Technical information supporting the 2023 Days at risk of soil erosion environmental trend and condition report card

Department for Environment and Water
August, 2023

DEW Technical note 2023/53

Government of South Australia

Department for Environment and Water

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Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present. We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders people have to Country. We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.

Acknowledgements

This document was prepared by Giles Forward (DEW). Tim Herrmann (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 Tim Herrmann, Amy Ide, comments from Stuart Wright, and mapping support from Brady Stead.

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Summary

The 2023 release of South Australia's environmental trend and condition report cards summarises our understanding of the current condition of the South Australian environment, and how it is changing over time.

This document describes the indicators, information sources, analysis methods and results used to develop this report and the associated 2023 Days at risk of soil erosion report card. The reliability of information sources used in the report card is also described.

The Days at risk of soil erosion report card sits within the report card Land theme and Agricultural land sub-theme. Report cards are published by the Department for Environment and Water and can be accessed at www.environment.sa.gov.au.

1 Introduction

1.1 Environmental trend and condition reporting in SA

The Minister for Climate, Environment and Water under the *Landscape South Australia Act 2019* is required to 'monitor, evaluate and audit the state and condition of the State's natural resources, coasts and seas; and to report on the state and condition of the State's natural resources, coasts and seas' (9(1(a-b)). Environmental trend and condition report cards are produced as the primary means for the Minister to undertake this reporting. Trend and condition report cards are also a key input into the State of the Environment Report for South Australia, which must be prepared under the *Environment Protection Act 1993*. This Act states that the State of the Environment Report must:

- include an assessment of the condition of the major environmental resources of South Australia (112(3(a))), and
- 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))), and
- identify significant trends in environmental quality based on an analysis of indicators of environmental quality (112(3(b))).

1.2 Purpose and benefits of SA's trend and condition report cards

South Australia's environmental trend and condition report cards focus on the state's priority environmental assets and the pressures that impact on these assets. The report cards present information on trend, condition, and information reliability in a succinct visual summary.

The full suite of report cards captures patterns in trend and condition, generally at a state scale, and gives insight to changes in a particular asset over time. They also highlight gaps in our knowledge on priority assets that prevent us from assessing trend and condition and might impede our ability to make evidence-based decisions.

Although both trend and condition are considered important, the report cards give particular emphasis to trend. Trend shows how the environment has responded to past drivers, decisions, and actions, and is what we seek to influence through future decisions and actions.

The benefits of trend and condition report cards include to:

- provide insight into our environment by tracking its change over time
- interpret complex information in a simple and accessible format
- provide a transparent and open evidence base for decision-making
- provide consistent messages on the trend and condition of the environment in South Australia
- highlight critical knowledge gaps in our understanding of South Australia's environment
- support alignment of environmental reporting, ensuring we 'do once, use many times'.

Environmental trend and condition report cards are designed to align with and inform state of the environment reporting at both the South Australian and national level. The format, design and accessibly of the report cards has been reviewed and improved with each release.

1.3 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 (SA) (Forward 2021a). Approximately 5.4 million hectares of agricultural land (61% of cleared land) in SA are inherently susceptible to wind erosion, and 2.9 million hectares (32%) are inherently susceptible to water erosion (DEW State Land and Soil Information Framework (SLASIF)). The soil's inherent susceptibility to erosion varies depending on soil characteristics and landscape features such as texture, slope and exposure (or elevation).

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, particularly during successive dry seasons, increase the risk of erosion where there is reduced vegetative cover resulting from poor crop and pasture growth. Fires remove surface vegetation, exposing the soil to erosion until new cover can be established.

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 erosion risk was due to cropping practices such as tillage (traditionally often multiple tillage passes) and stubble burning, which mainly occurred in late autumn to early winter. These practices nowadays are usually carried out on only a small proportion of rain-fed cropping land. The practices of no-till and stubble retention are now widely adopted across SA's agricultural lands. Threats such as pests (e.g. mice, snails), and herbicide resistant weeds can lead to increased use of tillage or burning at times. Grazing management is also an important factor, especially in dry seasons. The highest risks associated with grazing occur in late summer and autumn when feed availability and the cover of annual crop and pasture residues dwindle.

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

This report card specifically covers erosion risk on rain-fed agricultural lands of SA (cropping and grazing) (Figure 2.1), and not erosion in the grazed rangelands of the state.

2 Methods

2.1 Indicator

The indicator used for the Days at risk of soil erosion report card is the estimated average number of days per year that cleared agricultural land is at risk of soil erosion. Data for this indicator are obtained from an analytical method developed by Trevor Hobbs in the Department for Environment and Water (DEW) that uses Moderate Resolution Imaging Spectroradiometer (MODIS) Fractional Cover (Guerschman et al. 2009) monthly data and data from DEW's erosion protection field surveys.

2.2 Data sources

Bureau of Meteorology monthly gridded rainfall
http://www.bom.gov.au/web03/ncc/www/agcd/rainfall/totals/month/grid/0.05/history/nat/

Department for Environment and Water (DEW) Erosion protection field surveys (2000–2022)

Department for Environment and Water (DEW) Land manager telephone surveys (2000–2017)

MODIS Fractional Cover (Guerschman et al. 2009) monthly data from Index of /remotesensing/v310/australia/monthly/cover (csiro.au)

Primary Industries Scorecard 2021–22, SA Department of Primary Industries and Regions (PIRSA 2023). Primary Industries Scorecard 2021–22 (pir.sa.gov.au)

Department for Environment and Water (DEW) State Land and Soil Information Framework (SLASIF)

2.3 Data collection

2.3.1 Modelled MODIS Fractional Cover

Since October 2021, DEW's erosion protection field surveys have been downscaled using an alternative method of monitoring soil erosion risk on agricultural land using MODIS satellite data.

MODIS Fractional Cover data estimates fractional percentage apparent ground cover for 'green' (photosynthetic) vegetation, 'dry' (non-photosynthetic) vegetation and bare soil. The sum of the green and dry fractions is the estimate of percentage vegetative groundcover which is used as the surrogate for estimating erosion risk. This data is calibrated with the 'cover ratings' from geolocated sites of previous (2006–2014) erosion protection field surveys conducted every March, May, June and October, to attempt to match the data metrics and increase the accuracy of the data under local conditions (cover characteristics, soil colour, moisture level etc.). The MODIS 500 metre resolution pixels are also disaggregated to a 100 metre resolution using LANDSAT 3-month summer persistent vegetation cover data. The model estimates erosion risk (cover rating) separately for land with inherent dominant wind erosion potential and water erosion potential, using data from DEW's State Land and Soil Information Framework.

While this method does not assess other factors that affect erosion risk which were previously assessed in the field survey such as soil disturbance (looseness), it spatially covers all of the agricultural landscape rather than just the transects observed in the field surveys. Smaller scale field surveys are now conducted on an ongoing basis to ground-truth the accuracy of the modelled data.

This report card uses the MODIS satellite-derived data, rather than the field survey data as used in the previous 2020 'Days protected from soil erosion' report card.

2.3.2 Erosion protection field surveys

The erosion protection field surveys have been conducted by DEW (and partly contracted to PIRSA staff) since 2000 on dryland cropping and grazing land in the four main broadacre agricultural regions in SA (Forward unpublished draft). These closely correspond to current landscape regions Eyre Peninsula (EP), Northern and Yorke (NY), Murraylands and Riverland (MR), and Limestone Coast (LC). The observational field survey method used is simple, rapid and repeatable, and all data are recorded against clearly defined categories with photo standards (Forward 2021b). The survey method is designed to estimate the relative risk of (or protection from) wind erosion and water erosion.

Since October 2021 selected survey transects of limited extent on key agricultural soil areas have been conducted in the EP, NY and MR landscape regions every March, May, June and October for ongoing ground-truthing of the modelled MODIS data.

2.3.3 Land manager telephone surveys

DEW commissioned a series of 7 telephone surveys of randomly selected, 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 including their awareness and understanding of these issues, and practices used to manage them. No additional surveys have been conducted since the previous 2020 report card.

Data obtained from these surveys include the proportion (percentage) of the crop area sown using no-till methods (practices carried out in the year prior to the survey conducted in autumn). This method minimises possible exposure of soil to the risk of erosion with cropping, compared to previously used cropping methods that typically involved (multiple pass) tillage and routine stubble burning. These data (together with other related indicators from the surveys) are highly relevant to this report card as they provide evidence to support the trend (and condition) in soil erosion risk.

2.3.4 Rainfall

Gridded monthly rainfall data from the Bureau of Meteorology for 2000 to 2021 was spatially calculated for the state, landscape regions and agricultural districts, and filtered using SA Land Cover data to 'dryland agriculture' land use, i.e. dryland cropping and grazing, corresponding to the days of erosion risk analysis.

This was done to compare erosion risk data with rainfall, with rainfall being a major factor influencing plant growth and therefore ground cover and erosion risk.

2.4 Data analysis

The modelled MODIS erosion risk data are categorical, with 8 categories of 'cover rating' from 1 (high cover, fully protected from risk of erosion) to 8 (bare soil, highly exposed to risk of erosion), corresponding to previously defined field survey 'cover' ratings (Forward 2021b). A threshold is applied to the data between a cover rating (CR) of 5 and 6 to estimate relative proportion of land 'at risk' of erosion (CR 6–8) versus 'protected' (CR 1–5). This same approach was applied to the field survey data in previous 'Days Protected from Soil Erosion' report cards. This threshold was chosen based on past experience and expert opinion of groundcover levels generally required to protect SA's agricultural soils from erosion.

The same threshold has been maintained with the MODIS data analysis to ensure the metrics between the field survey data and modelled MODIS data used in these report cards align as closely as possible. The two metrics and data sets however are not directly the same. The raw MODIS Fractional Cover is largely an estimate of percentage ground cover, whereas the field survey cover ratings are a composite of percentage cover, cover height and density which in combination all affect erosion risk (with different weightings for land inherently susceptible to wind or water erosion). The modelling process attempts to estimate equivalent cover rating through calibration with the field survey observations and probability modelling.

The annual 'days of risk' is calculated from the proportion of land at risk in the March, May, June and October surveys each year using the same integration algorithm as was used with the field survey data (Donaldson unpublished). This estimates the cumulative risk days (hectare.days divided by hectares) over each 12 month period, nominally 1 August to 31 July. At 1 August, ground cover on agricultural cropping/grazing land is assumed to be 100%.

The MODIS-derived erosion risk data is filtered using SA Land Cover 2010–2015 data to 'dryland agriculture' land use, i.e. 'dryland cropping and grazing', which is the primary land use of interest for monitoring and reporting of erosion risk. The previous field survey erosion risk data was based on similar land use/geographic extent.

The indicator used in this report card is 'days of risk' (equivalent to 365 minus days protected) rather than the 'days protected' indicator used in the 2020 'Days protected from soil erosion' report card. This enables more direct and critical measurement of changes/trends in erosion risk across SA's agricultural lands. It also relates directly to the concept of the 'window of exposure' when cropping soils are most likely to be exposed to erosion around the time crops are sown and pastures are yet to fully establish following autumn rains.

Agricultural districts

The data for this report card have been analysed for the state (agricultural zone) and geographical areas of agricultural districts (or subregions based on PIRSA crop reporting districts with minor modifications) (Table 2.1, Figure 2.1). The agricultural districts fit mostly, but not entirely, within landscape regions in the agricultural zone of SA.

Data analysis has been done at the district scale to report in more detail the local extent and severity of soil erosion risk, which may not be revealed when the data are presented at the landscape region scale.

A baseline mean for the 10 year period 2008–2017 was used for analysis of the days of erosion risk data. This period is approximately representative of the typical range of annual rainfall, and therefore erosion risk levels.

Table 2.1. South Australian agricultural districts

Agricultural district	Abbreviation
Western Eyre Peninsula	WEP
Eastern Eyre Peninsula	EEP
Lower Eyre Peninsula	LEP
Upper North	UN
Mid North	MN
Lower North	LN
Yorke Peninsula	YP
Central Hills and Fleurieu	CHF
Kangaroo Island	KI
Northern Mallee	NM
Southern Mallee	SM
Lower Murray	LM
Upper South East	USE
Lower South East	LSE

Figure 2.1. Location of agricultural districts in SA's agricultural zone

2.5 Methods to assign trend, condition and reliablity

2.5.1 Trend

The trend in annual days of erosion risk was assessed based on the short term (5-year) average rate of change (days; data expressed as 3 year rolling means) as a percentage of 365 days. Trends were classified as stable, getting better or getting worse if the rate of change in the 5-year trend (of 3 year rolling mean data) was calculated as a ≤2.5% change, >2.5% decrease, or >2.5% increase, respectively (Table 2.2).

Table 2.2. Definition of trend classes used

Trend	Description
Getting better	Over a scale relevant to tracking change in the indicator it is improving in status with good confidence
Stable	Over a scale relevant to tracking change in the indicator it is neither improving nor declining in status
Getting worse	Over a scale relevant to tracking change in the indicator it is declining in status with good confidence
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

2.5.2 Condition

Based on expert opinion, the condition classifications of average days of erosion risk (3 year rolling mean) are: Very good <7 days; Good ≥7 to <28 days; Fair ≥28 to <56 days; Poor ≥56 days (Table 2.3). This is equivalent to threshholds used with the field survey data in previous report cards (i.e. days of erosion protection = 365 minus days of risk).

Table 2.3. Definition of condition classes used

Condition	Description	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)	Less than 7 days at risk of 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)	Greater than or equal to 7 and less than 28 days at risk of 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)	Greater than or equal to 28 and less than 56 days at risk of 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)	Greater than or equal to 56 days at risk of 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	-

2.5.3 Limitation

The MODIS Fractional Cover product gives an estimate of percentage groundcover, i.e. 'apparent cover' within the limitations of the model. It has been calibrated to some extent for the main land uses, vegetation types, climatic environments and soil types across Australia but may not necessarily be well calibrated for SA's dryland agricultural cropping and grazing landscapes.

Initial comparison of erosion risk derived from raw MODIS Fractional Cover data (using a fixed threshold method) against the DEW field survey data showed relatively poor agreement. After the MODIS data were calibrated against the field survey cover data by probability modelling (which provided data correction for local conditions including atmospheric and soil moisture conditions and soil colour), much better agreement was achieved.

Nonetheless, even with these improvements the MODIS data method provides an estimation of 'apparent cover' that may vary to some degree from actual (absolute) cover.

2.5.4 Reliability

Information is scored for reliability based on the minimum 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 2.44 for currency, 5 for applicability, Table 2.66 for spatial representation and Table 2.77 for accuracy.

Table 2.4. 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 2.5. 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 2.6. 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

Table 2.7. Guides for applying accuracy information

Accuracy score	Criteria
1	Better than could be expected by chance
2	> 60% better than could be expected by chance
3	> 70 % better than could be expected by chance
4	> 80 % better than could be expected by chance
5	> 90 % better than could be expected by chance

2.6 Data transparency

Data transparency for this report card is represented in Appendix C.

3 Results

3.1 Trend

The state trend in days of erosion risk over the last 5 years (3 year rolling mean) is getting worse (increased by 3.5%) (Table 3.4) according to the trend definitions set out in Section 2.5.1.

For the state (agricultural zone), the annual average days of erosion risk has varied considerably over the 2001 to 2022 period (Table 3.1, Figure 3.1). This can be largely related to variations in annual rainfall (Figure 3.2), where the average days of erosion risk were typically higher following lower rainfall years (e.g. 2003, 2008, 2019, 2020), and lower following higher rainfall years (e.g. 2002, 2011, 2014). This correlation was present, although relatively weak, for the whole agricultural zone (Figure 3.3) but was stronger in many of the lower rainfall agricultural subregions (Figure 4.1).

Table 3.1. Days of erosion risk, annual and 3 year rolling mean for state (agricultural zone), 2001–2022

State days of erosion risk	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Annual	22	18	47	30	37	24	36	54	36	29	17	27	23	11	17	18	18	32	38	43	36	27
3 year rolling mean			29	31	38	30	33	38	42	40	27	24	22	20	17	16	18	23	29	38	39	36

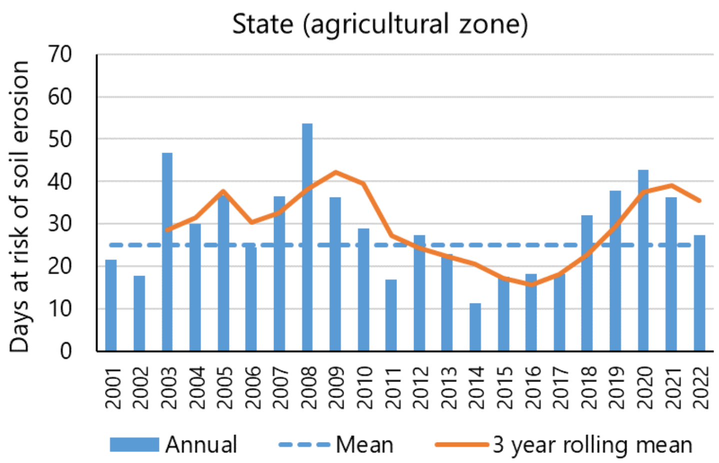


Figure 3.1. Days of erosion risk for SA's agricultural zone, 2001–2022

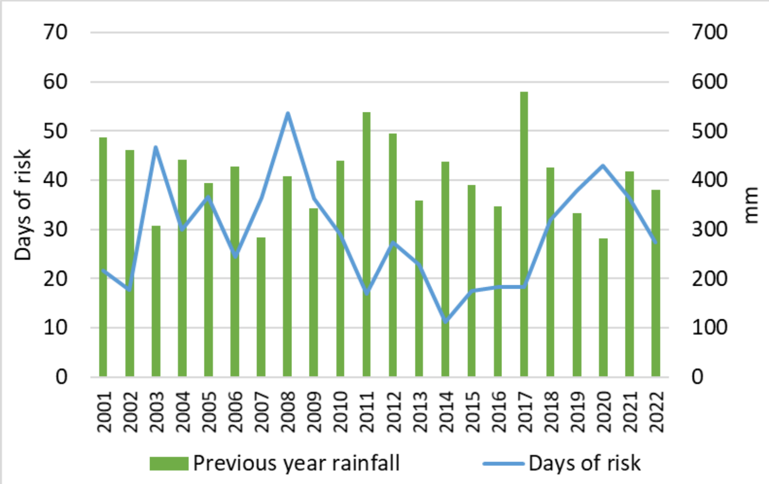


Figure 3.2. Days of erosion risk and previous year's annual rainfall on dryland agricultural land in SA's agricultural zone, 2001–2022

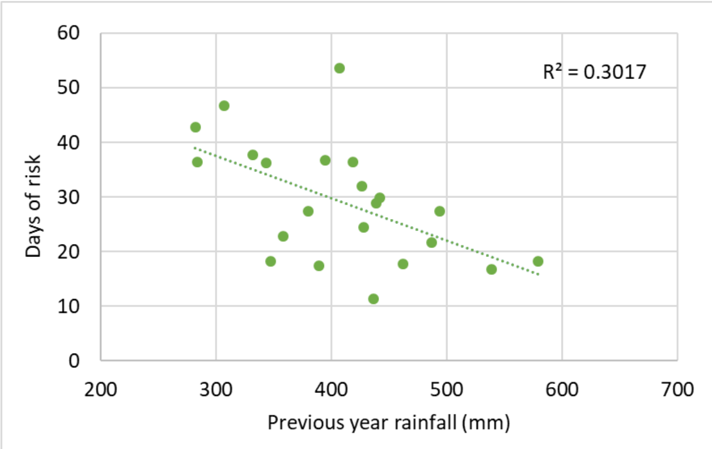


Figure 3.3. XY plot of days of erosion risk and previous year's annual rainfall on dryland agricultural land in SA's agricultural zone, 2001–2022

Days of erosion risk for the agricultural districts are shown in Appendix A (data tables) and Appendix B (charts).

The 5 year trend in days of erosion risk is getting worse in 6 of the agricultural districts (Western Eyre Peninsula, Eastern Eyre Peninsula, Upper North, Mid North, Northern Mallee and Lower Murray), (Figure 3.4, Table 3.2). These are the lower rainfall districts within the agricultural zone where the impact of lower rainfall seasons on plant growth and ground cover (hence exposure to erosion risk) is greater than in the more reliable, higher rainfall districts.

The remaining agricultural districts have a stable trend in days of erosion risk (Table 3.2). Most of these had a small increase in days of erosion risk but this was below the threshold (2.5%) for a worsening trend. The high rainfall districts (particularly Central Hills and Fleurieu, Kangaroo Island, Upper South East, Lower South East) had very small or negligible change in days of erosion risk.

Based on past annual variations in days of erosion risk, it is evident that the trend is highly dependent on seasonal conditions, particularly the amount and timing of rainfall. It tends to get worse in dry seasons but gets better in above average rainfall years.

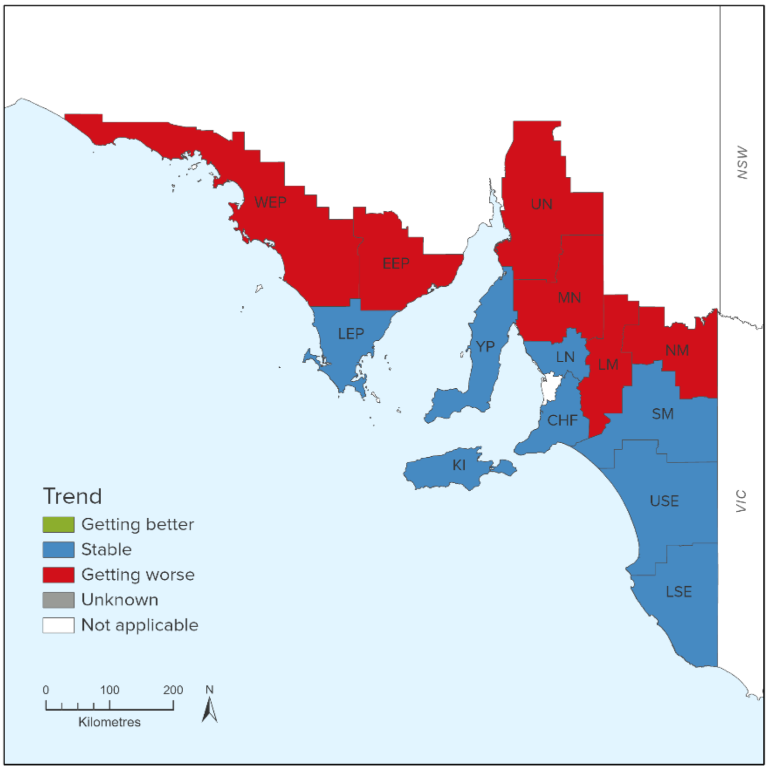


Figure 3.4. Map of trend ratings for agricultural districts. See Table 2.1 for agricultural district names and abbreviations

Table 3.2. Five-year change in days of erosion risk (3 year mean) 2018–2022 as a percentage of 365 days and trend rating for the state agricultural zone and agricultural districts

Agricultural district	5 year change 2018–2022 (3 year mean) as percentage of 365 days	Trend rating
State (agricultural zone)	3.5	Getting worse
Western Eyre Peninsla	2.6	Getting worse
Eastern Eyre Peninsula	4.8	Getting worse
Lower Eyre Peninsula	-0.6	Stable
Upper North	13.2	Getting worse
Mid North	5.7	Getting worse
Lower North	1.2	Stable
Yorke Peninsula	1.7	Stable
Central Hills and Fleurieu	0.1	Stable
Kangaroo Island	0.1	Stable
Northern Mallee	9.0	Getting worse
Southern Mallee	0.5	Stable
Lower Murray	3.0	Getting worse
Upper South East	0.0	Stable
Lower South East	0.0	Stable

3.2 Condition

Based on the condition thresholds set out in Section 2.5.2, the condition score for days of erosion risk for the agricultural zone in the state in 2022 is 'fair' (Table 3.3).

Condition scores for agricultural districts in 2022 varied markedly from 'poor' to 'very good' (Figure 3.5, Table 3.3) largely due to rainfall zone, the succession of drier than average seasons most years since 2017, and landscape/soil type.

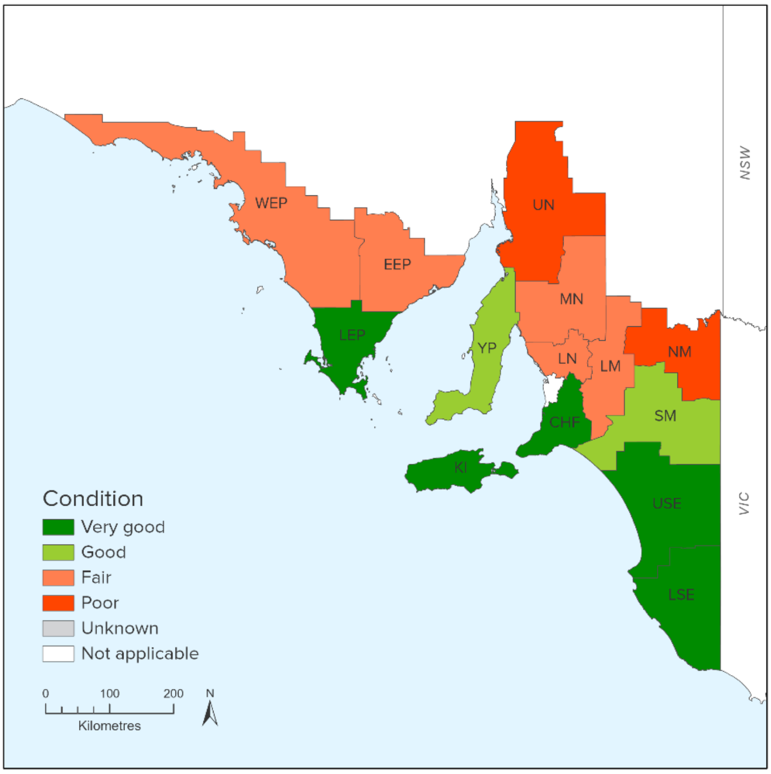


Figure 3.5. Map of condition ratings for agricultural districts. See Table 2.1 for agricultural district names and abbreviations

The effect of below average rainfall seasons on soil erosion risk was most acute in the lower rainfall areas such as the Upper North and the Northern Mallee. The condition score for these subregions was 'poor'.

In contrast, the condition score was 'very good' in the higher rainfall districts (Lower Eyre Peninsula, Central Hills and Fleurieu, Kangaroo Island, Upper and Lower South East). The condition score was 'fair' or 'good' in the remaining districts that are regarded as being mainly in the medium rainfall zone.

The trend ratings were generally related to condition ratings (Table 3.3), whereby districts with 'poor' or 'fair' condition ratings mostly had a 'getting worse' trend, and those with 'good' or 'very good' condition ratings had a 'stable' trend rating.

The trend and condition ratings are highly dependent on seasonal conditions, particularly the amount and timing of rainfall. The condition ratings tend to get poorer after below average rainfall seasons, and get better after above average rainfall years.

Table 3.3. Days of erosion risk (3 year rolling mean) in 2022, condition rating and trend rating for agricultural districts

Agricultural district	Days of erosion risk (2022; 3 year mean)	Condition rating	Trend rating
State (agricultural zone)	36	Fair	Getting worse
Western Eyre Peninsula	55	Fair	Getting worse
Eastern Eyre Peninsula	45	Fair	Getting worse
Lower Eyre Peninsula	7	Very good	Stable
Upper North	85	Poor	Getting worse
Mid North	48	Fair	Getting worse
Lower North	29	Fair	Stable
Yorke Peninsula	18	Good	Stable
Central Hills and Fleurieu	2	Very good	Stable
Kangaroo Island	1	Very good	Stable
Northern Mallee	77	Poor	Getting worse
Southern Mallee	16	Good	Stable
Lower Murray	36	Fair	Getting worse
Upper South East	4	Very good	Stable
Lower South East	0	Very good	Stable

3.3 Reliability

The overall reliability score for this report card is 4 out of 5 based on definitions in Section 2.5.4 and Table 3.4. This is considered to be 'Very good' reliability.

Table 3.4. Information reliability scores for trends in days of erosion risk

Indicator	Applicability	Currency	Spatial	Accuracy	Reliability
Days at risk of soil erosion	5	5	4	4	4

3.3.1 Notes on reliability

The MODIS data has direct applicability (score 5).

The MODIS data used applies to each year of analysis (currency up to 3 years old, score 5).

MODIS Fractional Cover monthly data covers 100% of the geographic agricultural area of SA (not stratified) and has a 500 m pixel resolution (spatial representation score 4).

The modelled data (i.e. calibrated against the field survey data) is regarded as having substantial accuracy (score 4).

4 Discussion

4.1 Trend

The ‘getting worse’ trend in days of erosion risk over the last 5 years to 2022 in low to medium rainfall districts has largely been driven by multiple below-average rainfall seasons, particularly 2018, 2019 and 2021 (Figure 3.2). In such seasons, the amount of crop and pasture plant biomass produced, even when using best management practices, can be inadequate to protect the soil from the risk of erosion through the summer–autumn period until new growth in the following winter. This situation becomes worse in successive dry seasons where low cover levels carrying over from the previous season are coupled with below average plant biomass production in the current season.

Over the period of the monitoring data (2000–2022), substantial improvements have been made to agricultural land management practices which reduce erosion risk. For example, acccording to DEW’s telephone surveys of farmers in SA, the proportion of the crop area sown using no-till increased from 16% in 1999 to 83% in 2016 (see SA Environmental trend and condition report card 2023 Soil protection: Adoption of no-till). Since then it is generally considered that the adoption of this method has stablilised 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.). No-till, particularly in conjunction with full stubble retention, minimises soil exposure to erosion at sowing, compared to multiple months of soil exposure prior to sowing that typically occurs using conventional tillage-based sowing methods. The method of confinement or containment feeding of livestock during dry conditions has also increased according to these surveys, from 31% (2000) to 54% (2017). This practice enables sufficient groundcover for erosion protection to be maintained in broadacre paddocks through summer–autumn or during dry seasonal conditions.

Overall, the days of erosion risk data do not clearly reflect the impacts of these changes in land management practices since 2001. It is apparent that seasonal variations in rainfall are the dominant factor affecting trends in days of erosion risk.

Nonetheless, at the subregional scale some correlations between days of erosion risk and changes in land management practices are evident. For example, in the Northern Mallee district, very low rainfall seasons occurred in 2002 and 2018, with similar April to October ‘growing season’ (GS) rainfall (2002: 87mm [GS] and 138mm [Year]; 2018: 98mm [GS] and 161mm [Y]; Figure 4.1). In the year following each of these dry seasons, there was considerable difference in days of erosion risk between 2003 and 2019: In 2003, there were 145 days of erosion risk, but only 98 days of erosion risk in 2019 (Figure 4.2). According to the DEW land manager surveys, in 2001 about 20% of the crop area within the South Australian Murray–Darling Basin Natural Resources Management Region was sown using no-till methods, compared to 77% in 2016. Apart from the small differences in rainfall, much of the difference in the days of erosion risk between 2003 and 2019 is likely to be due to the increased use of no-till sowing methods, replacing conventional tillage based sowing methods.

If average to above average rainfall occurs in coming seasons, then it is likely that the trend scores would improve overall.

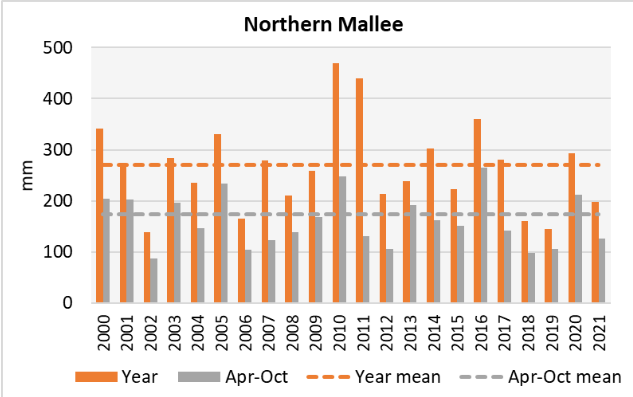


Figure 4.1. Annual and April–October rainfall in the Northern Mallee district, 2000–2021

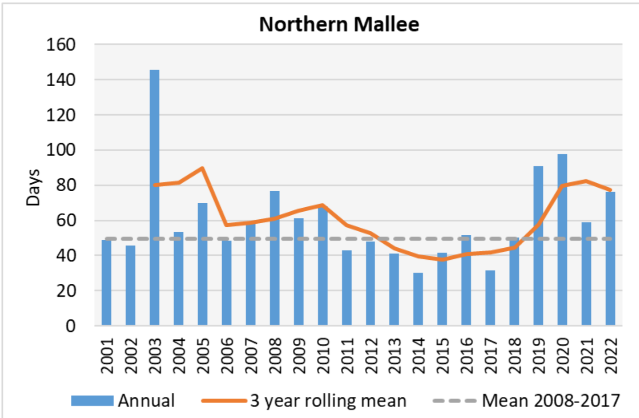


Figure 4.2. Days of erosion risk in the Northern Mallee district, 2000–2021

4.2 Condition

The condition score for the state overall in 2022 (Table 3.5) was 'fair'. This is an area-weighted mean of the condition scores for the SA agricultural subregions, which varied from 'poor' to 'very good'. The condition scores for individual districts is closely related to rainfall zone. The effect of below average rainfall seasons (as has occurred in 2018, 2019 and 2021) on soil erosion risk is most acute in the lower rainfall areas such as the Upper North and the Northern Mallee, where growing and maintaining sufficient plant biomass for erosion protection throughout the season through to the break of the following season can be difficult to achieve. This impact is higher on more clayey textured soils compared to sandier soils, where soil water is less plant-available, resulting in poorer plant growth.

If average to above average rainfall occurs in coming seasons, it is expected that condition scores for erosion risk would improve.

There are a number of ongoing and future pressures (risks) that have the potential to increase erosion risk, which were taken into account when setting the condition rating thresholds:

- 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 and more variable '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 thresholds for condition scores take these factors into account.

5 Appendices

A. Days of erosion risk tables for agricultural districts

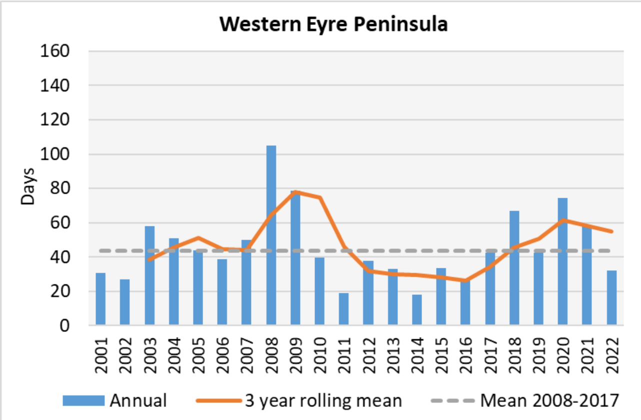
Days of erosion risk (annual) for agricultural districts

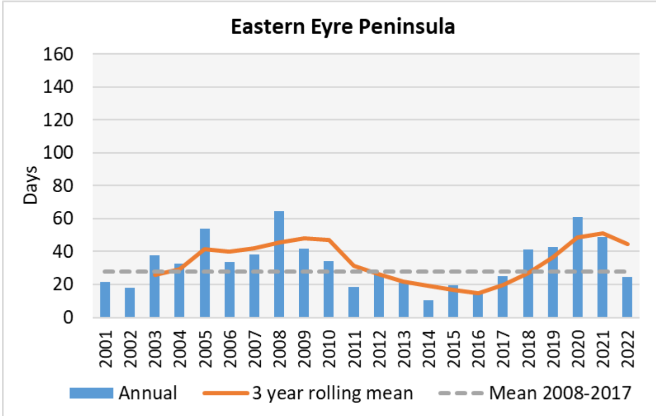
Days of erosion risk (annual)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Western Eyre Peninsula	31	27	58	51	44	39	50	105	79	40	19	38	33	18	33	27	42	67	42	75	58	32
Eastern Eyre Peninsula	21	18	38	33	54	34	38	64	42	34	18	26	21	11	19	15	25	41	43	61	49	25
Lower Eyre Peninsula	6	8	19	11	23	11	10	22	8	10	7	9	6	4	6	3	16	9	3	6	10	5
Upper North	51	22	94	68	66	51	98	114	73	66	30	67	67	23	28	25	16	69	100	99	82	73
Mid North	28	18	58	31	54	23	54	56	35	34	23	41	27	10	18	26	19	36	57	54	54	36
Lower North	21	18	42	26	36	17	32	34	18	27	19	35	19	11	11	27	21	26	35	31	38	19
Yorke Peninsula	21	19	35	24	32	21	24	28	15	21	17	24	15	7	9	9	12	15	11	17	21	17
Central Hills and Fleurieu	1	1	3	3	5	1	2	3	1	1	1	2	1	1	1	1	1	2	3	2	2	2
Kangaroo Island	1	0	1	1	2	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	2	1
Northern Mallee	49	46	146	54	70	49	58	77	61	68	43	48	41	30	42	51	32	50	91	98	59	76
Southern Mallee	9	18	41	17	27	17	22	39	21	18	15	16	11	8	16	19	10	13	28	14	18	16
Lower Murray	27	28	53	30	46	14	25	49	43	33	17	22	21	10	15	27	17	32	52	40	35	33
Upper South East	1	3	6	6	7	7	9	9	7	4	5	4	4	4	4	5	5	3	4	3	5	4
Lower South East	1	0	0	0	2	0	1	1	1	0	0	1	1	0	0	1	0	1	0	0	1	0

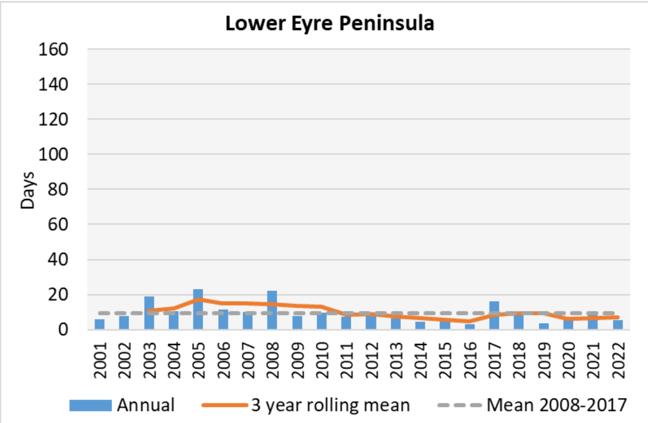
Days of erosion risk (3 year rolling mean) for agricultural districts

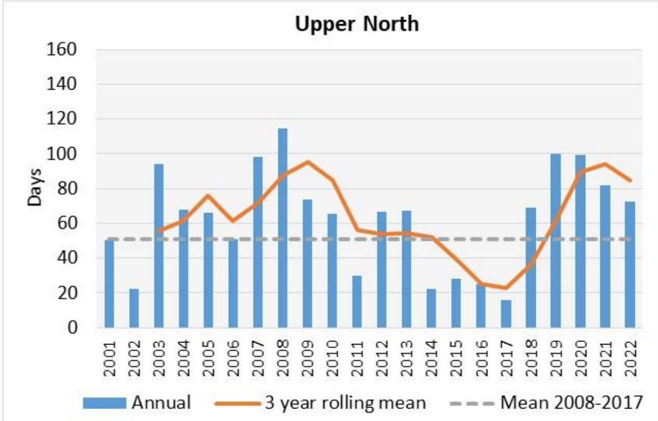
Days of erosion risk (3 year rolling mean)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Western Eyre Peninsula	39	45	51	44	44	64	78	74	46	32	30	30	28	26	34	46	51	61	58	55
Eastern Eyre Peninsula	26	30	42	40	42	45	48	47	32	26	22	19	17	15	20	27	36	48	51	45
Lower Eyre Peninsula	11	12	17	15	15	15	13	13	8	9	8	7	6	5	8	9	9	6	6	7
Upper North	56	62	76	62	72	88	95	85	56	54	55	52	39	25	23	37	62	90	94	85
Mid North	35	36	48	36	44	44	48	41	30	32	30	26	18	18	21	27	37	49	55	48
Lower North	27	29	35	27	29	28	28	27	22	27	24	22	14	17	20	25	27	31	35	29
Yorke Peninsula	25	26	30	26	26	24	22	22	18	21	18	15	10	8	10	12	13	14	17	18
Central Hills and Fleurieu	2	2	4	3	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2	2
Kangaroo Island	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1
Northern Mallee	80	82	90	57	59	61	65	69	57	53	44	40	38	41	42	44	58	80	82	77
Southern Mallee	23	26	29	20	22	26	27	26	18	16	14	12	12	14	15	14	17	18	20	16
Lower Murray	36	37	43	30	28	29	39	42	31	24	20	18	15	17	20	25	34	41	43	36
Upper South East	3	5	6	6	8	8	8	7	5	4	4	4	4	4	4	4	4	3	4	4
Lower South East	0	0	1	1	1	1	1	1	0	0	1	1	0	0	0	1	0	0	0	0

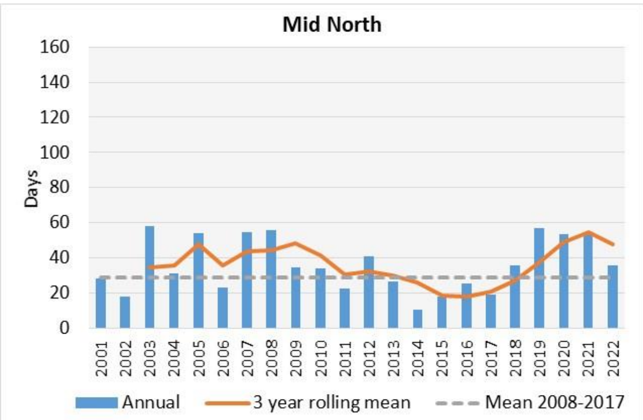
B. Days of erosion risk charts for agricultural districts

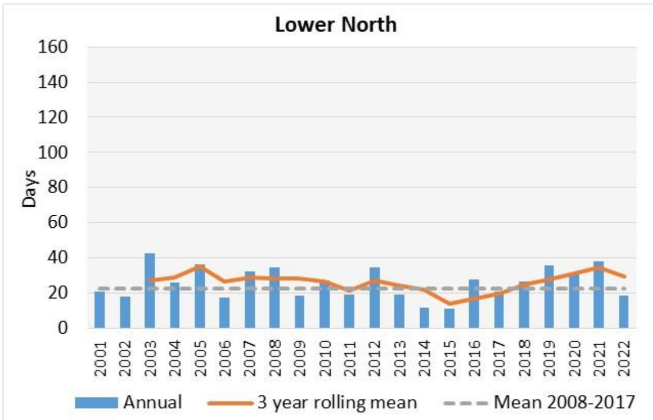


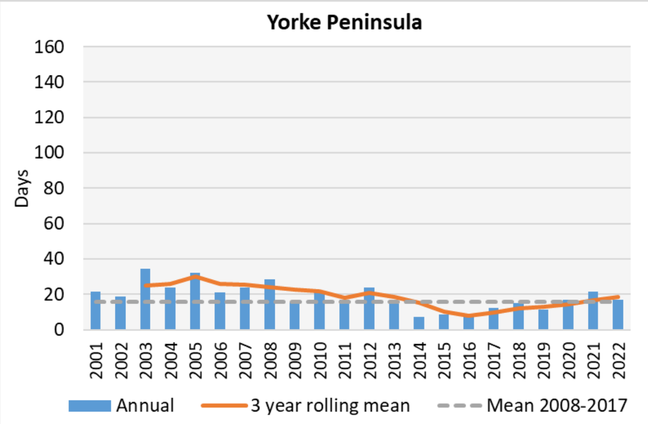


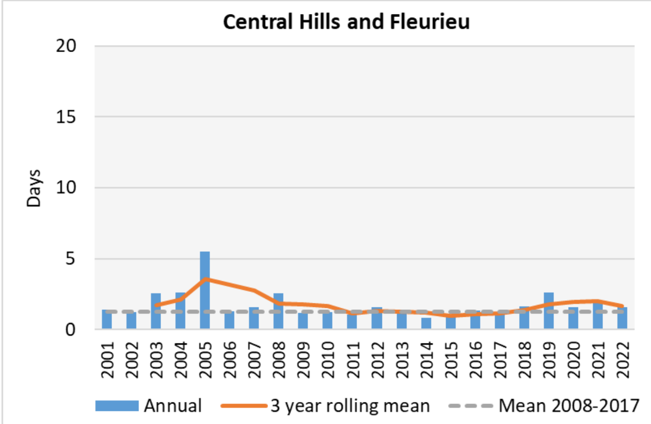


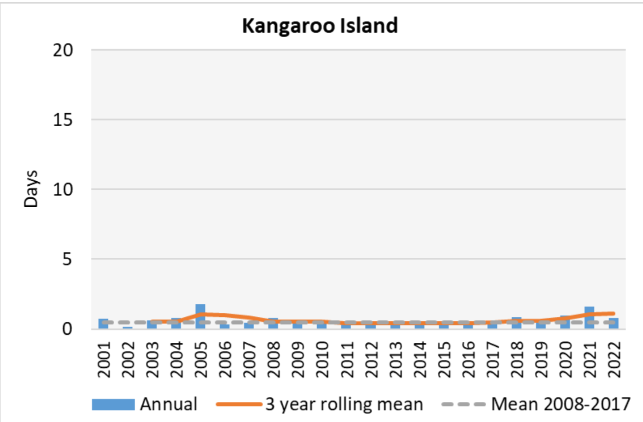


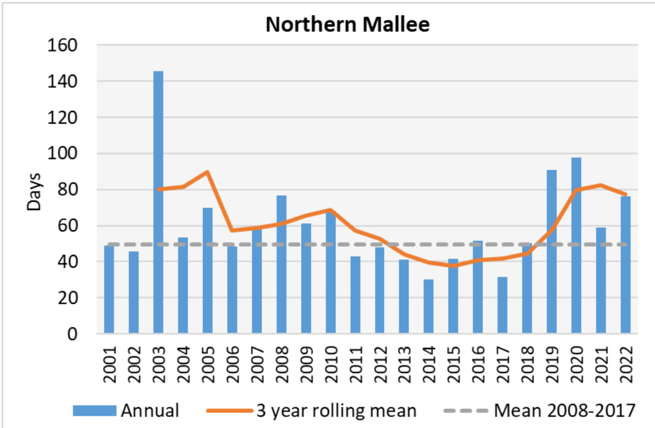


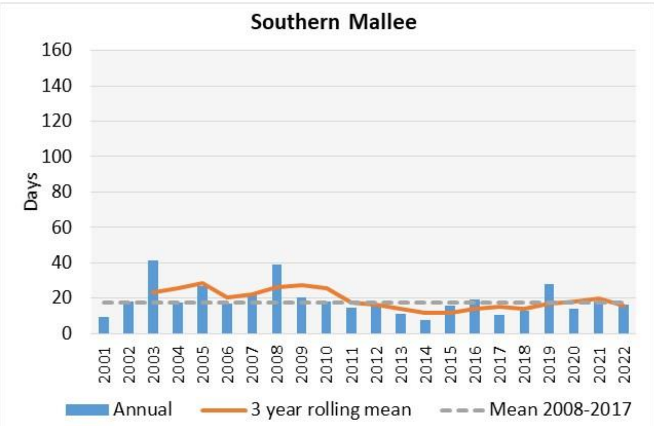


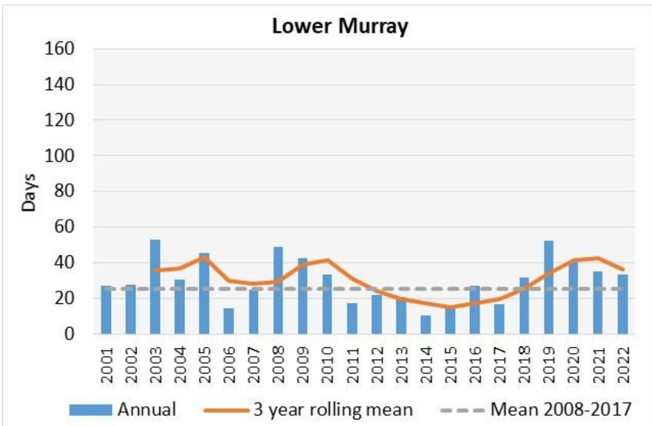

Yorke Peninsula
Days
Annual
3 year rolling mean
Mean 2008-2017

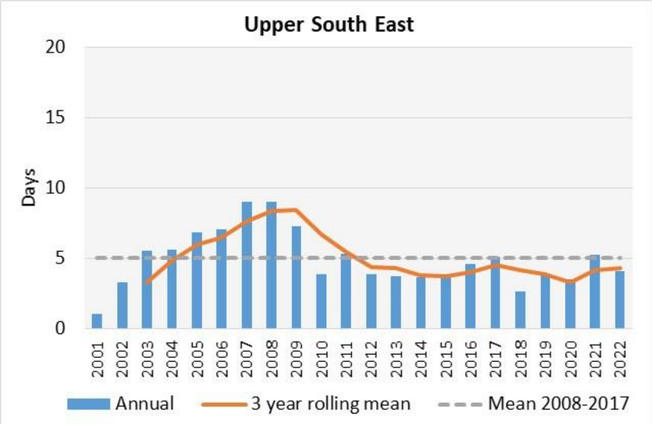

Central Hills and Fleurieu
Days
Annual
3 year rolling mean
Mean 2008-2017

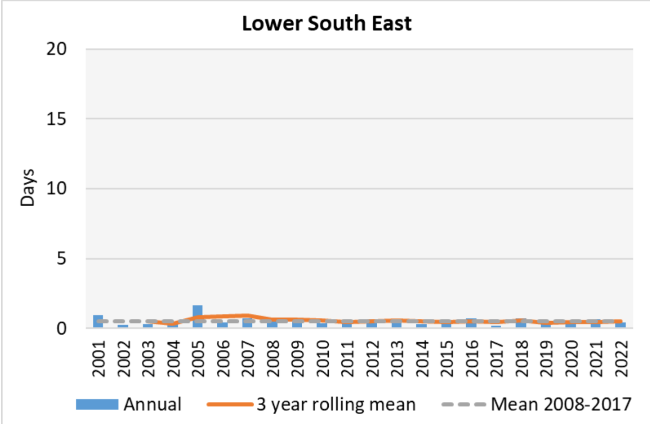

Kangaroo Island
Days
Annual
3 year rolling mean
Mean 2008-2017


Northern Mallee
Days
Annual
3 year rolling mean
Mean 2008-2017

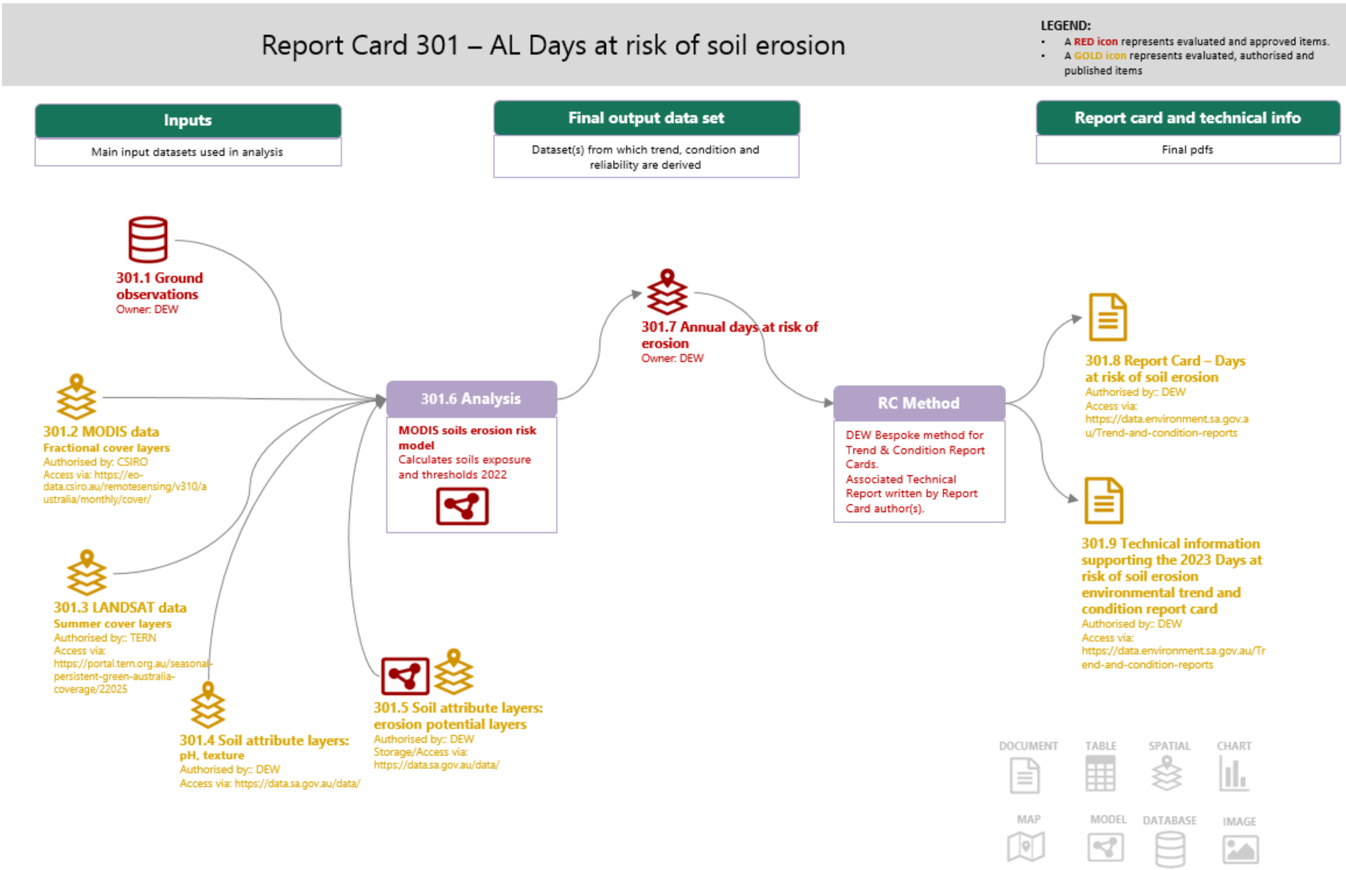

Southern Mallee
Days
Annual
3 year rolling mean
Mean 2008-2017


Lower Murray
Days
Annual
3 year rolling mean
Mean 2008-2017


Upper South East
Days
20
15
10
5
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Annual
3 year rolling mean
Mean 2008-2017


Lower South East
Days
20
15
10
5
0
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Annual
3 year rolling mean
Mean 2008-2017

C. Managing environmental knowledge chart for Days at risk of soil erosion



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