Progress report on soil erosion protection in the South Australian Murray-Darling Basin Region

Prepared for the SA Murray-Darling Basin Natural Resources Management Region - July 2017

Key points:

- **Protection from soil erosion is a high priority soil management issue in the SA Murray-Darling Basin Region.**
- **Protection from wind erosion has improved significantly since monitoring began but has largely plateaued.**
- **As at July 2017, protection from wind erosion was 332 days, the highest achieved since monitoring began.**
- **Groundcover levels over the last 3 seasons were higher than the long term average.**
- **Improvements reflect good biomass producing seasons, combined with adoption of improved land management practices; e.g. 77% of crop area was sown using no-till in 2016.**
- **Further improvement in erosion protection will be limited by challenges of ongoing and emerging issues.**

Prepared by:
Giles Forward
Conservation, Sustainability and Wildlife Management Unit

Healthy soils support the production of premium food and wine

Government of South Australia
Department of Environment, Water and Natural Resources

Summary (Soil erosion protection report 2017 – SAMDB NRM Region)

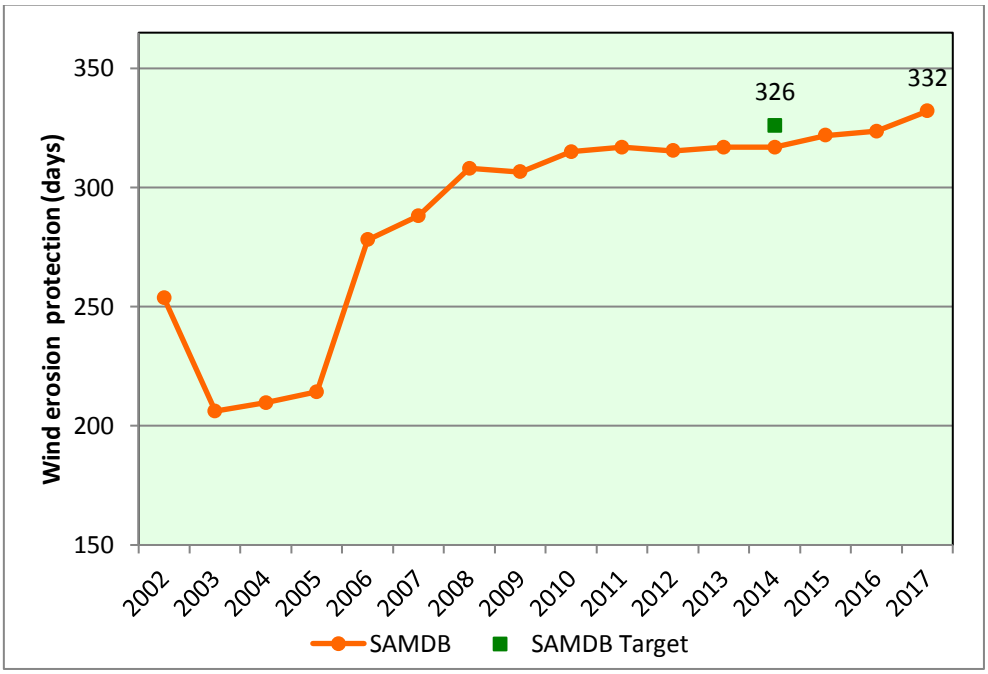


Figure 1. Wind erosion protection index (days, 3 year rolling mean) for the SAMDB region from 2002 to 2017, with the previous SAMDB Target L2.1

- Protection of soils from the risk of erosion has been the highest priority soil management issue in the SAMDB region. The risk is relatively low at present with adoption of sound soil management practices but could increase due to adverse conditions (bushfires, dry seasons, or increased pests – mice, snails).
- Agricultural cropping land in the SAMDB Region was protected from wind erosion for 332 days in 2017 (Figure 1). This is the highest recorded since monitoring began (and exceeds the previous SAMDB NRM Plan Target of 326 days at 2014).
- From the 2002 drought up to 2010, there was a strong upward trend in wind erosion protection, which correlates with adoption of improved land management practices, particularly no-till cropping methods. Since 2010, the rate of improvement has mainly tapered off, probably mirroring the uptake of no-till which has also plateaued.
- The 3 year mean cover levels as at 2016-17 were generally slightly higher than the long term average, particularly in June. This is likely to reflect the uptake of no-till and stubble retention methods as well as relatively favourable early season rains and rapid crop and pasture establishment in the last few seasons.
- Erosion protection is compromised where land managers use stubble burning or cultivation, most commonly to control snails, summer weeds, and weed herbicide resistance. Herbicide resistance is increasing, and water repellence appears to be increasing where no-till has been used for over a decade.
- To achieve the SAMDB wind erosion protection target, efforts will be needed to investigate, develop and implement new or modified practices and systems to achieve greater soil erosion protection.

Background

The SAMDB NRM Region has approximately 2.5 million hectares of cleared agricultural land.

About 1.7 million hectares (66%) are inherently susceptible to wind erosion due to sandy textured soils (Figure 2).

There are also approximately 720,000 hectares (29%) that are inherently susceptible to water erosion, on sloping, hilly land in the eastern Mt Lofty Ranges and southern Flinders Ranges (Figure 3).

Soil erosion protection has been the highest priority soil management issue in the SAMDB region. The risk is relatively low at present with adoption of sound soil management practices and mostly favourable seasons but could increase due to adverse conditions such as bushfires, dry seasons including climate change, or increased threats of pests such as mice and snails.

The frequency and magnitude of wind erosion and water erosion of soil in the agricultural areas have steadily declined over the past 70 years due to improvements in farming practices. Nonetheless, soil erosion still occurs at times, particularly associated with extreme wind or rainfall events, and after fires.

The risk of erosion is increased during and following very dry seasons when plant growth may be inadequate to provide sufficient groundcover for erosion protection. In annual crop/pasture systems, soil exposure is usually highest in late summer through to the time of crop sowing (May).

Modelling has shown that climate change will significantly increase the susceptibility of soils to wind erosion and water erosion.

Soil erosion results in more or less irreversible degradation of soil productive capacity, particularly as many of SA's topsoils are shallow and relatively infertile.

It can damage plants and has a wide range of costly off-site impacts including damage to roads, disruption to transport and electricity supply, siltation of watercourses, and human health and wellbeing impacts caused by raised dust.

The use of agricultural land management practices that maintain protective groundcover and minimise soil disturbance are crucial to minimising the risk of wind or water erosion.

The key factors in reducing the risk of erosion are keeping the soil surface covered and protected from wind and water; maintaining soil in a cohesive or undisturbed condition so that soil particles are not easily loosened, detached and transported; and keeping it in this protected state for as long as possible.

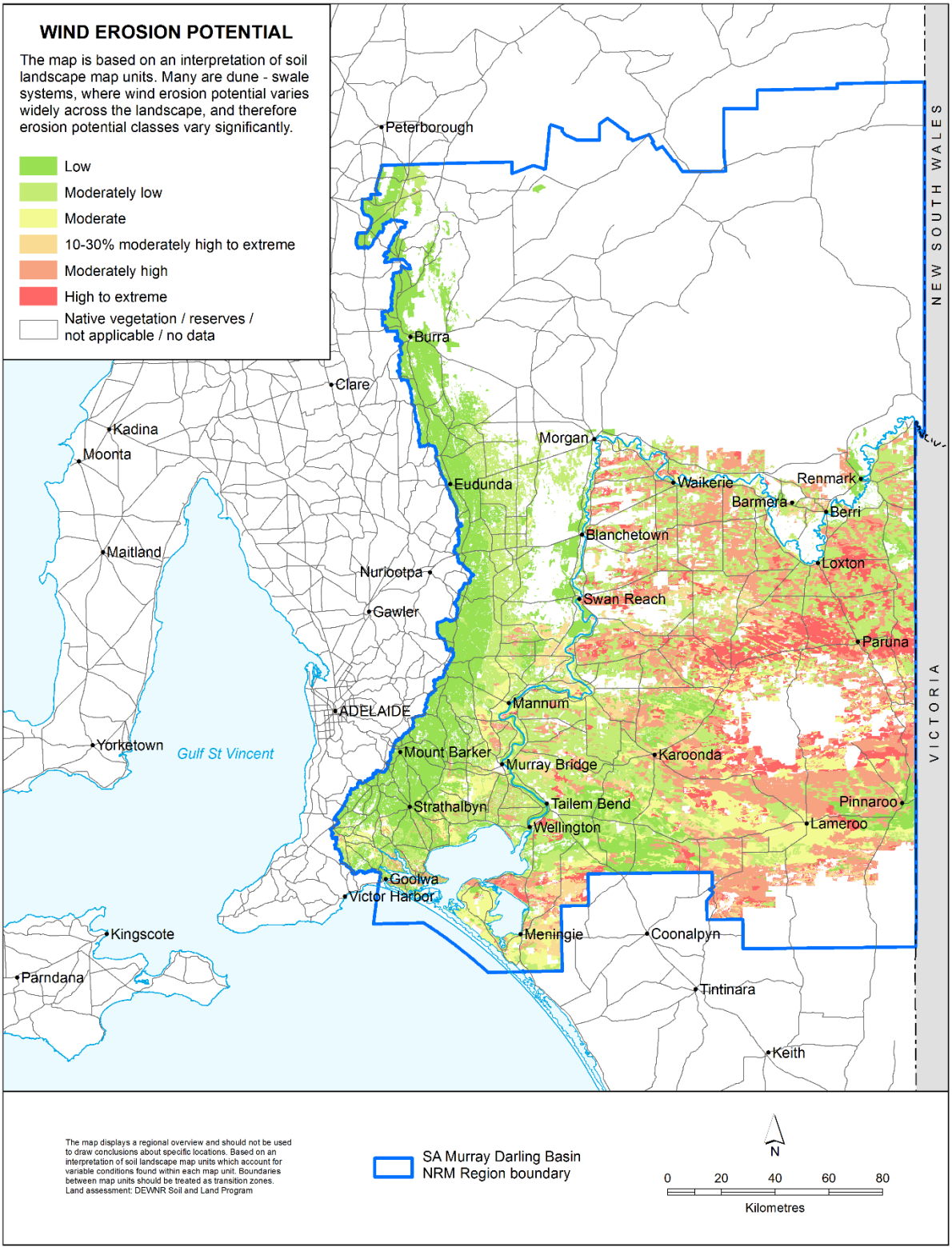


Figure 2. Inherent susceptibility of cleared agricultural land to wind erosion in the SAMDB NRM Region.

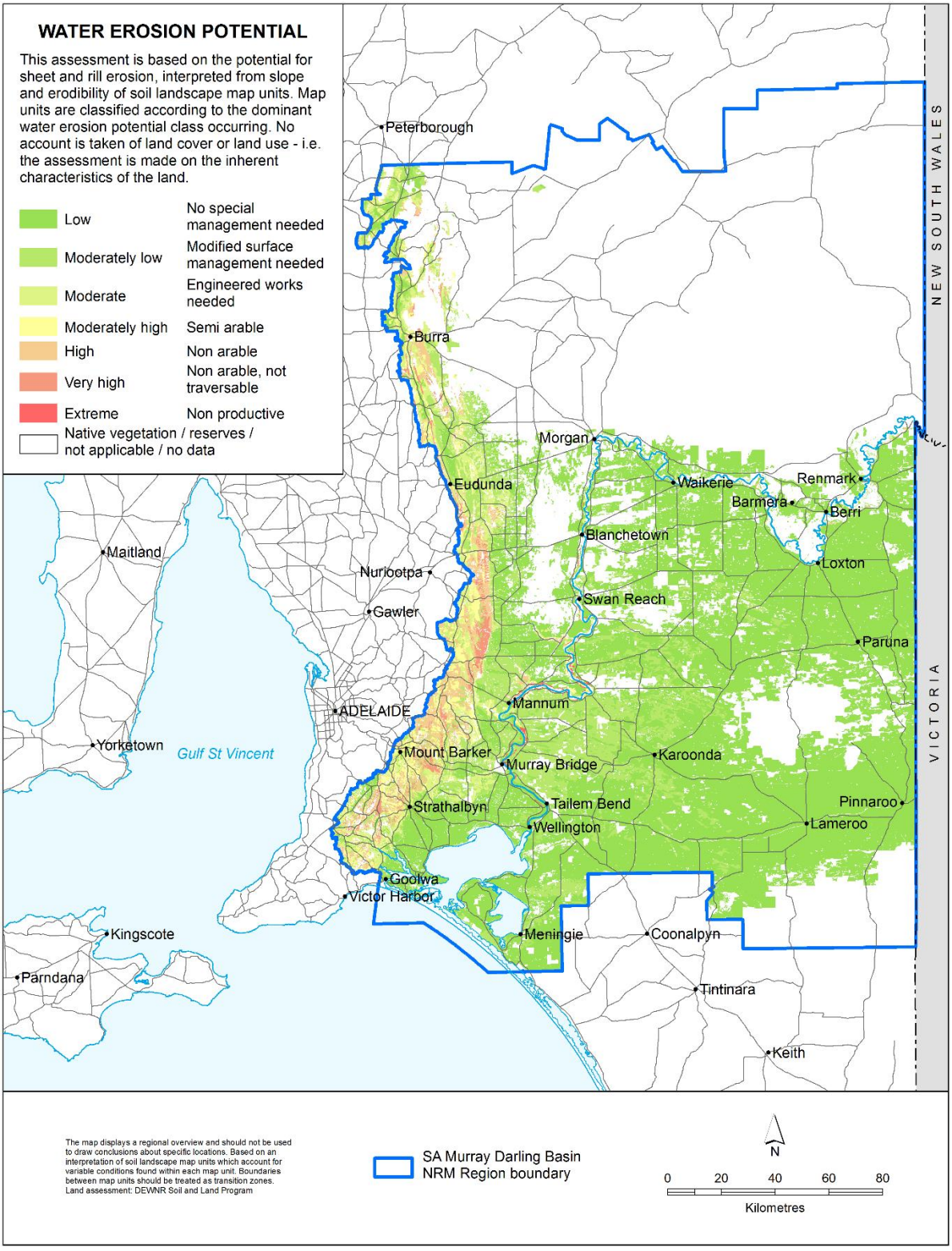


Figure 3. Inherent susceptibility of cleared agricultural land to water erosion in the SAMDB NRM Region.

Monitoring erosion risk

The Department of Environment, Water and Natural Resources (DEWNR) conducts observational field surveys to monitor trends in the protection of soil from erosion in the SAMDB Region and other agricultural cropping regions in SA. The surveys are undertaken in October, March, May and June each year. Soil surface cover levels and soil disturbance are visually rated during these surveys at nearly 1400 sites in the SAMDB region. It should be noted however that since October 2014, due to budget constraints, the field surveys have been scaled down and data has been collected from a reduced number of sites in the region. This has slightly reduced the accuracy of results.

The surface cover rating system used is based on a scale of 1-8 where 1 = full cover and 8 = bare ground.

The field surveys do not cover sloping land in the eastern Mt Lofty Ranges which have potential for water erosion but are mainly grazed pastures.

DEWNR has recently developed a method to monitor groundcover levels across the region using MODIS Fractional Cover satellite data, which has been calibrated against the surface cover rating data from the field surveys. While this method does not capture field observations of soil disturbance, cropping phase and other land management factors, it does provide a relative estimate of groundcover level (therefore erosion risk) on all agricultural land across the region. The model is currently under revision so results are not available for this reporting period, but provisional 2016 maps are included in Appendix 2.

Soil surface cover levels

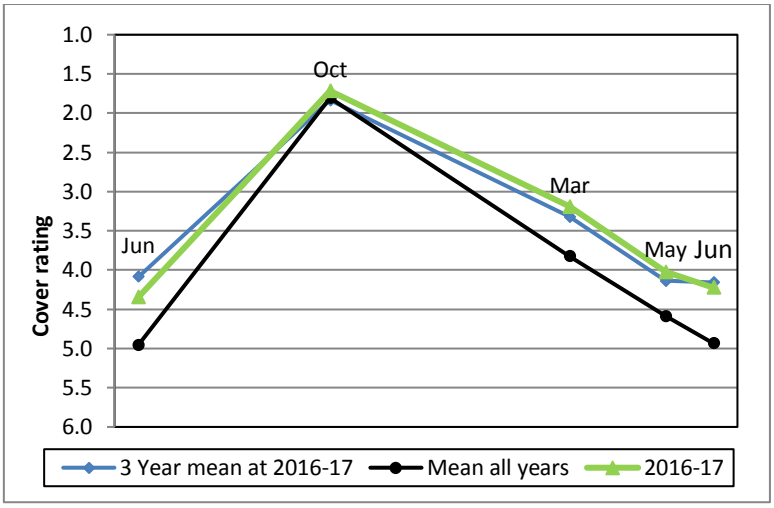
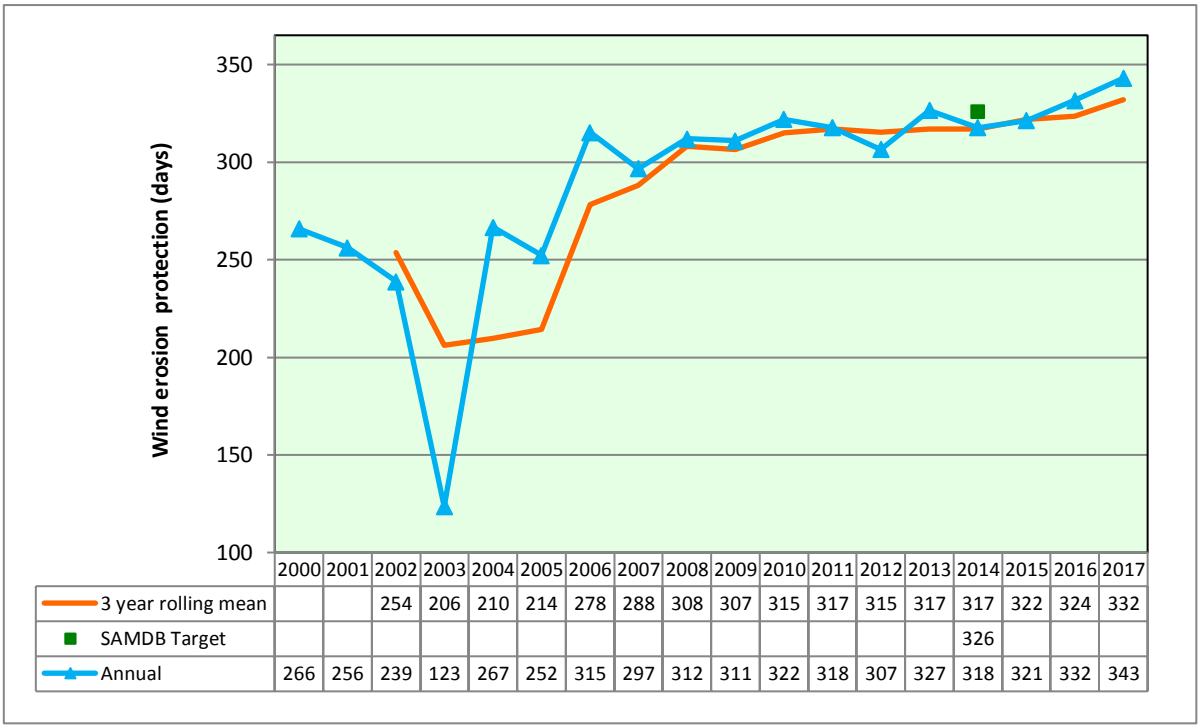


Figure 4. Mean surface cover rating on agricultural land in the SAMDB region from field surveys from June 2016 to June 2017 compared to the three year rolling mean at 2016-17 and the average for the monitoring period since 1999-2000.

Note: Cover rating 1 = full cover, 8 = bare soil

Figure 4 shows that mean groundcover levels in the SAMDB region from June 2016 to June 2017 were about the same as the average of the last 3 years. Overall, cover was better in 2016-17 than the long term average. This probably reflects the high biomass producing season in 2016 which included a wet spring, but also due to the adoption of improved land management practices such as no-till and stubble retention that retain more groundcover.

Soil erosion protection



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
3 year rolling mean			254	206	210	214	278	288	308	307	315	317	315	317	317	322	324	332
SAMDB Target															326			
Annual	266	256	239	123	267	252	315	297	312	311	322	318	307	327	318	321	332	343

Figure 5. Protection of susceptible cropping land from wind erosion (days), annual and 3 year rolling mean, in the SAMDB region from 2000 to 2017, and the previous SAMDB Target L2.1.

Although the SAMDB region's soil protection target uses the wind erosion protection index which is a 3 year rolling mean means to dampen seasonal effects and be more indicative of management influences. The annual days of wind or water erosion soil protection reflect the impact of yearly seasonal conditions but are also affected by management.

Figure 5 shows that the annual wind erosion protection in 2017 was 343 days, significantly higher than 2015, and is the highest since monitoring began.

Wind erosion protection has increased substantially since monitoring began. The impact of the extremely dry year in 2002 (decile 1 growing season rainfall in the Murraylands) is clearly evident in Figure 3, where very low crop and pasture production resulted in low surface cover levels going into 2003, and a corresponding low level of wind erosion protection. The 2006 season was also very dry, but erosion protection was only minimally affected in 2007 when there was substantially more no-till being used together with more careful management of groundcover levels by land managers. There was also enough rain around sowing time to get reasonable establishment of cover.

Notably, however, since 2006, the level of wind erosion protection only increased slightly. This probably reflects the plateauing of the uptake of no-till practices in the region. If drier than average conditions occur in coming seasons, this could result in a temporary fall in wind erosion protection.

Seasonal conditions, land management practices and their impacts on soil protection

The following is a summary of conditions and practices in agricultural areas of the SAMDB NRM Region over the past three years, which relate to the three year rolling mean erosion protection indices.

2014-15

- The 2014 growing season produced good biomass of crops and pastures, although very dry conditions from August onwards markedly reduced yields. There was increased hay cutting of poorer yielding crops due to the dry spring, crops severely affected by frost, and canola crops that were severely infected by Beet Western Yellows Virus.
- By the end of spring, however, crop and pasture biomass in most paddocks was good, providing good groundcover levels going into summer/autumn.
- Heavy rainfall in January germinated summer weeds and volunteer cereals, although hot dry weather followed and much growth died off.
- By the end of March, dry summer-autumn conditions led to depletion of cover in some grazed paddocks with some wind erosion observed in the Northern Mallee.
- Good rains in April enabled sowing to get underway and stimulated pasture germination. May rainfall was patchy across the region, and plant establishment on water repellent sands was reduced in many areas.

2015-16

- The 2015 growing season in the SAMDB region produced average to above average crop biomass, but yields were variable due to below average spring rain. Yields were also reduced in some areas by frost damage. Some poorer yielding or frost-affected crops were cut for hay.
- There was early senescence of pastures due to the dry spring, reducing pasture biomass.
- Through summer and autumn, groundcover levels had become low on grazed pastures and grain legume stubbles. Some sandy rises became bare, with some drift occurring on windy days. Elsewhere, groundcover levels remained adequate for soil protection, particularly in cereal stubbles.
- On 25th November a fire occurred on farm land near Lameroo, which burnt 1700 hectares. Some wind erosion occurred on burnt areas with sandy soils. Emergency ripping was done on areas with sub-surface clayey soils, and manure was spread on drifting areas.
- Rains in January to March 2016 resulted in growth of summer weeds and volunteer plants, mainly in the western part of the region. Herbicides were predominantly used to control this growth, although a small number of paddocks were cultivated in some areas.
- In April some pre-sowing cultivation was evident, and some paddocks were dry-sown. Significant wind erosion occurred on 27 April and again in early May on exposed areas

such as over-grazed sandy rises and cultivated paddocks. Some eroded areas were levelled and sown with a cover crop.

- In May crop sowing and emergence was delayed in the northern Mallee due to dry conditions until significant rain fell late in the month. Poorly covered or cultivated paddocks, and areas with water repellent soils, were exposed to erosion until crops established on these areas.
- By the end of June, crops and pastures were well established on almost all land across the region.

2016-17

- Above average rainfall in 2016 growing season with a wetter than average spring produced above average biomass of crops and pastures.
- Severe storms with large hail in November flattened crops in some local areas, knocking grain to the ground, creating a haven for mice.
- Substantial rainfall through summer produced extensive growth of summer weeds and volunteer plants, providing additional groundcover and feed. Multiple applications of herbicide were commonly required to control growth, and a small number of paddocks were cultivated in some districts.
- There was generally more than average paddock burning done to control snails and mice, and heavy stubbles. Mice numbers were higher than average, necessitating baiting in some districts around seeding time.
- In late April, significant rains of up to 30-40mm provided a good break to the season. Average May rainfall enabled most crop sowing to progress, although below average June rainfall slowed crop emergence and pasture establishment.
- By the end of June, groundcover levels were generally adequate for erosion protection except on a few sandy rises.

Trends in land management practices

DEWNR has commissioned a series of telephone surveys of agricultural land managers in SA (broadacre cropping, livestock grazing, dairy) between the years 2000 and 2017 to obtain data on their soil management issues and the land management practices used in their farming systems, including their understanding of soil and land management issues. Over the survey period, data from these surveys have shown increasing adoption of land management practices that improve protection of the soil from erosion.

Figure 6 shows that the proportion of the crop area reportedly sown using no-till methods in the SAMDB region has increased dramatically from 9% in 1999 to 77% in 2016. A similar trend was reported in the other main cropping regions of SA. The practice of cultivated fallowing is now rare, and if any cultivation is done it is usually strategic and limited, for specific purposes. According to the 2017 survey, 50% of SAMDB region croppers did some pre-sowing cultivation in 2016, but this was done on only 21% of the total cropped area. The main reasons given for doing cultivation were to control weeds (48% of those who cultivated), break up compacted soil (47%), and control diseases (15%).

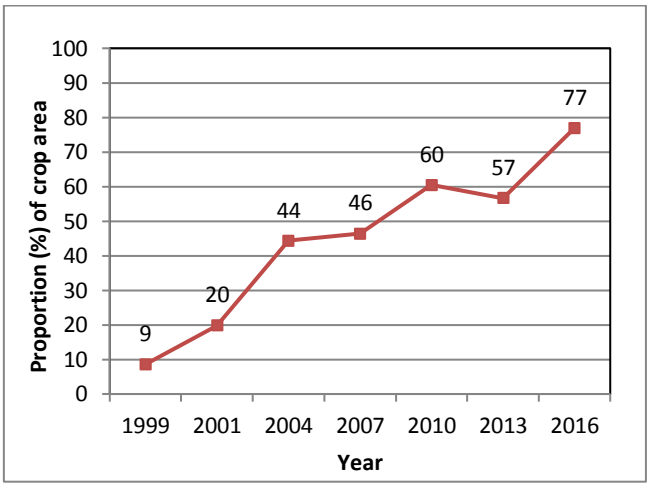


Figure 6. Proportion (%) of crop area in the SAMDB region sown using no-till methods (including zero till) according to survey respondents

Figure 7 shows that since the 2008 survey (when question first asked), there has been an increase in the proportion of croppers who aim to leave on average at least 50% surface cover prior to sowing.

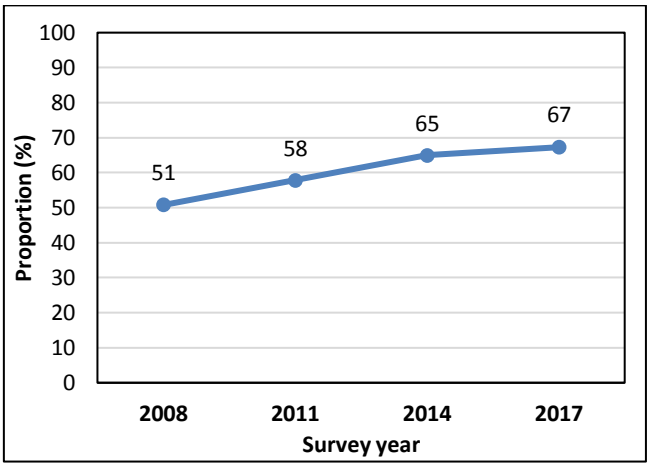


Figure 7. Proportion of cropping land managers in the SAMDB region who aim to leave on average at least 50% surface cover of stubble/residues immediately prior to sowing.

The relative incidence of stubble or residue burning can be estimated from Geoscience Australia's Sentinel Hotspots infra-red remote sensing data (Figure 8). This shows the number of fires (mainly 'hot' burns) detected on agricultural land, which gives an approximate indication of the incidence of deliberate paddock burning each year in the SAMDB region. This shows marked seasonal variation in the use of burning. This reflects the volume of stubble/residues remaining from the previous year (ie high volumes can interfere with the seeding operation) and the perceived threat to crops from pests such as mice or snails. The relatively high use of burning in 2017 was probably related to the higher risk of mice and snails as well as heavy stubbles following the high producing season in 2016. It should be noted however that this only about a third of the frequency of burning in the Northern and Yorke NRM Region in 2017.

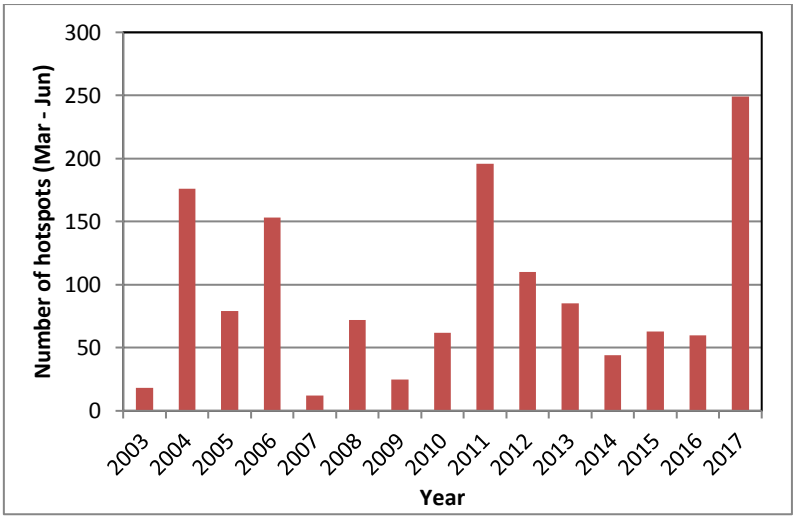


Figure 8. Number of hotspots recorded (infra-red remote sensing) on cleared agricultural land in the SAMDB NRM Region from March to June each year from 2003 to 2017; data from Geoscience Australia Sentinel Hotspots

Burning of windrows or stubble dumps to reduce weed seed numbers is now a common practice in the region, and leaves the rest of the stubble intact to provide protection from erosion. More complete paddock burns tend to be used where snails or mice are problems. Figure 9 shows that the use of full burning in 2016 was lower than 2013, with a corresponding increase in windrow burning.

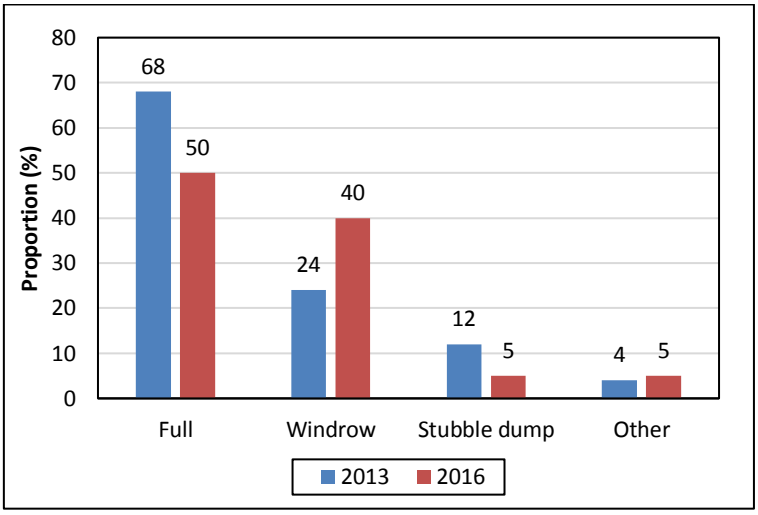


Figure 9. Type(s) of burning done by cropping land managers in the SAMDB region when preparing to crop in 2013 and 2016 (proportion of those who burnt).

Figure 10 shows that the reasons given by croppers for burning were snail control, weed control, and reducing (high) stubble loads.

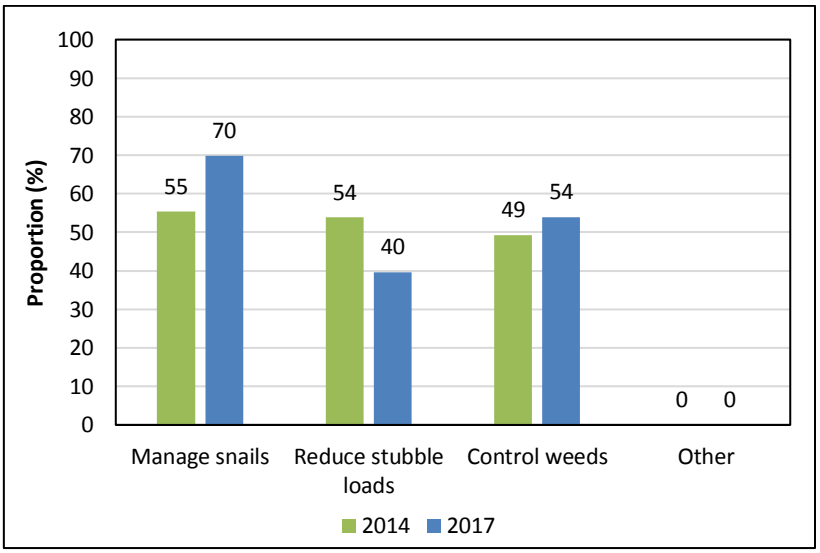


Figure 10. Main reasons given for burning stubbles/residues, cropping land managers who ever burn when preparing to crop; 2014 and 2017 surveys.

Removing stock from paddocks and feeding them in containment areas helps stop paddocks from becoming devoid of surface cover. The proportion of farmers in the region who reported using this practice has increased from around 30% to over 50% over the period of the surveys to 2017 (Figure 11). Supplementary feeding of stock in paddocks is also commonly used through summer-autumn particularly where pasture feed availability is lower, and this was done widely through the dry summer in 2012-13. However, this may not necessarily protect surface cover.

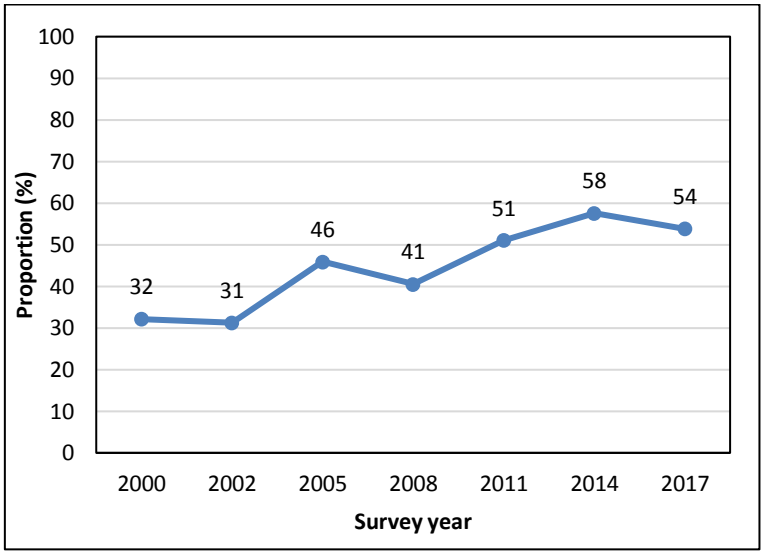


Figure 11. Proportion of land managers in the SAMDB region who use confinement feeding areas for stock when necessary to manage erosion risk in paddocks.

These survey results indicate that farmers generally are increasingly using practices that protect the soil from erosion. The exception to this is burning stubble residues that are perceived to be likely to cause problems for the next season's crops.

The uptake of improved land management practices, particularly no-till, in the SAMDB region over the survey period, correlates with the increased protection of agricultural cropping land from wind erosion. This data shows that the uptake of no-till in the SAMDB has levelled off, similarly to the other main cropping regions of SA. This reflects that the use of no-till methods is reaching an optimum level (that is, some tillage needed to manage pests, disease, weeds, herbicide resistance or water repellence), so the achievement of further improvements in soil erosion protection will become more challenging. Investigation, development and implementation of modified or new practices or systems to manage these issues while maintaining or improving erosion protection, is needed.

Current and emerging issues

While land managers have no control over seasonal climatic variability, there are opportunities to better manage and improve soil protection through their management of land, including strategies to adapt and respond to climate variability.

There are a number of current and emerging issues that could impede achievement of the erosion protection target in the SAMDB region.

A significant amount of stubble burning is typically undertaken in the region. Whole paddock burning, which is less commonly used now, is usually done for snails and mice control. Header row burning is now more frequently carried out to reduce weed seed numbers, as a non-chemical method of averting the development of weed herbicide resistance. Sowing canola into burnt stubbles in the past has resulted in erosion damage / smothering of seedlings. More canola has been sown into cereal stubbles but this increases snail numbers. Stubble "bashing" can have a significant effect but relies on a period of hot weather occurring when farmers have time available to spend on the tractor and achieves about 60% control.

Wild radish is becoming a significant problem in parts of the region and has developed resistance to herbicides. Herbicides to control radish cost an estimated extra $20/ha. Cropping systems on some properties are now being based on controlling radish rather than disease, nutrition or crop profitability reasons.

Brome grass remains a problem for direct drill / no till systems and is a major cost for farmers so could lead to more burning and cultivation as control measures. After about 20 years of no-till, problems are starting to build up, such as herbicide resistant weeds. Rhizoctonia is reappearing. There is increasing hay production in the area because being it is being used as a method for managing herbicide resistance.

Cultivation is practised more in the northern Mallee / lower rainfall areas due to the higher relative cost of using herbicides for summer weed control rather than cultivation. There are some indications that the area of land cultivated for weed control is increasing. There is an incentive in controlling weeds early, particularly ones such as caltrop, melons, and potato weed, as it costs less to control small plants.

Water repellence appears to be increasing in no-till soils. In particular, greyer sands are suffering poor crop establishment where no-till plus stubble retention is practised. There are also problems with weed control as non-wetting properties of the soil delays the germination of weeds resulting in staggered germination. Shallow, stonier soils and sandier non-wetting grey sands produce less growth and surface cover as they dry out for long periods of time.

There is an increasing demand for straw for feedlots in the region. Paddocks cut low for straw have less protective cover against wind erosion.

More dry-sowing is occurring with better soils tending to be sown by a set date while non-wetting soils are sown more according to rainfall. In dry finishes to the season, early sown crops have tended to yield better than later sown ones. There are fewer farmers operating larger machinery who want to finish at a reasonable time therefore tend to sow early or dry-sow crops.

Most agricultural systems in the SAMDB region are based on annual plant species which germinate with autumn or winter seasonal rainfall and senesce in spring. These residues deteriorate over summer with no more biomass produced until the next autumn or winter rainfall. Generally there are not many perennial plants or summer growing plants in these

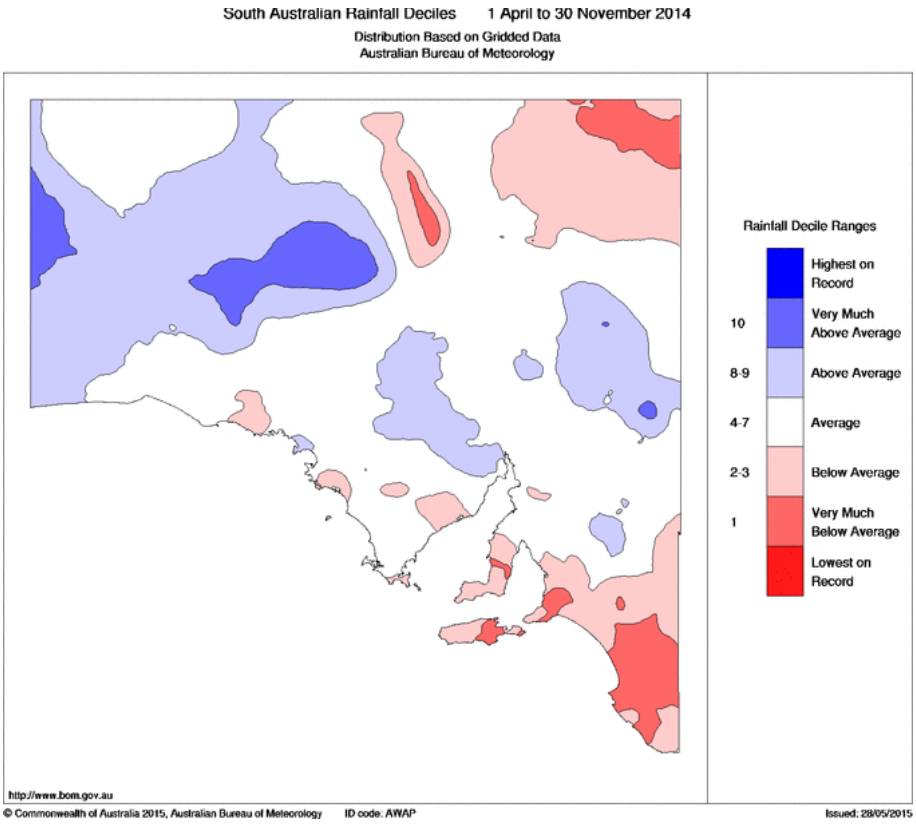
systems. Annual based systems provide more flexibility for growers, whereby paddocks are not locked into a particular crop for more than one year. Crops that leave the soil more at risk of erosion such as grain legumes can be sown into standing stubbles from the previous crop (usually cereal), to improve soil erosion protection.

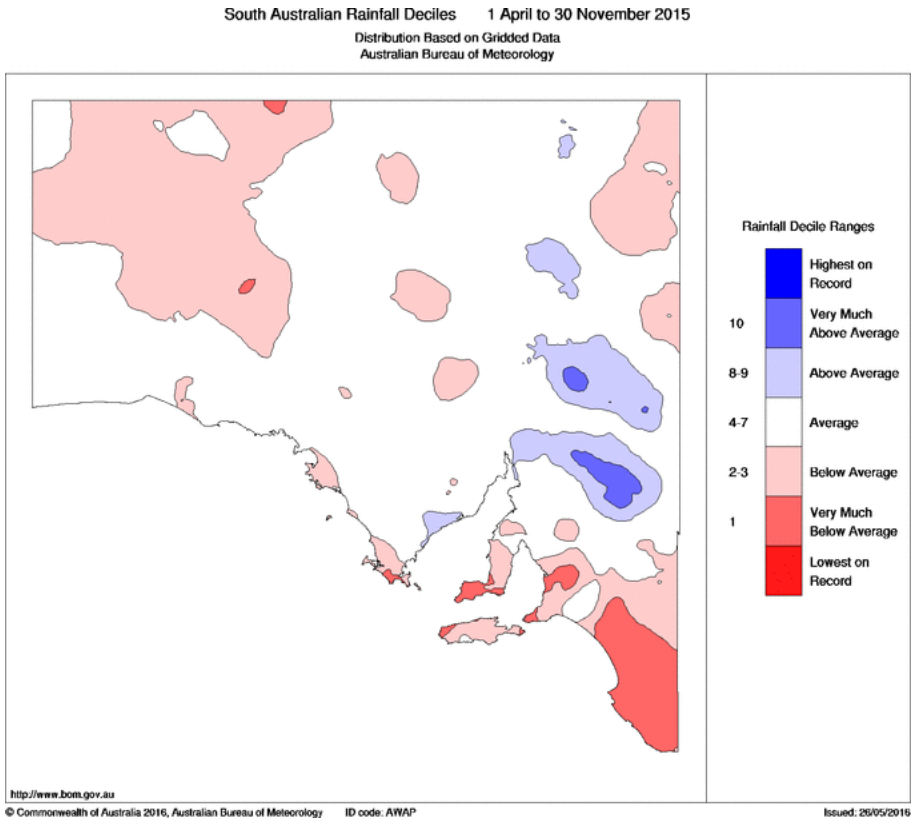
The length of the period between the senescence of annual plants in spring to the growth of new plants in autumn-winter, combined with natural breakdown of residues (particularly grain legumes), means that soil cover levels can drop below those regarded as adequate for erosion protection, irrespective of the management applied to residues. This is a particular concern in drier seasons when less biomass is produced.

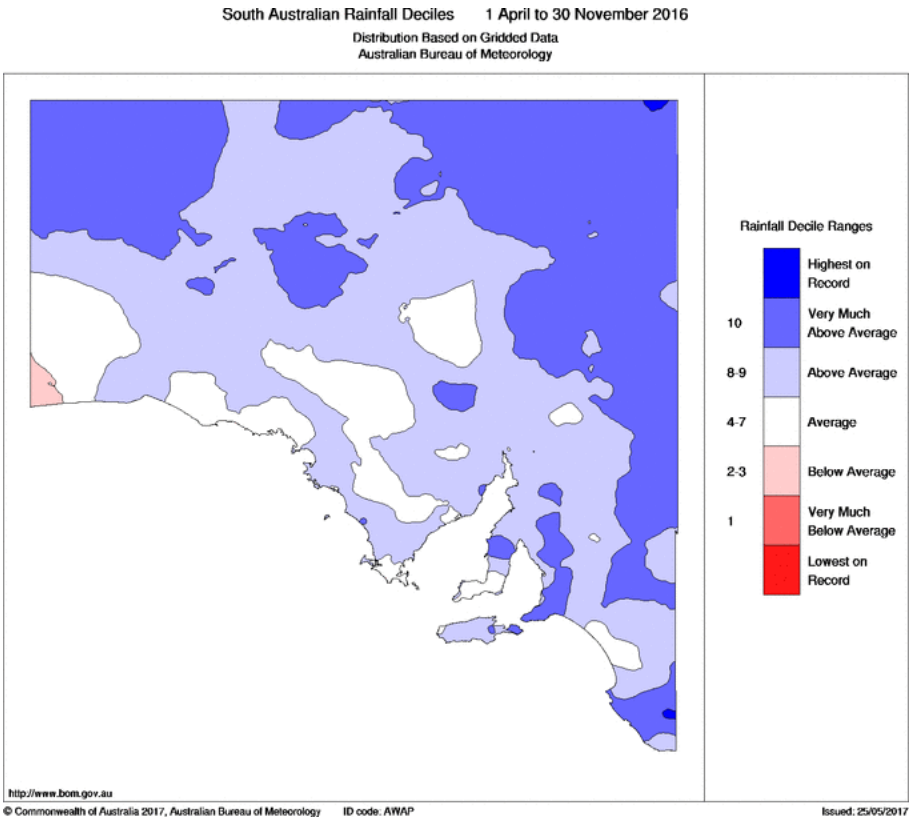
To achieve the SAMDB NRM Plan wind erosion protection target, efforts will be needed to investigate, develop and implement new or modified practices and systems to achieve greater soil erosion protection.

Appendix 1: Rainfall decile maps

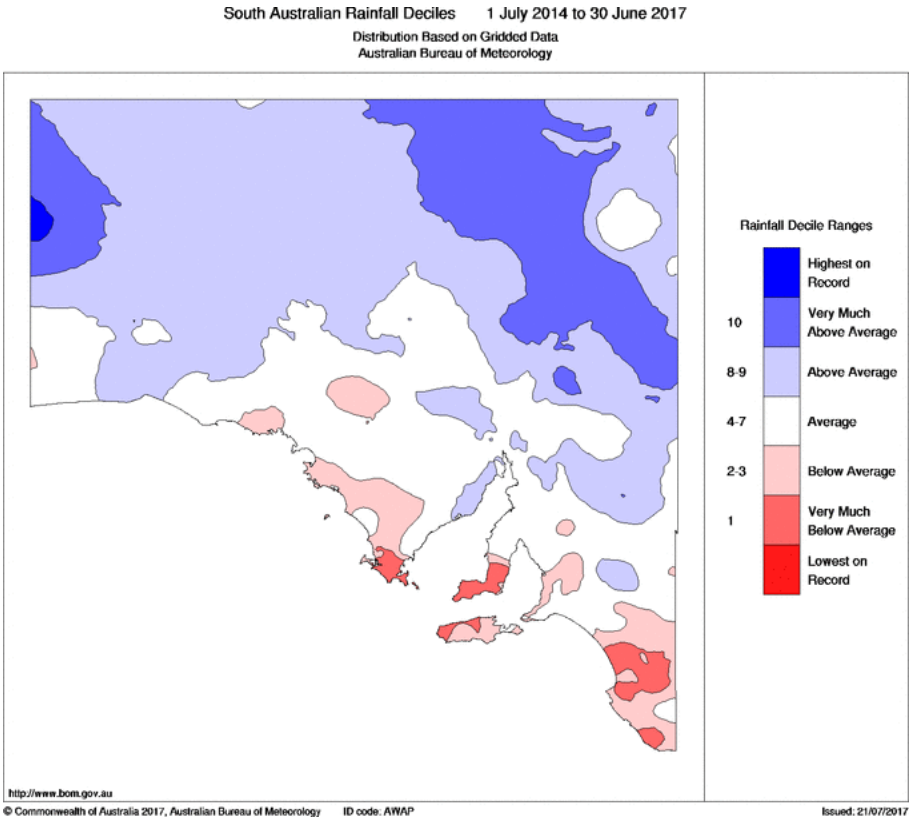
SA Rainfall Deciles April – November 2014, 2015, 2016



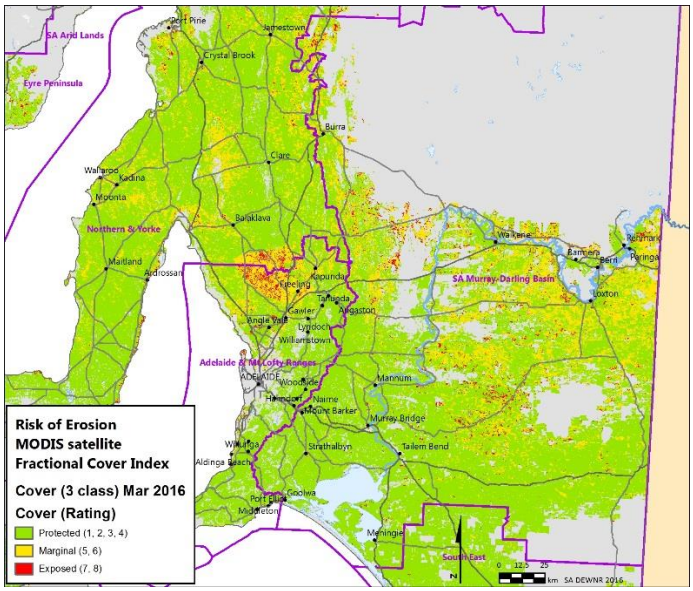


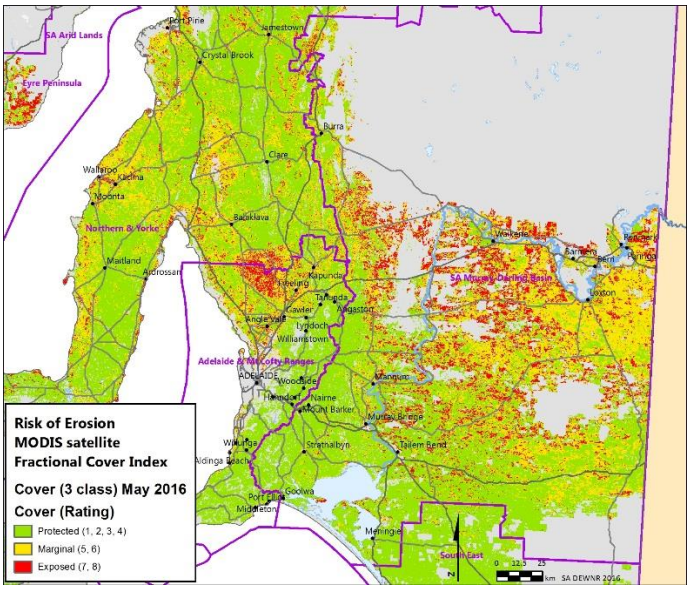


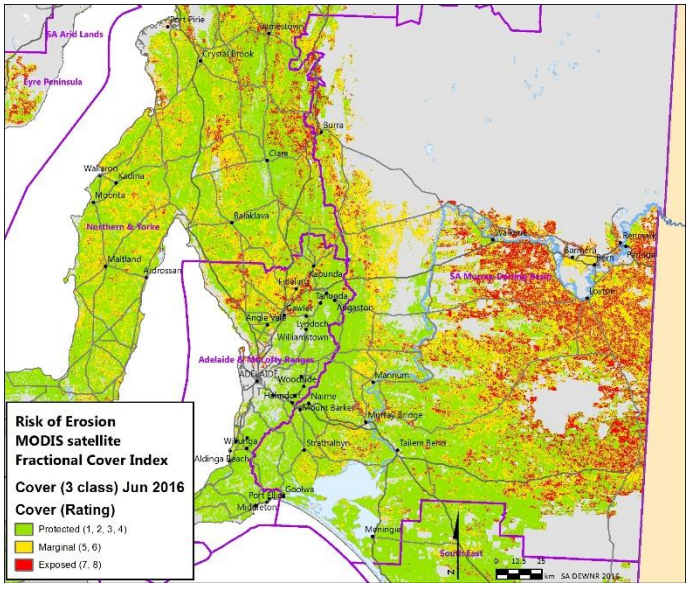
SA 3 Year Rainfall Deciles to June 2017

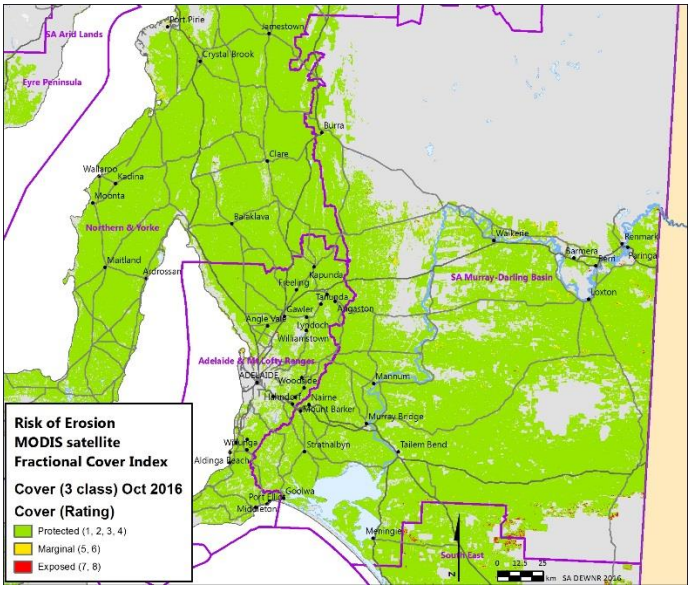


Appendix 2: Erosion risk maps using modelled satellite data (MODIS Fractional Cover) 2016









About this report

The information presented in this report outlines effects of recent seasonal conditions and land management practices on protection of agricultural land from soil erosion, and indicates what strategies or actions might be needed to ensure adequate erosion protection going into the next season.

The Department of Environment, Water and Natural Resources (DEWNR) conducts surveys to monitor trends in the protection of soil from the risk of erosion across the SAMDB and other NRM regions. Data from other sources is also compiled to assist with interpretation of data from these surveys.

DEWNR produces regular reports on soil erosion protection for the SAMDB NRM Region, including:

- An annual progress report for the Region's NRM Plan Soil Protection target in July each year, including a summary of trends in soil erosion protection since monitoring began
- On request, seasonal erosion protection reports.

For further information, contact:

Giles Forward

Conservation, Sustainability and Wildlife Management Unit

08 8207 7726

Giles.forward@sa.gov.au