NSW GOVERNMENT Local Land Services Western

DustWatch Network and Roadside Survey 2016

Report for contract WN00732.

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Contents

Executive Summary

The Local Land Services Western Region and its predecessors have been monitoring landscape condition using dust as an indicator since 2003. To understand the trends in landscape condition, ground cover monitoring and land management practice surveys in the south west cropping areas are undertaken.

Overall the project reports that:

- Best Management practices are increasing in the cropping lands of the south-west of the region;
- That the area with less than 50% ground cover was above the benchmark
- That the land was managed sustainably
- That the level of collaboration is high and effective in delivering knowledge, skills and changes to behaviour

The 2015/16 monitoring has been used to report on three KPI for three different Goals and four Strategies listed in the Western Region Local Strategic Plan for 2016-2021.

- For Goal 1, Strategy CC2, KPI “An improvement in the capacity of land managers to improve land management and agricultural enterprise productivity”.

There has been a 50% improvement in the use of Best Management Practices, and therefore the capacity of landholders, in the cropping areas of the southwest of the Western Region over the last 13 years

- For Goal 2, the project reports on two strategies

1. LM2: Support land managers and stakeholders to improve management of terrestrial and aquatic environments for landscape resilience. For this strategy the KPI of “An increase in the number of properties being actively managed across the region to achieve a protective groundcover layer of 50% or above” cannot be directly reported on due to lack of information at property level. However, we present a climate adjusted ground cover index (CAGI) of ground cover measured within 50km of DustWatch Nodes. The index enables comparison of this year’s ground cover against an eleven year benchmark corrected for rainfall.

After correcting for rainfall, there was an increased area achieving a protective ground cover layer of 50% in the summer of 2015/16 in each of the Northern Rangelands, and the Southern Rangelands and Cropping lands assessment areas compared to the 11 year benchmark.

2. LM3: Support land managers to implement practices that increase enterprise productivity and sustainability. For this strategy “sustainability” is measured by climate adjusted sustainability index (CASI).

The landscape was sustainably managed as there were less hours of dust in each of the Northern Rangelands, and the Southern Rangelands and Cropping lands assessment areas compared to the 11 year benchmark

- For Goal 3, strategy AG4, KPI “An improvement in the level of regional collaboration with customers, stakeholders and industry with respect to delivery of Western Local Land Services’ services”. The level of collaboration was bench marked. The Community DustWatch project survey revealed that

Community DustWatch is a collaborative project that increased people’s knowledge, skills and changes their attitude to land management. It has also positively influenced peoples land management behaviour...

It is recommended that Community DustWatch be continued so it can continue to support the Local Land Service Western Region as it has done for many years.

1. Introduction

This report is an output for contract WN00732 and forms part of the Local Land Services Western Region (Western Region) monitoring and evaluation program. The program began in 2003 and offers a decade perspective on trends in land condition. The project uses protocols approved by Caring for Our Country and provides objective data on the condition and trend of the soil resource as measured by level of soil erosion and the land management practices used in the Western Region. The project has clearly shown progress towards implementing the actions in the Western Local Region strategic plan and reporting against KPIs (Table 1).

Table 1. Local Land Services Western Region (Western Region) draft Strategic Plan goals, actions and Key Performance Indicators (KPI) that Community DustWatch supports

Goal 1 Self-reliant, adaptive and prepared communities.			
Strategy	**Actions**	**KPI**	**Measure**
CC2: Collaborate with stakeholders and industry to improve innovation, viability and sustainability of primary industries	Support the development of viable performance-based enterprise models, based on delivery of ecosystem services such as carbon sequestration, active conservation management and groundcover maintenance	An improvement in the capacity of land managers to **improve land management** and agricultural enterprise productivity	Land management practices at 260 sites in the cropping lands of the south west of the Western Region
Goal 2: Productive, biosecure and sustainable primary industries operating in resilient landscapes			
Strategy	**Actions**	**KPI**	**Measure**
• LM2: Support land managers and stakeholders to improve management of terrestrial and aquatic environments for **landscape resilience** • LM3: Support land managers to implement practices that increase enterprise productivity and **sustainability**	• Provide information, workshops and other capacity building activities to land managers to enable effective management of total grazing pressure • Provide information and incentives to land managers to implement grazing, cropping and horticultural best management practices	An increase in the number of properties being actively managed across the region to **achieve a protective groundcover layer of 50% or above**	• Fractional ground cover level within 50 km of DustWatch nodes • Dust hours at fifteen DustWatch nodes
Goal 3: Effective, efficient, integrated service delivery and local decision making			
Strategy	**Actions**	**KPI**	
AG4: Strengthen partnerships with customers, stakeholders and industry using principles of collaboration and local delivery	Collaborate with community based organisations including Landcare to improve development and delivery of services and projects	An improvement in the level of regional **collaboration** with customers, stakeholders and industry with respect to delivery of Western Local Land Services' services	• Contracts • Survey of DustWatch community

1.1 Contract tasks

Under contract WN00732, the Office of Environment and Heritage was contracted to undertake the following. All milestones have been achieved.

Activity	Task / KPI	Progress
Milestone 1	Execute contract	Completed
Milestone 2	Maintain DustWatch nodes in Western LLS. Include data in monthly reports	Completed
Milestone 3	• Undertake bi-annual roadside survey in Western LLS • Produce final report that incorporates DustWatch and Roadside Survey data	Completed

1.2 This report

The WN00253-2014 contract stipulates that the output will be an annual report. This report provides evidence of progress on Western Region's KPIs. Three Goals are addressed in the following three sections:

Section 2: Goal 1 "Self-reliant, adaptive and prepared communities". For strategy CC2 the KPI is *An improvement in the capacity of land managers to* ***improve land management*** *and agricultural enterprise productivity*. This section focuses is on the adoption of improved land management. We focus on best management practices as they underpin "a good reserve of natural capital to ensure groundcover is maintained to support livestock and prevent erosion" (Western Local Land Services 2016, p19).

Land management actives have been monitored on the cropping areas of the south west part of the region since 2003. Changes in the capacity of land managers is measured by the proportion of 260 sites with evidence of best management activity is observed.

Section 3 Goal 2 "Productive, biosecure and sustainable primary industries operating in resilient landscapes". This section focuses on two strategies:

- LM2: Support land managers and stakeholders to improve management of terrestrial and aquatic environments for **landscape resilience** and
- LM3 Support land managers to implement practices that increase enterprise productivity and **sustainability**

For strategy LM2 the KPI is *An increase in the number of properties being actively managed across the region to achieve a protective groundcover layer of 50% or above*. The logic for this KPI is discussed and a climate adjusted ground cover index presented. For LM3 there is no specific KPI, so we discuss and present a climate adjusted sustainability index based on dust.

Dust is used as wind erosion is a threat to the sustainability of the communities, landscapes and agriculture in the Western region (Western Local Land Services 2016, p36). However, surveys undertaken by the Western Region indicate that soil erosion generally was considered by landholders as an issue they didn't have the skills or resources to address (Western Local Land Services 2016, p29). This may be true for stream bank and highly water eroded areas like gullies, but wind erosion can be controlled in most years via the management of ground cover. Evidence of its control is presented.

Section 4 Goal 3 "Effective, efficient, integrated service delivery and local decision making". For strategy AG4 the KPI is *An improvement in the level of regional collaboration with customers, stakeholders and industry with*

respect to delivery of Western Local Land Services' services. This section focuses on how collaboration with Office of Environment and Heritage and the Community DustWatch project can be used to report on this KPI.

2. KPI - An improvement in the capacity of land managers to improve land management and agricultural enterprise productivity.

In this section we report on the trend and status of the KPI for Goal 1 "Self-reliant, adaptive and prepared communities", strategy CC2 the - An improvement in the capacity of land managers to improve **land management** and agricultural enterprise productivity.

2.1 Rational for KPI

The land managers of the Western region determine on a daily basis how the land is managed Self-reliant landholders who are adaptive and prepared will deliver the best outcomes for the region. Having the capacity to improve land management practices and enterprise productivity will contribute to Goal 1. We focus on the "**improve land management**" part of this KPI. We also measure the outcome of improved capacity; that is, the improved land management practices. So the indicator addresses how well the strategy of "Collaborate with stakeholders and industry to improve innovation, viability and sustainability of primary industries" actually is working.

2.2 Method

Land management practices and their outcomes, in terms of erosion and ground cover level, have been monitored on the cropping areas of the south west part of the region since 2003 (Figure 1).

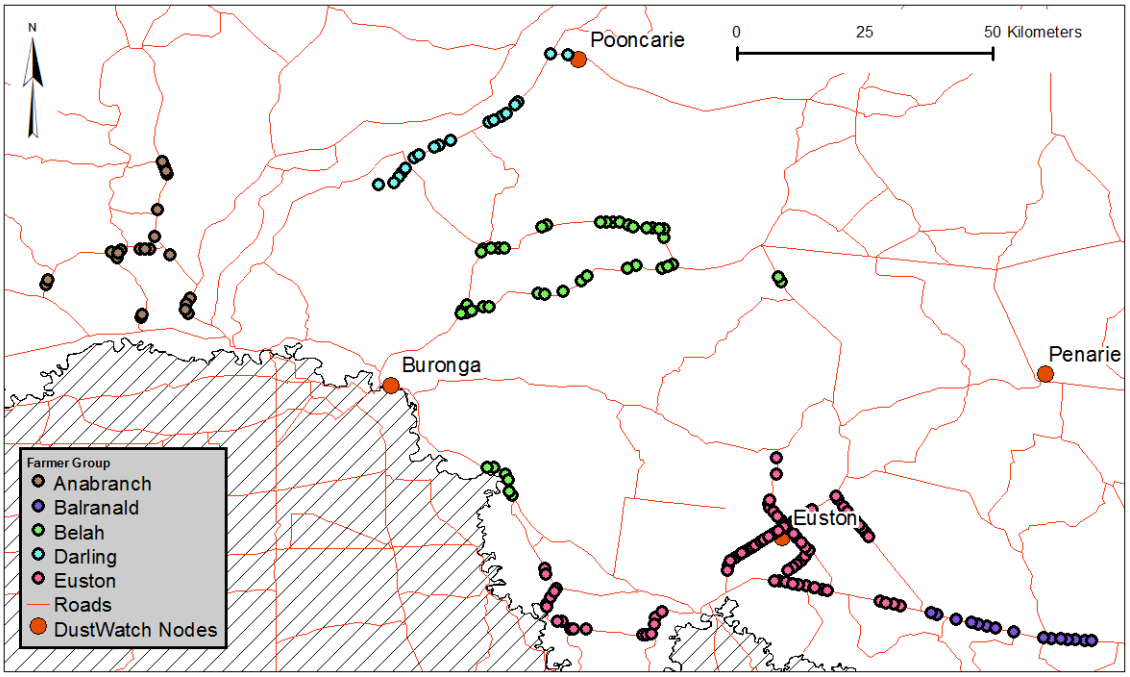


Figure 1. Location of survey sites within lower Local Land Services Western Region and the farmer groups referred to in this report.

The roadside survey (RoS) is a rapid assessment method that was identified in the national review on erosion monitoring (Leys et al., 2009b) as a way of tracking change in soil condition and land management practices. The

surveys obtain data on 17 variables with a focus on measuring: soil erosion status, ground cover type and cover level and management practice at the paddock scale.

A nationally agreed method and a set of parameters to be assessed was proposed by (Forward, 2009). This project uses these nationally agreed methods but also includes additional parameters to meet the needs of NSW Local Land Services. All data is held within a relational data base (LandMAPT) as described in (Murphy, 2009).

The full methods for both the surveys are published in the previous reports (Leys, 2013; Leys et al., 2015; Leys et al., 2009a; Leys et al., 2010; Leys et al., 2007; Leys et al., 2011).

Changes in the capacity of land managers is measured by the proportion of 260 sites where best management practices are observed.

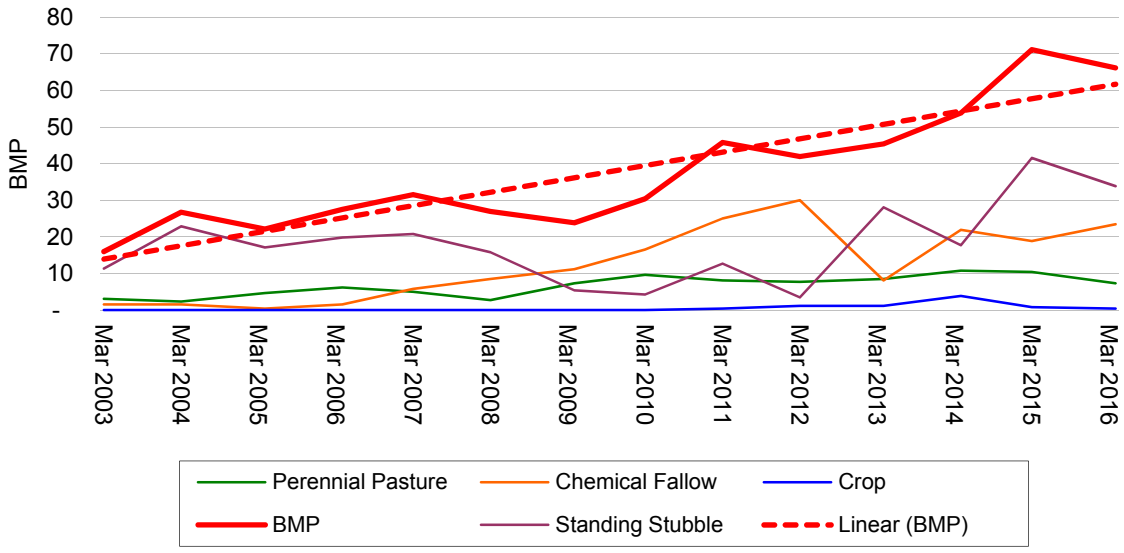
A workshop was held in Forbes in May 2016 with all in-land Local Land Services attending. They were asked to note the Best Management Practices (BMPs) for irrigation, grazing and cropping land uses. The outcome was the refinement of the list (see Appendix A) of BMPs used in previous surveys, e.g. in Leys et al. (2015).

2.3 Results Discussion

The collaborative programs of the Western Region have delivered viable performance-based enterprise models in the cropping areas of the south west. This has been achieved via improved capacity of the land holders which is measured by the increasing number of sites (260) with BMPs. Between 2003 and 2016 the percentage of sites with BMPs has increased from 16% to 66%.

There has been a 50% improvement in the use of Best Management Practices, and therefore the capacity of landholders, in the cropping areas of the southwest of the Local Land Services Western region over the last 13 years (Figure 2).

Figure 2 Trend in Best Management Practices (BMP) and each BMP for cropping land in southwest Local Land Services Western Region



These BMPs have delivered ecosystem services such as reduced erosion and are sustaining the soil assets of the region. The next section shows that sustainable land management practices are also being practiced in the rangelands.

3. KPI - An increase in the number of properties being actively managed across the region to achieve a protective groundcover layer of 50% or above

In this section we report on the trend and status of the KPI for Goal 2 “Productive, biosecure and **sustainable** primary industries operating in **resilient** landscapes”. Two strategies are reported on

- LM2: Support land managers and stakeholders to improve management of terrestrial and aquatic environments for **landscape resilience**, and
- LM3: Support land managers to implement practices that increase enterprise productivity and **sustainability**.

To report on the two strategies we use the existing KPI of “An increase in the number of properties being actively managed across the region to achieve a protective groundcover layer of 50% or above” for LM2 and suggest a new indicator and KPI for LM3.

3.2 Rational for KPIs

3.2.2 Ground cover as indicator for resilience

We define resilience of the landscape as “the capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly” (Wikipedia 2016).

Wind erosion is identified in the Local Strategic Plan as threat to the communities, landscapes and agriculture in the Western region (Western Local Land Services 2016, p36). The logic behind the KPI is that groundcover is an indicator of level of protection of the soil resource. So we test if the ground cover recovers to the level previously achieved for a given rainfall.

Currently it is not possible to report directly on the KPI as ground cover data on every property is not easily available. This is currently the focus of an on-going project (contract WN00705) with the Western Region. In the interim we use the ground cover with in 50 km of the 15 DustWatch nodes (Figure 3).

3.2.2 Dust as indicator for sustainability

We define sustainability as “the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions” (FAO 2016).

Wind erosion is a threat to ecosystems services and economic outcomes of the community. For example the single dust storm on 23 September 2009 cost the NSW economy nearly $300 million (Tozer and Leys, 2013).

We propose using dust as an indicator because if there is dust blowing about the Western Region then the soils are being degraded and this diminishes the sustainability of the resource and agricultural industries. Also by managing ground cover above threshold levels required to control erosion, ecosystem services such as clean air and reduced economic costs are delivered to the community of NSW (Tozer and Leys, 2013).

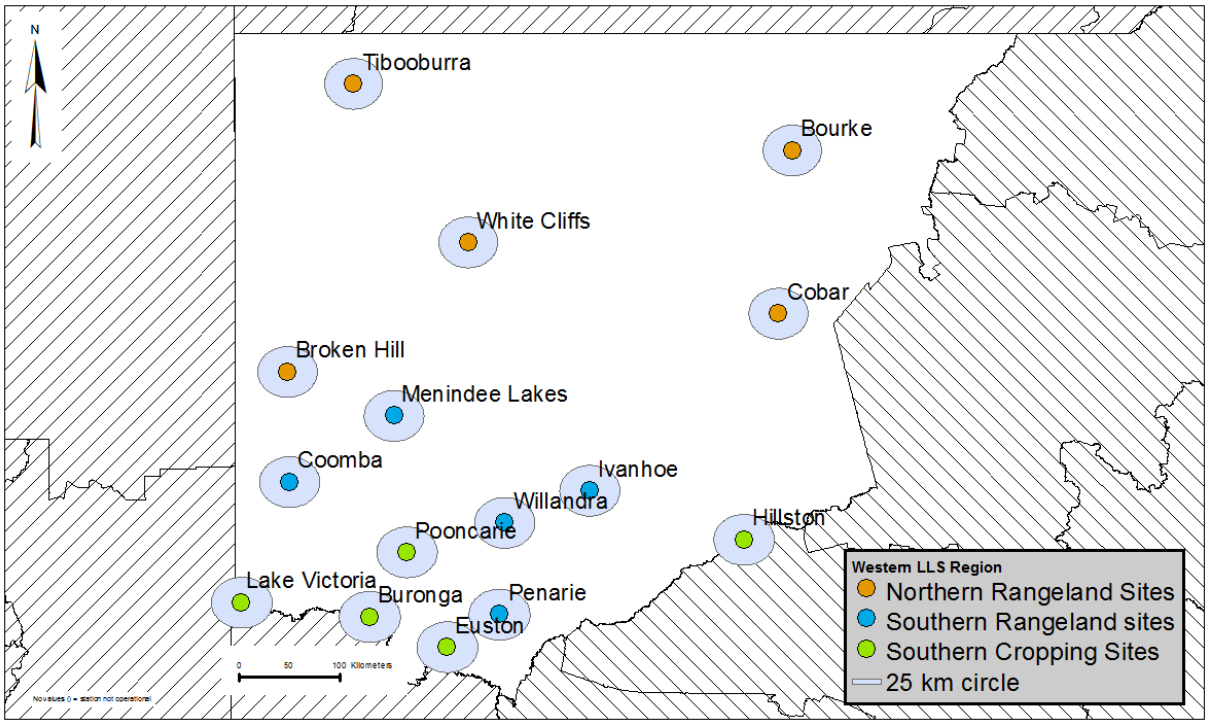
Ground cover and wind erosion are a function of land management and climate (Leys, 1999). The climate changes between years so it is important to compare the dust and ground cover with “like” climate years.

3.3 Methods

Data is reported using land use / climate areas. We group the DWNs into three land use / climate areas:

- Northern rangelands.
- Southern rangelands.
- Southern cropping lands (Figure 3).

Figure 3. Classification of DustWatch Nodes in to land use / climate areas. Assessment area around each node for rainfall and ground cover (blue circle)



3.3.1 Resilience of the landscape

Ground cover is an excellent measure of resilience because is reflects the soil/water/plant system. If rain falls and the vegetation cover does not increase to previous levels for similar rainfall, then the resilience of the area has been degraded.

We use two indicators:

1. Time series for fractional ground cover for a defined area.
2. Climate adjusted groundcover index (CAGI) that determines the area of ground cover with less than 50% ground cover based on the previous 36 months of accumulated rainfall.

Fractional ground cover data is sourced from CSIRO (ftp://qld.auscover.org.au/modis/fractional_cover/monthly/v3_0_1/ . This fractional cover data is based on MODIS satellite data which is at 500m resolution and analyzed using the method of (Guerschman et al., 2015). (Leys et al., 2015).

3.3.2 Sustainability

Dust is used an indicator for wind erosion. This is because if the soil is blowing away it is degrading the soil, reducing on-site productivity and increasing costs off-site. Therefore limiting wind erosion will benefit the people of the Western Region and NSW. The full methods for measuring dust are explained in Leys et al. (2015).

In short, 15 dust monitors (called DustWatch Nodes – DWN) are maintained by volunteers who live near the monitors. Hourly dust records are collected:

- quality controlled (Baddock et al., 2014)
- stored in a data base called CoDii (https://codii.environment.nsw.gov.au/),
- made publicly available (http://www.environment.nsw.gov.au/dustwatchapp/Default.aspx) and
- reported monthly in a web report (http://www.environment.nsw.gov.au/dustwatch/).

Rainfall plays an important part in determining the outcome of wind erosion via its effects on soil moisture and subsequent vegetation growth. We use Bureau of Meteorology monthly rainfall grids with a resolution of 5km (http://www.bom.gov.au/climate/data-services/maps.shtml). Rainfall data from a circle of diameter 100 km is extracted from the rainfall grid for each DWN for each month. Dust data is extracted from CoDii for the same areas and times (Figure 3).

We use two indicators:

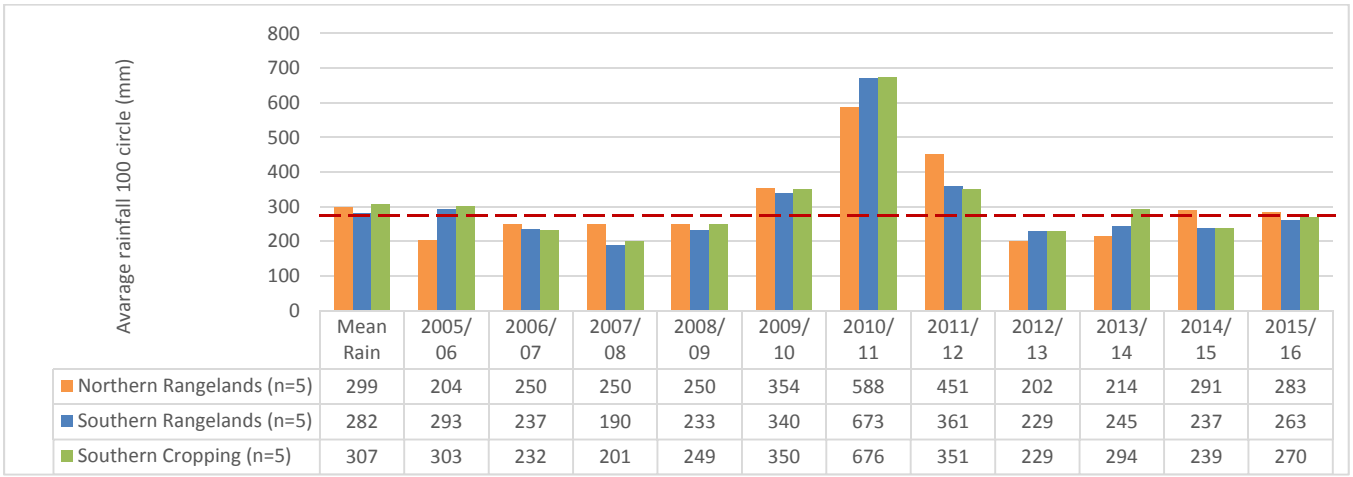
1. Hours of dust.
2. Climate adjusted sustainability index (CAGI) that determines the hours of dust based on the accumulated 36 months of rainfall.

3.4 Results and Discussion

3.4.1 Rainfall

Rainfall varies from year to year and this impacts on dust and ground cover levels. Across the 15 DWN, rainfall was about 8% below the long term average for 2015/16. The Southern Cropping area had about 12% below average while the Northern Rangeland was only 5% below average. So the **rainfall** can be viewed as being **just below average for the 2015/16** period.

Figure 4. Mean annual rainfall (1961-1990) and yearly rainfall for the three land use / climate areas



	Mean Rain	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Northern Rangelands (n=5)	299	204	250	250	250	354	588	451	202	214	291	283
Southern Rangelands (n=5)	282	293	237	190	233	340	673	361	229	245	237	263
Southern Cropping (n=5)	307	303	232	201	249	350	676	351	229	294	239	270

3.4.2 Landscape resilience

3.4.2.1 Time series for fractional ground cover for a defined area

Ground cover can be used as an indicator of landscape resilience because resilient landscapes have plant growth and increased ground cover in response to rain. A resilient response for ground cover for the Western Region would be to have less than 10% of the landscape with less than 50% ground cover.

Figure 5 shows that each land use / climate area has had a different response to rainfall over the last 16 years. The Northern Rangelands has the largest areas with less than 50% ground cover due to the arid climate. The notable feature in Figure 5 is that during the winter of 2010 and 2011 all land use / climate areas have less than 10% of the landscape with less than 50% ground cover. This implies that the landscape is resilient in wet years. But not every year has high rainfall. To compare the ground cover between years

From a sustainability point of view, it is the area of minimum ground cover that is important. Figure 6 shows the percentage area (average of the 100km circle around five DWN) during summer for each of the land use / climate areas. The Northern Rangelands has the highest area and the Southern Cropping areas the lowest area of the landscape with less than 50% ground cover. This implies the Northern rangelands are most likely to have wind erosion.

Figure 5. Area each month for Western Region with cover < 50% ground cover for the three land use / climate areas (each area is the average of the 100km circle around five DWN)

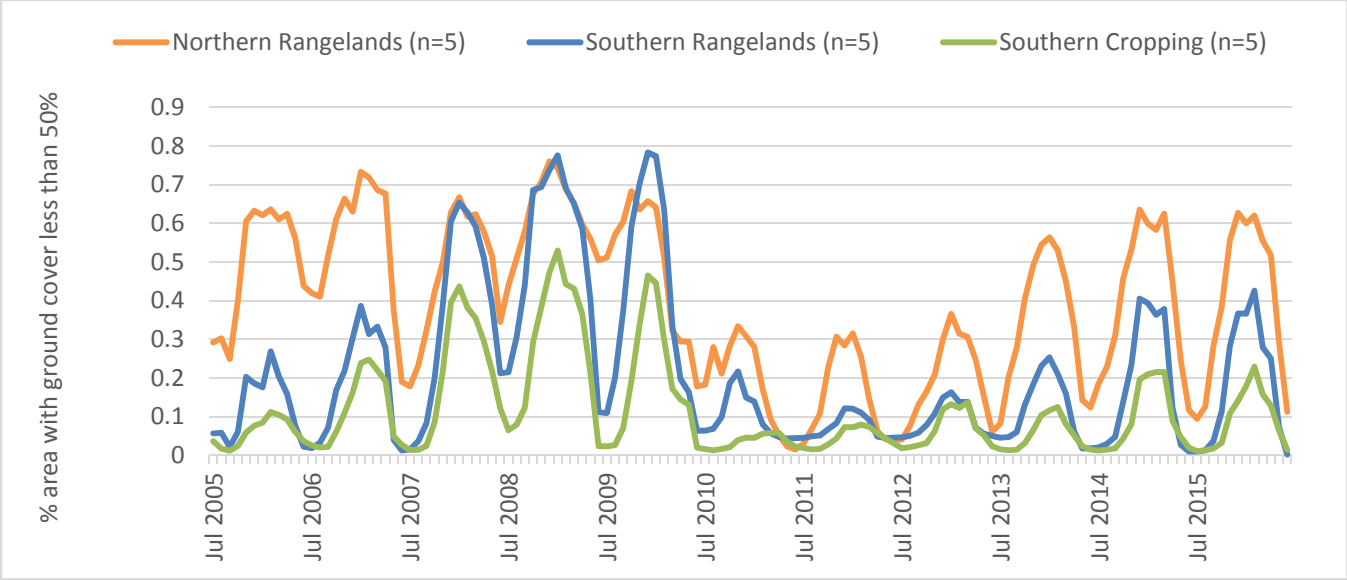
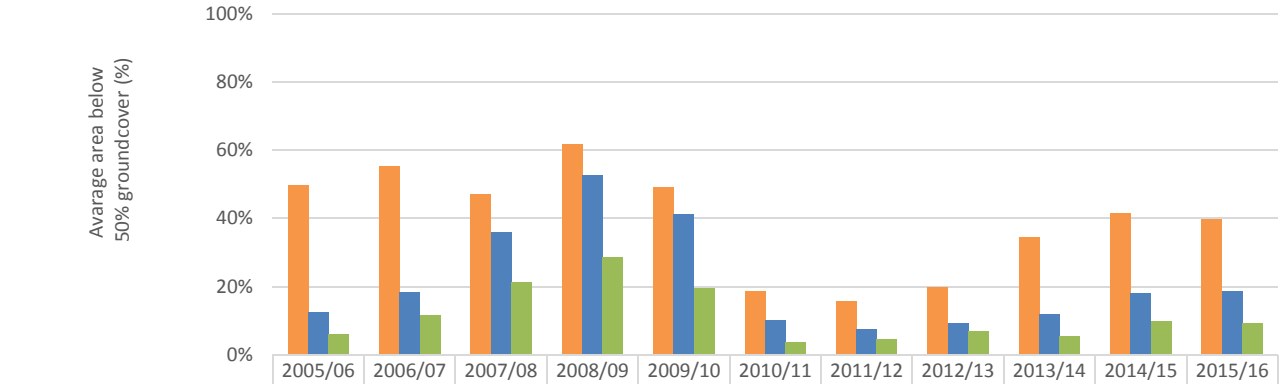


Figure 6. Average area in summer for the three land use / climate areas with cover < 50% ground cover for the three land use / climate areas (each area is the average of the 100km circle around five DWN)



	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Northern Rangelands (n=5)	50%	55%	47%	62%	49%	19%	16%	20%	35%	41%	40%
Southern Rangelands (n=5)	12%	18%	36%	52%	41%	10%	7%	9%	12%	18%	19%
Southern Cropping (n=5)	6%	11%	21%	29%	19%	4%	5%	7%	5%	10%	9%

3.4.2.2 Climate adjusted groundcover index (CAGI)

Rainfall has a major effect on ground cover levels. Comparing the rainfall in Figure 4 with the ground cover levels in Figure 6 clearly shows the impact of dry years like 2009/10 and wet years like 2010/11 on ground cover. To enable comparison between years with different rainfall, we have developed the DustWatch “climate adjusted ground cover index” (CAGI) to enable comparison between years.

The KPI is “An increase in the number of properties being actively managed across the region to achieve a protective groundcover layer of 50% or above”. The critical word in this KPI is “increase”; therefore, success is indicated when the indicator drops, i.e. area with cover < 50% ground cover decreases. For a fair comparison we require a benchmark that that enables us to compare years with the same rainfall.

The concept behind CAGI is that over the last decade land managers have achieved certain levels of ground cover for a range of rainfall conditions ranging from drought years in the Millennium drought (2002 to 2009) to the record breaking wet years like 2010. We can use this 11 year record to establish a benchmark. We can then compare the area with cover < 50% ground cover for a given rainfall against the benchmark CAGI to see if the year had more or less ground cover than the benchmark.

There is one more piece of analysis to understand to this CAGI benchmarking. The rainfall in the month has little correlation to the ground cover level in that month. Ground cover tends to have a time lag between the rain and the growth and similarly a lag in the decline after extended periods of no rain.

To determine the best correlation between the ground cover and sum of the preceding months rainfall we correlated the sum of rainfall in the preceding 3, 6, 12, 18, 24, 30, 36 and 42 months with the average percentage area below 50% ground cover for each financial year and for each land use / climate area. For the three land use / climate areas, the preceding 36 months of rainfall in summer correlated the best (Figure 7). For the rest of this report “preceding rainfall” is the accumulated rainfall in mm for the preceding 36 months to July each year.

The CAGI benchmarks for each land use / climate area are shown in Figure 8.

Figure 7. Regression coefficients for the three land use / climate areas of preceding cumulated rainfall

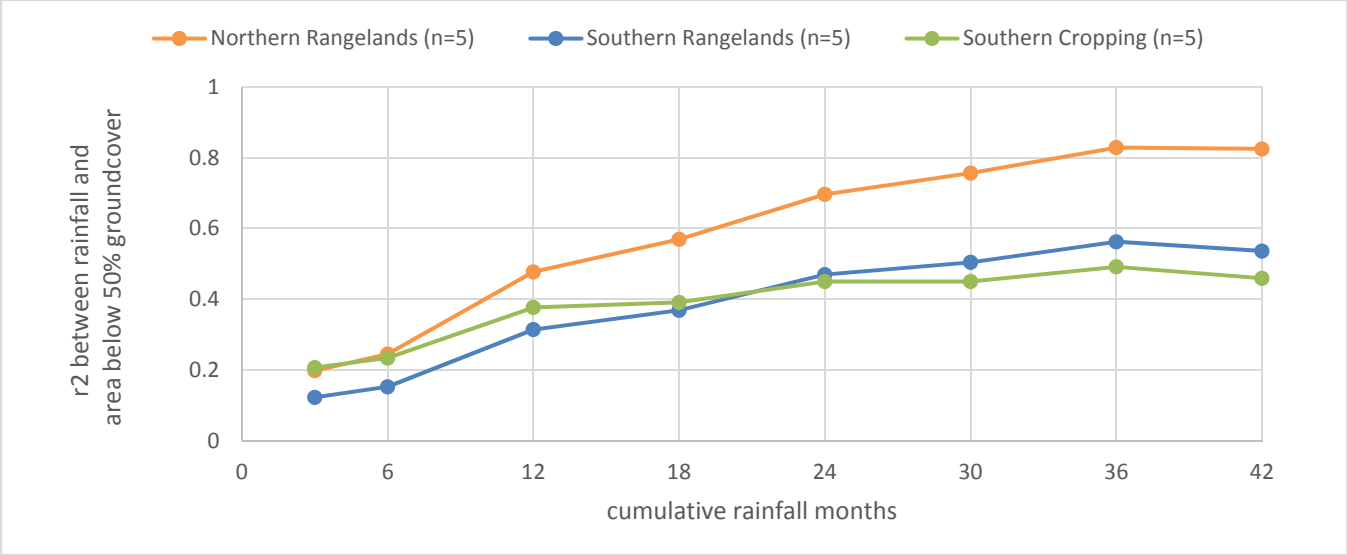
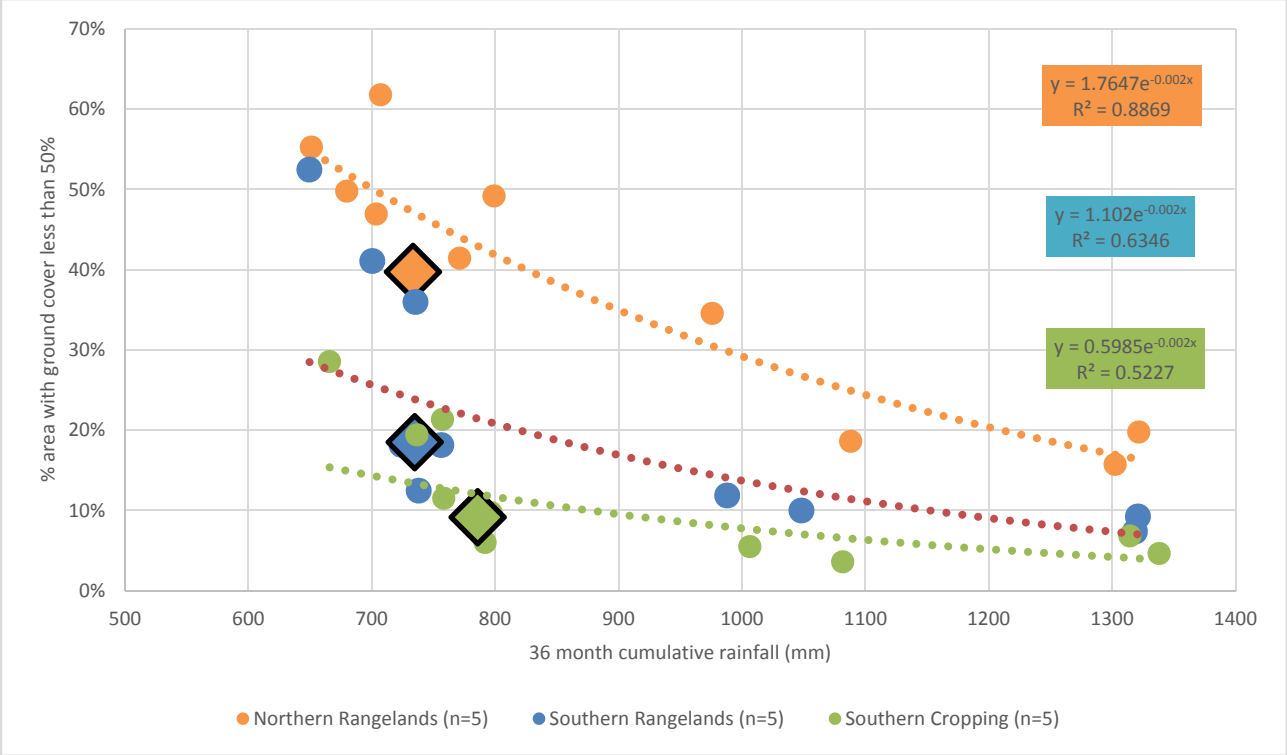


Figure 8. The three climate adjusted ground cover index (CAGI) benchmarks of area less than 50% ground cover for preceding 36 months of accumulated rainfall for each land use climate area. 2015/16 data noted as ◊



The preceding rainfall for the last 36 months prior to June 2019 was 733mm in the Southern Cropping and Rangelands and 785mm for the Northern Rangelands for the preceding. Area with less than 50% ground cover was 40% (n=5 for each area) for the Northern Rangelands, 19% for Southern Rangelands and 9% for the Southern Cropping lands. Therefore, each area did much better than the benchmark for the summer of 2015/16.

The average area with less than 50% ground cover for the 2015/16 year for the Northern Rangelands, and Southern Rangelands and Cropping lands were well below the climate adjusted ground cover index (CAGI) benchmark. This indicates the landscape had more cover for equivalent rainfall than during the previous 11 years.

3.4.3 Sustainability

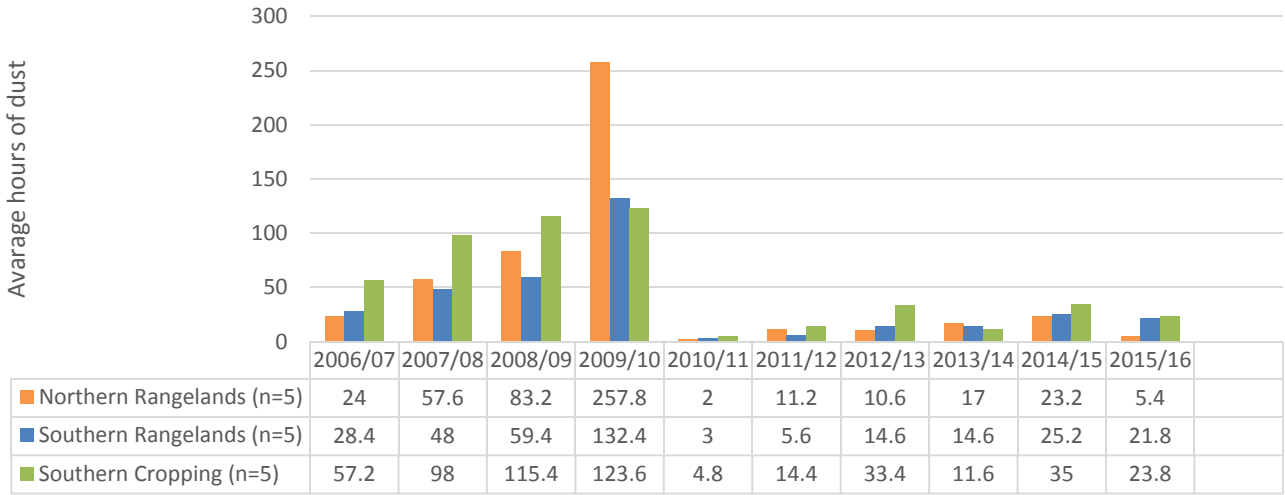
Dust is an indicator of landscape sustainability and environmental services to the community. If dust levels are high, the land is being degraded, agricultural production reduced and off-site costs are being imposed on the community. In this section we report the hours of dust recorded in the LLWS for 2015/16. The trend in dust levels is also reported for the last 11 years. Because dust is driven by climate and land management we present a climate adjusted sustainability index (CASI) and benchmark to enable comparison of the dust levels between years with different rainfall.

3.4.3.1 Hours of dust

Hours of dust were lower than 2014/15 for 11 out of 15 DWN. We are only concerned when the hours of dust are > 50h for a DWN as this was the previous Western CMA target. Fourteen of the fifteen DWN had <50h of dust in 2015/16. Euston was the only DWN to exceed the dust target with 63h. Euston had 238mm rainfall which was 76mm or 24% below the long term average and this contributed to the higher dust levels.

All three land use / climate areas, each with 5 DWN, were less than the dust target in 2015/15. The Southern Cropping and Rangelands had higher hours of dust (about 22h) compared to the northern Rangelands (5h); however, this was below the dust target (Figure 9).

Figure 9. Hours of dust in each land use climate region for the 2006/07 to 2015/16 period



	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Northern Rangelands (n=5)	24	57.6	83.2	257.8	2	11.2	10.6	17	23.2	5.4
Southern Rangelands (n=5)	28.4	48	59.4	132.4	3	5.6	14.6	14.6	25.2	21.8
Southern Cropping (n=5)	57.2	98	115.4	123.6	4.8	14.4	33.4	11.6	35	23.8

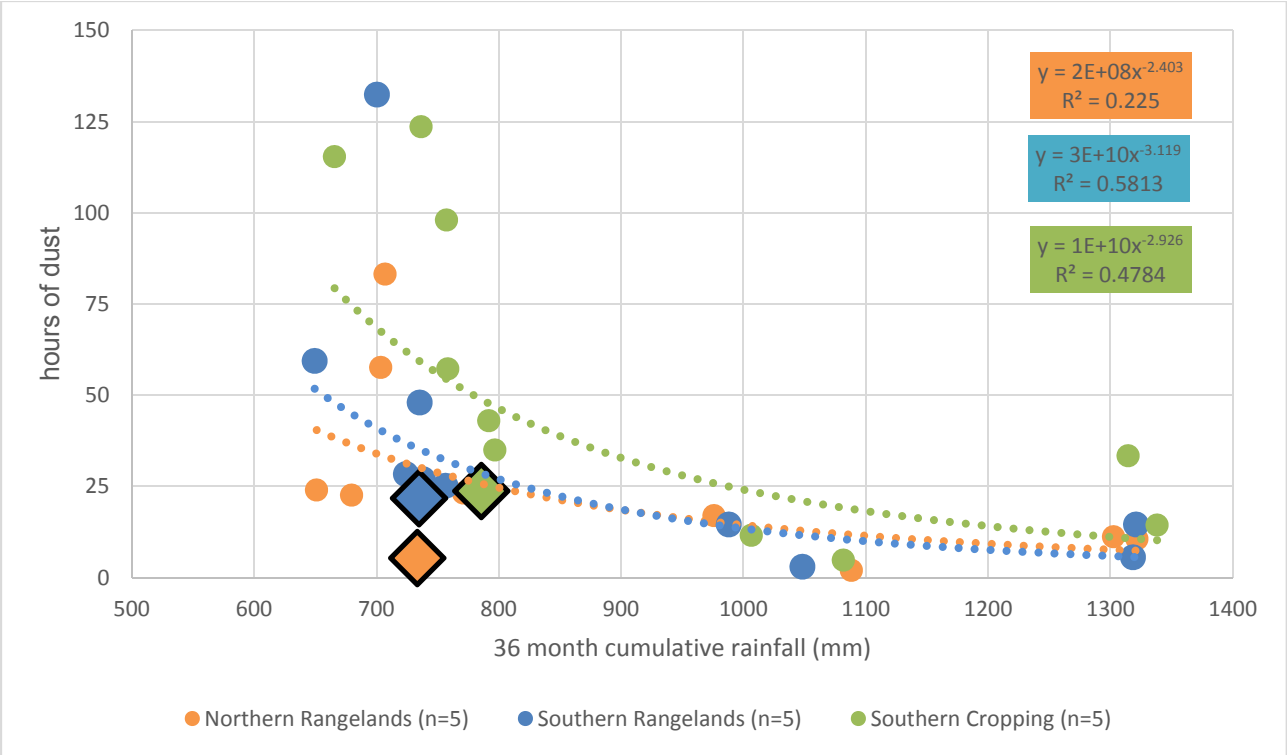
3.4.3.2 Climate adjusted sustainability index

Rainfall has a major effect on dust levels. Comparing the rainfall in Figure 4 with the dust hours in Figure 9 clearly shows the impact of dry years like 2009/10 and wet years like 2010/11 of dust hours. To enable comparison between years with different rainfall, we have developed the DustWatch “climate adjusted sustainability index” (CASI) to enable comparison of land condition between years.

The concept behind CASI is the same as CAGI, that over the last 11 years land managers have achieved certain levels of dust for a range of rainfall conditions. We use this 11 year record to establish the benchmark and then compare the hours of dust for a given rainfall against the benchmark CASI to see if the year had more or less dust than the benchmark.

The CASI benchmarks for dust hours for preceding rainfall for each land use climate area presented in Figure 10.

Figure 10. The three climate adjusted sustainability index (CASI) benchmarks of dust hours for preceding 36 months of accumulated rainfall for each land use climate area. 2015/16 data noted as ◊



The preceding rainfall for the last 36 months prior to June 2016 was 733mm in the Southern Cropping and Rangelands and 785mm for the Northern Rangelands for the preceding. Average hours (n=5 for each area) of dust were all below 23h with the Northern Rangelands having only an average of 5h. Therefore, each area did much better than the benchmark (Figure 10).

The CASI target was met for each land use / climate area because the hours of dust recorded for all three land use / climate areas in 2015/16 were well below the climate adjusted sustainability index (CASI) benchmark.

4. KPI - An improvement in the level of regional collaboration with customers, stakeholders and industry with respect to delivery of Western Local Land Services' services

In this section we report on the status of the KPI for Goal 3 "Effective, efficient, integrated service delivery and local decision making". For strategy AG4 the KPI is *An improvement in the level of regional collaboration with customers, stakeholders and industry with respect to delivery of Western Local Land Services' services*.

4.1 Rational for KPI

The KPI addresses the improvement in collaboration with customers, stakeholders and industry. The Western Region's relationship via this project includes primary links to: OEH and the Community DustWatch community. This is evidence of the Western Region's collaboration with customers, stakeholders and industry.

Community DustWatch and the Western Region and its predecessors have funded OEH to gather data and report on Catchment Action Plans and now their Strategic Plan. DustWatch has being operating for over a decade. It is a community based citizen science project run by the Office of Environment and Heritage in collaboration with volunteers, multiple Local Land Services, Natural Resource Management agencies, universities, CSIRO and the Bureau of Meteorology. Changes in collaboration can be reported.

Indicators used are:

1. Number of volunteers and communications with the community.
2. Community satisfaction with DustWatch as an indicator of the collaboration and its impact.

4.2 Method

A count of the volunteers and communications with Community DustWatchers is tabulated.

An online survey of Community DustWatchers was undertaken in March 2016. All DustWatchers on the mailing list, about 250 people, were asked these questions:

Has DustWatch:

- increased their knowledge about wind erosion
- increased their knowledge about ground cover
- increased their knowledge about land management increased their skills
- changed their attitude about soil erosion and/or land and grazing
- changed their organisation behavior
- provided information that they or their organisation use
- increased their understanding or appreciation of science

4.3 Results and Discussion

This project is an example of Western Region's collaboration with customers, stakeholders and industry.

4.3.1 DustWatch contacts

DustWatch produced 12 collaborative web reports, 4 journal publications, 5 presentations. It received over 100 emails and phone calls that provided information or requested advice.

During the 20115 period DustWatch:

- had 103 contacts with the community
- emailed the 256 people on the mailing list 16 times about the project
- produced 12 on-line monthly reports
- presented five presentations to the Australian government and or conferences

- Published 4 scientific papers using DustWatch data
- Visited the East Local Community Advisory Group on two occasions
- Attended three workshops with the Western Region staff or Local Community Advisory Group

4.3.2 Survey results

Overwhelmingly DustWatch is a collaborative project that increased people's knowledge, skills and changes their attitude to land management. It has also positively influenced peoples.

The survey results are listed below:

- **95% said they had increased their knowledge about wind erosion**
- **95% said they had increased their knowledge about ground cover**
- **94% said they had increased their knowledge about land management**
- **66% said they had increased their skills.** Their new skills included:
  - calibrating, operating, and maintaining DustWatch equipment, and understanding how it operates under various conditions;
  - analysing data, reading maps and interpreting remote sensed images to identify dust source areas, determine wind erosion, and the connection to land management
- **54% said they had changed their attitude about soil erosion and/or land and grazing management**. DustWatch also reinforced the importance of sustainable land management practices. Many people changed their attitudes about groundcover and recognised the importance of maintaining it.
  - **38% said they or their organisation had changed their behaviour.** Changes included:
    - changed priorities for work/management; engaged more across agencies; driven research and investment
    - in groundcover monitoring in Australia; emphasised the role of groundcover to conserve soils;
    - better aligned processes to service DustWatch.
  - **71% said they or their organisation used the information DustWatch provides.** DustWatch information was used for: evidence for better decision making; monitoring; assessments; reporting; education/research; community capacity building; setting priorities; remediation; marketing; Workplace Health and Safety.
  - **87% said they had increased their understanding or appreciation of science.** This included:
    - better understanding of scientific method; how to better communicate research results;
    - importance of data to inform decision making; greater interest and awareness of impacts and consequences of wind erosion and its causes;
    - better understanding of frequency, spatial scale and impact of dust, and value of groundcover (and how to better manage communicate research results;
    - importance of data to inform decision making; greater interest and awareness of impacts and consequences of wind erosion and its causes;
    - better understanding of frequency, spatial scale and impact of dust, and value of groundcover (and how to better maintain it), and importance of coordinated effort to change land management practices.

More information

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Appendix A. Best Management Practice codes and scores

Land Use	Land Mgmt Code	ManagementPhase	Definition	Mgt Code Score
Arable	B	Bushes	Perennial bushes <2 m in height makeup >25% of cover, e.g. bluebushes, saltbushes, cottonbush etc.	2
Arable	CBG	Copperburr Good	Biannual copperburrs makeup >25% of cover, e.g. more palatable ones like grey, silky copperburr,	2
Arable	CBB	Copperburr Bad	Biannual copperburrs makeup >25% of cover, e.g. more thorny ones like poverty bush, cannonball, galvanised burr	1
Arable	CC	Crop Cereal	E.g. wheat, barley, oats, triticale etc	2
Arable	CF	Crop Forage	Crop grazed by livestock not for grain production	2
Arable	Cfi	Crop Fibre	e.g. cotton	2
Arable	CH	Crop Hay	Crop cut for hay or silage, round or square bales	2
Arable	CL	Crop Legume	e.g. field peas, vetch, lupins	2
Arable	CO	Crop Oilseed	e.g. canola, mustard, etc.	2
Arable	FCC	Fallow Chemical Crop	Land kept free of live vegetation with the use of herbicides. No mechanical disturbance of crop residue	2
Arable	FCP	Fallow Chemical Pasture	Land kept free of live vegetation with the use of herbicides. No mechanical disturbance of pasture residue	2
Arable	FTC	Fallow Tilled Crop	Land kept free of live vegetation with the use of mechanical cultivation initiated from crop residue	1
Arable	FTP	Fallow Tilled Pasture	Land kept free of live vegetation with the use of mechanical cultivation initiated from pasture residue	1
Arable	INS	Invasive Native Shrub	Perennial invasive native shrubs makeup >25% of cover, e.g. hopbush, turpentine, pine etc.	1
Arable	PABl	Pasture Annual Broadleaf	Pasture dominated by annual broadleaf species >50% of cover, e.g. pattersons curse, medic, wards weed, thistles etc.	1
Arable	PAG	Pasture Annual Grass	Pasture dominated by annual grass species >50% of cover e.g. barley grass, rye grass, brome grass, wildoats.	1
Arable	PAGE	Pasture Annual Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. vulpia	1
Arable	PAL	Pasture Legume Annual	>50% of cover annual legumes e.g. medics	1

Land Use	Land Mgmt Code	ManagementPhase	Definition	Mgt Code Score
Arable	PB	Pasture Burnt	>50% of cover burnt by wildfire or for management	1
Arable	PC	Pasture Cropping	Sown crop (ceral) emerging from dead or alive pasture	2
Arable	PPGE	Pasture Perennial Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. sweet vernal grass, Chilean needle grass, surrated tussock	1
Arable	PPGN	Pasture Perennial Grass Native	Perennial native grass species makeup >25% of cover, e.g. redgrass, wallaby grass, speargrass , wiregrass.	2
Arable	PPGT	Pasture Perennial Grass Temperate	Perennial temperate grass species makeup >25% of cover, e.g. phalaris, cocksfoot, etc.	2
Arable	PPL	Pasture Legume Perennial	Perennial legume species makeup > 25% of cover, e.g. lucerne.	2
Arable	SB	Stubble Burnt	>50% of cover burnt by wildfire or for management	1
Arable	SBS	Stubble Burnt Strips	Wind row and or header trails burnt only, not entire paddock	2
Arable	SG	Stubble Grazed	Crop residues with signs of grazing by livestock. More than 50% knocked down	1
Arable	SM	Stubble Mulched	Crop residues flattened or mulched (chopped-up)by mechanical means but no soil disturbance	2
Arable	SS	Stubble Standing	Crop residues post harvest, more than 50% standing	2
Conservation	B	Bushes	Perennial bushes <2 m in height makeup >25% of cover, e.g. bluebushes, saltbushes, cottonbush etc.	2
Conservation	CBG	Copperburr Good	Biannual copperburrs makeup >25% of cover, e.g. more palatable ones like grey, silky copperburr,	2
Conservation	CBB	Copperburr Bad	Biannual copperburrs makeup >25% of cover, e.g. more thorny ones like poverty bush, cannonball, galvanised burr	1
Conservation	INS	Invasive Native Shrub	Perennial invasive native shrubs makeup >25% of cover, e.g. hopbush, turpentine, pine etc.	1
Conservation	PABl	Pasture Annual Broadleaf	Pasture dominated by annual broadleaf species >50% of cover, e.g. pattersons curse, medic, wards weed, thistles etc.	1
Conservation	PAG	Pasture Annual Grass	Pasture dominated by annual grass species >50% of cover e.g. barley grass, rye grass, brome grass, wildoats.	1
Conservation	PAGE	Pasture Annual Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. vulpia	1
Conservation	PAL	Pasture Legume Annual	>50% of cover annual legumes e.g. medics	1
Conservatio	PB	Pasture Burnt	>50% of cover burnt by wildfire or for management	1

Land Use	Land Mgmt Code	ManagementPhase	Definition	Mgt Code Score
n				
Conservation	PPGE	Pasture Perennial Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. sweet vernal grass, Chilean needle grass, serrated tussock	1
Conservation	PPGN	Pasture Perennial Grass Native	Perennial native grass species makeup >25% of cover, e.g. redgrass, wallaby grass, speargrass , wiregrass.	2
Conservation	W	Woody with no understorey	Woody native vegetation with canopy >25% , with no shrubby understorey.	2
Conservation	WU	Woody with understorey	Woody native vegetation with canopy >25%, with shrubby understorey.	2
Forestry	WPN	Woody Production Natural	Natural woodlots managed for wood products.	2
Forestry	WPP	Woody Production Planted	Planted woodlots managed for wood products.	2
Horticulture	HTB	Orchard without cover crop	Tree crops (nuts, fruit, olives) with no cover crops between rows	1
Horticulture	HTC	Orchard with cover crop	Tree crops (nuts, fruit, olives) with cover crops between rows	2
Horticulture	HV	Horticulture Vegetables	Vegetable crop (e.g potatoes)	1
Horticulture	HVB	Vines without cover crop	Vine crops (grapes, berries) with no cover crops between rows	1
Horticulture	HVC	Vines with cover crop	Vine crops (grapes, berries) with cover crops between rows	2
Irrigation	B	Bushes	Perennial bushes <2 m in height makeup >25% of cover, e.g. bluebushes, saltbushes, cottonbush etc.	2
Irrigation	CBB	Copperburr	Biannual copperburrs makeup >25% of cover, e.g. copperburr, poverty bush, cannonball.	1
Irrigation	CBG	Copperburr Good	Biannual copperburrs makeup >25% of cover, e.g. more palatable ones like grey, silky copperburr,	2
Irrigation	CC	Crop Cereal	E.g. wheat, barley, oats, triticale etc	2
Irrigation	CF	Crop Forage	Crop grazed by livestock not for grain production	2
Irrigation	Cfi	Crop Fibre	e.g. cotton	2
Irrigation	CH	Crop Hay	Crop cut for hay or silage, round or square bales	2
Irrigation	CL	Crop Legume	e.g. field peas, vetch, lupins	2

Land Use	Land Mgmt Code	ManagementPhase	Definition	Mgt Code Score
Irrigation	CO	Crop Oilseed	e.g. canola, mustard, etc.	2
Irrigation	FCC	Fallow Chemical Crop	Land kept free of live vegetation with the use of herbicides. No mechanical disturbance of crop residue	2
Irrigation	FCP	Fallow Chemical Pasture	Land kept free of live vegetation with the use of herbicides. No mechanical disturbance of pasture residue	2
Irrigation	FTC	Fallow Tilled Crop	Land kept free of live vegetation with the use of mechanical cultivation initiated from crop residue	1
Irrigation	FTP	Fallow Tilled Pasture	Land kept free of live vegetation with the use of mechanical cultivation initiated from pasture residue	1
Irrigation	PABl	Pasture Annual Broadleaf	Pasture dominated by annual broadleaf species >50% of cover, e.g. pattersons curse, medic, wards weed, thistles etc.	1
Irrigation	PAG	Pasture Annual Grass	Pasture dominated by annual grass species >50% of cover e.g. barley grass, rye grass, brome grass, wildoats.	1
Irrigation	PAGE	Pasture Annual Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. vulpia	1
Irrigation	PB	Pasture Burnt	>50% of cover burnt by wildfire or for management	1
Irrigation	PPGE	Pasture Perennial Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. sweet vernal grass, Chilean needle grass, serrated tussock	1
Irrigation	PPGN	Pasture Perennial Grass Native	Perennial native grass species makeup >25% of cover, e.g. redgrass, wallaby grass, speargrass , wiregrass.	2
Irrigation	PPGT	Pasture Perennial Grass Temperate	Perennial temperate grass species makeup >25% of cover, e.g. phalaris, cocksfoot, etc.	2
Irrigation	PPL	Pasture Legume Perennial	Perennial legume species makeup > 25% of cover, e.g. lucerne.	2
Irrigation	SB	Stubble Burnt	>50% of cover burnt by wildfire or for management	1
Irrigation	SBS	Stubble Burnt Strips	Wind row and or header trails burnt only, not entire paddock	2
Irrigation	SG	Stubble Grazed	Crop residues with signs of grazing by livestock. More than 50% knocked down	1
Irrigation	SM	Stubble Mulched	Crop residues flattened or mulched (chopped-up)by mechanical means but no soil disturbance	2
Irrigation	SS	Stubble Standing	Crop residues post harvest, more than 50% standing	2
Rangeland	B	Bushes	Perennial bushes <2 m in height makeup >25% of cover, e.g. bluebushes, saltbushes, cottonbush etc.	2
Rangeland	CBG	Copperburr Good	Biannual copperburrs makeup >25% of cover, e.g. more palatable ones like	2

Land Use	Land Mgmt Code	ManagementPhase	Definition	Mgt Code Score
			grey, silky copperburr,	
Rangeland	CBB	Copperburr Bad	Biannual copperburrs makeup >25% of cover, e.g. more thorny ones like poverty bush, cannonball, galvanised burr	1
Rangeland	INS	Invasive Native Shrub	Perennial invasive native shrubs makeup >25% of cover, e.g. hopbush, turpentine, pine etc.	1
Rangeland	INSB	Invasive Native Shrub Burnt	Perennial invasive native shrubs makeup >25% of cover, e.g. hopbush, turpentine, pine burnt for mangagement reasons	2
Rangeland	PABl	Pasture Annual Broadleaf	Pasture dominated by annual broadleaf species >50% of cover, e.g. pattersons curse, medic, wards weed, thistles etc.	1
Rangeland	PAG	Pasture Annual Grass	Pasture dominated by annual grass species >50% of cover e.g. barley grass, rye grass, brome grass, wildoats.	1
Rangeland	PAGE	Pasture Annual Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. vulpia	1
Rangeland	PAL	Pasture Legume Annual	>50% of cover annual legumes e.g. medics	1
Rangeland	PB	Pasture Burnt	>50% of cover burnt by wildfire or for management	2
Rangeland	PPGE	Pasture Perennial Grass Exotic	Perennial exotic grass species make up >25% of cover, e.g. sweet vernal grass, Chilean needle grass, serrated tussock	1
Rangeland	PPGN	Pasture Perennial Grass Native	Perennial native grass species makeup >25% of cover, e.g. redgrass, wallaby grass, speargrass , wiregrass.	2
Rangeland	W	Woody with no understorey	Woody native vegetation with canopy >25% , with no shrubby understorey.	2
Rangeland	WU	Woody with understorey	Woody native vegetation with canopy >25%, with shrubby understorey.	2
Revegetation	RB	Biodiversity plantings	Woodlots planted for the purposes of conservation such as salinity control and biodiversity	2
Revegetation	RW	Windbreak	Woodlots planted for the purposes of sheltering crops and livestock	2
Transition	WPT	Woodland Pushed Timber	Logs and stumps pushed into piles for burning in last 12 months. Bull dozers pushed timber into piles for burning.	1
Transition	WRC	Woodland Recently Cleared	Woody vegetation felled in last 12 months. Bull dozers and or chains used to fell timber.	1
Transition	WWR	Woodland Wheel Raked	Sticks and roots wheel-raked into rows in last 12 months. Wind rowed sticks and roots with very high level of soil disturbance.	1