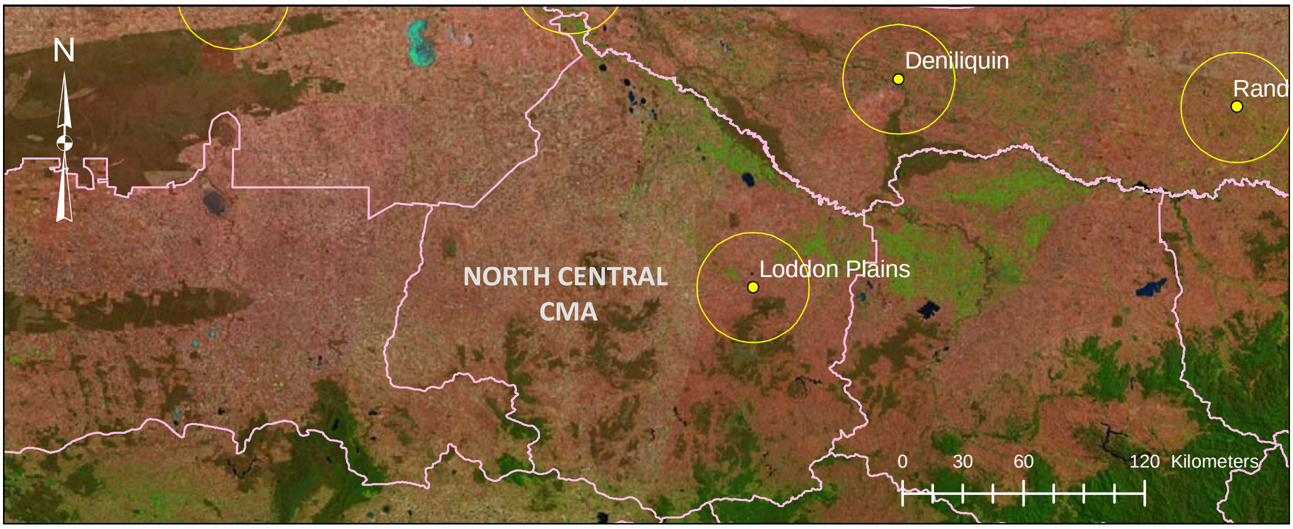


Figure 63. LandSat7 image: location and ground cover assessment area of the Loddon Plains DWN in the North Central CMA and other DWNs in neighbouring CMAs.

Dust activity – annual trends

As this DWN has only been operational since July 2011, there is not enough long term data to discuss annual trends. In 2011-12 DSY the Loddon Plains DWN measured 7h of dust activity. This puts the DustWatch node in 15th place out of a total of 40, with the lowest 9 nodes recording no dust at all and the highest site (Walpeup in the Victorian Mallee) recording a total of 45 hours.

Dust activity – directional component

The Loddon Plains DWN lies well within the CMA regional boundary and receives local dust from all directions. It can also receive dust from regional events that have blown from distant sources. With 3 hours of dust activity recorded in 2011–12 from the north-west (Figure 64) it is likely that this dust originated in the Mallee CMA.

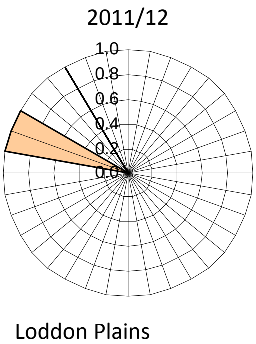


Figure 64. Annual dust rose for 2011–12 showing direction and hours of dust activity for the Loddon Plains DWN.

The closest DWN outside the North Central CMA is the Deniliquin DWN in the Murray CMA. This DWN was installed in July 2007 and has an almost complete dataset. It indicates that, in 2008–09 in particular, some of the dust measured in Deniliquin could have originated in the dryland cropping areas between Swan Hill and Charlton.

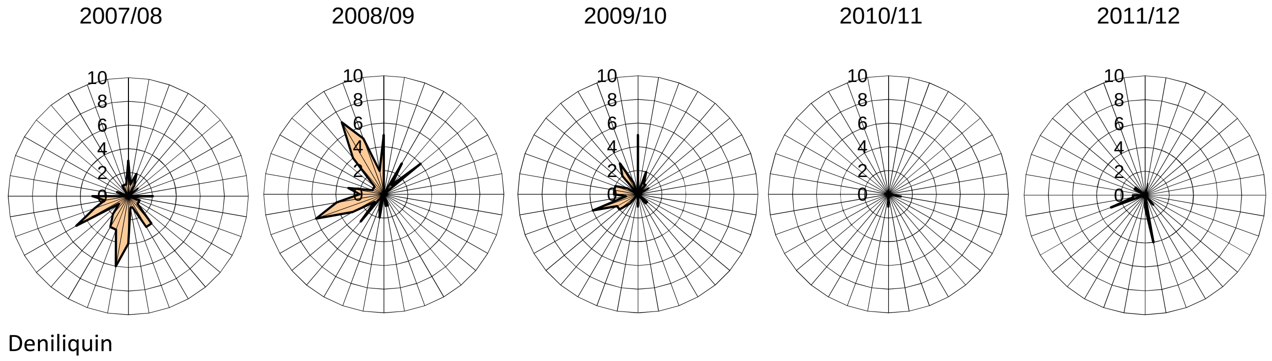


Figure 65. Annual dust roses showing hours of annual dust activity according to direction at Deniliquin DWN since 2007–08.

The only dust recorded in the 2011–12 DSY was from the west-north-west (Figure 64), pointing at the same source areas as the Deniliquin DWN in previous years (Figure 66).

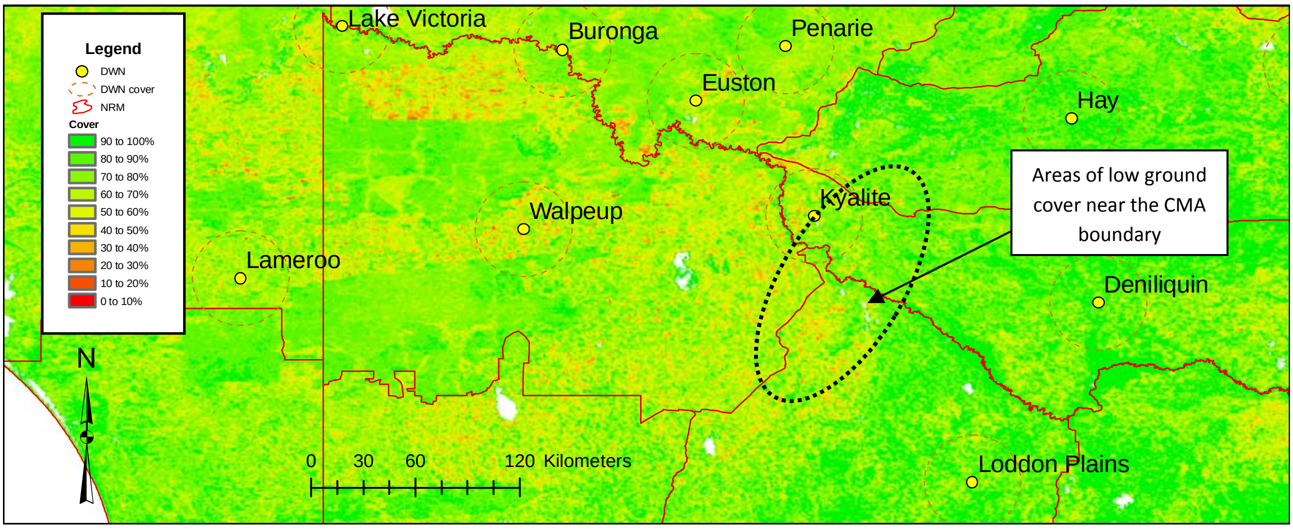


Figure 66. Areas of low ground cover in North Central CMA and Mallee CMA in April 2012.

Causes of recent dust activity in the North Central CMA region

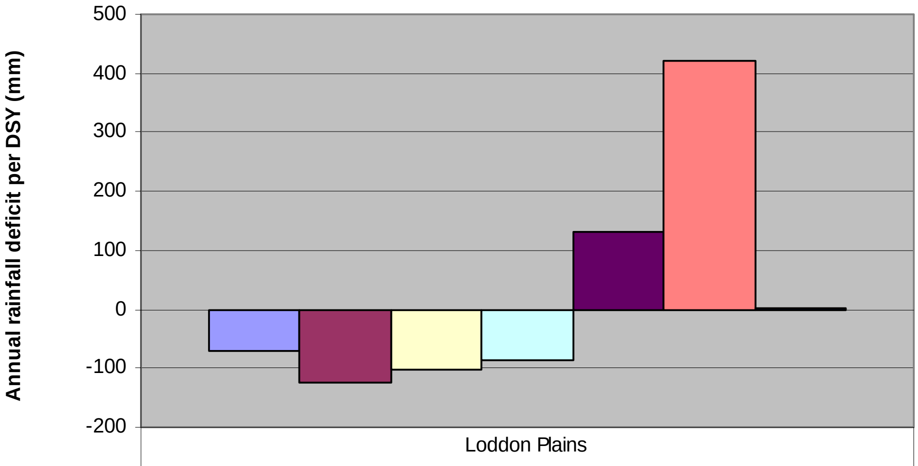
In 2011–12 dust activity was measured in February (1 hour) and April (3 hours). The dust activity measured in February was carried on pre-frontal northerly winds associated with a widespread event from the Victorian Mallee region. The dust measured in April (3 hours) was part of a widespread event mostly attributed to the Mallee and carried on moderate west-north-westerly winds. Sources of dust within the CMA region that might have added to the dust from the Mallee CMA region include dryland farming areas in preparation for winter crops near the western boundary of the Mallee CMA (Figure 66).

Near the Loddon Plains DWN, ground cover levels were well-maintained throughout the year in 2011–12. Increases to the area at risk to wind erosion occur between December and June coinciding with harvest and preparation of winter cropping paddocks.

Rainfall

The long-term average rainfall for Loddon Plains is 436 mm.

The annual rainfall deficits show the deviation from average at the Loddon Plains DWN since 2005–06 (Figure 67). Below average conditions were experienced between 2005–06 and 2008–09. In 2010–11 exceptional rainfall fell across eastern Australia, and Loddon Plains recorded nearly double its annual average rainfall (859 mm), with 581 mm falling between October and February. 2011–12 saw a return to average conditions.



	Loddon Plains
2005/06	-71
2006/07	-125
2007/08	-102
2008/09	-85
2009/10	131
2010/11	423
2011/12	2

Figure 67. Annual rainfall deficit (mm) for the Loddon Plains DWN.

Summary

Around the Loddon Plains DWN ground cover is generally well-maintained throughout the year, and little dust was recorded in 2011–12. No measurements are available prior to that DSY.

The north-west corner of the North Central CMA region is dominated by dryland cropping, and, looking at ground cover images (Figure 66), has many areas that do not maintain ground cover and are at risk of wind erosion in the summer/autumn fallow of dryland cereal production. This is further ascertained by measurements from the Deniliquin DWN in the Murray CMA region that point to the same source area.

5.3 South Australia

5.3.1 Eyre Peninsula NRM

Catchment description

The Eyre Peninsula NRM region is located along the coast, west of Spencers Gulf in South Australia and covers approximately 80 000 km^2. Major centres are Whyalla, Port Lincoln, Ceduna and Fowlers Bay. Land uses inland from the coast include dryland cereal, wool and livestock production and mining. Annual mean rainfall across the Eyre Peninsula varies between 300 mm in the central parts to 500 mm in the south-east.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration >

25 µg/m³. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circle in Figure 68).

DWNs in the Eyre Peninsula NRM region

The Eyre Peninsula NRM region has one DWN located at Minnipa (installed in February 2012) which is located in the central northern region of the NRM (Figure 68). This DWN is owned and maintained by OEH with in-kind contributions from Eyre Peninsula NRM.

The land use in the DWN is dryland farming, with some timbered areas to the west (Figure 68).

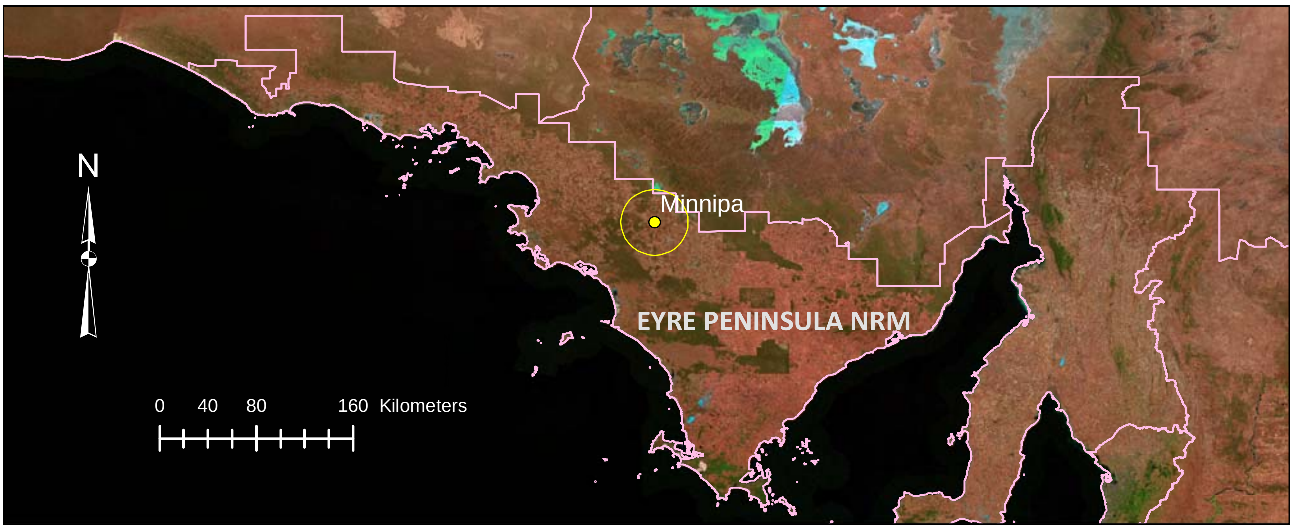


Figure 68. LandSat7 image: location and ground cover assessment area of the Minnipa DWN in the Eyre Peninsula NRM region.

Dust activity – annual trends

As this DWN has only been operational since February 2012, there is not enough long-term data to discuss annual trends. In the five months of operation in the 2011–12 DSY, the Minnipa DWN measured 3 hours of dust activity. For the 8 months of the 2012–13 DSY until February 2013, 23 hours of dust activity have been measured at Minnipa. The ground cover of the area surrounding the Minnipa DWN has been very good since June 2009 due to favourable seasonal conditions. Prior to June 2009 dust emissions in the area would have been likely during the summer months (Figure 69).

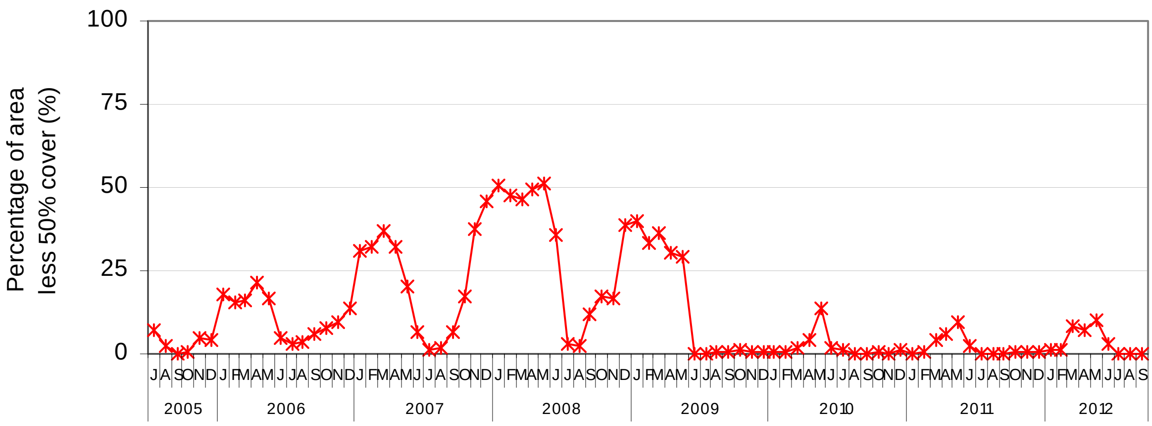


Figure 69. Cover time series for the Minnipa DWN.

Dust activity – directional component

The Minnipa DWN lies well within the NRM region boundary and receives local dust from all directions. It can also receive dust from regional events that have blown from distant sources.

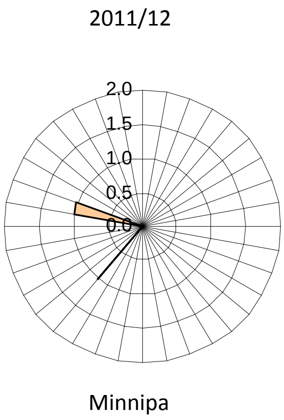


Figure 70. Annual dust rose for 2011–12 showing direction and hours of dust activity for the Minnipa DWN.

In the 2011–12 DSY, dust blew from the west-north-west (Figure 70) pointing at some of the high-risk erosion-prone soils identified in the 2010 NRM Board Report (published on the Eyre Peninsula CMA website at http://www.epnrm.sa.gov.au/). In September 2012 the predominant direction for the 13 hours recorded was from the north.

Causes of recent dust activity in the Eyre Peninsula NRM region

In 2011–12 dust was recorded in April (2 hours) and May (1 hour). The dust measured in April and May came from local sources to the west-north-west and south-west of the DWN and appears to be associated with fallow preparation for dryland cereal production. Scattered areas of bare ground are seen throughout the cropping regions in the north-west of the NRM during this period (Figure 71). The soils in this area have also been identified as being at high-risk and erosion-prone by the Eyre Peninsula NRM Board (http://www.epnrm.sa.gov.au/).

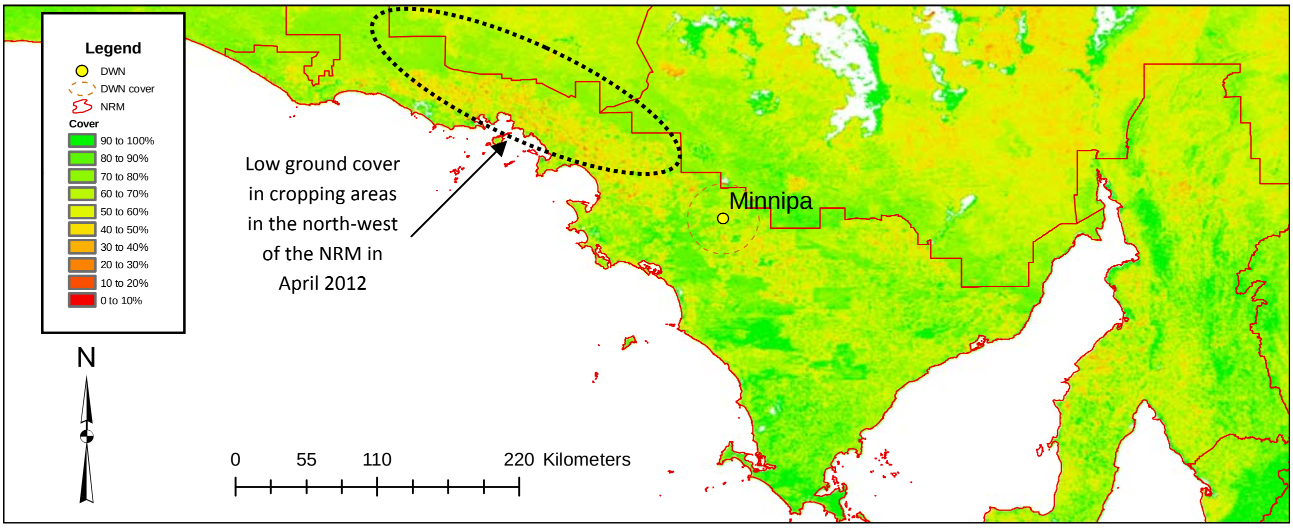


Figure 71. Cover (%) in the Eyre in Peninsula NRM region, April 2012.

Until February in 2012–13, dust has been measured during September, January and February. In September 13 hours of dust activity were recorded. This dust was sourced from outside the NRM region to the north-

north-east of the DWN in the Gawler Ranges region. During this time ground cover levels in the rangelands were below 50% (Figure 72) and rainfall was very much below average during the previous six months.

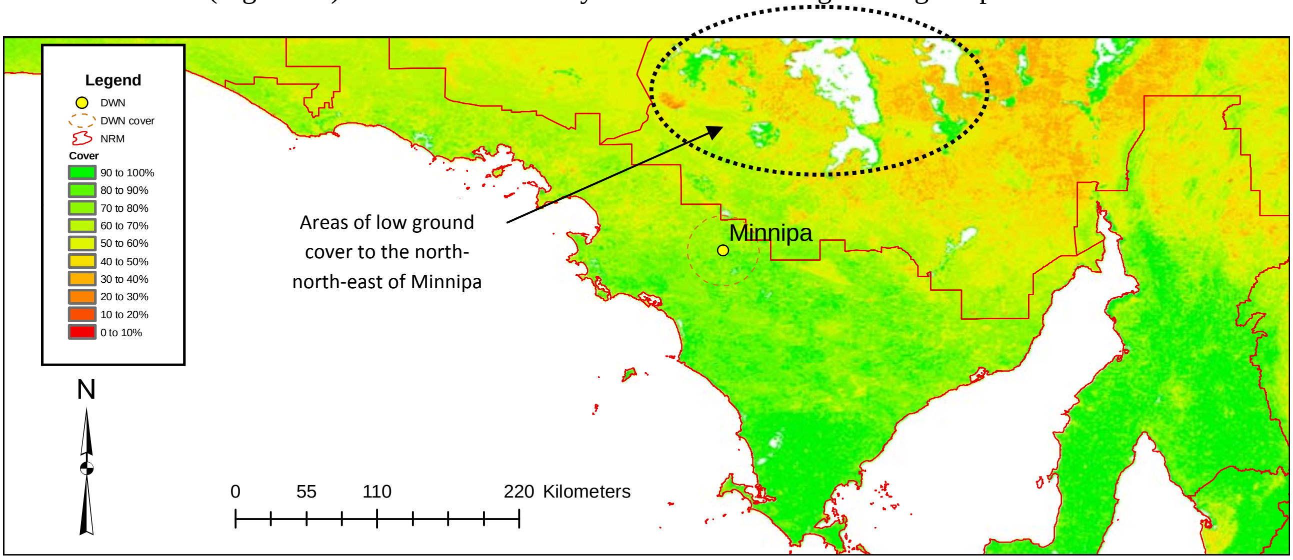


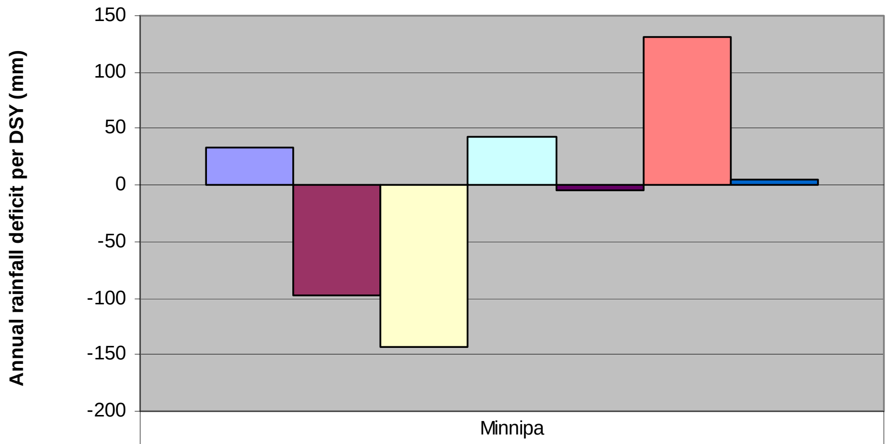
Figure 72. Ground cover (%) Eyre Peninsula and SA Arid Lands region, September 2012.

In February 2013 9 hours of dust activity was recorded, with most attributed to one event. Again dust was carried on strong northerly winds from the rangelands to the north causing severe haze, with the wind shifting to the south-west later in the day. During this time ground cover levels near Minnipa remained well above 50% cover.

Rainfall

The long-term average rainfall per DSY for Minnipa is 345 mm.

The annual rainfall deficits show the deviation from average at the Minnipa DWN since 2005–06 (Figure 73). Minnipa emerged from two years of drought in 2008–09 and returned to near average conditions in 2009–10. In 2010–11 exceptional rainfall fell across eastern Australia, and Minnipa recorded 476 mm, nearly 40% above its long-term average rainfall. 2011–12 saw a return to average conditions.



	Minnipa
2005/06	34
2006/07	-98
2007/08	-144
2008/09	42
2009/10	-5
2010/11	131
2011/12	5

Figure 73. Annual rainfall deficit for the Minnipa DWN.

Summary

The modelled risk of wind erosion in the Eyre Peninsula NRM region is mostly moderate to severe (Figure 2). Around the Minnipa DWN ground cover is generally well-maintained throughout the year in good seasons. However, in average to below average years, large areas in the Eyre Peninsula have inadequate ground cover that is prone to wind erosion (Figure 69).

As outlined by Giles Forward and Mary-Anne Young (SA Department of Environment and Natural Resources) in *Protection of agricultural land against erosion in the Eyre Peninsula Region, Seasonal Report November 2011*, (available from www.epnrm.sa.gov.au/SustainableAgriculture.aspx), concerns regarding machinery problems at sowing can prompt landholders to resort to tillage and burning as stubble management, which will increase their erosion risk.

The dryland cropping belt near the northern border areas of this NRM region has many areas that do not maintain cover and are at severe risk of wind erosion during the summer/autumn fallow period prior to dryland cereal production. In drier years pasture and stubble paddocks can also be at risk of wind erosion if they are overgrazed.

Some of these areas have soils that are very prone to erosion which, in combination with inadequate cropping management, can lead to severe wind erosion. This will become more substantiated with a growing DustWatch record for the site. Monitoring could be improved with a second DWN further west near Ceduna, upwind from the main erosion-prone area.

5.3.2 South Australian Arid Lands NRM

Catchment description

The South Australian (SA) Arid Lands NRM region covers over 50% of the state, some 520 000 km^2 (approximately). The region is sparsely populated, with towns including Oodnadatta, Roxby Downs and

Coober Pedy. Natural features include the Flinders Ranges, Lake Eyre, and many deserts. Widespread land use is cattle and sheep production on pastoral leases, parks and reserves and conservation areas and mining. Tourism during the winter months is an alternative source of income for some landholders and tourist operators. Rainfall in the Arid Lands is between 200 mm and 300 mm for the vast majority of the area. The Lake Eyre portion of the SA Arid Lands NRM region is the dustiest place in Australia due to the large natural sources of dust, like the lake systems. However, the surrounding rangelands can become dust sources if managed inadequately.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 $\mu g/m^3$. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circles in Figure 74).

DWNs in the SA Arid Lands NRM region

The SA Arid Lands NRM region has one DWN located at Moolawatana (installed in July 2008) (Figure 74). This DWN is owned and maintained by OEH with in-kind contributions from the local community.

The land surrounding the Moolawatana DWN is arid rangelands with the primary use being cattle production.

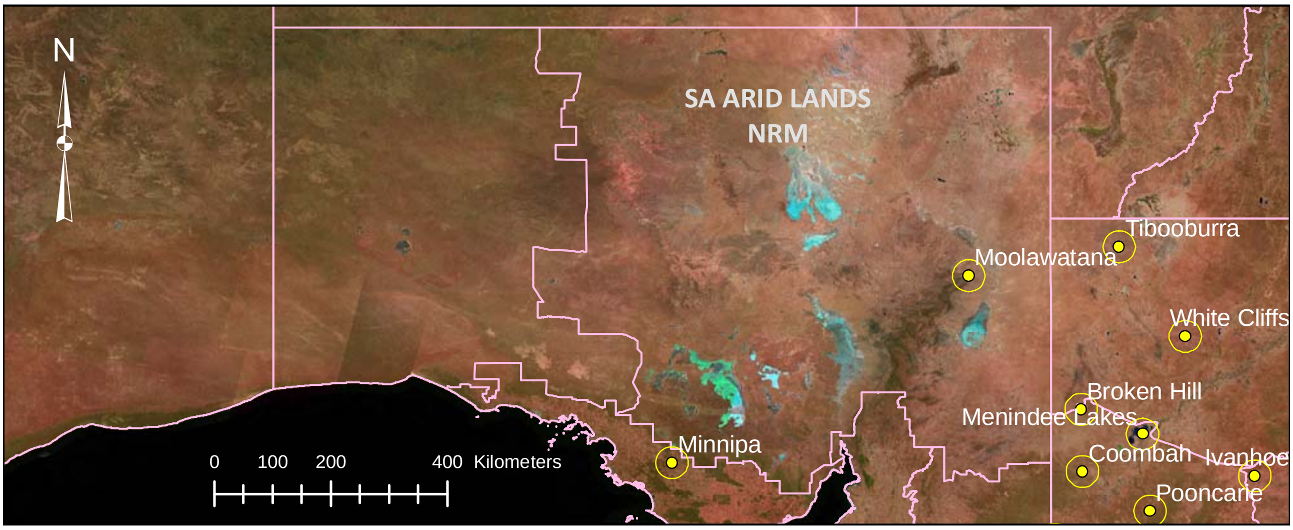


Figure 74. LandSat7 image: location and ground cover assessment area of the Moolawatana DWN in the SA Arid Lands NRM and other DWNs in neighbouring NRM regions.

Dust activity – annual trends

Dust activity was high in 2008–09 (264 hours) and increased to a peak in 2009–10 (301 hours). Dust activity at the DWN ceased in 2010–11 and remained at that level in 2011–12 (Figure 75). In 2008–09 Moolawatana was ranked highest for dust activity of the 28 DWNs in the network at that time (264 hours). In 2009–10 Moolawatana was ranked third (301 hours) behind Tibooburra (413 hours) and White Cliffs (320 hours) (Table 12).

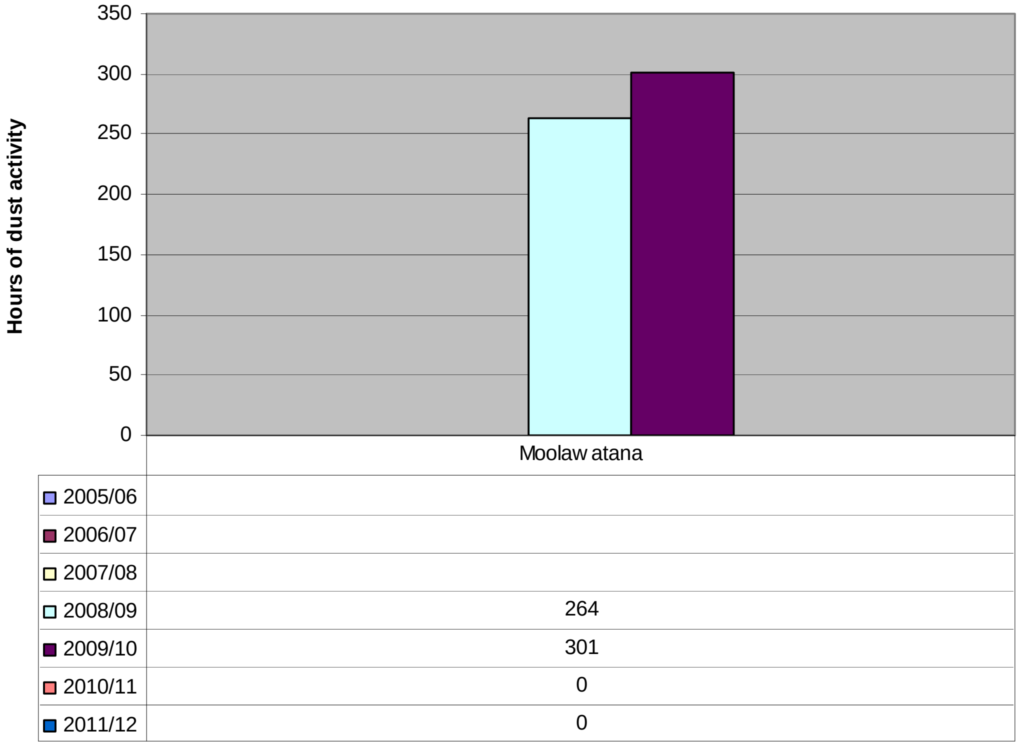


Figure 75. Annual hours of dust activity for the Moolawatana DWN.

Dust activity – directional component

The Moolawatana DWN lies well within the NRM region and receives dust from all directions. Dust at the Moolawatana DWN mainly comes from the north and south-south-easterly directions (Figure 76). The dry lake beds of Lake Frome to the south and the channels south of Lake Gregory to the north are known sources of dust but the associated rangelands are the dominant source of dust in the SA Arid Lands, particularly in dry years. "Red Dawn", the widely publicised dust storm that blanketed NSW in September 2009, had part of its source area in the northern part of the SA Arid Lands.

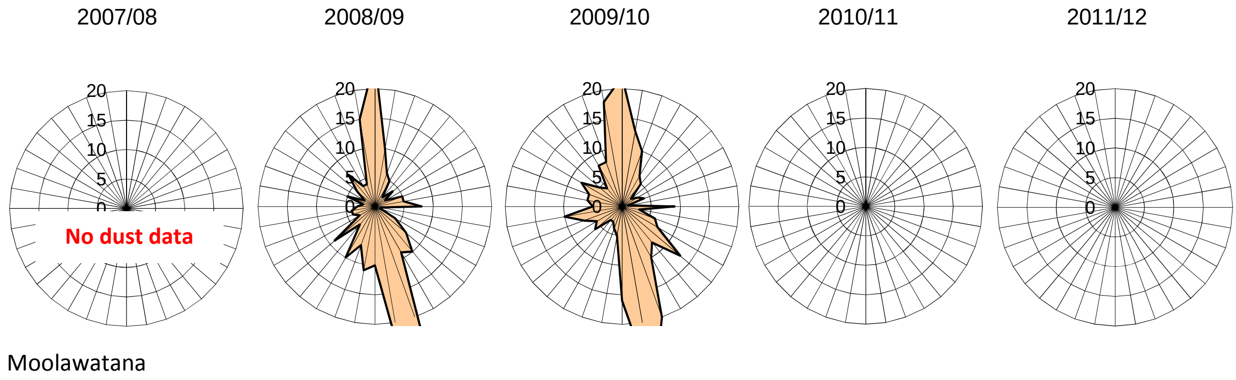


Figure 76. Annual dust roses showing direction and hours of dust activity for the Moolawatana DWN.

Causes of recent dust activity in the SA Arid Lands NRM region

Following consecutive years of well below average rainfall around the DWN, Moolawatana recorded the highest dust emissions for the entire network (264 hours) in its first year of operation in the 2008–09 DSY.

In 2009–10 dust emissions increased to a peak of 301 hours. Most dust activity occurred between September 2009 and March 2010. Several dust events from the lower Lake Eyre Basin (Figure 77) were carried through the Moolawatana area on strong southerly winds, resulting in widespread events that effected many parts of eastern Australia. Many other events travelled east (“Red Dawn”, 23 September 2009) and south with one major event travelling via New Zealand into Sydney (Hobart event, 12 September 2009). Raised dust was also emitted from some areas east and south of Lake Frome near Moolawatana with inadequate soil cover. During this time, on average, 76% of land in the assessment area had less than 50% ground cover.

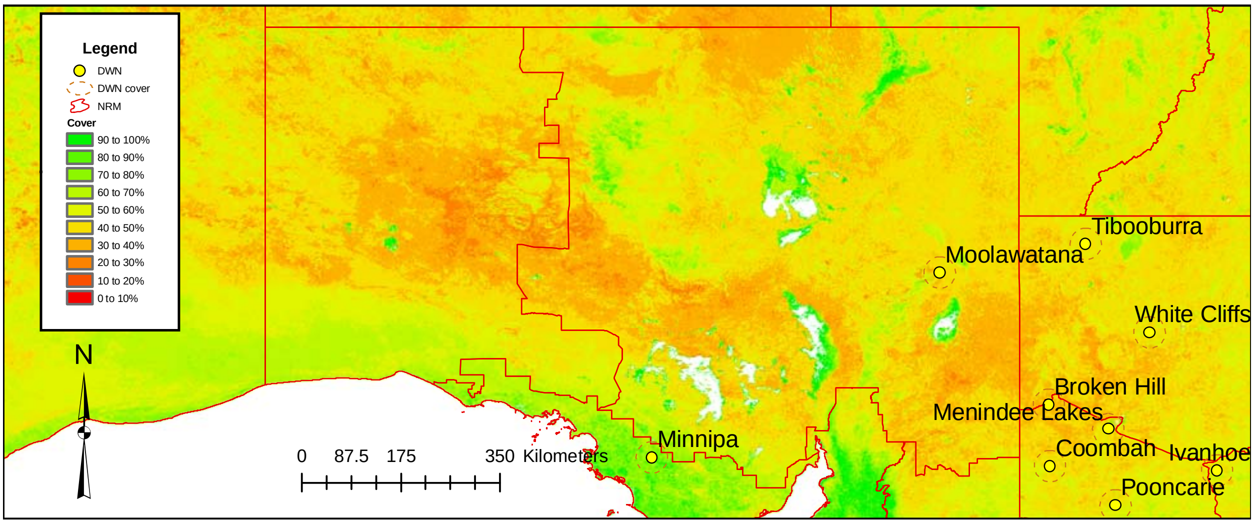


Figure 77. Widespread areas of low ground cover to the south and west of Moolawatana in November 2009.

In 2010–11 most areas in Australia, including the SA Arid Lands NRM region received above average or record rainfall. Following very good falls in 2010, ground cover recovered to levels that prevented wind erosion. The overall magnitude of the recorded dust at Moolawatana fell by three orders of magnitude to record no dust that DSY.

In 2011–12 no dust was recorded at Moolawatana. In 2011–12 rainfall levels were lower than in 2010–11 but still above average for eastern Australia. During the summer months, an average of 28% of land near Moolawatana had less than 50% ground cover, but above average rainfall ensured that no dust emissions occurred at that time.

Following 30 months of no dust activity, dust was recorded at the Moolawatana DWN in 2012–13 in September 2012 (6 hours) carried on north to north-westerly winds. Even though most of the rangelands were in reasonable condition, critical ground cover levels were approached in rangelands near Moolawatana and the rangelands of South Australia (Figure 78).

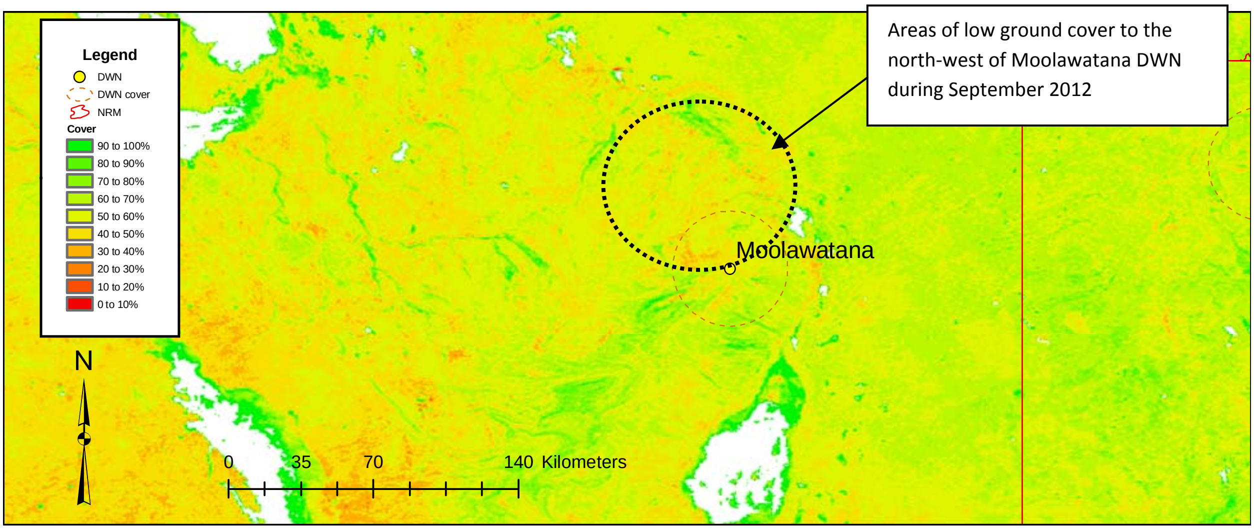
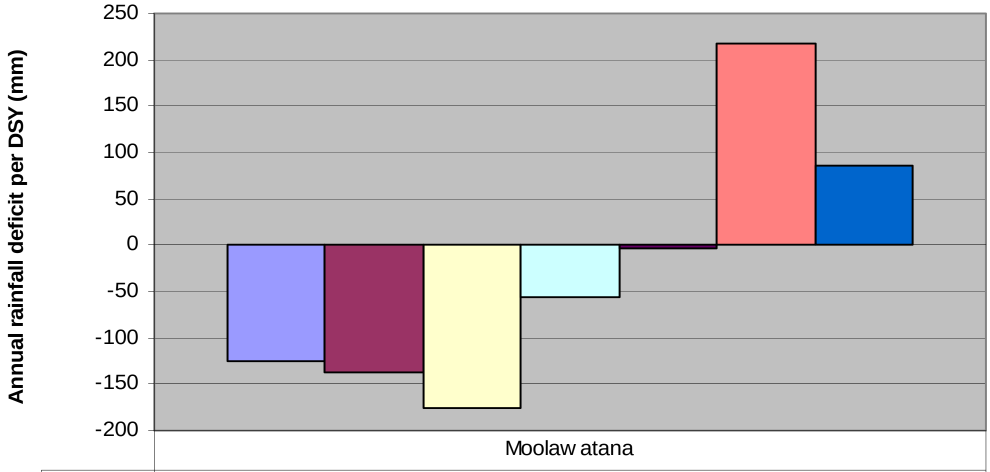


Figure 78. Areas of low ground cover near the Moolawatana DWN in September 2012.

Rainfall

The average annual rainfall at Moolawatana is 249 mm. The annual rainfall deficits show the deviation from average at the Moolawatana DWN since 2005–06 (Figure 79). Rainfall is summer dominant.

Below average rainfall was experienced from 2005–06 until 2008–09. Near average rainfall was received in 2009–10. In 2010–11 Moolawatana received above average rainfall of 446 mm, 218 mm above its long-term average. Although above average rainfall was received in 2011–12 the rainfall had decreased from the previous year.



	Moolaw atana
2005/06	-126
2006/07	-137
2007/08	-177
2008/09	-56
2009/10	-3
2010/11	218
2011/12	86

Figure 79. Annual rainfall deficit for the Moolawatana DWN.

Summary

The modelled risk of wind erosion in the SA Arid Lands NRM region is mostly localised and moderate in the west, to widespread moderate to severe in the east (Figure 2). Around the Moolawatana DWN ground cover has improved dramatically since 2009–10 due to good seasonal conditions. As the seasons return to drier conditions, care will be needed to prevent loss of ground cover due to overgrazing. Current practices are maintaining ground cover except in areas south and east of Lake Frome.

If well-managed, the rangelands in the SA Arid Lands NRM region have a good resilience against drought as shown by the well-managed ground cover around the Moolawatana DWN in 2009–10. Nevertheless, if drought conditions prevail and land management practises are inadequate these rangelands will become one of the major dust source regions in Australia and will have great impact on the communities downwind. Under extreme conditions dust storms from the SA Arid Lands NRM region can reach the major population centres on the east coast, New Zealand and Antarctica and cause significant disruption and financial losses for the Australian economy as demonstrated by the “Red Dawn” and other events in late 2009.

5.3.3 South Australian Murray–Darling Basin NRM

Catchment description

The SA Murray–Darling Basin NRM region covers an area of approximately 56 000 km^2. The region extends from the NSW and Victorian border region to the east, to the Mount Lofty Ranges in the west. Major towns include Renmark, Berri, Mt Barker and Murray Bridge. Natural features include the Mount Lofty Ranges to the west, the River Murray that runs through the central and southern portion and Mallee country to the south-east. Land uses include grazing of rangelands to the north, dryland cropping and grazing for wool and meat production in the south and irrigated horticulture along the River Murray. Rainfall in the SA Murray–Darling Basin NRM region ranges from 300 mm in the north-eastern corner to 800 mm in the foot slopes of the Adelaide and Mount Lofty ranges.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 $\mu g/m^3$. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circles in Figure 80).

DWNs in the SA Murray–Darling Basin NRM region

The SA Murray–Darling Basin NRM region has one DWN located at Lameroo (installed in February 2012) which is part of the Murray Mallee and Murray Plains region of the NRM. This DWN is owned and maintained by OEH with in-kind contributions from the SA Murray–Darling Basin NRM.

The land use surrounding the Lameroo DWN is mixed dryland farming, with some forestry to the south and into the South East NRM region (Figure 80).

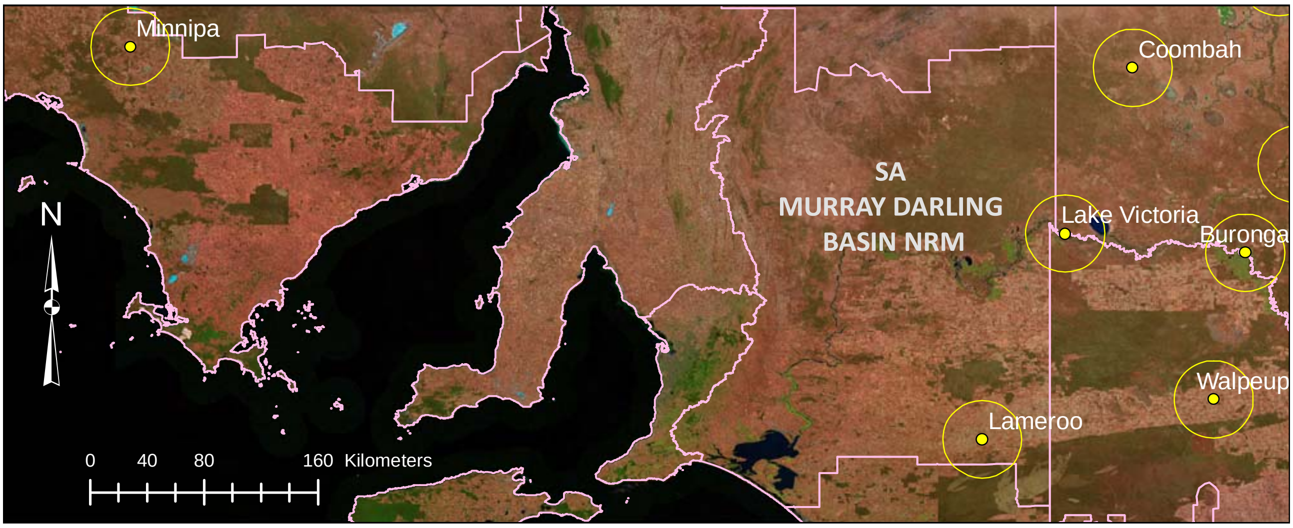


Figure 80. LandSat7 image: location and ground cover assessment area of the Lameroo DWN in the SA Murray–Darling Basin NRM and other DWNs in neighbouring NRMs.

Dust activity – annual trends

As this DWN has only been operational since February 2012, there is not enough long-term data to discuss annual trends. In the five months of operation in the 2011–12 DSY, the Lameroo DWN measured 7 hours of dust activity. For the 10 months of the 2012–13 DSY until April 2013, 19 hours of dust activity has been measured at Lameroo.

Dust activity – directional component

The Lameroo DWN is located near the southern border of the NRM region and receives local dust from all directions. It can also receive dust from regional events that have blown from distant sources.

The major directions from which dust is received in the past 14 months (February 2012 to April 2013) are the south-west, the west and the north (orange dust rose in Figure 81). All three directions point at dryland farming areas within the Murray–Darling Basin NRM region. The south-westerly component might include some dust from dryland farming across the border in the South East NRM region. No dust was received in Lameroo from any easterly direction, nevertheless this is related to the direction of the strong winds for the site (blue wind rose in Figure 81), rather than good ground cover in the area. There were no strong winds recorded between north-north-east and south at all during this time.

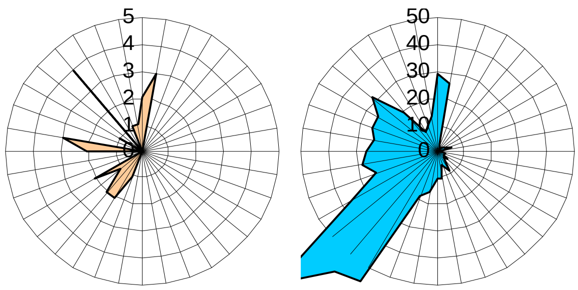


Figure 81. Dust (orange) and wind (blue) roses showing direction and hours of wind and dust activity from February 2012 to April 2013 for the Lameroo DWN.

Causes of recent dust activity in the NRM

In the 2011–12 DSY dust was recorded in April (2 hours), May (4 hours) and June (1 hour). Both the April and June events were probably from local sources in fallow preparation and early crop stages. In May dust was sourced from cultivated areas up to 100 km away in the north (Figure 82).

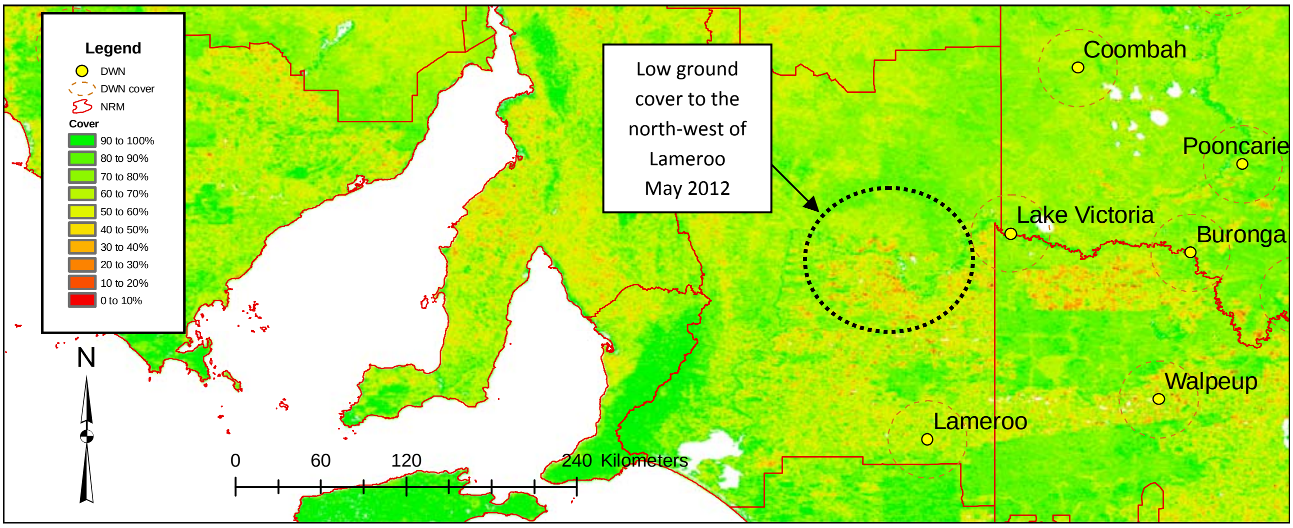


Figure 82. Ground cover (%), SA Murray–Darling Basin, May 2012.

Until April in 2012–13, dust activity has been measured during November (1 hour), January (2 hours), February (6 hours) and March (10 hours). The increase in dust activity is in line with the increase of bare ground in the surrounding dryland cropping areas (Figure 82). The February and March dust events were on the back of strong south-westerly winds.

Since 2009–10 the area with greater than 50% cover (red line in Figure 83) has remained above 90% of the circle around Lameroo largely driven by two summers of good rainfall. Of all the DWNs in this project, Lameroo is the windiest site (blue line in Figure 83), with an annual average of 951 hours of wind > 30 km/h since the 2005–06 DSY. Suspected gross failures of crops in 2006–07, 2007–08 and 2008–09, high winds and low rainfall would have led to widespread wind erosion during that time.

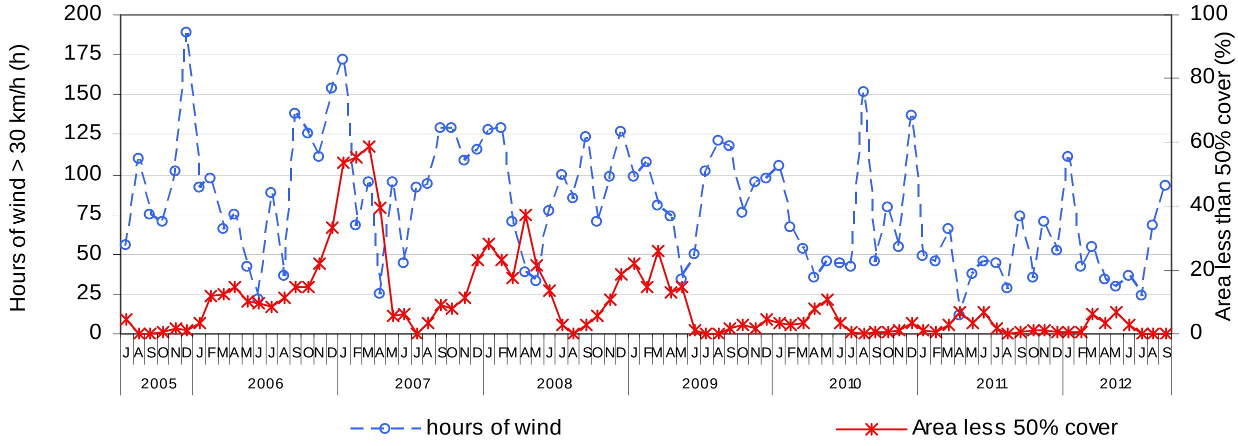
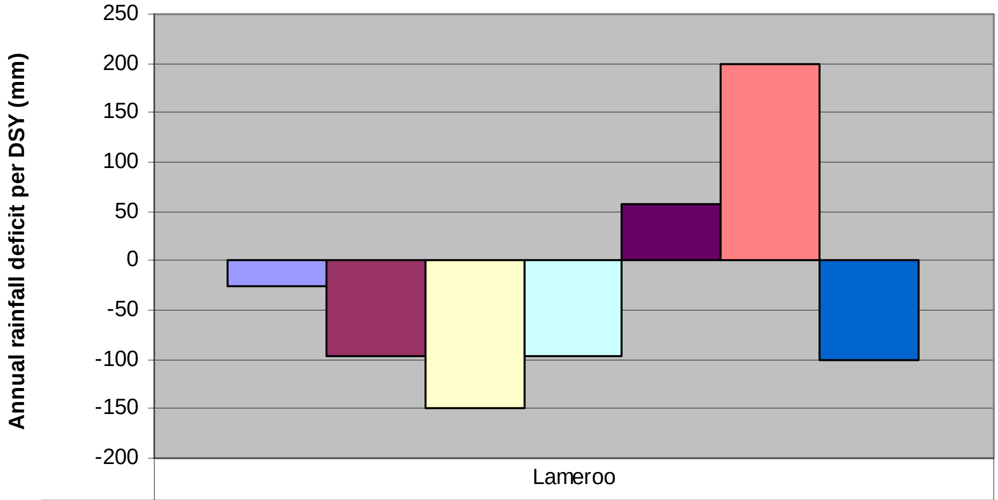


Figure 83. Hours of wind and % area at risk of wind erosion (area with less than 50% ground cover) from July 2005.

Rainfall

The long-term annual average rainfall per DSY for Lameroo is 385 mm.

The annual rainfall deficits show the deviation from average at the Lameroo DWN since 2005–06 (Figure 84). Below average rainfall was experienced from 2005–06 until 2008–09. Above average rainfall was received in 2009–10. In 2010–11 Lameroo received above average rainfall of 584 mm, 199 mm above its long–term average. Below average conditions returned to Lameroo in 2011–12.



	Lameroo
2005/06	-25
2006/07	-97
2007/08	-150
2008/09	-97
2009/10	57
2010/11	199
2011/12	-101

Figure 84. Annual rainfall deficit (mm) for the Lameroo DWN.

Summary

The modelled risk of wind erosion in the SA Murray–Darling Basin NRM is moderate to severe for most parts of the NRM region (Figure 2).

Following a good season in 2010–11, ground cover around the Lameroo DWN was still reasonable throughout the following year and little dust was recorded in 2011–12. The 2012–13 period is shaping up as a very dry year for the area and summer/autumn ground cover values have dropped below the critical 50% in some of the dryland cropping areas. Dust has been recorded from those directions.

The central and southern region of the NRM region has many areas that do not maintain ground cover and are at severe risk of wind erosion in the summer/autumn fallow of dryland cereal production. These areas are likely to show up on the DustWatch records in years to come.

Two additional DWNs, at the following locations, would greatly benefit both the SA Murray–Darling Basin NRM region and the entire DustWatch network:

1. the Loxton Research Centre, to distinguish between dust sources in the SA Murray–Darling Basin NRM region and the Mallee NRM region
2. the central north area along the border with the SA Arid Lands NRM region, preferably in the NextG coverage area approximately 70 km due south of the Yunta Automatic Weather Station.

5.4 Western Australia

5.4.1 Northern Agricultural Catchments Council NRM region

Catchment description

The Northern Agricultural Catchments Council region of Western Australia covers approximately 75 000 km^2 to the north of Perth. The only large town is Geraldton on the coast; other townships include Mullewa, Dongara and Moora. The area is subdivided into four regions being Greenough in the north, West Midland in the west, Moore River in the south-east and Yarra Yarra in the east. Land uses are predominantly cereal and lupin production and livestock. Rainfall in the NRM region is predominantly between 300 mm and 400 mm increasing in the south-west to 800 mm on the coast. There are some large nature reserves and national parks along the southern coast, in the north-west and south-east.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration > 25 $\mu g/m^3$. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circle in Figure 85).

DWNs in the Northern Agricultural Catchments Council NRM region

The Northern Agricultural Catchments Council NRM region has one DWN located at Mullewa (installed in July 2008). This DWN is owned and maintained by the Department of Agriculture and Food WA (DAFWA).

The land use surrounding the Mullewa DWN is dryland farming. There are scattered pockets of forestry within this area (Figure 85).

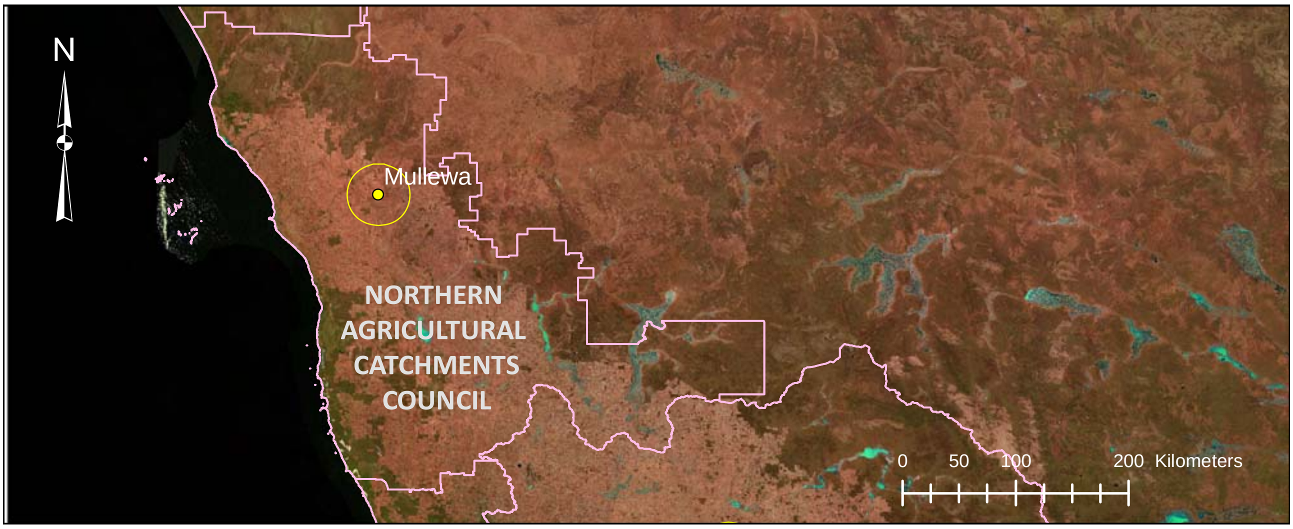


Figure 85. LandSat7 image: location and ground cover assessment area of the Mullewa DWN in the Northern Agricultural Catchments Council NRM.

Dust activity – annual trends

In 2008–09 no dust was recorded at Mullewa. Dust activity increased in 2009–10 to its recorded annual peak of 27 hours. Dust activity declined in 2011–12 (9 hours) (Figure 86). For 2012–13 (until February 2013), dust activity is 8 hours.

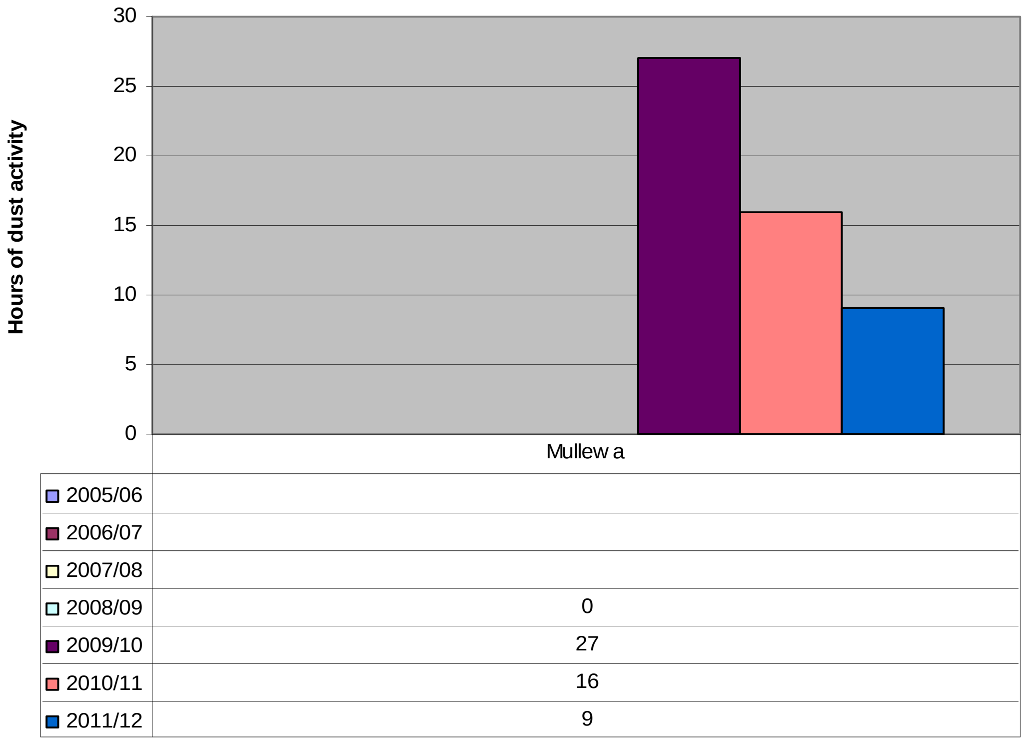


Figure 86. Annual hours of dust activity for the Mullewa DWN.

Dust activity – directional component

The Mullewa DWN is located well within the NRM region's boundary and receives local dust from all directions. It can also receive dust from regional events that have blown from distant sources.

In 2009–10 and 2010–11 Mullewa had a strong directional component from the south-west (Figure 87), pointing at dryland farming areas within 25 km of Mullewa. In 2011–12 dust was also received from the east, again related to dryland farming. Smaller signals of dust come from the west and north-east.

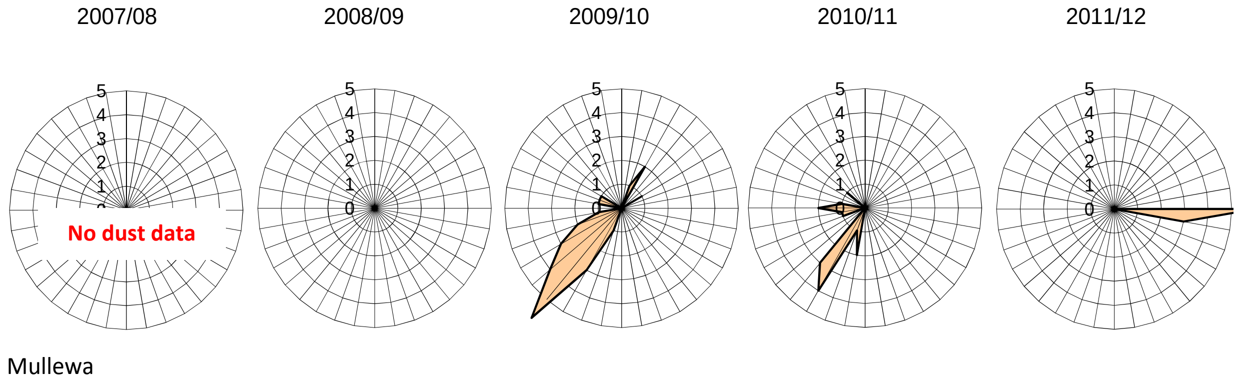


Figure 87. Annual dust roses (showing hours of dust activity and direction) for the Mullewa DWN.

Causes of recent dust activity in the NRM

In 2008–09 no dust was recorded at the Mullewa DWN.

In 2009–10 the annual dust activity was 27 hours and was recorded between July 2009 and March 2010. The maximum was recorded in February (9 hours) from sources to the south-west of the DWN.

Annual dust activity in 2010–11 was 16 hours and was recorded from October to April from local sources to the west and south-west, probably due to fallow management of the winter crop. No dust was measured for the remainder of the DSY. Mullewa topped the DustWatch network ranking for this year, recording the most hours for the year.

In 2011–12 dust measured in May (2 hours) came from local sources to the east of the DWN due to winter fallow preparations (Figure 88).

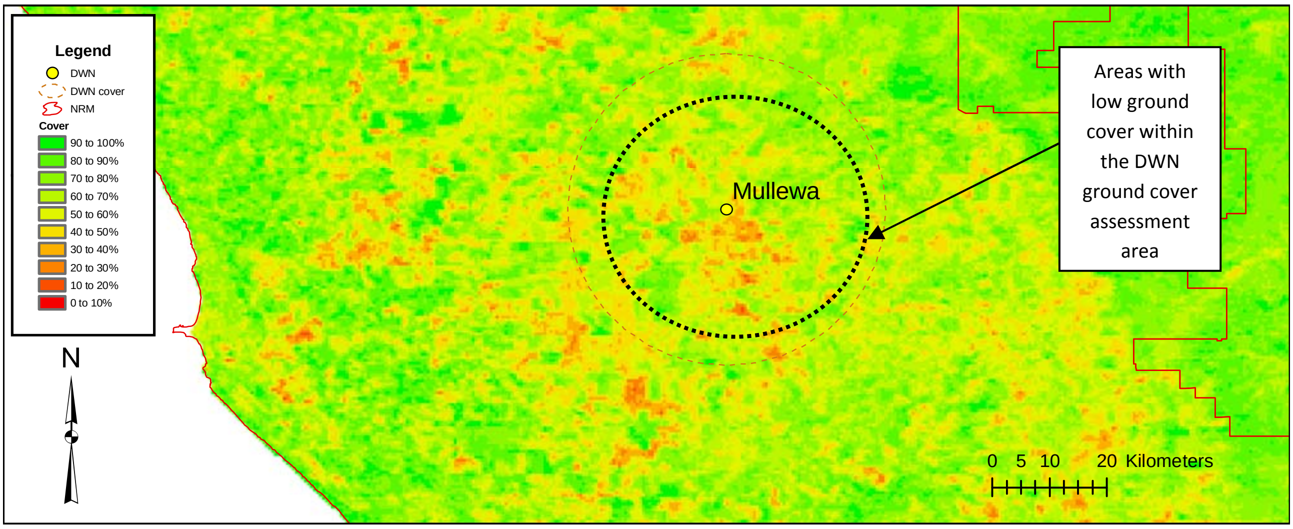


Figure 88. Low ground cover in the Northern Agricultural NRM near Mullewa DWN, May 2012.

In 2012–13 dust activity was measured for the first time in nine months in December 2012 (6 hours). Three events in this month were attributed to local sources: bare paddocks after harvest and some failed crops (Figure 89). In February 2 hours of dust activity were measured. These events were driven by several days of strong local south-east to south-west winds.

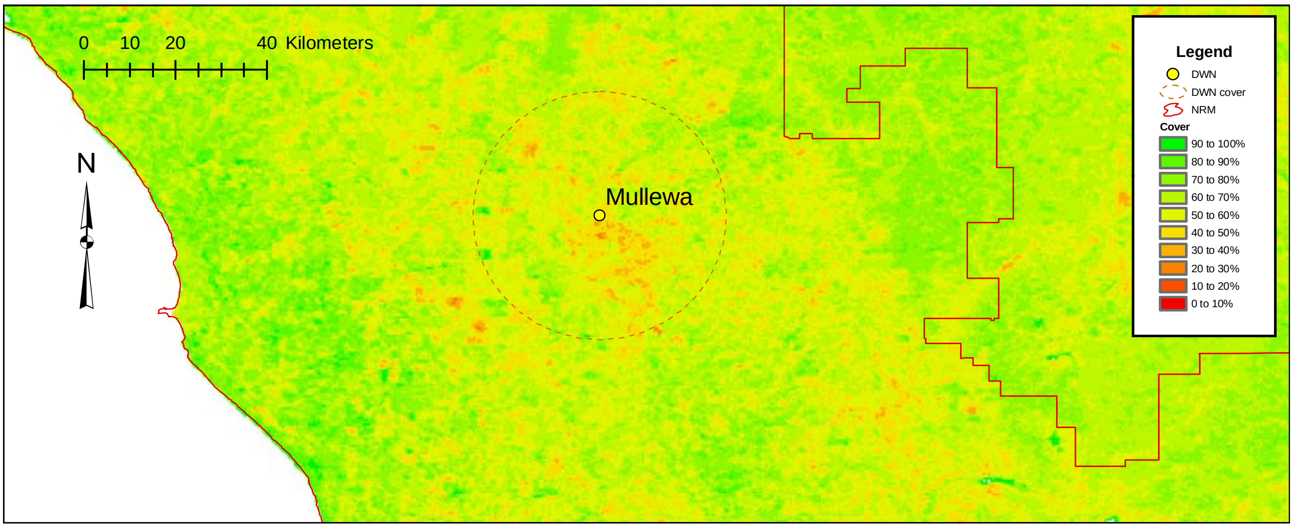


Figure 89. Dust sources to the south-east of the Mullewa DWN, December 2012.

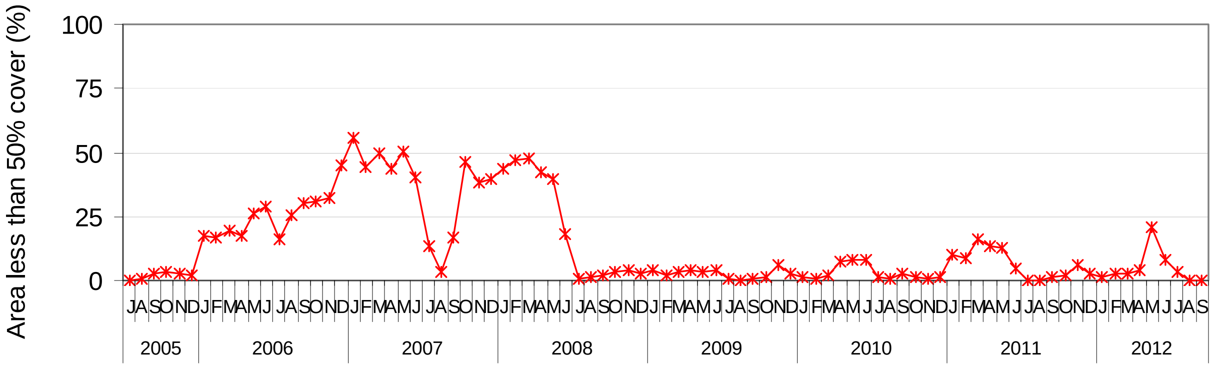


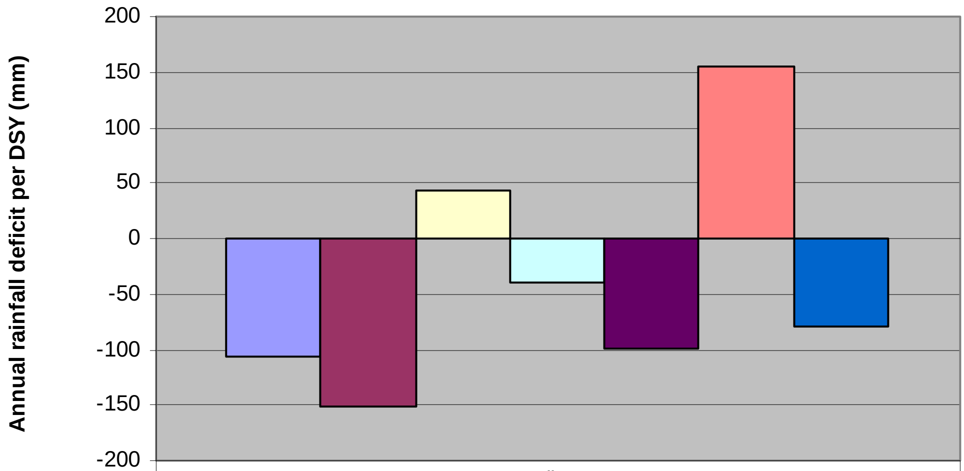
Figure 90. Monthly ground cover time series (%) in and around the Mullewa DWN from July 2005 to September 2012.

Regionally the potential for wind erosion is highest during autumn (Figure 90) when ground cover is at its lowest. Although ground cover has improved greatly since the crop failures of 2006–07 and 2007–08, there has been a trend of decreasing autumn ground cover levels since 2008–09 to 2011–12, possibly due to stubble burning as preparation for winter cropping.

Rainfall

Mullewa (BoM station 8095) averages 336 mm a year. The annual rainfall deficits show the deviation from average at the Mullewa DWN since 2005–06 (Figure 91).

Below average rainfall was experienced in all years from 2005–06 until 2009–10, with the exception of 2007–08. Above average rainfall was received in 2010–11 when Mullewa recorded 491 mm, 155 mm above its long-term average. Below average conditions returned to Mullewa in 2011–12.



	Mullew a
2005/06	-107
2006/07	-151
2007/08	43
2008/09	-39
2009/10	-100
2010/11	155
2011/12	-79

Figure 91. Annual rainfall deficit (mm) for the Mullewa DWN.

Summary

The modelled risk of wind erosion in the Northern Agricultural Catchments Council NRM region is widespread and moderate in the northern part and localised and moderate in the southern part of the NRM region (Figure 2).

Around the Mullewa DWN, ground cover has been well-maintained in recent years. However, fallow management such as stubble burning and weed management for winter crops provide opportunities for reduced ground cover and associated wind erosion. This would have been aggravated during the very dry years of 2006–07 and 2007–08 which most likely saw some serious wind erosion. The recently measured dust activity since the installation of the local DWN at Mullewa has been predominantly related to crop management practices in the fallow management. The overall hours were not disastrous but do leave room for improvement.

Local roadside surveys recorded a reduction in sheep numbers during recent dry years but no increase in the following wet years, indicating a possible shift in management practices away from sheep.

Windrow burning has increased in recent years, and has assisted in the retention of stubble, but hot and complete burns have been on the increase in 2012–13 due to high remaining biomass and concerns about machinery failure at sowing. This explains part of the recent dust emissions.

Additional DWNs to the north and south of the current DWN in this NRM region would help to identify the dust source areas, and would turn a single point measurement into a monitoring network.

5.4.2 Wheatbelt NRM region

Catchment description

The Wheatbelt NRM region of Western Australia is located inland to the west of Perth and covers approximately 120 000 km^2. It includes the Avon, Lockhart and Yilgarn river systems. Land uses are mainly agriculture, Crown land, minor pastoral leases and mining. Rainfall in the majority of the Wheatbelt NRM region is 400 mm with some areas in the west reaching up to 600 mm.

Data at DWNs

At all DWNs, rainfall, ground cover and wind data is available from 2005, and dust data from the date of installation. Data is updated weekly and is current. The annual reporting period is called a Dust Storm Year (DSY) and is from 1 July to 30 June. Dust is recorded as the hours of dust activity with PM_{10} concentration $> 25\ \mu g/m^3$. Land use, rainfall and ground cover surrounding the DWNs presented refer to the surrounding 25 km (yellow circles in Figure 92).

DWNs in the Wheatbelt NRM region

The Wheatbelt NRM region has two DWNs which are located at Merredin (installed in October 2009) and Newdegate (installed in December 2011). The Merredin DWN is owned and maintained by DAFWA. The Newdegate DWN is owned by Wheatbelt NRM, maintained by DAFWA, with in-kind contributions from the local community.

The land use in the surrounding the Merredin and Newdegate DWNs is dryland farming with scattered pockets of forestry. To the west and east of the Newdegate assessment area are salt lakes (Figure 92).

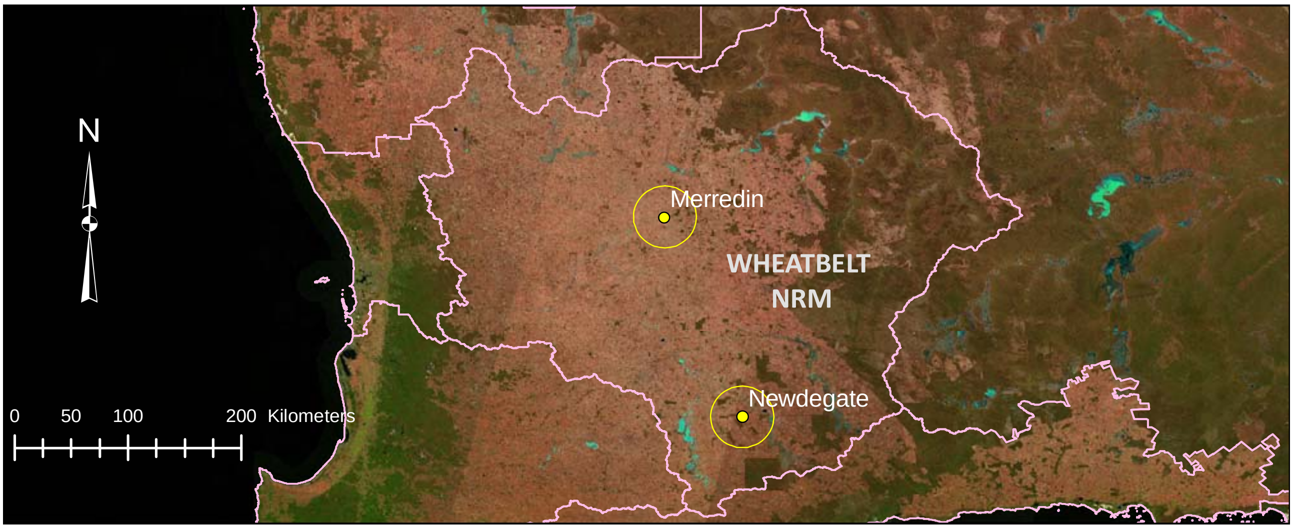


Figure 92. LandSat7 image: location and ground cover assessment area of DWNs in the Wheatbelt NRM region.

Dust activity – annual trends

The Merredin DWN has experienced various technical difficulties since its installation in October 2009. This has resulted in some periods of outage (Figure 93). As a result there is not enough long-term data to discuss annual trends at Merredin. In the three months of operation in the 2011–12 DSY, the Merredin DWN measured 3 hours of dust activity. In the 2012–13 DSY (until March 2013), 11 hours of dust have been measured at Merredin.

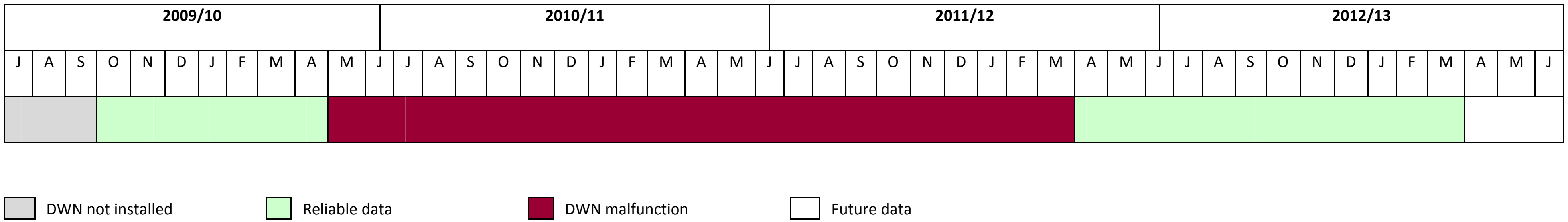


Figure 93. Reliability of data from the Merredin DWN since the 2009–10 DSY.

The Newdegate DWN has only been operational since December 2011 and there is not enough long-term data to discuss annual trends. In the seven months of operation in the 2011–12 DSY, the Newdegate DWN measured no dust activity. For the eight months of the 2012–13 DSY until February 2013, 10 hours of dust have been measured at Newdegate.

Dust activity – directional component

The Merredin and Newdegate DWNs are located well within the NRM region's boundary and can receive local dust from all directions. They can also receive dust from regional events that have blown from distant sources.

The Merredin DWN primarily receives dust from the south-south-east to the south-west and west. Dust is also received from the north to north-east.

At Newdegate dust has been recorded from the north-west. Wind data has been unavailable since November 2012. However, wind data from Lake Grace suggests that Newdegate also receives dust from the south-west to south-east directions.

Causes of recent dust activity in the NRM

In 2009–10 no dust was recorded at the Merredin DWN. In 2010–11 the Merredin DWN was experiencing malfunction and did not collect reliable dust data. The Newdegate DWN was not installed in both these years.

In 2011–12 dust activity was recorded at Merredin in early June from local sources to the north-east. Local agencies identify March to July as having the highest risk to wind erosion in mixed farming areas. Low ground cover at this time is due to sheep grazing the last of the summer feed, and soil disturbance due to land preparation for winter crops. In May and June 2012, Merredin experienced the lowest levels of ground cover in six years, with 13% and 18% of land respectively having less than 50% ground cover (Figure 94). Newdegate recorded no dust activity.

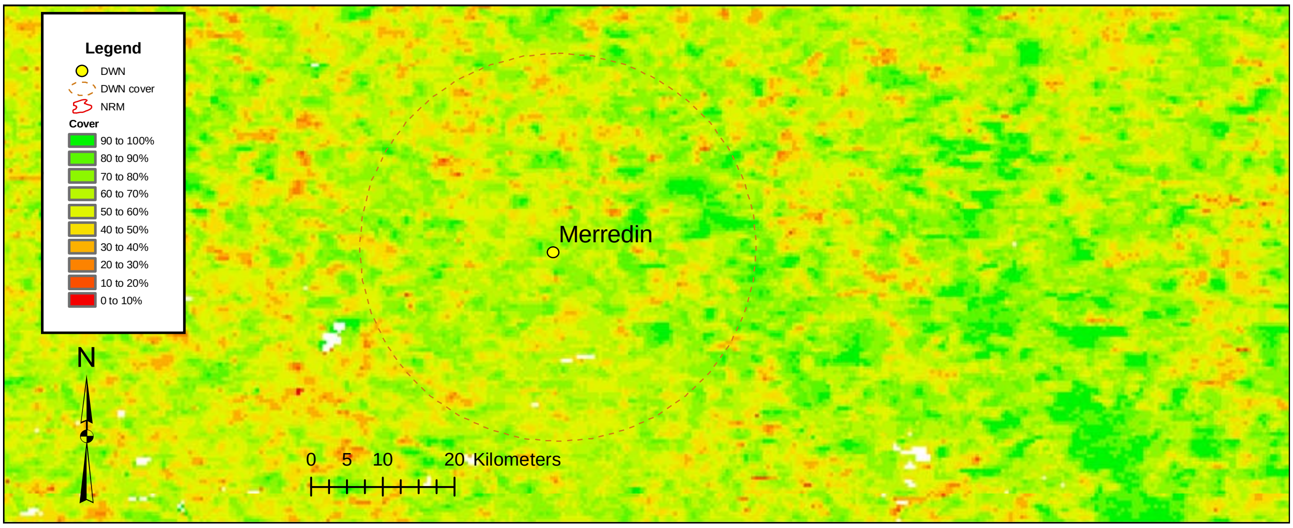


Figure 94. Patchy areas of low ground cover (%) near the Merredin DWN, May 2012.

In 2012–13, the Newdegate DWN recorded 1 hour of dust activity in September 2012, coming from the north-west. Both sites recorded dust in early December, carried on winds from the south-south-east at Merredin (no wind data available at Newdegate). This was attributed to low vegetation following harvest of winter crops and failed crops. On 15 January dust was recorded at both sites (Newdegate 5 hours, Merredin

1 hour), with a moderate dust storm recorded at Newdegate. Dust was carried on pre-frontal north-westerly winds before swinging to the south-west and south-east (Figure 95).

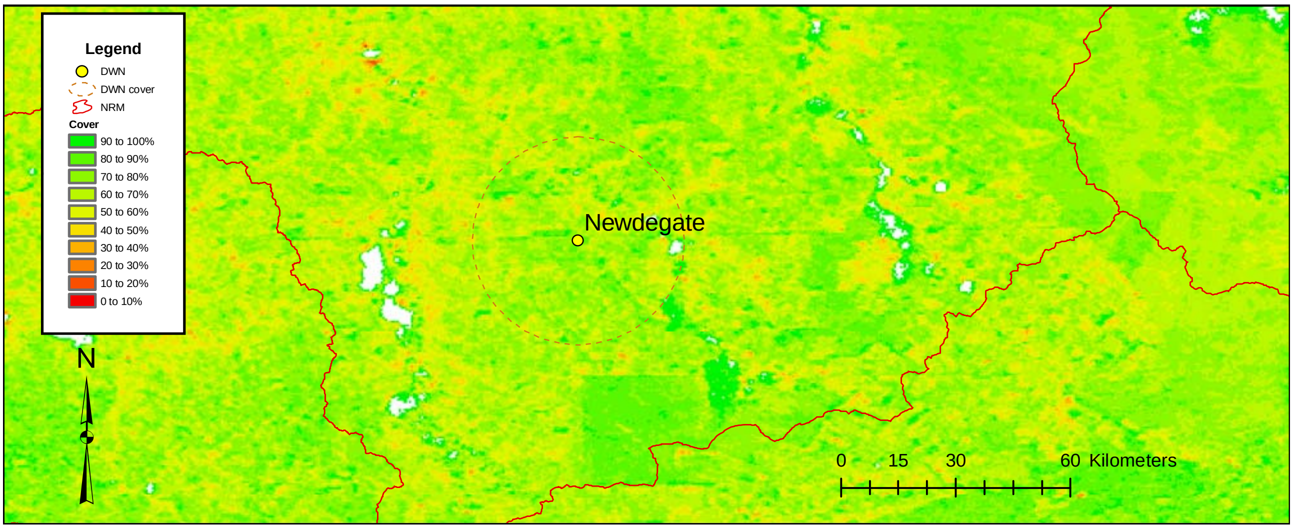


Figure 95. Areas of low ground cover to the north-west and south-west near Newdegate, January 2013.

In February 2013 three dust events were recorded at Merredin, each carried on pre-frontal northerly winds before changing to the south-west to south-east.

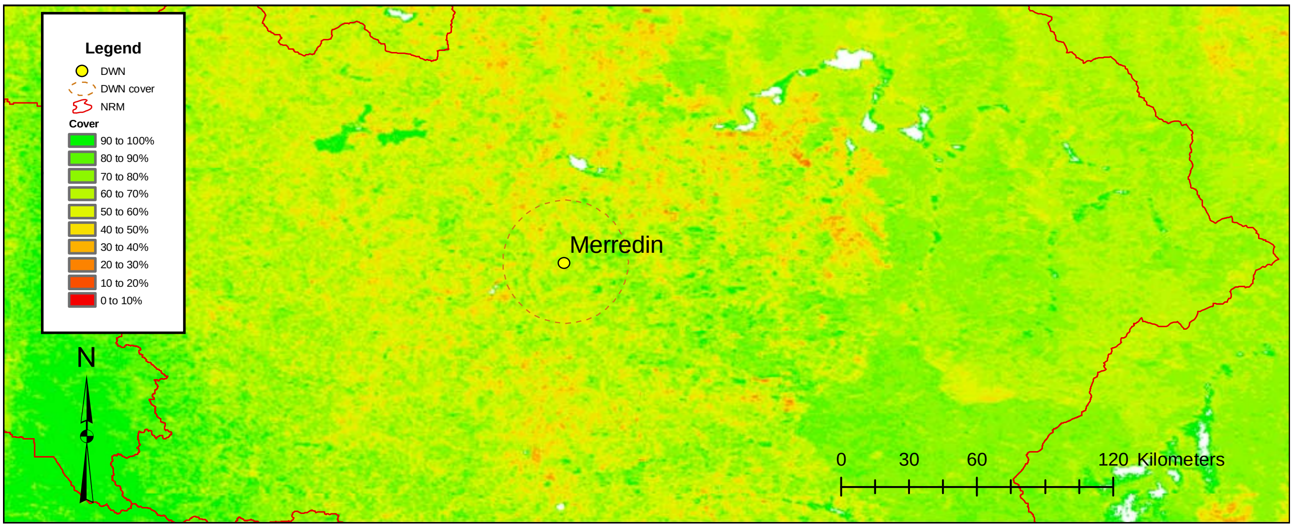


Figure 96. Areas of low ground cover to the north-west and south-west near Merredin, March 2013.

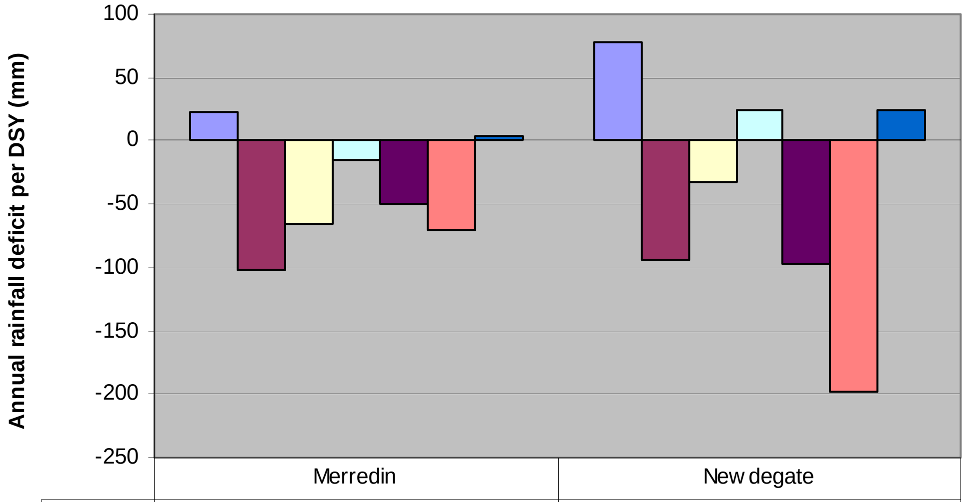
The Newdegate site is one of the windiest in the DustWatch project, averaging 819 hours of wind > 30 km/h per year since the 2005–06 DSY.

The area surrounding the Newdegate DWN generally maintains ground cover throughout the year, with ground cover levels dropping in the autumn months as a result of fallow preparation for winter crops.

Rainfall

The average annual rainfall at Merredin is 313 mm and at Newdegate is 370 mm. The annual rainfall deficits show the deviation from average at each DWN since 2005–06 (Figure 97). Rainfall is winter dominant.

Merredin has recorded five years of below average conditions from 2006–07 until 2010–11 with a return to average conditions in 2011–12. Newdegate has also experienced below average conditions, with 2010–11 rainfall nearly 200 mm below average. In 2011–12 Newdegate returned to slightly above average conditions.



	Merredin	New degate
2005/06	22	78
2006/07	-102	-94
2007/08	-65	-32
2008/09	-15	24
2009/10	-50	-97
2010/11	-70	-198
2011/12	5	25

Figure 97. Annual rainfall deficit (mm) for DWNs in the Wheatbelt NRM region.

Summary

In the Wheatbelt NRM, ground cover patterns are determined by preparations for winter dryland cropping, with lowest ground cover generally in the early autumn in both regions. Recent dust events have been small and locally sourced and are related to cropping management practices.

According to one local NRM officer, “There are the occasional erosion events outside this period, but our highest risk period is at the end of the summer–autumn feed gap when sheep have consumed most of the vegetation (low ground cover), and when farmers begin to seed their paddocks (soil disturbance and a further reduction in ground cover). There is almost no erosion risk once the vegetation has established after sowing.”

6 Further information

6.1 References

Auditor General (2008), *Regional Delivery Model for the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality*. Canberra, Australian National Audit Office, (ANAO Report: 21), 130 pp.

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6.2 Useful websites

Australian Bureau of Meteorology (BoM) – for current and past weather data and maps, seasonal analysis and long-term trends: http://www.bom.gov.au.

Office of Environment and Heritage – DustWatch for all archived and current monthly DustWatch reports for NSW and Australia: http://www.environment.nsw.gov.au/dustwatch/dwreports.htm.

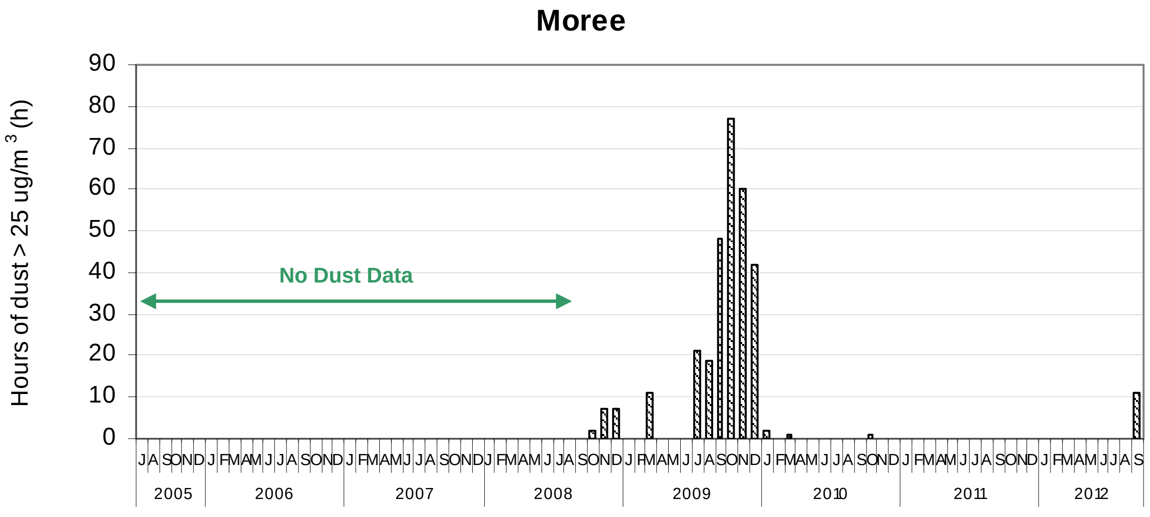
Community DustWatch Information Interface (CoDii) – This website contains current and past DustWatch and BoM records. It is password protected. Please apply to dustwatch@environment.nsw.gov.au if you require access: https://codii.environment.nsw.gov.au/.

Griffith University - DustWatch Australia – for current and past dust data and information: http://dustwatch.edu.au/.

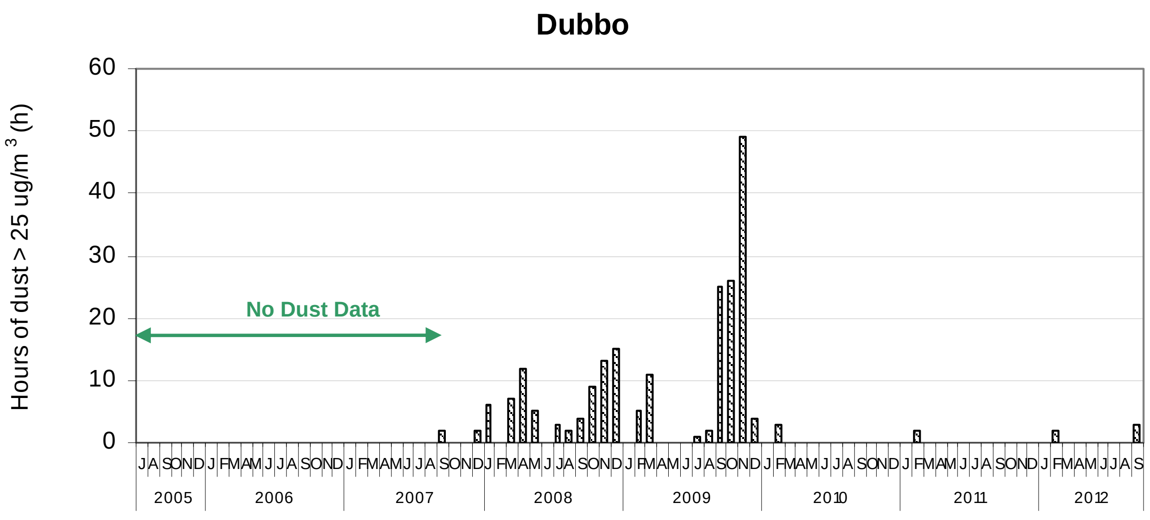
7 Dust activity time series for each NRM region

7.1 New South Wales

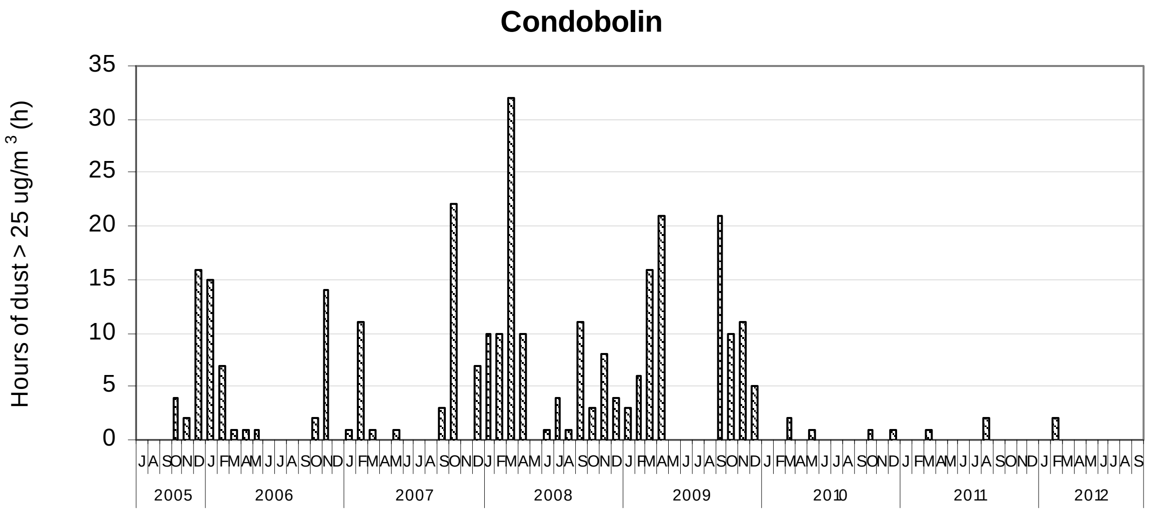
7.1.1 Border Rivers–Gwydir CMA region

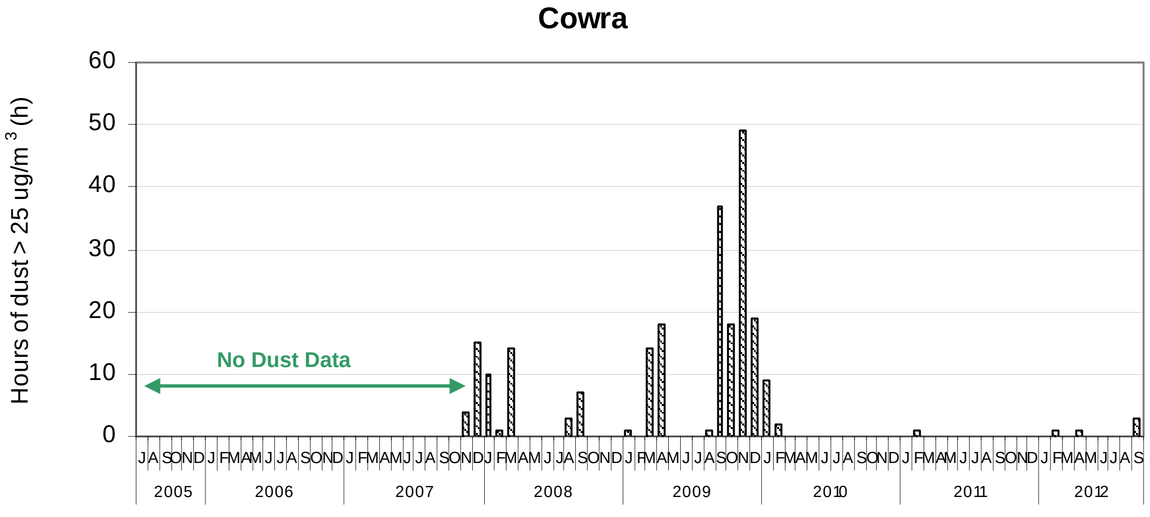


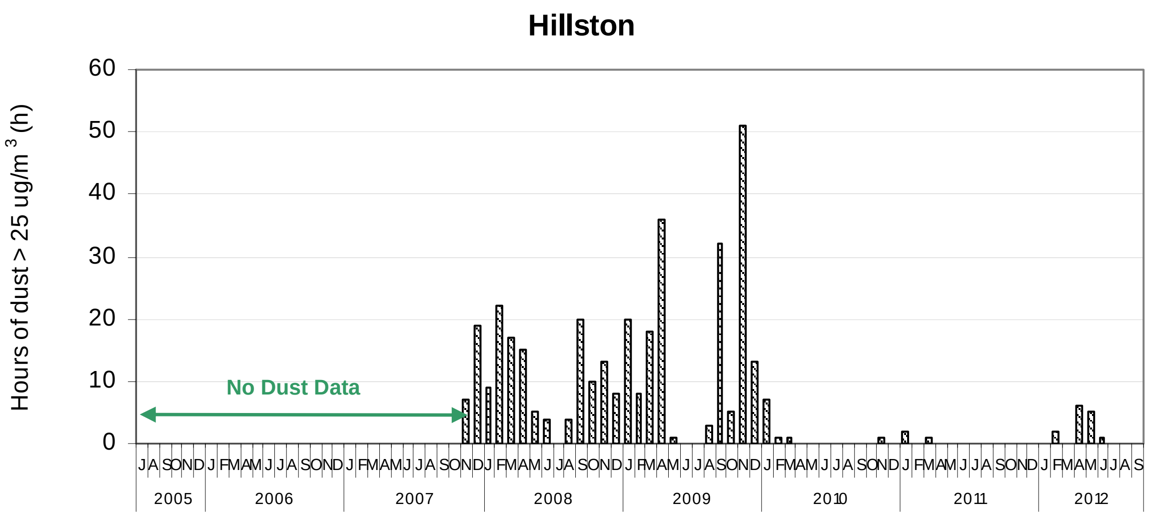
7.1.2 Central West CMA region

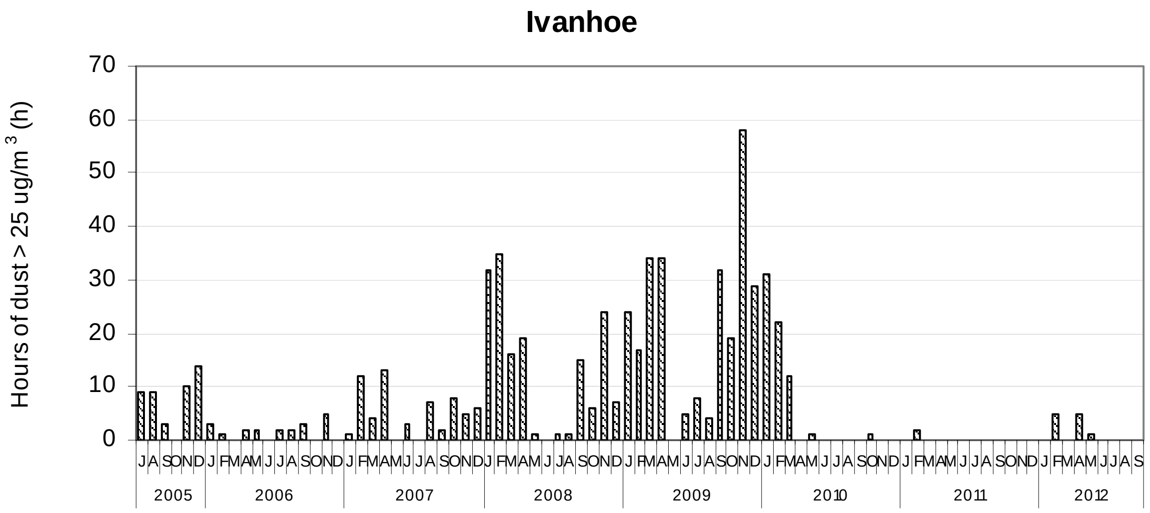


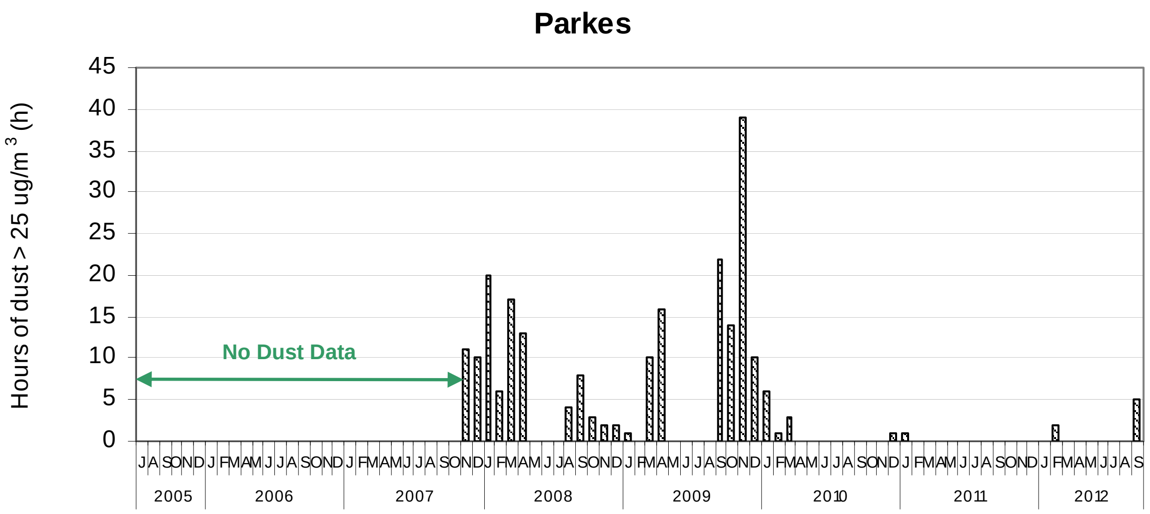
7.1.3 Lachlan CMA region

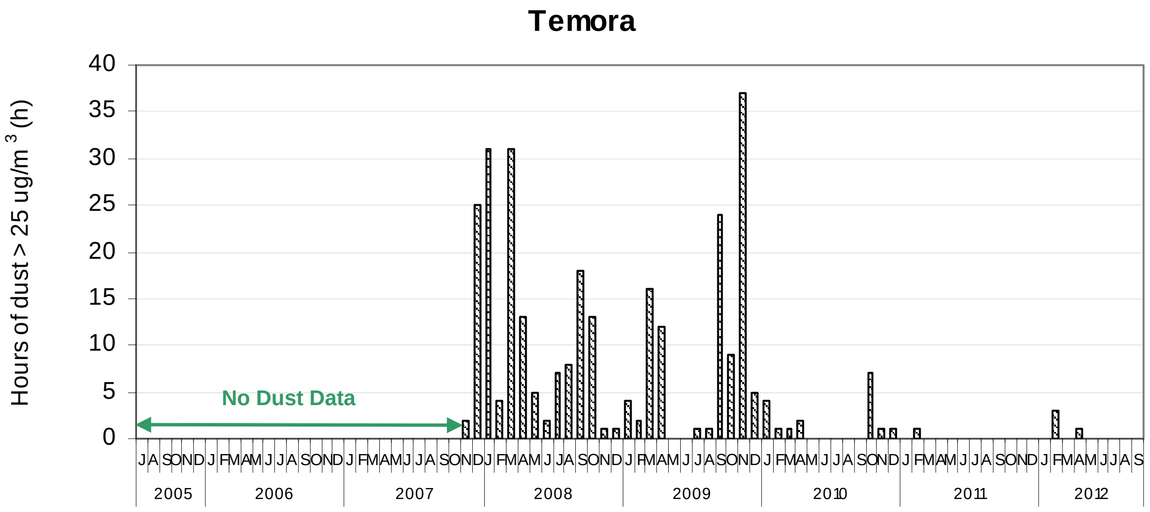


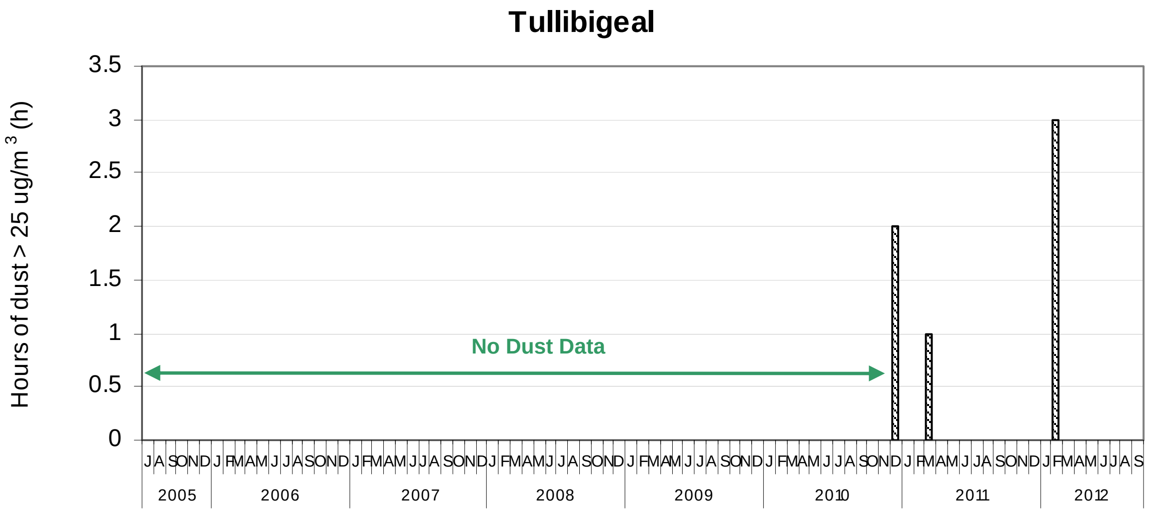


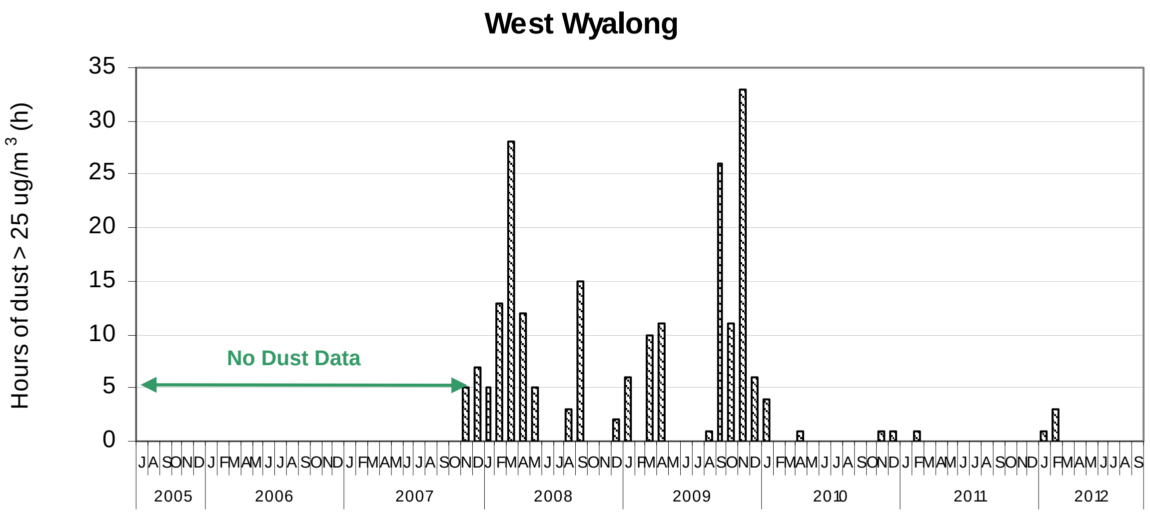

Hillston
Hours of dust > 25 ug/m3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012


Ivanhoe
Hours of dust > 25 ug/m3 (h)
2005
2006
2007
2008
2009
2010
2011
2012

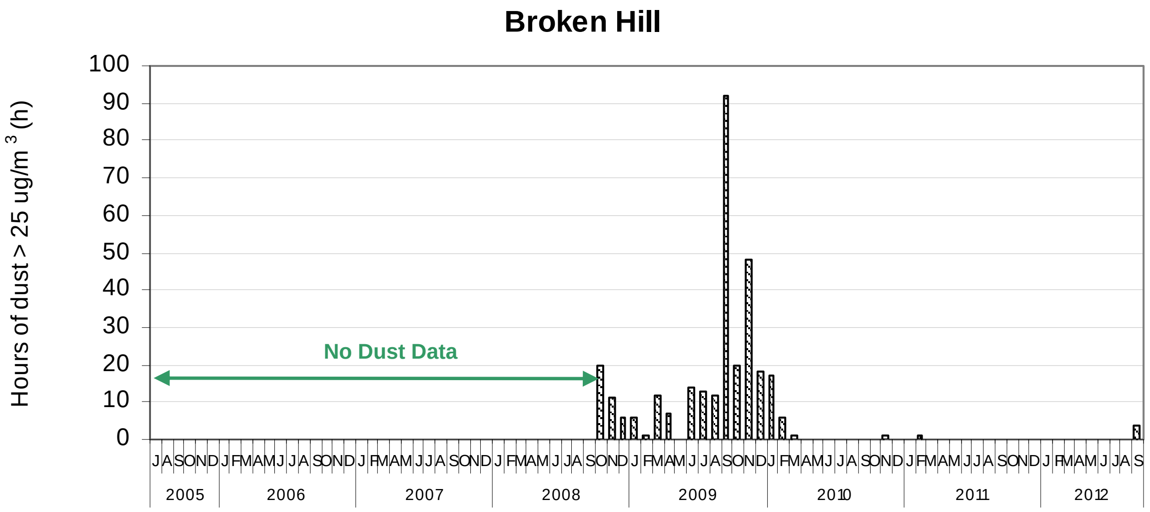

Parkes
Hours of dust > 25 ug/m3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012

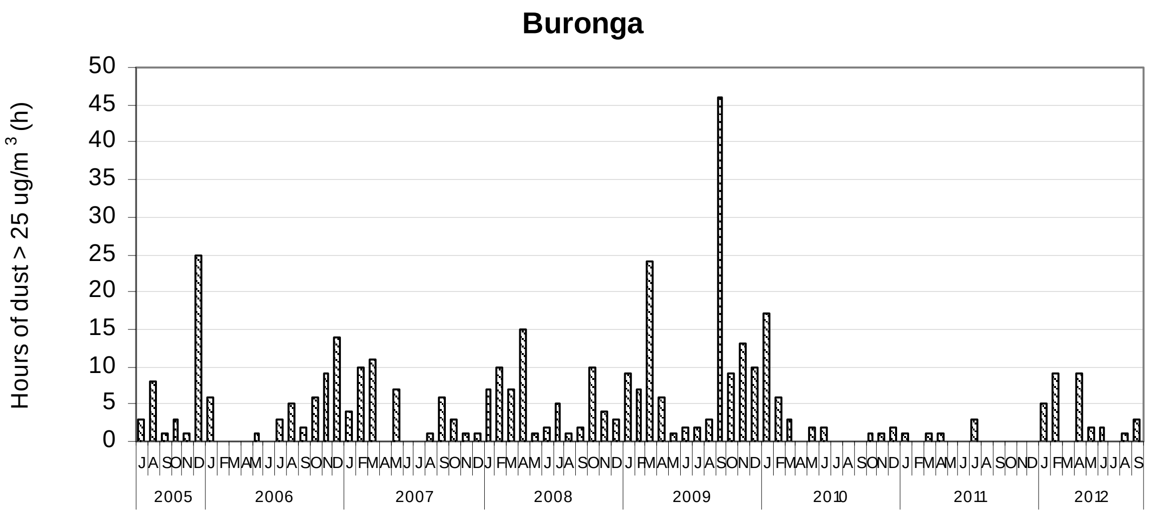

Temora
Hours of dust > 25 ug/m 3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012


Tullibigeal
Hours of dust > 25 ug/m 3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012

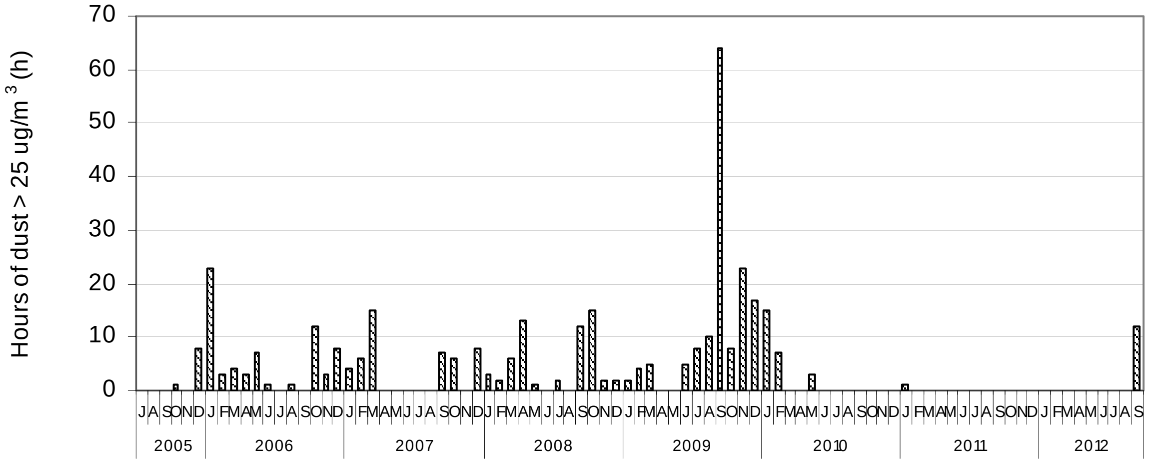

West Wyalong
Hours of dust > 25 ug/m 3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012

7.1.4 Former Lower Murray–Darling Basin CMA region

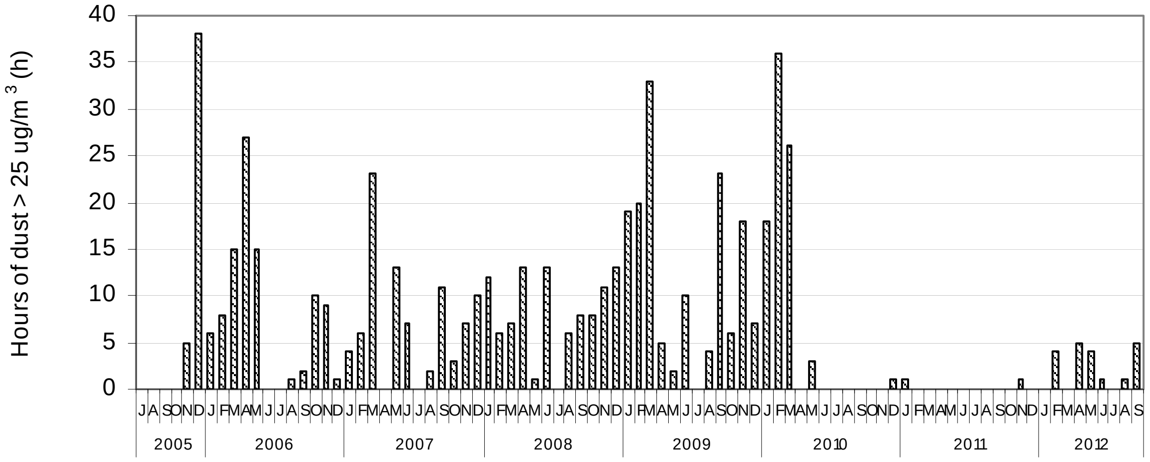




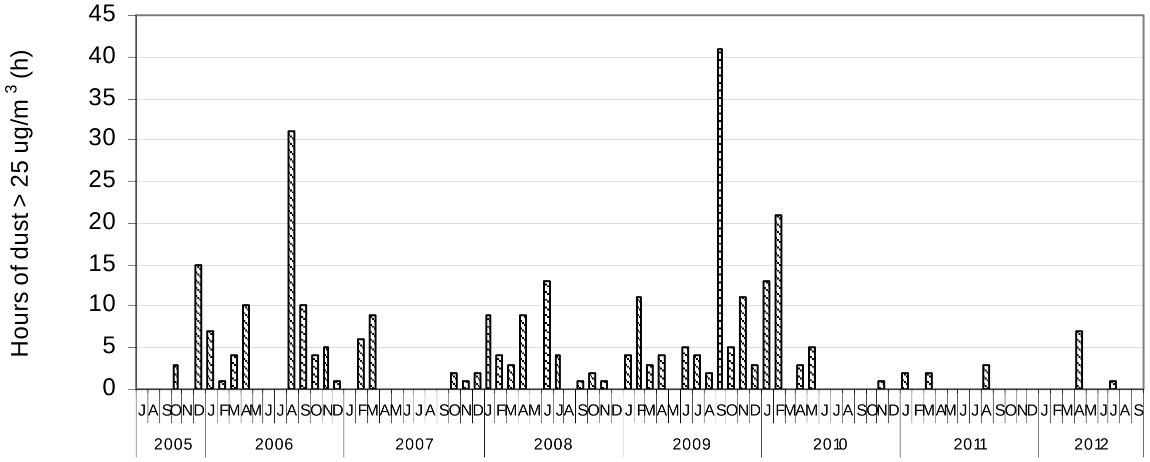
Coombah

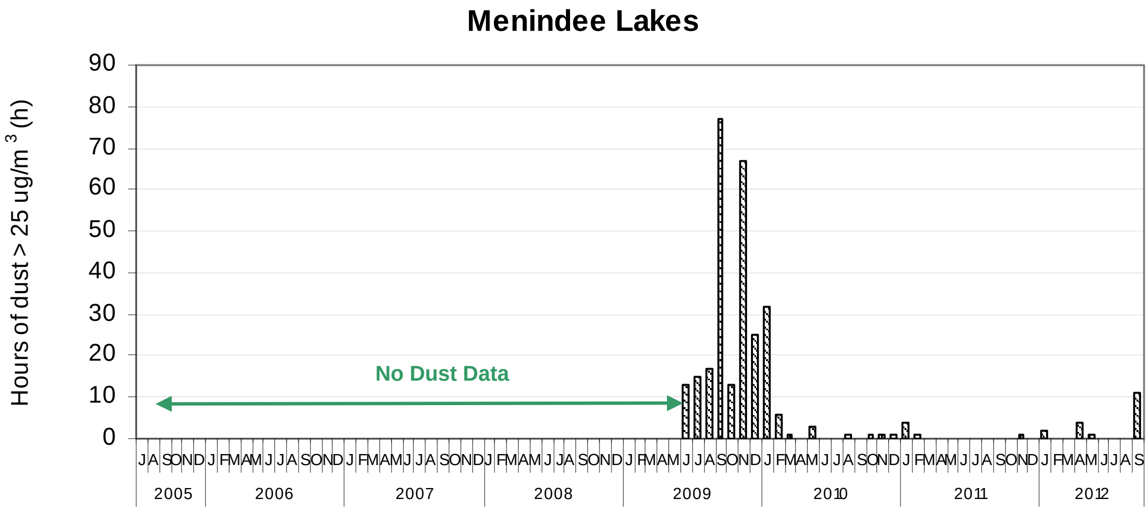


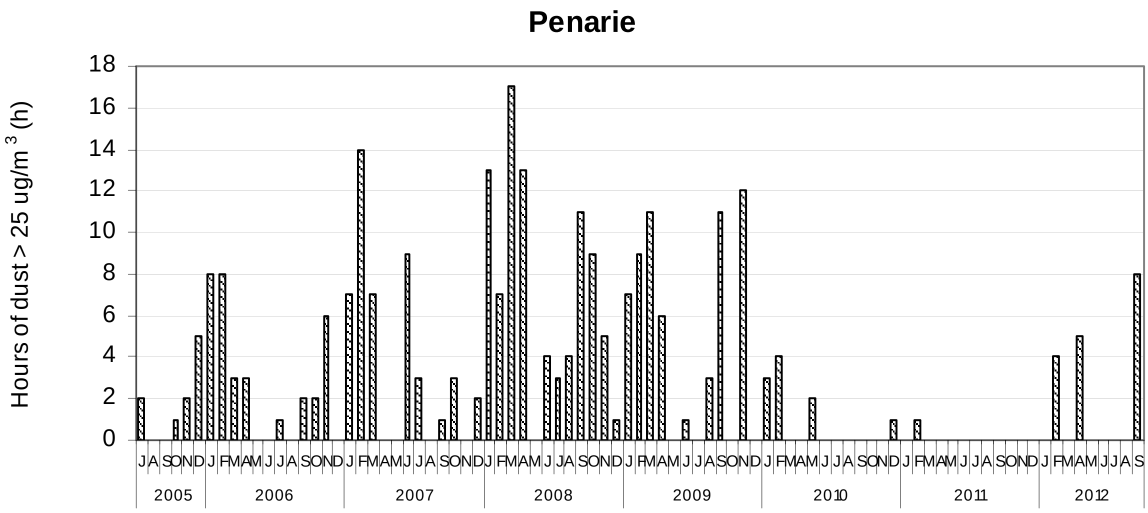
Euston

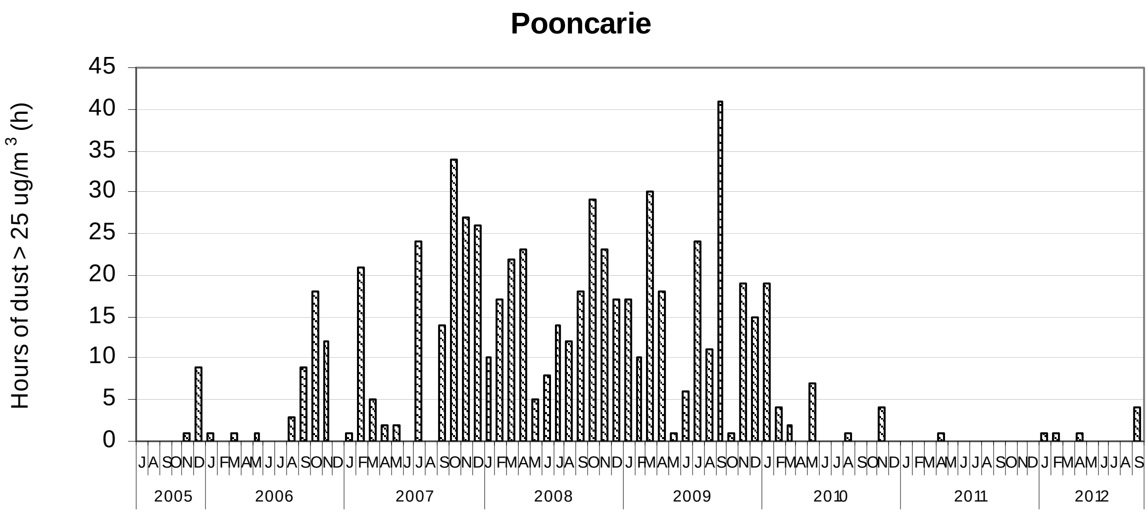


Lake Victoria

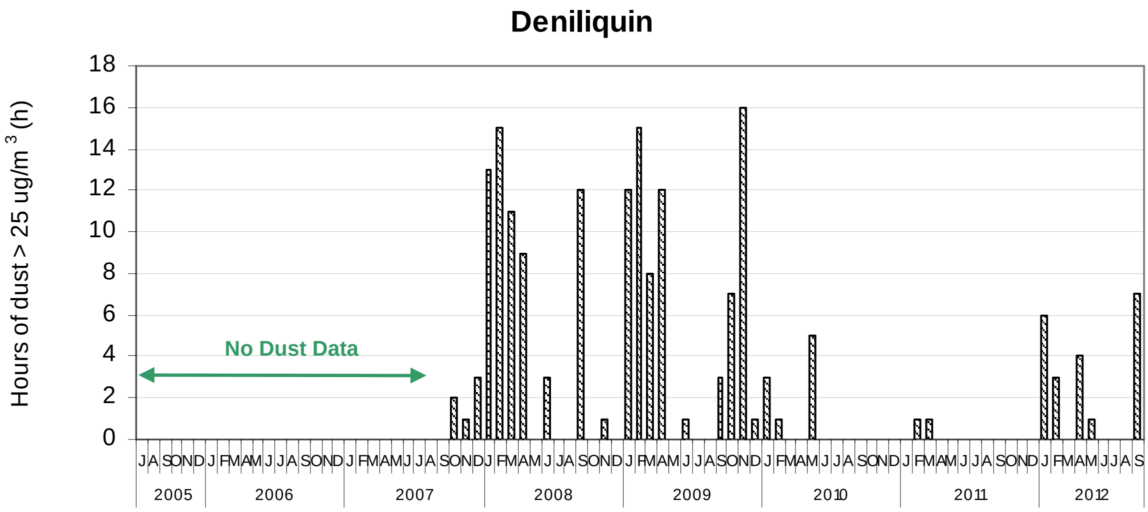


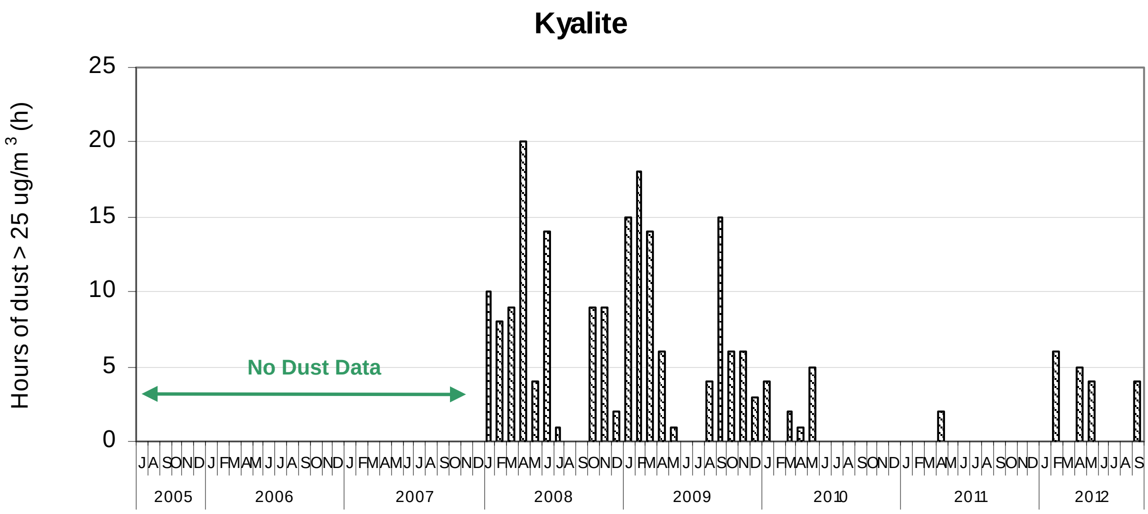

Menindee Lakes
Hours of dust > 25 ug/m 3 (h)
No Dust Data
2005 2006 2007 2008 2009 2010 2011 2012

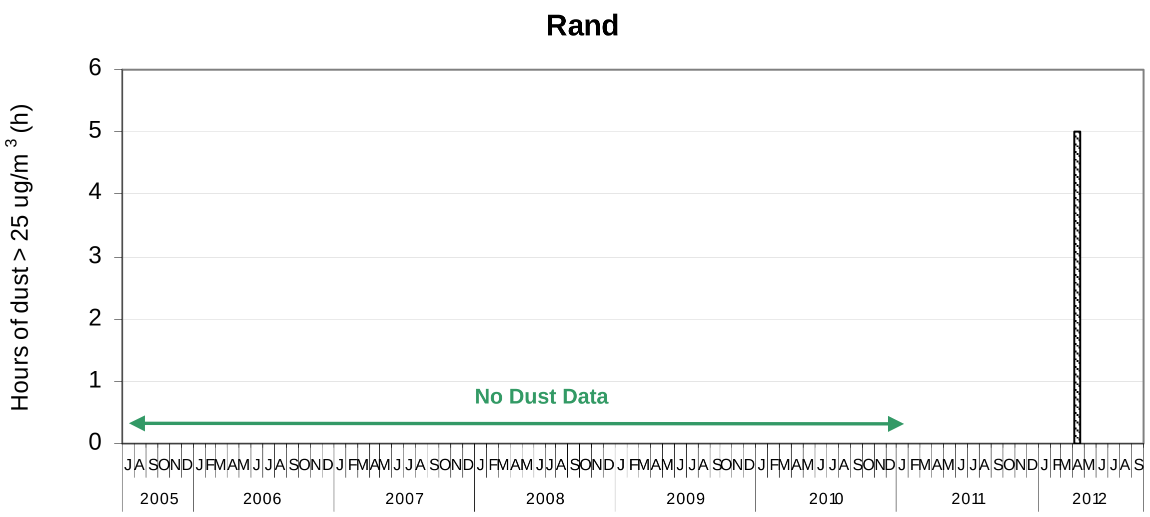

Penarie
Hours of dust > 25 ug/m 3 (h)
2005 2006 2007 2008 2009 2010 2011 2012


Pooncarie
Hours of dust > 25 ug/m 3 (h)
2005 2006 2007 2008 2009 2010 2011 2012

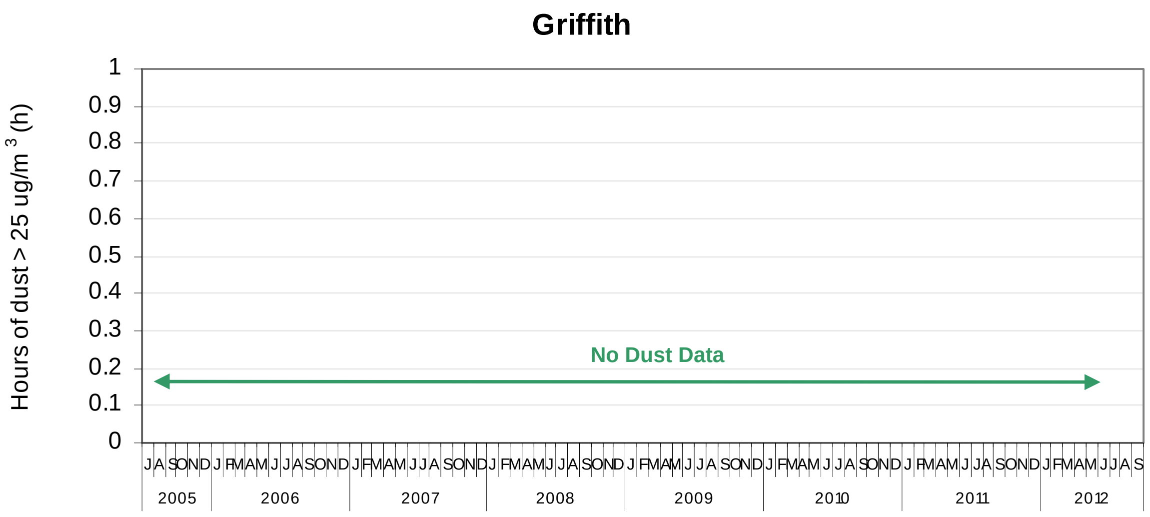
7.1.5 *Murray CMA region*

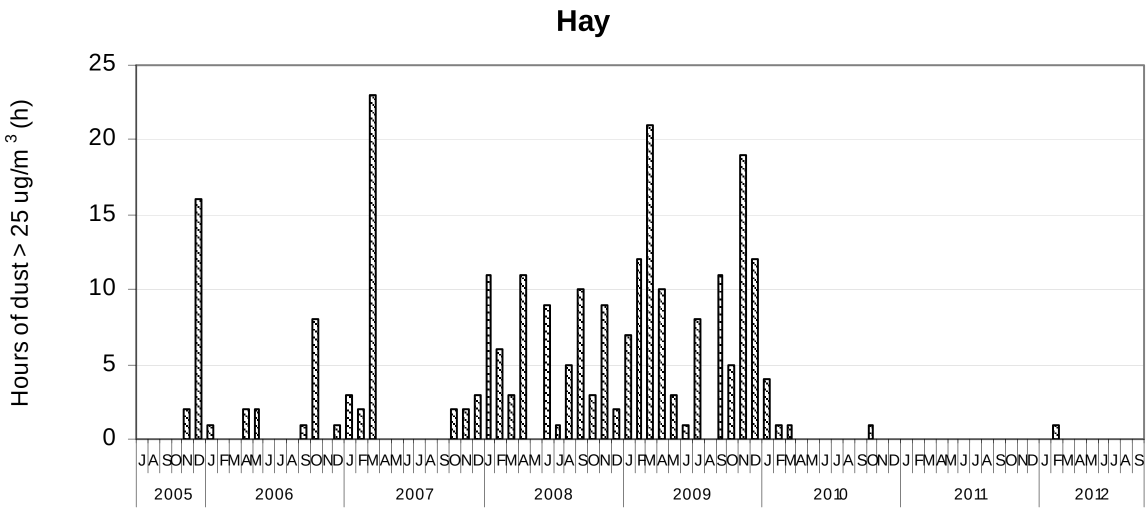


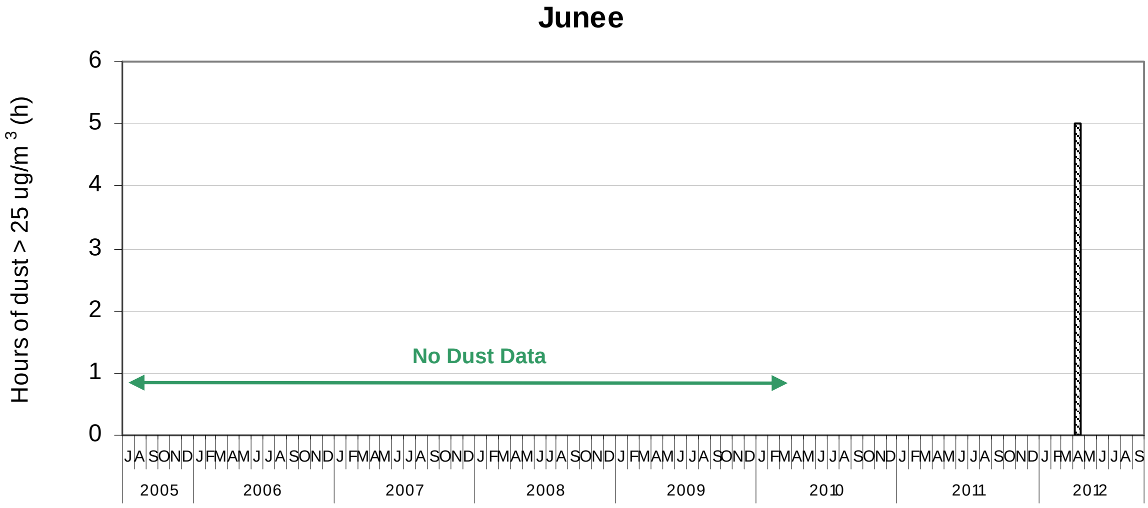


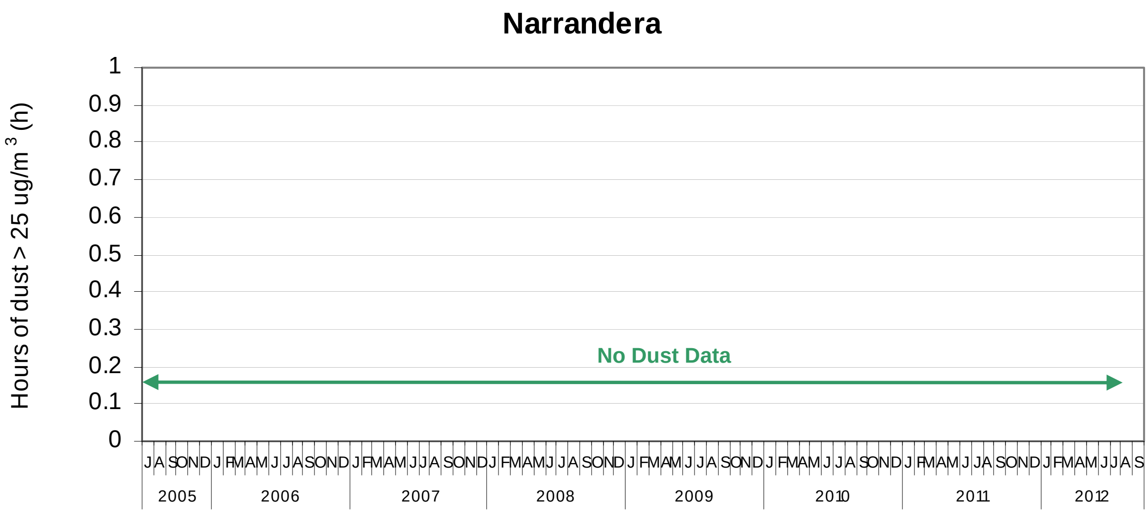


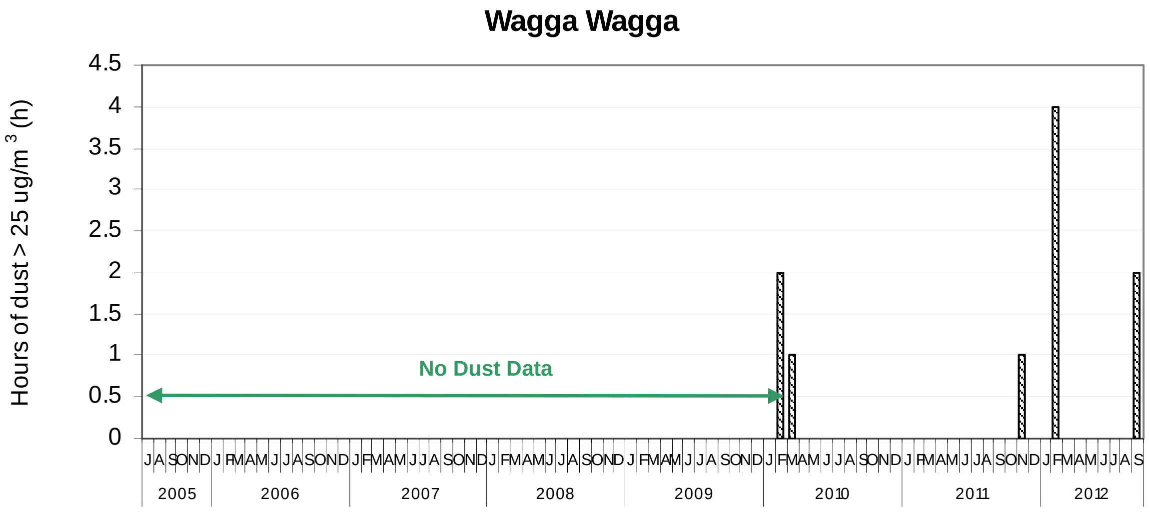
7.1.6 Murrumbidgee CMA region



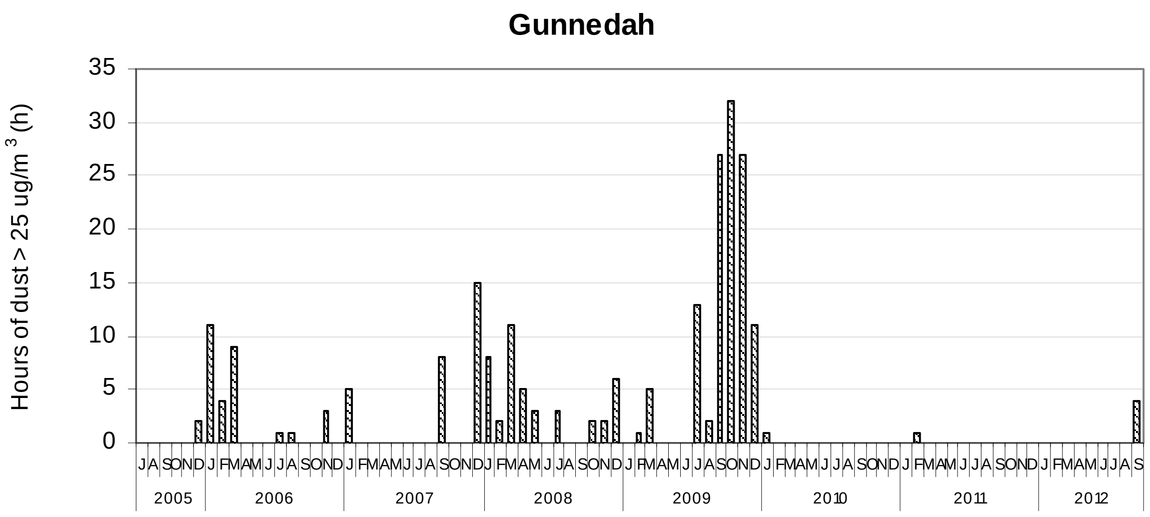

Hay
Hours of dust > 25 ug/m 3 (h)
25
20
15
10
5
0
2005
2006
2007
2008
2009
2010
2011
2012

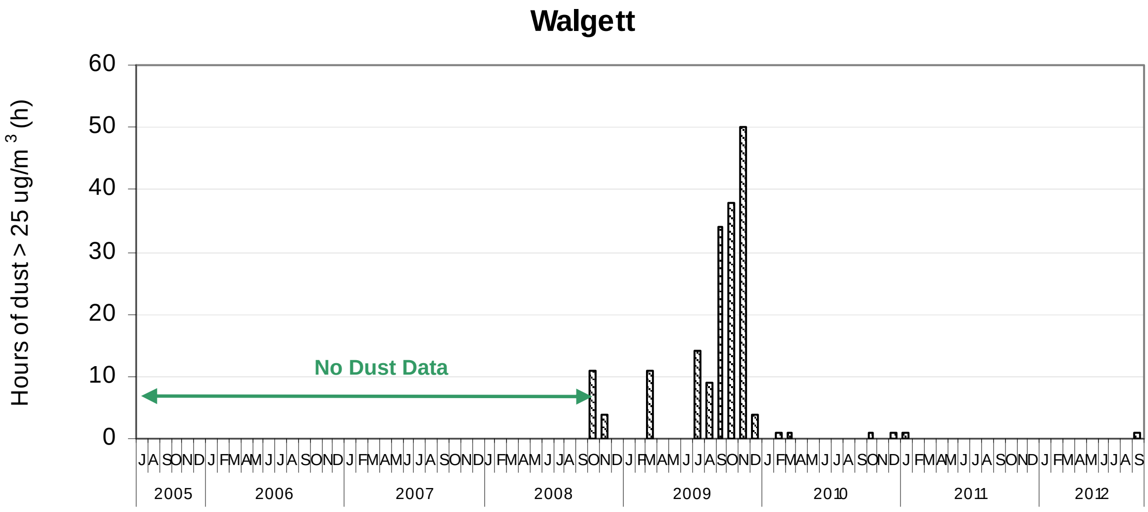

Junee
Hours of dust > 25 ug/m 3 (h)
6
5
4
3
2
1
0
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012


Narrandera
Hours of dust > 25 ug/m 3 (h)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012

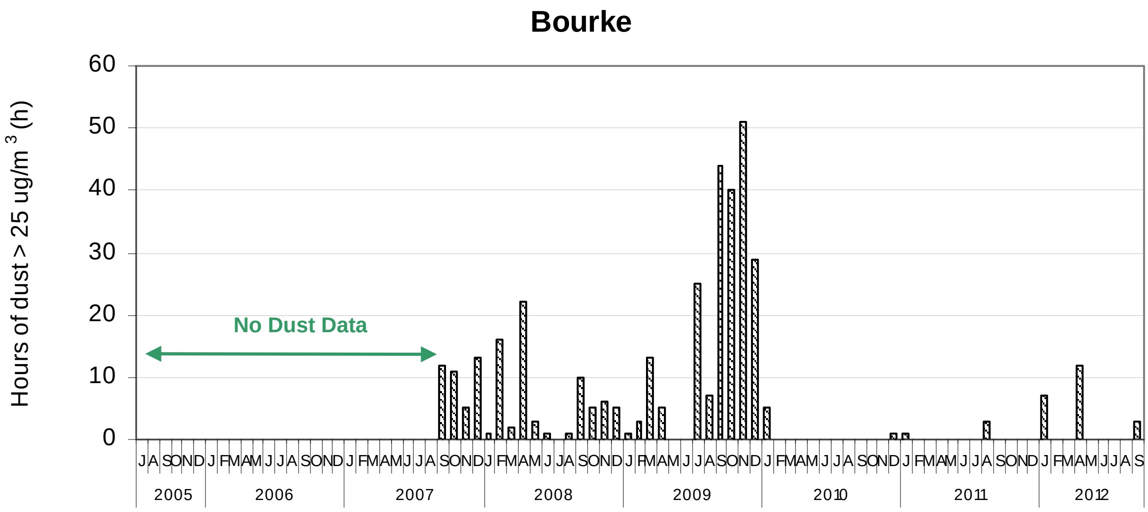


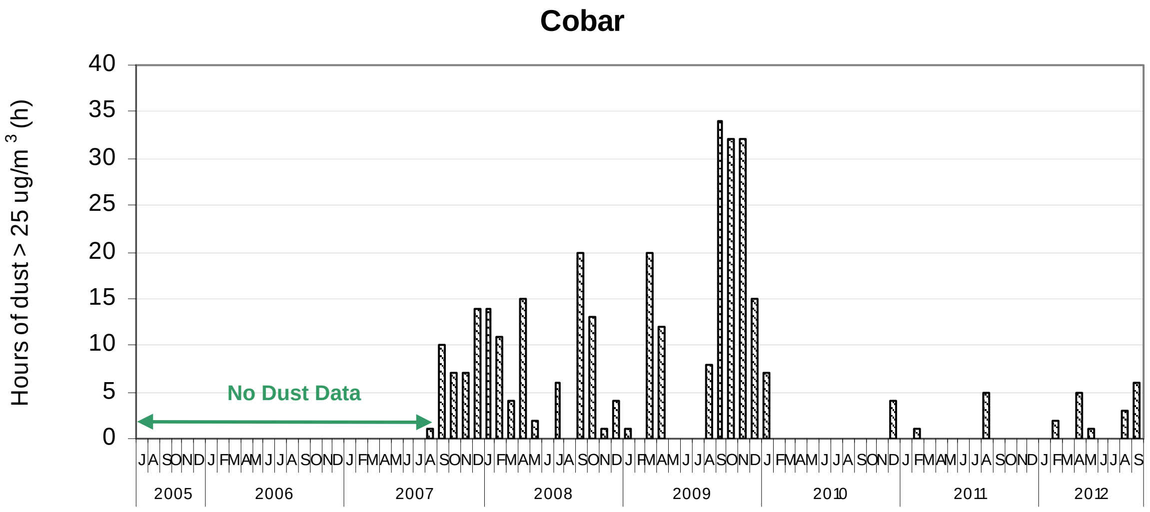
7.1.7 Namoi CMA region

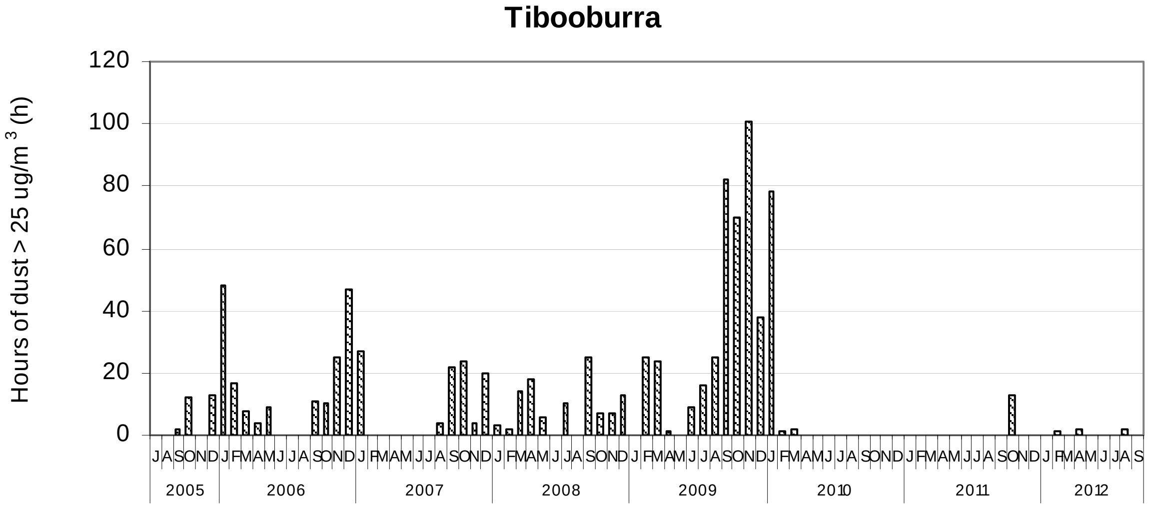


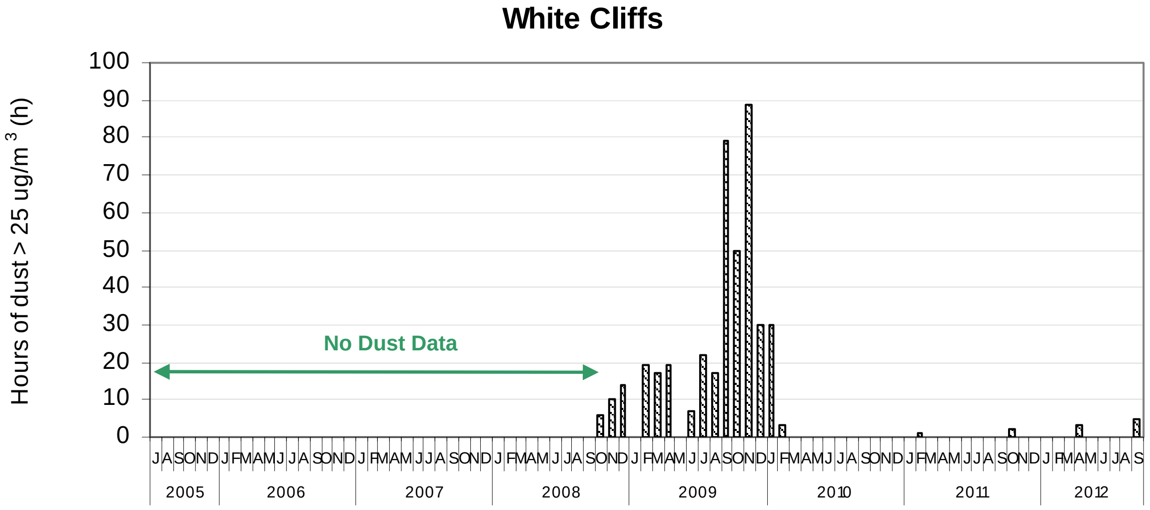


7.1.8 Western CMA region



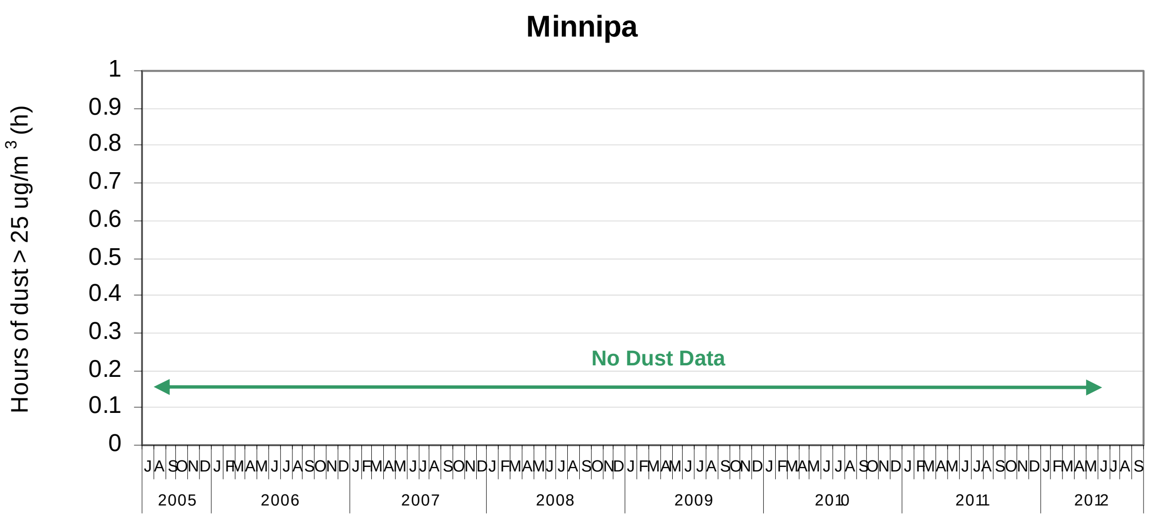

Cobar
Hours of dust > 25 ug/m3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012


Tibooburra
Hours of dust > 25 ug/m3 (h)
2005
2006
2007
2008
2009
2010
2011
2012

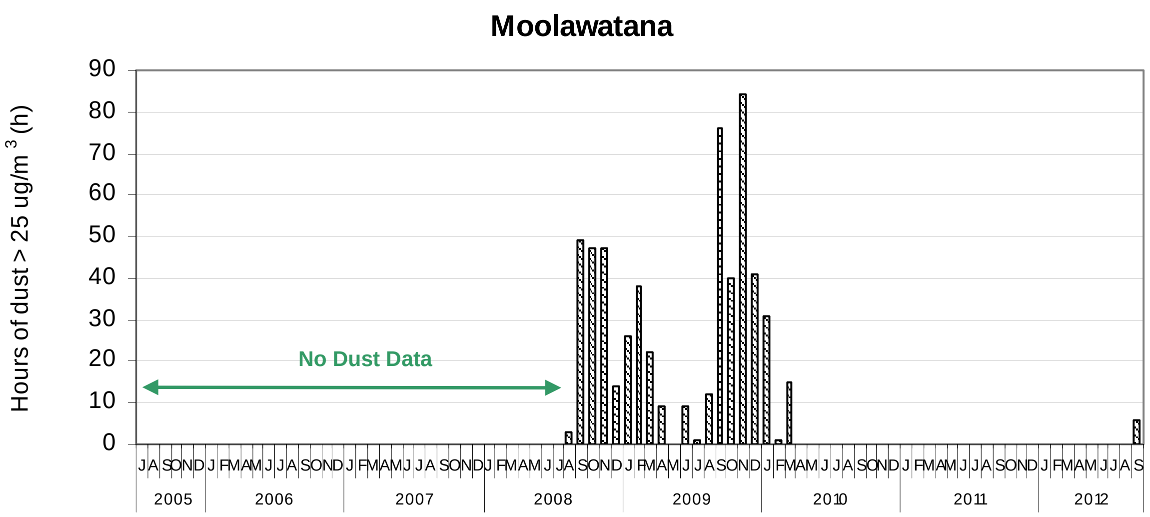

White Cliffs
Hours of dust > 25 ug/m3 (h)
No Dust Data
2005
2006
2007
2008
2009
2010
2011
2012

7.2 South Australia

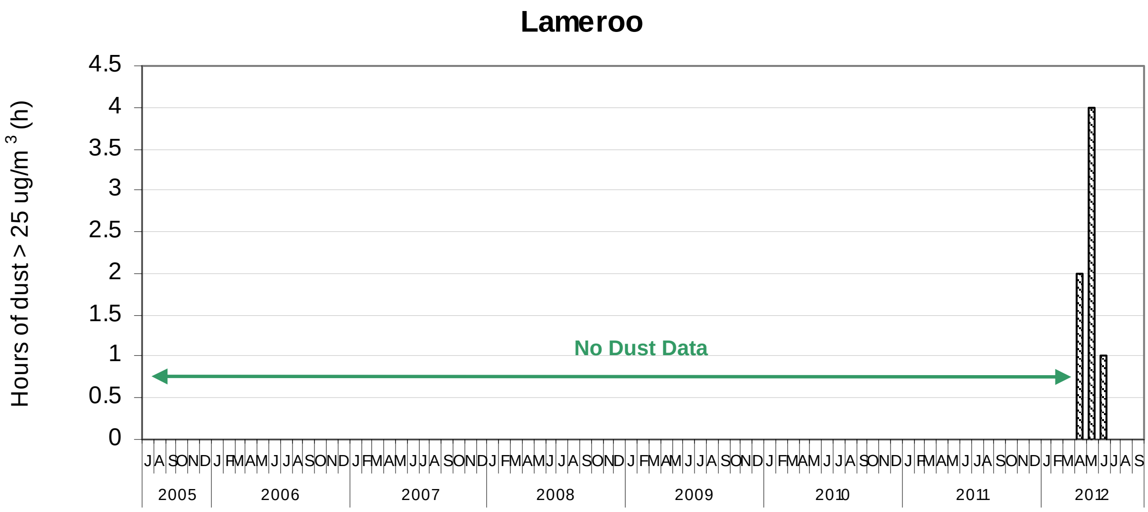
7.2.1 Eyre Peninsula NRM region



7.2.2 SA Arid Lands NRM region

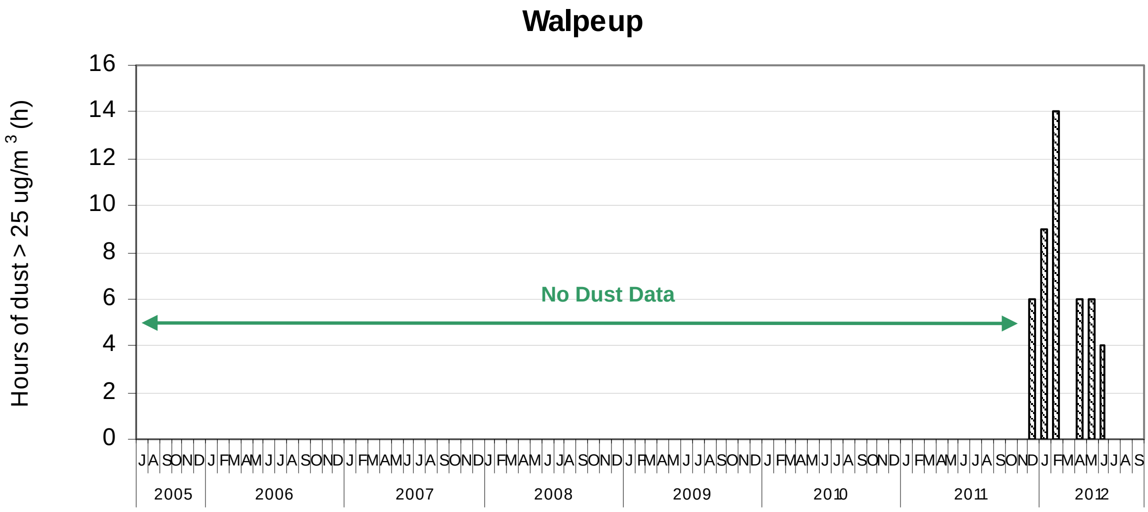


7.2.3 SA Murray–Darling Basin NRM region

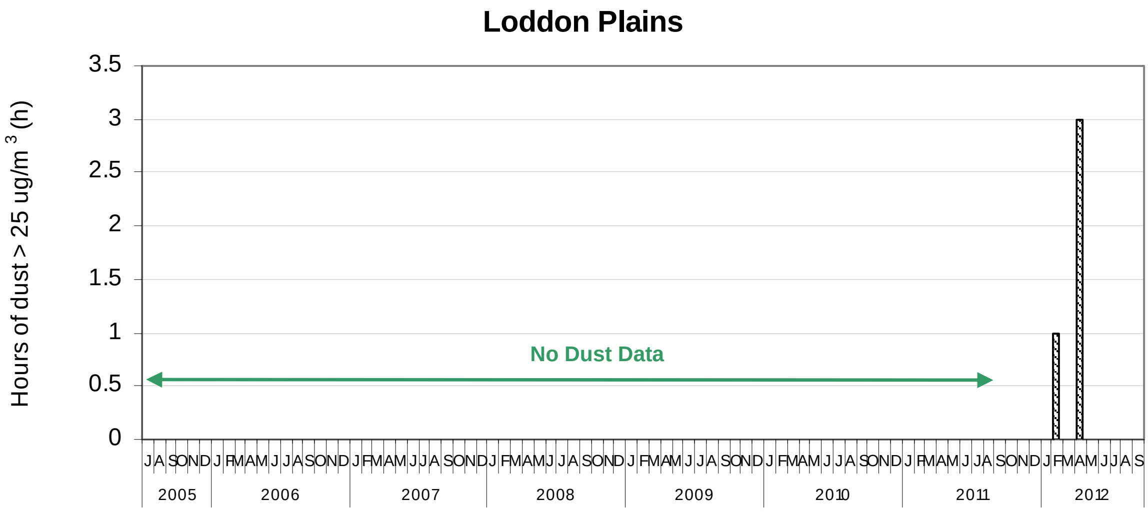


7.3 Victoria

7.3.1 Mallee CMA region

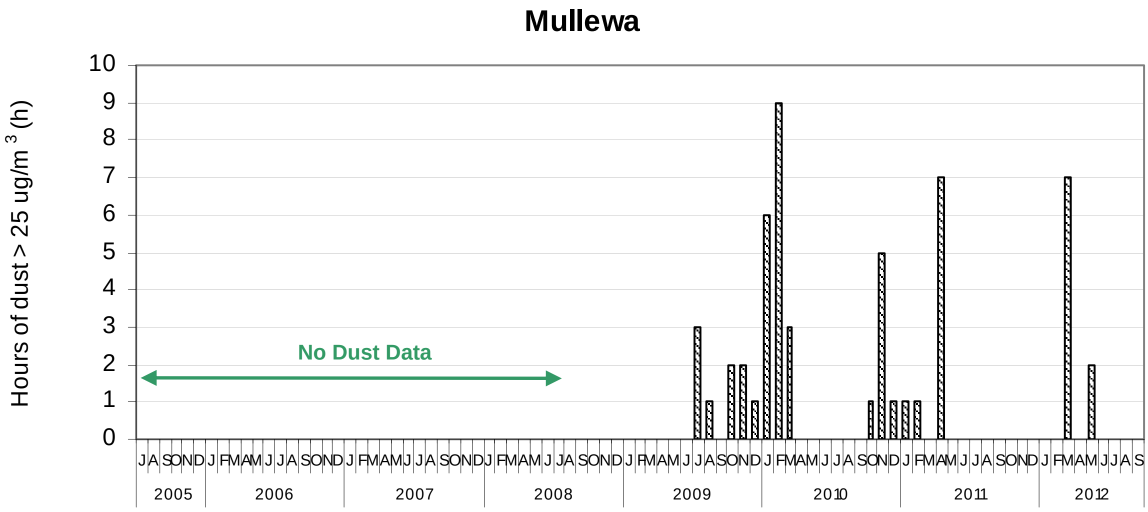


7.3.2 North Central CMA region



7.4 Western Australia

7.4.1 Northern Agricultural NRM region



7.4.2 *Wheatbelt NRM region*