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 2018

Key points:

- **Protection from soil erosion is a high priority natural resource management issue in the SA Murray-Darling Basin Region.**
- **In 2018 agricultural land was regarded as being at risk of erosion for 17 days, a decrease from 56 days in 2002.**
- **Groundcover levels in 2017-18 were slightly less than the 3 year average due to below average rainfall.**
- **The improving trend in erosion risk reflects the adoption of improved land management practices; e.g. 77% of crop area was sown using no-till in 2016, and improved grazing management.**
- **Adverse weather conditions, fires, and stubble reduction/removal to manage snails, mice and weeds could compromise erosion protection.**

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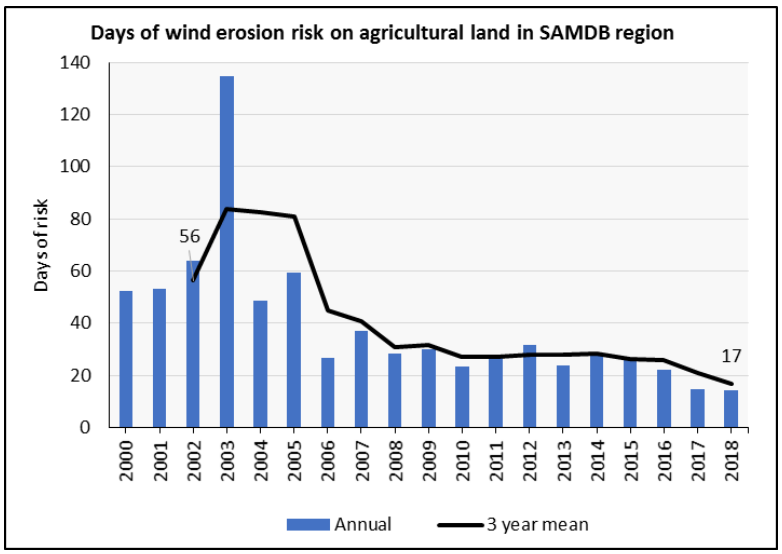
Government of South Australia
Department for Environment and Water

Summary (Soil erosion protection report 2018 – SAMDB NRM Region)



- Protection of soils from the risk of erosion a high priority natural resource 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).
- In 2018, wind erosion prone agricultural land in the SAMDB region was regarded as being at risk of wind erosion for 17 days (3 year mean), a decrease of 39 days from 56 days in 2002.
- From the 2002 drought season until 2010, there was a marked improvement (reduction) in wind erosion risk, which correlates with adoption of improved land management practices, particularly no-till cropping methods. Since 2010, there has been a smaller improvement in wind erosion risk.
- Mean groundcover levels from June 2017 to March 2018 dipped below the 3 year mean to 2017-18 but returned to the 3 year level from March to June 2018. This is probably due to below average growing season rainfall in the northern parts of the region in 2017, producing less crop and pasture biomass and cover.
- Erosion protection is compromised where stubble burning or cultivation are used, 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.
- Ongoing programs are needed to investigate, develop and implement new or modified practices and systems to manage these issues and achieve greater soil erosion protection.

1. 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 1).

There are also approximately 720,000 hectares (29%) that are inherently susceptible to water erosion, on sloping, hilly land in the eastern slopes of the Mt Lofty Ranges (Figure 2).

Soil erosion protection is a high priority natural resource management issue in the SAMDB region. The risk of erosion 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.

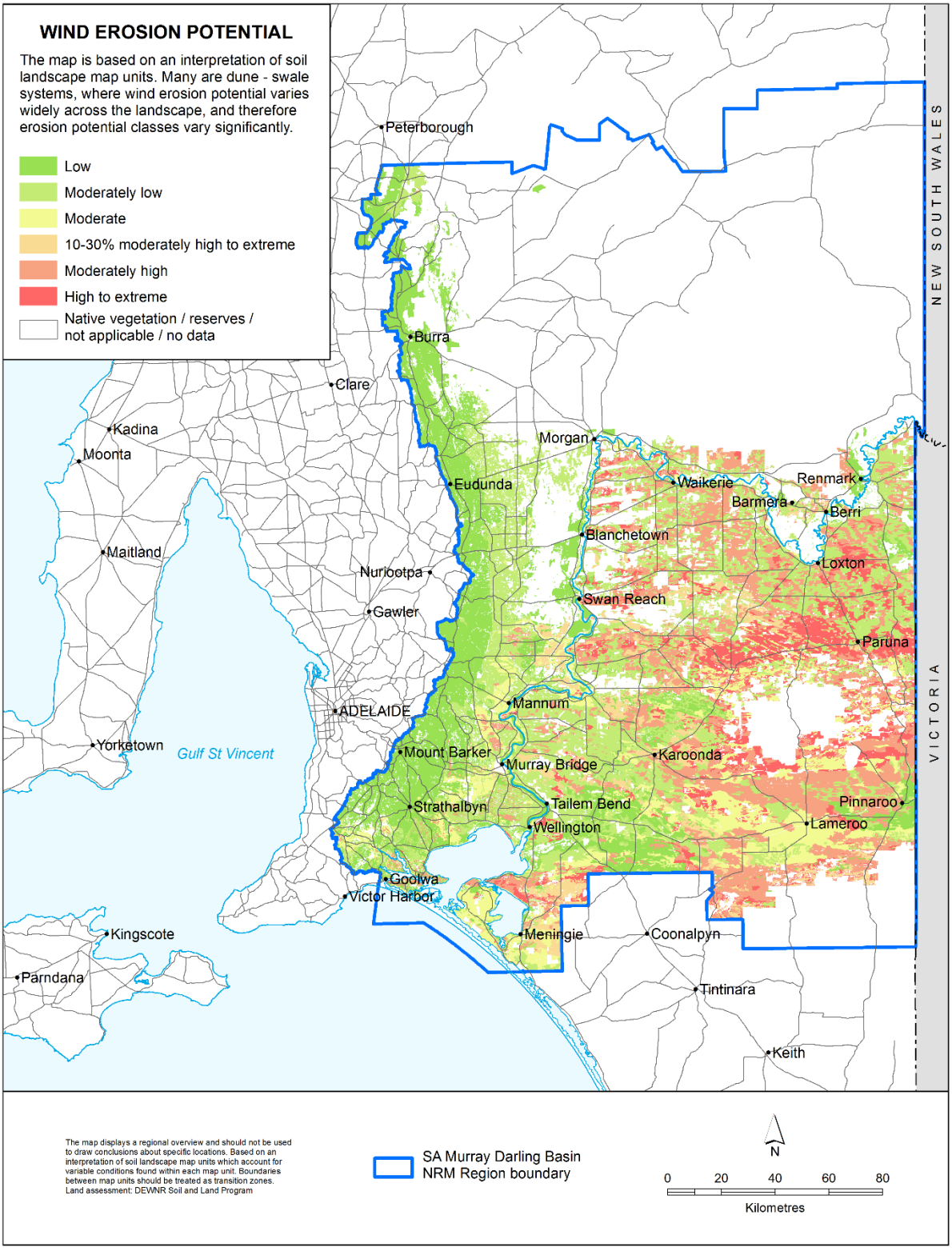


Figure 1. Inherent susceptibility of cleared agricultural land to wind erosion in the SAMDB NRM Region.

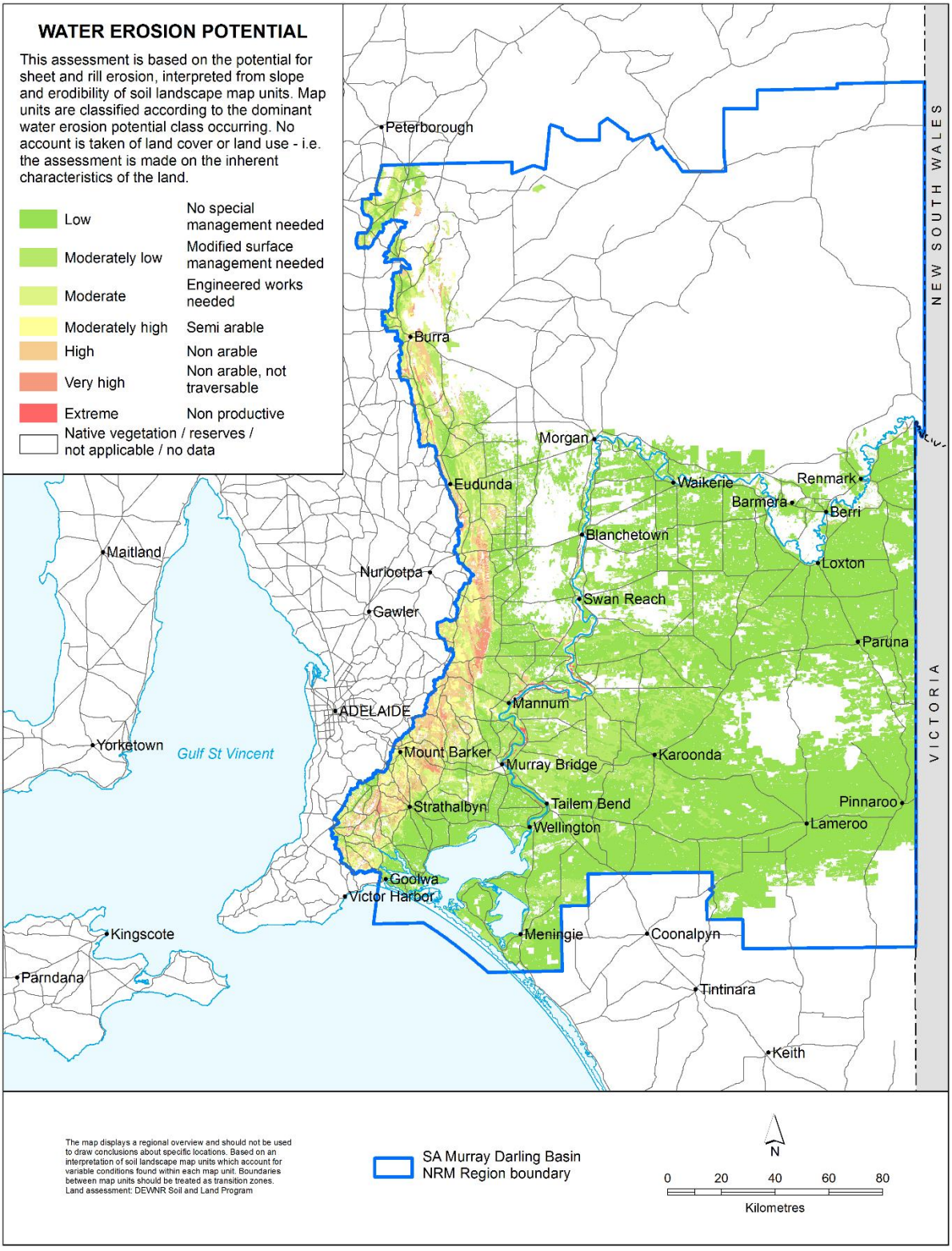


Figure 2. Inherent susceptibility of cleared agricultural land to water erosion in the SAMDB NRM Region.

2. Soil surface cover levels

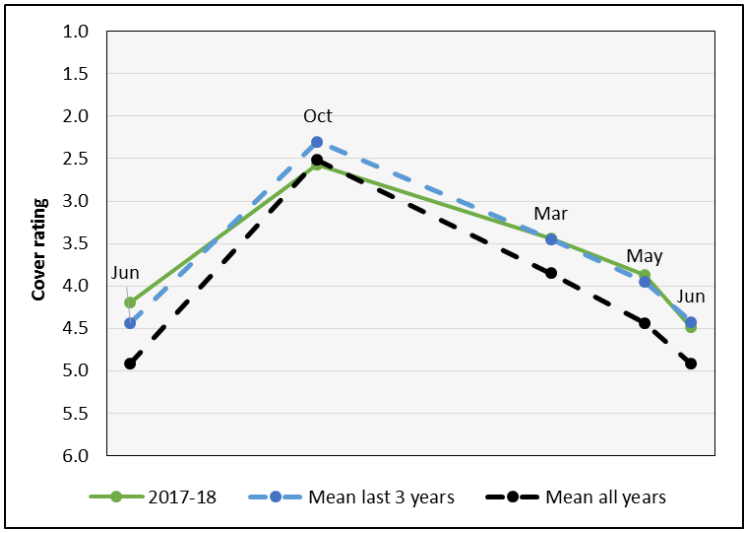


Figure 3. Mean surface cover rating on agricultural land in the SAMDB region from field surveys from June 2017 to June 2018 compared to the mean for the last three years, and the average for the monitoring period since 1999-2000.

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

Figure 3 shows that mean groundcover levels in the SAMDB region from June 2017 to March 2018 dipped below the 3 year mean but returned to the 3 year level from March to June 2018. This is probably due to below average growing season rainfall in the northern parts of the region in 2017, producing less crop and pasture biomass and cover.

The mean cover levels for the last 3 years are better than the long term average, mainly due to the adoption of land management practices such as no-till and stubble retention, and improved grazing management such as supplementary or confinement feeding of livestock in autumn.

3. Wind and water erosion risk on agricultural land

Indices specifically for wind and water erosion risk on agricultural land are calculated from field observations of soil disturbance (looseness – e.g. cultivated vs undisturbed) as well as the groundcover level. These indices take into account the inherent susceptibility of the survey sites to wind erosion (e.g. sandy soils) or water erosion (e.g. sloping land) and apply to crop and pasture land in the regions surveyed.

This provides a more accurate and realistic estimation of erosion risk on erosion – susceptible agricultural land across the state than indices used in previous reports.

These indices can be combined into a single index of erosion risk, or reported separately.

In the SAMDB region, the field surveys do not traverse the water erosion prone sloping hilly land of the eastern Mt Lofty Ranges, which are mainly long term pastures. The wind erosion risk index applies to the sandier textured wind erosion prone soils of the Murraylands.

Wind Erosion risk

The trend in the wind erosion risk on agricultural land in the SAMDB region is shown in Figure 4. This is presented as annual days of risk, and as a 3 year rolling mean. The 3 year mean tends to dampen annual seasonal effects on erosion risk and show overall trends that are mainly the result of land management practices.

The three year mean wind erosion risk has decreased by 39 days from 56 days in 2002, to 17 days in 2017. Most of this improvement occurred prior to 2010.

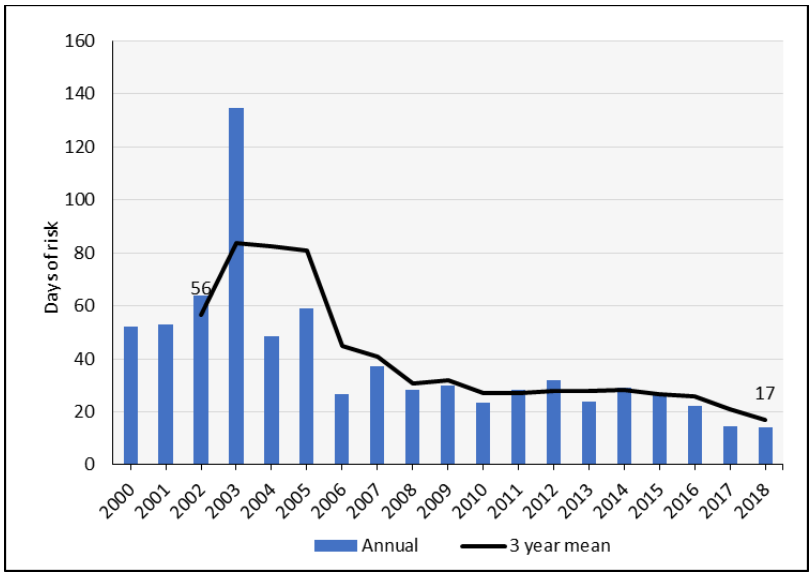


Figure 4. Days of wind erosion risk (annual and 3 year rolling mean) on agricultural land in the SAMDB region from 2000 to 2018

The effect of the extremely dry season in 2002 had a large impact on wind erosion risk index the following year (year index is calculated from 1st August to 31st July).

The wind erosion risk has decreased (improved) 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 4, where very low crop and pasture biomass 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 risk has only decreased slightly. This probably reflects the plateauing of the uptake of no-till practices in the region (to a high level of adoption). If drier than average conditions occur in coming seasons, this could result in a temporary fall in wind erosion protection.

4. 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.

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 became sparse on grazed pastures and grain legume stubbles. Some sandy rises were bare and drifted 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 where there was sub-surface clay, and manure was spread on drifting areas.
- Rains in January to March 2016 stimulated 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 growth 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.

2017-18

- Mice damage to crops in some areas left small patches bare and at risk of erosion.
- Cereal crops had reasonable yields given average to below average growing season rainfall, although stubble biomass was lower than average, and some crops were affected by frost. Grain legume crop yields were reduced by below average rainfall and frost damage. Isolated hail knocked grain to the ground, increasing the feed source for mice. Pasture biomass was poorer than average.
- Following harvest, cereal stubbles provided good erosion protection through summer. Pasture paddocks from 2017 and grain legume stubbles had less cover, and wind erosion occurred in late summer onwards on some sandy rises.
- Rain in November and December produced growth of summer weeds, and perennial pastures. Weed growth was controlled with herbicides.
- As paddock feed reserves declined through summer, many producers removed livestock from paddocks vulnerable to erosion, and supplementary fed or confinement fed them in safer areas.
- Opening season rainfall was below average, particularly in the northern Mallee. Crop sowing was generally slightly later than average, and delayed until June in the northern Mallee. There was minimal stored soil moisture due to the dry autumn. Crop emergence was patchy on sandier soils, and some erosion occurred.

5. Trends in land management practices

DEW 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 the soil and 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, following a similar trend 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%).

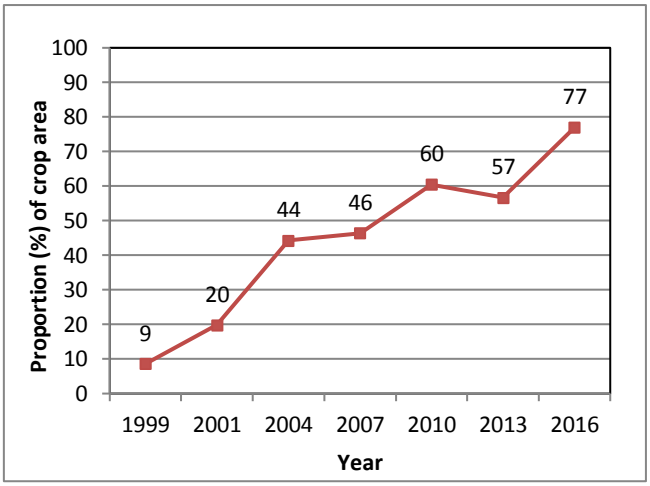


Figure 6. Proportion (%) of crop area in the SAMDB region sown using no-till methods (including zero till) according to survey respondents

Figure 7 shows that since the 2008 survey (when the question was 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.

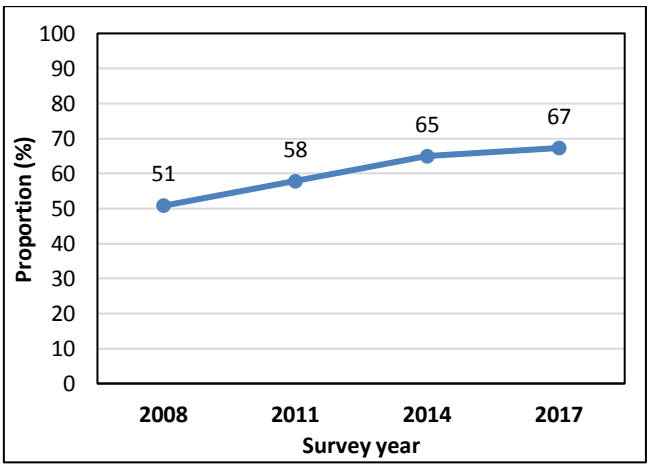


Figure 7. Proportion of cropping land managers in the SAMDB region who aim to leave on average at least 50% surface cover of stubble/residues immediately prior to sowing.

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 (and 2018) 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.

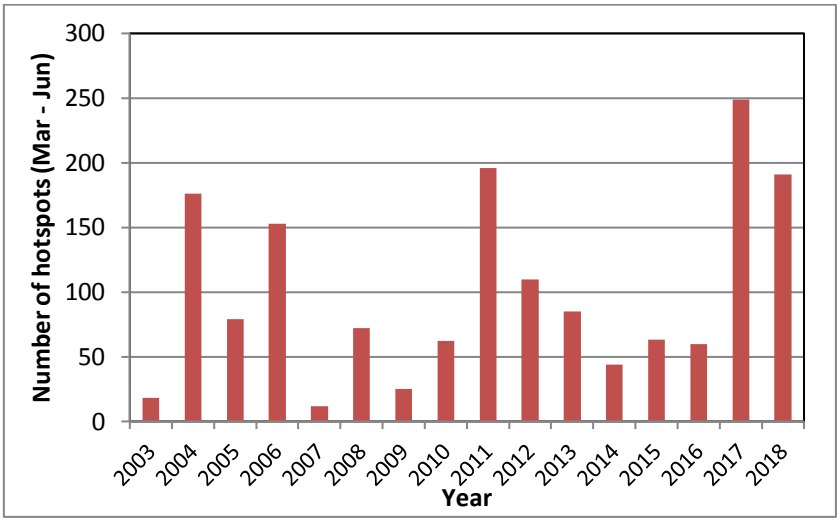


Figure 8. Number of hotspots recorded (infra-red remote sensing) on cleared agricultural land in the SAMDB NRM Region from March to June each year from 2003 to 2018; data from Geoscience Australia Sentinel Hotspots

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.

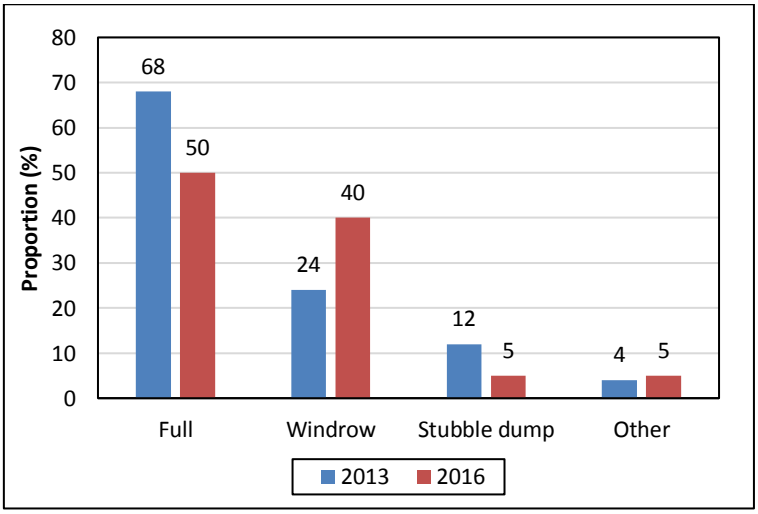


Figure 9. Type(s) of burning done by cropping land managers in the SAMDB region when preparing to crop in 2013 and 2016 (proportion of those who burnt).

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

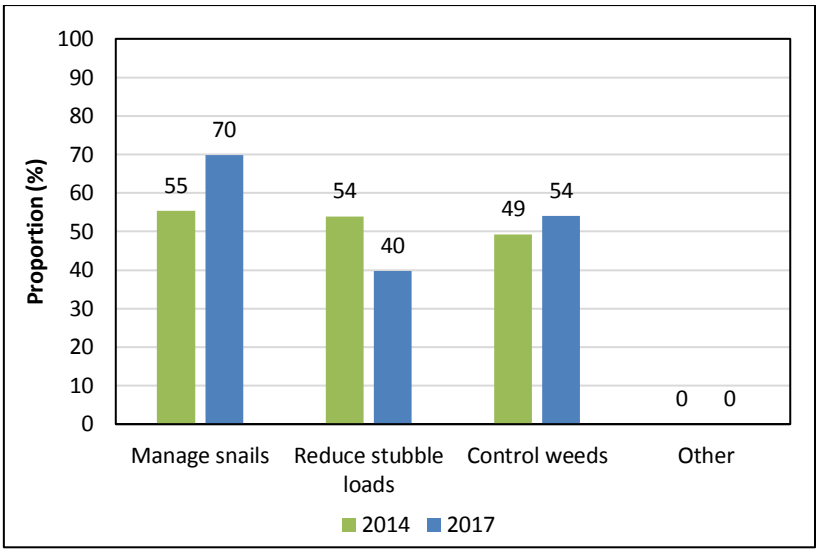


Figure 10. Main reasons given for burning stubbles/residues, cropping land managers who ever burn when preparing to crop; 2014 and 2017 surveys.

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.

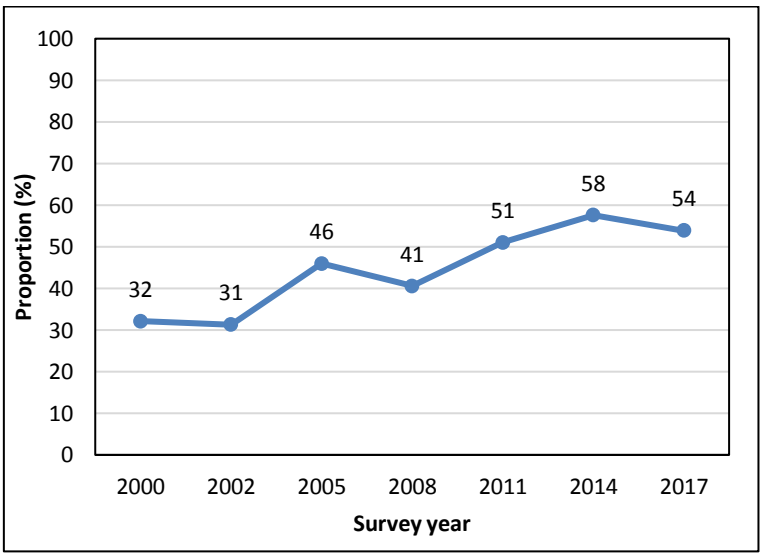


Figure 11. Proportion of land managers in the SAMDB region who use confinement feeding areas for stock when necessary to manage erosion risk in paddocks.

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.

6. 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.

Stubble management

Whole paddock burning is less commonly used now, and 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.

There is some demand in the region for straw for bedding in piggery and poultry shed. Paddocks cut low for straw have less protective cover against wind erosion.

Weed 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 repellent soils

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.

Sowing to a set date

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.

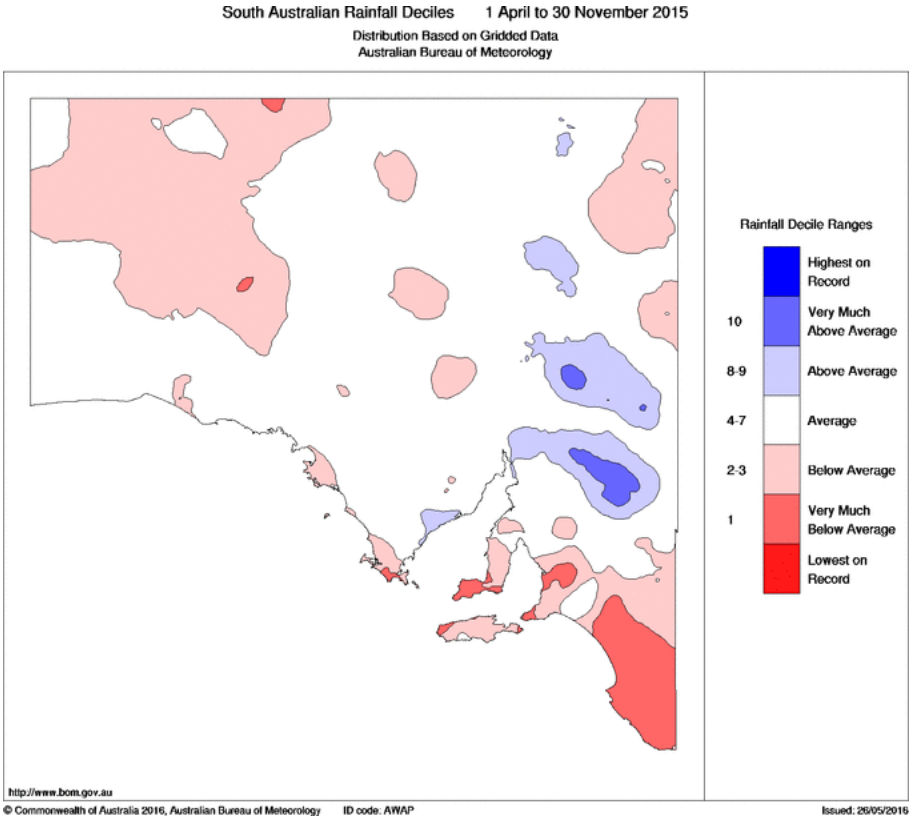
Most agricultural systems in the SAMDB region are based on annual plant species which germinate with autumn or winter seasonal rainfall and senesce in spring. These residues deteriorate over summer with no more biomass produced until the next autumn or winter rainfall. Generally there are not many perennial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

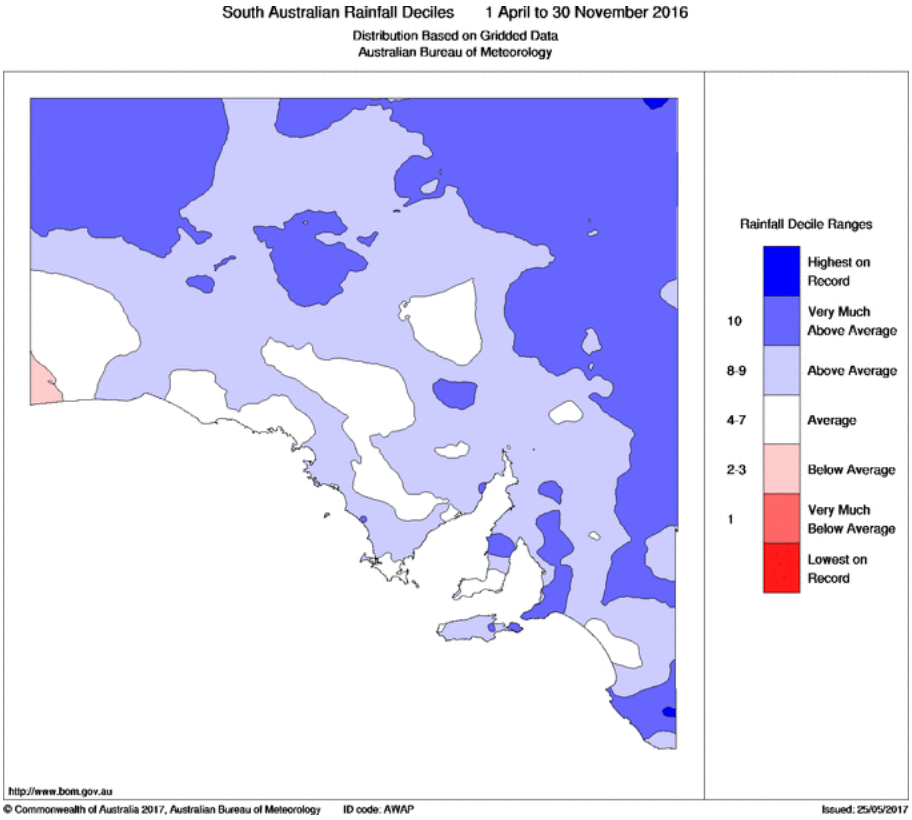
The length of the period between the senescence of annual plants in spring to the growth of new plants in autumn-winter, combined with natural breakdown of residues (particularly grain legumes), means that soil cover levels can drop below those regarded as adequate for erosion protection, irrespective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

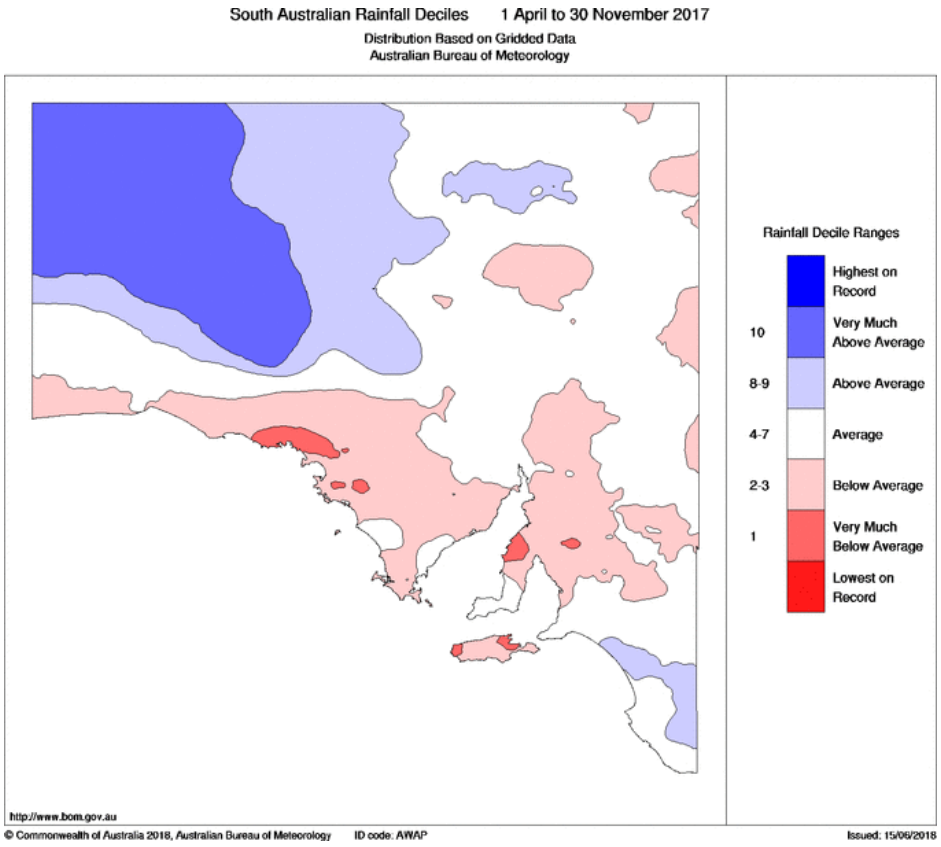
To maintain or improve soil erosion protection in the SAMDB region, efforts will be needed to investigate, develop and implement new or modified practices and systems to achieve greater soil erosion protection, particularly relating to managing pests and weeds.

Appendix 1: Rainfall decile maps

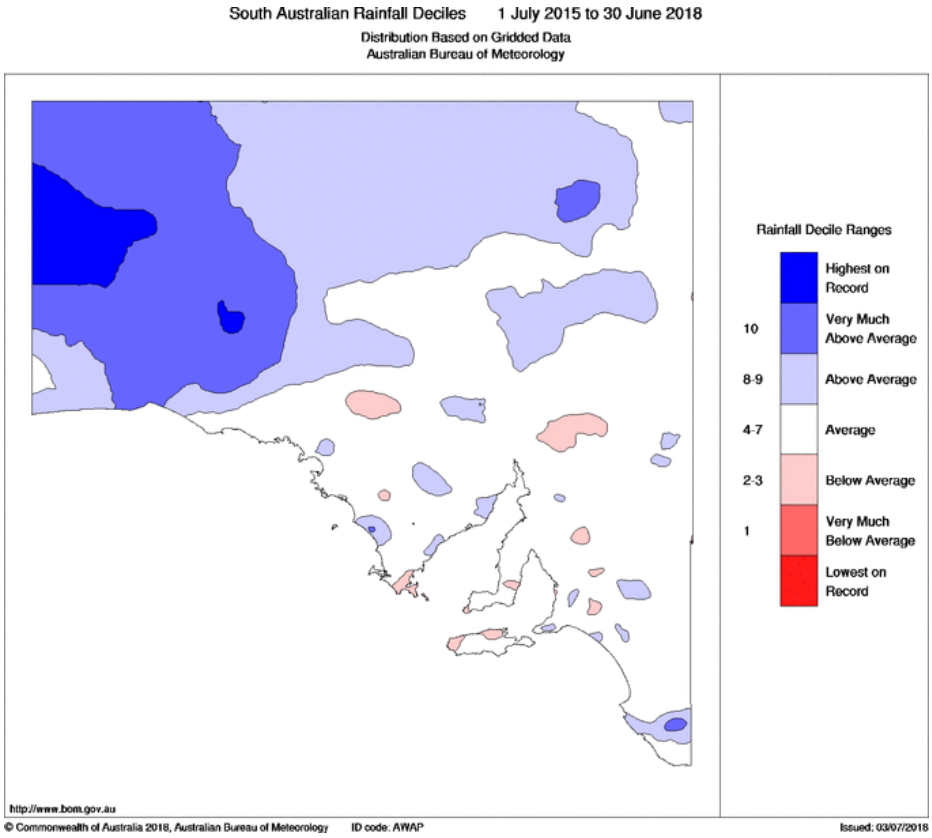
SA Rainfall Deciles April – November 2015, 2016, 2017



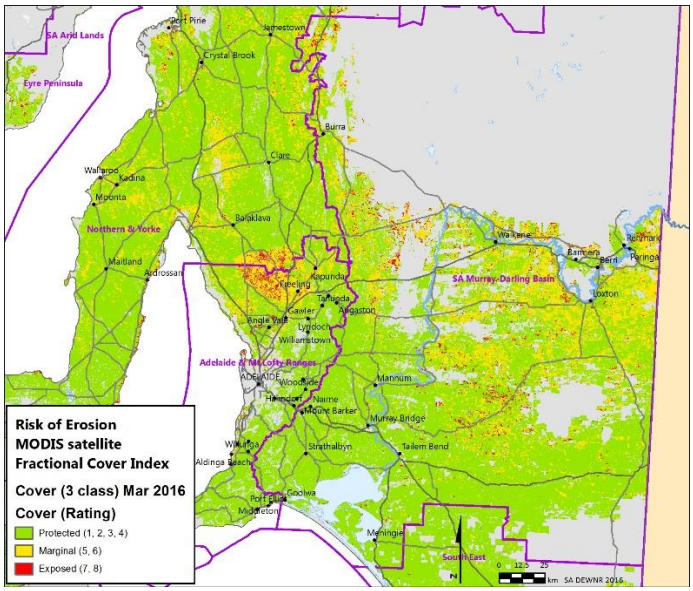


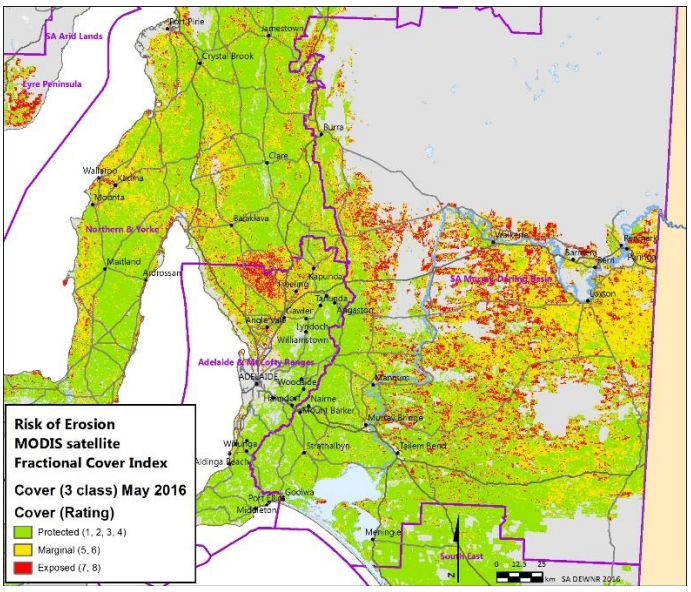


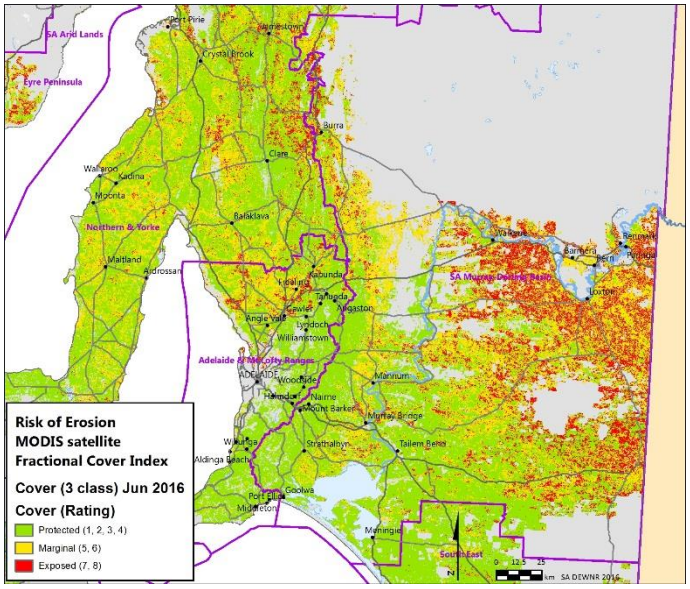
SA 3 Year Rainfall Deciles to June 2018

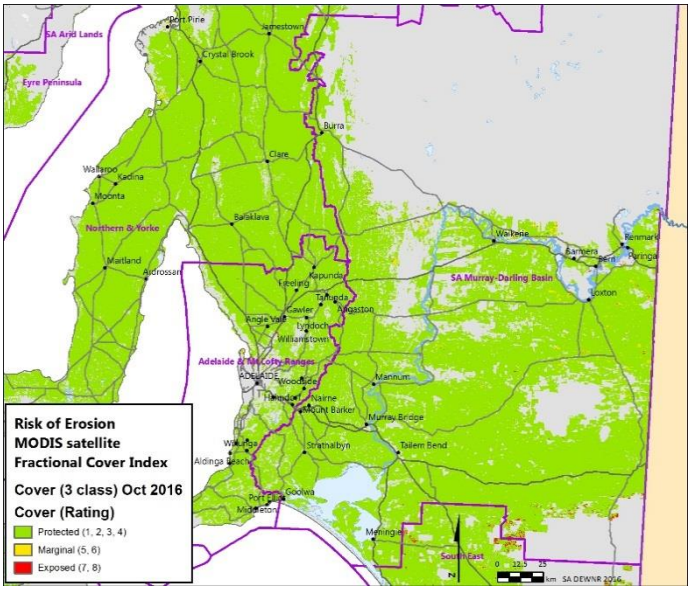


Appendix 2: Erosion risk maps using modelled satellite data (MODIS Fractional Cover) 2016









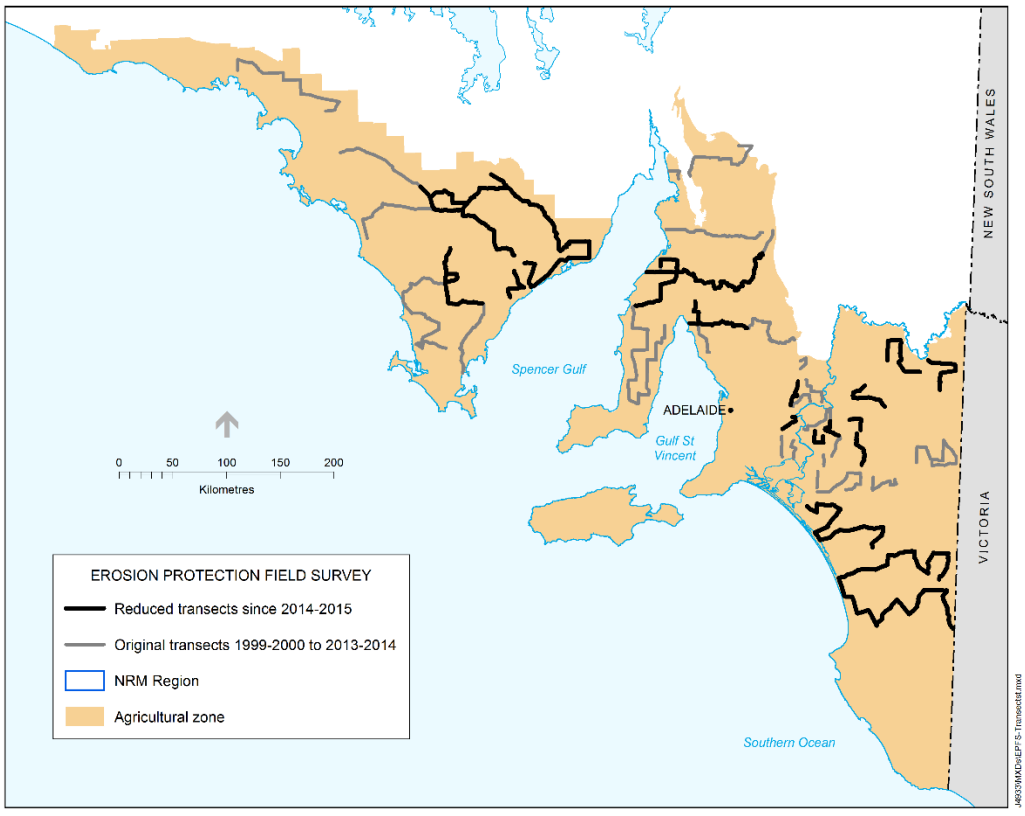
Monitoring erosion risk

The Department for Environment and Water (DEW) 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 (570) 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.

DEW 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.



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 for Environment and Water (DEW) 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.

DEW 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:

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