Technical information supporting the 2018 agricultural land (days protected from soil erosion) trend and condition report card

DEW Technical note 2018/25

Government of South Australia
Department for Environment and Water

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June, 2018

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ISBN 978-1-925668-68-1

Preferred way to cite this publication

DEW (2018). Technical information supporting the 2018 agricultural land (days protected from soil erosion) trend and condition report card. DEW Technical note 2018/25, Government of South Australia, Department for Environment and Water, Adelaide.

Download this document at https://data.environment.sa.gov.au

Consultation and acknowledgements

This document was prepared by Giles Forward, Tim Herrmann and Craig Meakin (DEW). Daniel Rogers (DEW) provided principal oversight throughout and technical review of this report. Improvements were made to this report and associated report card based on reviews by Colin Cichon, Ben Smith, Michelle Bald, Fi Taylor.

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Summary

This document describes the indicators, data sources, analysis methods and results used to develop this report and the associated report card. The reliability of data sources for their use in this context are also described.

1 Introduction

1.1 Soil erosion on agricultural land

Erosion is a natural process, however the clearance and cultivation of land for agriculture has resulted in rates of soil loss many times higher than in undisturbed environments. Soil erosion is the highest priority threat to the agricultural soils in South Australia. Approximately 6.2 million hectares (60% of cleared land) of agricultural land is inherently susceptible to wind erosion, and 3.3 million hectares (32%) is inherently susceptible to water erosion. The magnitude of this threat is recognised in South Australia's Strategic Plan, Target 70 (sustainable land management) which includes a soil protection component for agricultural land.

Without intervention, soil erosion can have adverse social, economic and environmental impacts. Soil erosion depletes the productive capacity of land as it removes nutrients, organic matter and clay from soil, which are most important for plant growth. Soil erosion has a wide range of costly off-site impacts including damage to roads, disruption to transport and electricity supply, contamination of wetlands, watercourses and marine environments, and human health impacts caused by raised dust.

Soil is predisposed to a risk of erosion by physical disturbance or removal of surface vegetative cover. Very dry seasonal conditions increase the risk of erosion where there is reduced vegetative cover resulting from poor crop and pasture growth. Bushfires remove surface vegetation, exposing the soil to erosion until new cover can be established.

The critical management practices that affect the risk of soil erosion are:

- the occurrence, intensity and timing of tillage operations
- the quantity and nature of surface cover.

In the past, most of the erosion risk was due to cropping practices such as tillage and stubble burning, which mainly occurred in late autumn to early winter. These practices, however, nowadays are usually done on only a small proportion of cropping land. Threats such as pests (e.g. mice, snails), and herbicide resistant weeds can lead to increased use of these practices at times. Grazing management is also an important factor, especially in dry years and droughts. The highest risks associated with grazing occur in late summer and autumn when feed availability and the cover of annual crop and pasture residues is declining.

The incidence of actual soil erosion is highly sporadic and variable, and is impractical to measure. The risk of erosion (or corresponding protection from erosion) is monitored at a broad scale across the agricultural areas of SA. Any trend in erosion risk/protection is likely to result in a corresponding change in actual soil erosion in the longer term.

This report card specifically covers erosion protection on agricultural lands of SA (cropping and grazing), and not erosion in the grazed rangelands of the state.

1.2 Environmental trend and condition reporting

The Minister for Environment and Water under the *Natural Resources Management Act 2004* is required 'to keep the state and condition of the natural resources of the State under review'. Environmental trend and condition report cards are produced as a primary means for undertaking this review. Previous environmental trend and condition trend and condition report card releases reported against the targets in the South Australian Natural Resources Management Plan (Government of South Australia 2012b) using the broad process outlined in the NRM State and Condition Reporting Framework (Government of South Australia 2012a).

As the state natural resources management plan is currently under review, environmental trend and condition report cards in early 2018 will instead inform the next South Australian State of the Environment Report (SOE) due out in 2018. Again, there is a legislative driver to guide the development of SOE reporting. The *Environment Protection Act 1993*, which is the legislative driver to guide the development of SOE reporting, states that the SOE must:

- include an assessment of the condition of the major environmental resources of South Australia 112(3(a))
- include a specific assessment of the state of the River Murray, especially taking into account the Objectives for a Healthy River Murray under the *River Murray Act 2003* 112(3(ab))
- identify significant trends in environmental quality based on an analysis of indicators of environmental quality 112(3(b)).

Environmental trend and condition report cards will be used as the primary means to address these SOE requirements.

1.2.1 Environmental trend and condition report card continual improvement

Key documents guiding the content of South Australian environmental trend and condition report cards are:

- Trend and Condition Report Cards Summary Paper (DEWNR 2017)
- NRM State and Condition Reporting Framework (Government of South Australia 2012a)

Both of these documents reference a process of continual improvement in the way environmental trend and condition report cards are produced and communicated. A review based on key stakeholder feedback (O'Connor NRM 2015) indicated five key learnings (DEWNR 2017):

1. Environmental trend and condition report cards are acknowledged as a useful communication tool. There is support for them to continue to be produced to highlight data gaps and reliability issues to a broad audience including: policy makers and investors; environmental managers; and the community
2. There are issues with data availability, access, consistency and transparency, which will need to be addressed and improved over time in future trend and condition report cards
3. Indicators or measures reported on were based on those outlined in the State NRM Plan. Not all of these are considered to be the most appropriate or relevant for those assets. These will be reviewed as part of the current State NRM Plan review and a set of agreed measures will be determined for future trend and condition report cards
4. Greater alignment of reporting relevant to project, regional, state, program and State of the Environment is seen as imperative
5. Better clarity is needed around target evaluation reporting, which should measure the impact or outcome of an investment at a project, regional, state or program scale. However the trend and condition reporting reflects the status of an environmental resource and its change based on impacts that affect its condition. In some cases, the same reporting can be used for both (e.g. soil erosion), and in others it cannot (e.g. threatened species).

As the process by which the environmental trend and condition report cards are produced evolves, there is an increased emphasis, in keeping with the Premier's digital by default declaration, on the use of open data and reproducibility. This is one key response to help address the second key learning outlined above. The report cards being produced to inform the 2018 State of the Environment Report are at varying stages along this route to open data and reproducibility.

2 Methods

2.1 Indicator

The indicator used to assess soil erosion protection is the estimated average number of days per year that cleared agricultural land is adequately protected from wind erosion and water erosion. Data for this indicator is obtained from DEW's erosion protection field surveys.

2.2 Data sources

Department for Environment and Water (DEW) Erosion protection field surveys (2000 – 2017); Land manager telephone surveys (2000 – 2017).

ABS 7503.0. Gross Value Production (GVP) of agricultural commodities - Value of Agricultural Commodities Produced, Australia, 2015–16.

2.3 Data collection

2.3.1 Erosion protection field surveys

The erosion protection field surveys have been conducted by DEW (and partly contracted to PIRSA staff) since 2000 on cropping and grazing land in the four main agricultural regions (EP, N&Y, SAMDB, SE) of SA. The observational field survey method used is simple, rapid and repeatable, and all data is recorded against clearly defined categories with photo standards (Forward 2015). The survey method is designed to estimate the relative risk of (or protection from) wind erosion and water erosion.

Thresholds are applied to the field data to estimate the proportion of land that is adequately protected from erosion at each survey. Cumulative annual days of protection are calculated using an algorithm that extrapolates the proportion of protected land at each survey over the year period (Donaldson 2008). The erosion protection data in this report card is calculated for agricultural land in each region that is inherently susceptible to wind erosion and water erosion.

The erosion protection algorithm used for this report card is different to that for the SASP Target 70 (agricultural land component) reporting, so the results cannot be directly compared. The SASP algorithm uses estimated erosion protection of all agricultural land (regardless of inherent erosion potential) but assumes that only land in crop that year can be at risk. This was designed in the earlier years of monitoring when most erosion risk was typically associated with cropping practices rather than grazed pastures.

Survey staff are well trained and experienced, and the DEW senior project officer (from time to time) accompanies the regional field survey staff on a rotational basis to maintain data quality control. Validity of the survey data is achieved through the relatively large number of sites (approx. 5500 sites up to 2014, reduced to about 2800 sites from 2015 onwards, surveyed four times per year) aggregated into regions (and state), then analysed in the context of seasonal and longer term trends.

2.3.2 Land manager telephone surveys

DEW has commissioned a series of telephone surveys of commercial agricultural land managers (dryland cropping, grazing, dairy) in agricultural regions of SA from 2000 to 2017 to obtain data on soil related issues they manage, their awarenss and understanding of these issues and practices used to manage them.

Data from these surveys includes the proportion (percentage) of the crop area sown using no till methods. This method minimises possible exposure of soil to the risk of erosion with cropping, compared to previously used cropping methods that typically involved tillage and stubble burning. This data is highly relevant to this report card as it provides strong evidence to support the trend (and condition) in soil erosion protection.

2.4 Analysis

2.4.1 Trend

Trend in days of erosion protection: Short term (5-year) average rate of change (data expressed as 3-year rolling means). Trends were classified as stable, positive or negative if the rate of change in the 5-year trend (of 3-year rolling mean data) was calculated as a <2% change, >2% increase, or >2% decrease, respectively (Table 2.1).

Table 2.1. Definition of trend classes used

Trend	Description	Threshold
Getting better	Over a scale relevant to tracking change in the indicator it is improving in status with good confidence	>2% increase
Stable	Over a scale relevant to tracking change in the indicator it is neither improving or declining in status	<2% change
Getting worse	Over a scale relevant to tracking change in the indicator it is declining in status with good confidence	>2% decrease
Unknown	Data are not available, or are not available at relevant temporal scales, to determine any trend in the status of this resource	
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above trend classes	

2.4.2 Condition

Based on expert opinion, the condition classifications of average days of erosion protection (3 year rolling mean) are: Very good = >358 days; Good = 337-358 days; Fair = 309-337 days; Poor = <309 days (Table 2.2). Note that these thresholds correspond to one, four and eight weeks of cumulative annual risk (days protection = 365-days of risk).

Table 2.2. Definition of condition classes used

Condition	Condition Definition	Threshold
Very good	The natural resource is in a state that meets all environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for all processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought)	Greater than 358 days protected from erosion
Good	The natural resource is in a state that meets most environmental, economic and social expectations, based on this indicator. Thus, desirable function can be expected for only some processes/services expected of this resource, now and into the future, even during times of stress (e.g. prolonged drought)	Between 337 days and 358 days protected from erosion

Fair	The natural resource is in a state that does not meet some environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from many processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought)	Between 309 and 337 days protected from erosion
Poor	The natural resource is in a state that does not meet most environmental, economic and social expectations, based on this indicator. Thus, desirable function cannot be expected from most processes/services expected of this resource, now and into the future, particularly during times of stress (e.g. prolonged drought)	Less than 309 days protected from erosion
Unknown	Data are not available to determine the state of this natural resource, based on this indicator	
Not applicable	This indicator of the natural resource does not lend itself to being classified into one of the above condition classes	

2.4.3 Reliability

Information is scored for reliability based on the average of subjective scores (1 [worst] to 5 [best]) given for information currency, applicability, level of spatial representation and accuracy. Definitions guiding the application of these scores are provided in Table 2.3 for currency, Table 2.4 for applicability and Table 2.5 for spatial representation.

Table 2.3. Guides for applying information currency

Currency score	Criteria
1	Most recent information >10 years old
2	Most recent information up to 10 years old
3	Most recent information up to 7 years old
4	Most recent information up to 5 years old
5	Most recent information up to 3 years old

Table 2.4. Guides for applying information applicability

Applicability score	Criteria
1	Data are based on expert opinion of the measure
2	All data based on indirect indicators of the measure
3	Most data based on indirect indicators of the measure
4	Most data based on direct indicators of the measure
5	All data based on direct indicators of the measure

Table 2.5. Guides for applying spatial representation of information (sampling design)

Spatial score	Criteria

1 From an area that represents less than 5% the spatial distribution of the asset within the region/state or spatial representation unknown

2 From an area that represents less than 25% the spatial distribution of the asset within the region/state

3 From an area that represents less than half the spatial distribution of the asset within the region/state

4 From across the whole region/state (or whole distribution of asset within the region/state) using a sampling design that is not stratified

5 From across the whole region/state (or whole distribution of asset within the region/state) using a stratified sampling design.

3 Results

3.1 Trend

The total number of days soils have been protected from erosion has increased in all NRM regions and at the statewide level. The annual days of protection (Table 3.1) have tended to fluctuate from year to year largely due to seasonal variations in rainfall, whereas the 3 year rolling mean (Table 3.2) better reflects trends in erosion protection due to changes in land management practices. The average days of erosion protection in the state has increased from around 309 days in 2002 and has stablilised at around 342 days over the last 5 years.

Table 3.1. Annual results for the number of days soils were protected from erosion

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EP	259	315	313	313	331	321	335	321	321	336	345	343	347	346	345	346	349	351
SAMDB	313	312	301	230	316	306	338	328	337	335	342	337	333	341	336	338	343	350
N&Y	312	318	328	300	313	311	318	303	317	341	341	336	336	341	341	340	332	342
SE	n/a	338	339	336	344	345	351	342	351	353	355	355	351	351	359	340	335	358
State	289	317	319	295	324	317	332	317	325	339	344	341	341	343	343	341	338	348

Table 3.2. Three year rolling mean of the number of days soils were protected from erosion

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
EP	296	314	319	322	329	326	326	326	334	341	345	345	346	345	346	349
SAMDB	309	281	283	284	320	324	334	333	338	338	337	337	337	338	339	344
N&Y	320	315	314	308	314	310	312	320	333	339	338	338	339	341	338	338
SE	n/a	338	340	341	346	346	348	349	353	355	354	352	354	350	345	344
State	309	311	313	312	324	322	325	327	336	341	342	342	342	342	341	343

Data from the three year rolling mean for the last five years was log transformed and the percentage rate of change was calculated. In all regions and statewide, the percent change fell within the stable category as outlined in section 2.4.1 (Table 3.3)

Table 3.3. Average rate of change over the period from 2013–17

Calculating RATE OF CHANGE over last 5 years										
Year	**State erosion**	**Ln (State)**	**Eyre Peninsula erosion**	**Ln (EP)**	**Northern & Yorke erosion**	**Ln (N&Y)**	***SAMDB erosion**	**Ln (*SAMDB)**	**South East erosion**	**Ln (SE)**
2013	342	5.8	345	5.8	338	5.8	337	5.8	352	5.9
2014	342	5.8	356	5.8	339	5.8	337	5.8	354	5.9
2015	342	5.8	345	5.8	341	5.8	338	5.8	350	5.9
2016	341	5.8	346	5.8	338	5.8	339	5.8	345	5.9
2017	343	5.8	349	5.9	338	5.8	344	5.9	344	5.8
	Percent change per year	0.0	Percent change per year	0.2	Percent change per year	0.6	Percent change per year	0.5	Percent change per year	-0.7

*SAMDB – South Australian Murray-Darling Basin

3.2 Condition

Based on the condition thresholds set out in Section 2 (Table 2.2), the statewide and regional condition was allocated the score of 'good' (protection range between 337 and 358 days).

3.3 Reliability

The overall reliability score for this report card is 4.66 based on Table 3.4.

Table 3.4. Information reliability scores for soil protection

Indicator	Applicability	Currency	Spatial	Accuracy	Reliability
Days protected from soil erosion	5	5	4	NA	4.66

3.3.1 Notes on reliability

1. The relatively large number of sites assessed each survey (up to 1500 per region for SAMDB, EP, NY and SE) provides robust representation of land condition across these regions.
2. In the South East region, surveys are confined to the mid and upper SE areas, as the higher, more reliable rainfall in the lower SE means broad scale erosion risk is normally very low in this area.
3. No surveys are undertaken in Adelaide and Mount Lofty Ranges, Kangaroo Island, SA Arid Lands or Alinytjara Wilurara NRM Regions. There is negligible agriculture in SA Arid Lands and Alinytjara Wilurara NRM regions, so those regions are not represented on this report. On Kangaroo Island, the survey method is not employed, because roadside vegetation obscures paddocks. In Adelaide and Mount Lofty Ranges NRM region the survey method is not suited to the hilly areas and broad scale erosion is a relatively minor issue.
4. The reliability score for the state is based on 4 out of 6 agricultural regions. These regions achieve 4.66/5.
5. The regions that are surveyed have about 93% (by area) of South Australia's agricultural land.

4 Discussion

4.1 Trend

Protection of soil from wind and water erosion has improved since 2002 statewide and in the four monitored NRM Regions. Since 2013 the trend in erosion protection has been stable in all monitored regions.

Improvements since 2002 closely match the increase in adoption of no till cropping methods, and other land management practices that improve erosion protection. According to telephone surveys of farmers in South Australia, the proportion of the crop area sown using no-till increased from 16% in 1999 to 83% in 2016. The trend in erosion protection has stablilised since around 2013 corresponding to a levelling off of the adoption of no till to a more or less practical maximum level (i.e. some tillage or burning is still needed at times to manage weeds, pests, dense stubbles, compacted soils etc).

The trend in the South East region since 2002 has been more stable because the main land use is grazed pastures, so the no-till trend had relatively less impact on average soil protection in this region. In addition, the slight decline in the 3-year rolling mean days of erosion protection since 2015 is related to very dry seasons in 2014 and 2015 in this region which resulted in reduced plant growth and groundcover levels.

4.2 Condition

At present, there is a 'good' level of erosion protection in all the agricultural NRM Regions where monitoring data is available. This reflects the high level to which agricultural land managers are now using management practices that minimise the risk of soil erosion.

This means that it is unlikely that much soil erosion would result if strong winds or intense rainfall events occurred.

However there are a number of ongoing and future pressures (risks) that could reduce erosion protection:

- Prolonged or very dry seasonal conditions could reduce soil protection where this results in insufficient plant growth to provide and sustain protective soil cover. Most rain-fed agricultural systems in SA are based on annual crop and pasture plant species. Growth and maintenance of protective soil cover by annual plants relies on seasonal rainfall and is more vulnerable to rainfall deficiency than perennial plant systems.
- Bushfires remove surface cover, leaving erosion-susceptible soils exposed to erosion until cover can be re-established.
- Threats of weeds (including herbicide resistant weeds), pests (mice, snails), some plant diseases, and seeder clearance problems posed by dense stubbles can require strategic use of tillage or burning, which can temporarily increase soil exposure.
- Modelling has shown that climate change will significantly increase the susceptibility of soils to wind erosion and water erosion, through reduced 'growing season' rainfall and increased incidence of high intensity rainfall and wind events.

Achievement of 100% erosion protection in the longer term is not practically achievable under agricultural production for these reasons. The definition of the condition scores take these factors into account.

Note that the agricultural land component of the SASP Target 70 is a complimentary 'condition' target for soil protection, although the days of protection are derived from a different algorithm and are not directly comparable to this report card (section 2.3.1). The target for the agricultural component of the SASP Target 70 (days of soil protection for cropping land) was achieved for the first time in 2017.

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