
Assessment of ground cover monitoring sites in South Australia

Giles Forward

Science, Monitoring and Information
Department of Water, Land and Biodiversity Conservation

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Science, Monitoring and Information Division

Department of Water, Land and Biodiversity Conservation

25 Grenfell Street, Adelaide

GPO Box 2834, Adelaide SA 5001

Telephone National (08) 8463 6946

International +61 8 8463 6946

Fax National (08) 8463 6999

International +61 8 8463 6999

Website www.dwlbc.sa.gov.au

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FOREWORD

South Australia's unique and precious natural resources are fundamental to the economic and social wellbeing of the State. It is critical that these resources are managed in a sustainable manner to safeguard them both for current users and for future generations.

The Department of Water, Land and Biodiversity Conservation (DWLBC) strives to ensure that our natural resources are managed so that they are available for all users, including the environment.

In order for us to best manage these natural resources it is imperative that we have a sound knowledge of their condition and how they are likely to respond to management changes. DWLBC scientific and technical staff continues to improve this knowledge through undertaking investigations, technical reviews and resource modelling.

Scott Ashby
CHIEF EXECUTIVE
DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

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1. INTRODUCTION

The National Land and Water Resources Audit (NLWRA 2007) highlighted the value of a uniform national dataset of ground cover to monitor the impacts of land management over time. The Australian Collaborative Land Use and Management Program (ACLUMP) is coordinating the development of a suitable methodology for mapping and monitoring ground cover and land management practices in agricultural areas of Australia.

ACLUMP proposes to establish national protocols for producing a data set of ground cover maintenance. This data set will focus on critical levels of ground cover (bare to low levels including both photosynthetically and non-photosynthetically active vegetation) under cropping and modified pasture land uses. A national network of reference sites will be used to calibrate and validate the ground cover levels estimated, and to support the interpretation of likely land management practices from satellite imagery.

In 2008/09, ACLUMP secured funding from the Australian Government Caring for Our Country for an initial project comprising:

1. Remote sensing demonstration pilot project, involving selected agencies, to assess the most appropriate satellite imagery product(s) to use together with ground reference site needs, for monitoring ground cover
2. Groundcover management practices – calendar of operations and assessment of monitoring sites project, involving state and territory agencies represented on the National Committee for Land Use and Management (NCLUM) with the Australian Government Bureau of Rural Sciences, coordinated through a technical working group represented by these agencies.

DWLBC, as the SA representative on NCLUM, is participating in the “Groundcover management practices” project and also a member of the project technical working group.

One of the outputs of this project for SA according to the project brief is a report that will:

- Assess the suitability of existing monitoring sites in SA as reference sites for calibration and validation of remote sensing products (i.e. MODIS fractional cover at 500m resolution ground truthed using a modified Statewide Land Cover and Trees Study - SLATS method)
- Compare the different methods used to collate information on ground cover and/or land management practices in SA to assist in determining national standards for monitoring using remote sensing
- Be accompanied by a spatial data set of SA’s existing monitoring sites showing their location, size, land use, purpose and attributes collected.

A further output produced by DWLBC for this project is a “Calendar of Operations” (i.e. typical timing of farming field operations that impact on ground cover) for major crop and pasture commodities in agricultural NRM regions of SA.

2. GROUND COVER MONITORING PROGRAMS IN SOUTH AUSTRALIA

2.1 SUMMARY OF PROGRAMS

DWLBC Land Condition Monitoring Program – Field survey program for erosion hazard

The current DWLBC land condition monitoring (LCM) program comprises a number of components to monitor soil and land condition and relevant agricultural land management practices in SA's agricultural areas. Of most relevance to this report is the field "windscreen" survey program for soil (wind/water) erosion hazard, which is discussed in relation to SLATS in section 2.2.

Land condition monitoring in the non-pastoral lease rangelands of SA

A land condition monitoring field survey program was established by DWLBC in the semi-arid, non-pastoral lease rangelands areas of SA in 1999/2000 along with the field survey program in the agricultural regions. This land occurs between the northern margins of the agricultural lands and the arid zone pastoral lease rangelands in SA's north. This monitoring program ran until 2004 and then discontinued.

DWLBC rangelands pastoral lease monitoring program

The current rangelands monitoring program was established during 1990–2000 in the pastoral lease rangelands of SA, to monitor land condition primarily for requirements under the Pastoral Land Management and Conservation Act 1989.

The program incorporates a number of different levels of on-ground monitoring at different sites for particular purposes. Groundcover is only quantitatively measured at the network of "photopoint" sites. Section 2.3 compares photopoint monitoring site methods with SLATS.

AussieGrass

AussieGrass is a simulation model developed to predict and monitor historical grass production and ground cover in all Australian regions. During 1997–2001, DWLBC was directly involved with this program in SA, but has since discontinued due to funding constraints. The data was used to produce regional drought and condition reports for the rangelands to the former Soil Conservation Council and later to support the Exceptional Circumstances (EC) applications for the pastoral zone. Information is available at the following link:

<http://www.longpaddock.qld.gov.au/AboutUs/ResearchProjects/AussieGRASS/>

2.2 DWLBC FIELD SURVEY PROGRAM FOR EROSION HAZARD

2.2.1 OVERVIEW

The DWLBC LCM field survey program for erosion hazard is an observational roadside survey in the main agricultural cropping regions of SA, established in 1999/2000. Requirements in the then Soil Conservation and Land Care Act 1989 prompted DWLBC to establish a suitable program to gather baseline data and monitor the condition of agricultural land over time, particularly in respect to management of soil erosion hazard, as well as monitor relevant agricultural land management practices. Significant erosion events in SA's agricultural areas are highly episodic, mainly associated with extremely dry seasonal conditions or intense rainfall events, but are more likely to occur wherever and whenever land is more highly exposed. Practices such as stubble retention, minimum tillage and improved grazing management have contributed to reduced soil exposure to erosion in recent decades.

The surveys involve observational assessment of the condition of farm paddocks primarily relating to soil erosion hazard (i.e. likelihood), which include observation of groundcover, other soil surface condition parameters, incidence of recent erosion and contextual observations of cropping rotation/land management phase. Field observations were designed to be relatively simple, repeatable and quick for drive-by roadside survey. The site assessment methods were not designed to be used for one-off assessment of individual field sites. Although the field observations by their nature are somewhat subjective, therefore open to surveyor error, statistical validity of the data is achieved through the aggregation of the large number of sites' data both spatially and temporally.

The survey methodology has many similarities to the roadside erosion survey programs currently carried out in the agricultural areas of WA (Department of Agriculture and Food, WA) and some agricultural Catchment Management Authority (CMA) regions in western NSW (Department of Environment and Climate Change, NSW).

A much more systematic and comprehensive assessment of land management practices (relevant to soil erosion hazard and other soil degradation issues) in SA's agricultural regions is conducted in the "land manager survey" program (McCord and Rix 2008, Forward 2008). This data is not geo-referenced but includes a postcode field for aggregation into regions.

As yet, no remote sensing technology is used with the LCM field survey program, but a collaborative research project recently initiated with the University of Adelaide (Clarke and Lewis 2009) is currently evaluating the potential for use of MODIS imagery to achieve the aims of the field survey program.

Data from the field surveys is used to estimate indices of the proportion of agricultural land at risk (or conversely, protected from risk) of erosion, both spatially and temporally. One of these indices is used to report against a soil protection target in South Australia's Strategic Plan 2007, and reports are regularly prepared for regional NRM Boards in agricultural areas of SA and other stakeholders.

2.2.2 PROGRAM INTENT

Roadside observational monitoring of erosion hazard in the agricultural cropping regions of SA.

2.2.3 DATA STORAGE

Field survey data is captured on hand-held, GPS linked PDAs using a customised ArcPad™ program. Site data shapefiles are uploaded into an MS Access™ relational database that was professionally designed for the specific data management requirements of the DWLBC field survey program. The database resides with the Program Manager, Land Condition Monitoring, DWLBC.

2.2.4 EXTENT

The field survey program is carried out in the main agricultural cropping regions of SA (Figure 1), corresponding approximately to the current NRM regions of Eyre Peninsula, Northern and Yorke, SA Murray-Darling Basin (Murraylands area) and the South East. The total area effectively monitored is approximately 8.1 million hectares, comprising about 80% of the state's agricultural land.

The sites are stratified across 39 land zones with varying soil/landform characteristics (based on the DWLBC Soil and Land Program soil landscape database – DWLBC 2007) and rainfall zones. Agricultural areas not included in the surveyed area are mainly higher rainfall permanent pastures, which are generally much less prone to soil erosion, and/or due to restricted paddock visibility due to dense roadside vegetation (Kangaroo Island).

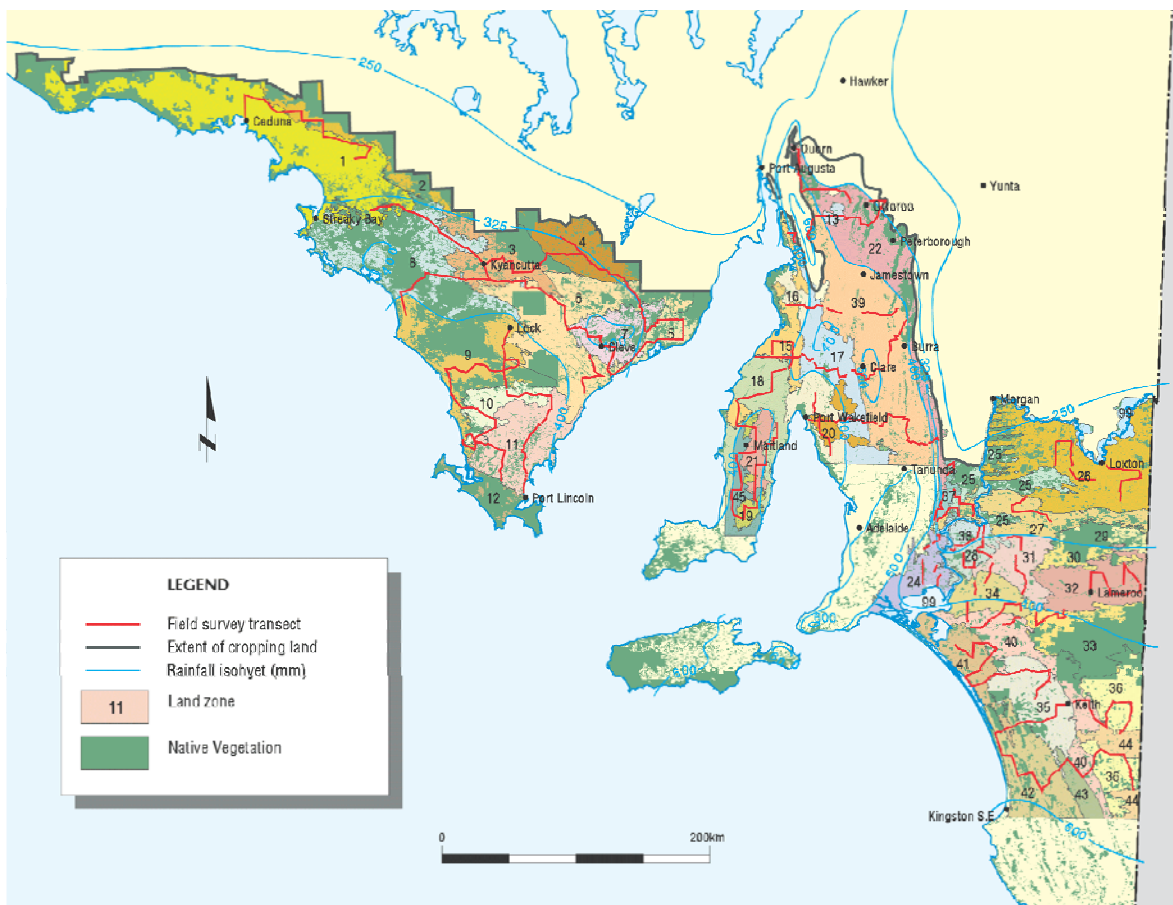
2.2.5 NUMBER OF SITES

At present, a total of 5611 geo-referenced sites are monitored, generally occurring on both sides of the road along the fixed transects.

2.2.6 CURRENT MONITORING

The monitoring methods are essentially unchanged since the program began, and are described in the field survey manual (McCord, 2008).

Field sites are a 200m x 200m area within a paddock adjacent to the roadside observation point, intended to represent the landform and land use/management regime of the paddock (or a distinct dune/flat land facet within the paddock). Prior to 2006, all visible paddocks both sides of the road along transects were assessed, but at the beginning of 2006, all field sites were geo-located to eliminate variation in actual observation points between surveys.



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Figure 1. Land zones and field survey transects for the DWLBC field survey program

The sites are monitored by roadside observation four times each year corresponding to critical periods for soil exposure in the annual growth and management cycle of winter crops and pastures (first week of March, May, June/peak sowing time, and October). In both crop and pasture phases, groundcover is usually at a maximum around October at crop and pasture maturity, then declines with crop harvest, grazing, stubble management operations, cultivation and natural residue breakdown through summer and autumn to a minimum around crop sowing time (May–June) or at the break of the season in pastures. Several regionally based survey teams conduct surveys concurrently in order to complete surveys in the desired timeframes. The time sequence of observations through each season is used to construct annual cumulative estimates of erosion hazard, as well as track within-season variation.

The observational assessments and site details recorded are shown in Table 1. Full details of the observational categories, definitions and photostandards are given in Appendix 1.

Table 1. DWLBC field survey site observation/data fields and categories

Field	Description	Categories/range	Type
Location	gps location		Site characterisation
Date	Survey date	dd-mm-yy	Dynamic
TransectID	Transect number	1 - 14	Site characterisation
ZoneID	Land Zone number. Equivalent to Level 3 (Zone) in ASRIS	1 - 45	Site characterisation
SiteID	Site number. Values identify transect number and site number	1xxx - 14xxx	Site characterisation
LandTypeID	Identifies land facets dune (d), flat (n), or both, in dune/swale land systems	d, n	Site characterisation
PhaseID	Identifies key land use/rotational phase relevant to time of survey	crop/cereal, canola, grain legume, pasture, stubble, tilled fallow, chemical fallow	Dynamic
TopoRWind	Characterisation of inherent wind erosion susceptibility by soil texture x landscape rating	1 - 5	Site characterisation
TopoRWater	Characterisation of inherent sheet/rill erosion susceptibility by slope rating	1 - 5	Site characterisation
WindSev	Severity of any recent wind erosion (drift banks, soil scouring) evident at site	1 - 5	Dynamic
SheetRillSev	Severity of any recent sheet or rill water erosion evident at site	1 - 5	Dynamic
DisturbRating	Disturbance of surface soil (e.g. by cultivation, grazing) intensity rating	1 - 3	Dynamic. Previously called <i>detachment</i> rating.
CoverRating	Relative cover of vegetative matter (incl stones) by class rating. Incorporates height, approx % cover, horizontal distribution and volume (bulk).	1 - 8	Dynamic. Ratings descriptions updated in May 2009.
Burn	Evidence of residue burning by completeness of burn e.g. nil, minor (<25% area), partial (25-50%), complete (>50%)	n, mb, pb, cb	Dynamic
Comments	Optional observations including contour banks, tillage type, irrigation, lucerne, clay spreading		Dynamic

Groundcover is assessed with the “cover rating”. This is an eight category, photostandard based scale that incorporates a number of observable parameters that control erosion hazard, including groundcover height, relative cover volume, approximate percentage cover, lateral cover distribution (evenness/patchiness) and cover anchorage to the soil. The scale incorporates estimated thresholds for protection and exposure of sites to erosion. The scale, however, is not directly equivalent to classes of percentage ground cover.

2.2.7 SITE ASSESSMENT SCHEDULE

The field survey sites are intended to be monitored under the current schedule (i.e. four times each year) until at least 2014 due to reporting commitments for the soil protection target in the 2007 SA Strategic Plan.

2.2.8 COMPARISON WITH SLATS

Table 2 contains a summary comparison of the field survey observations with the SLATS assessment fields.

It can be seen that the field survey roadside observations generally do not meet the SLATS criteria. There is no measurement of percentage ground cover nor biomass, which would presumably be required parameters for validating/calibrating remote sensing imagery groundcover fractions. The roadside observational type assessments have inherent subjectivity, even with clear category definitions and photostandards, so are not suitable for the needs of a small number of ground validation sites, where accurate quantitative assessments are needed. Further, the existing field survey program does not collect systematic temporal land management practice/action information at sites, which would be presumably required at the ground validation sites.

2.2.9 POTENTIAL USE WITHIN PROPOSED NATIONAL LAND COVER PROGRAM

The attributes collected at the field survey sites are quite different to the SLATS method, therefore not suitable for ground validation of remote sensing under the national ACLUMP project.

A number of the existing DWLBC field survey sites could notionally be utilised as ground validation/calibration sites given their location across a broad representation of the areas used for agricultural cropping in SA. However, to establish sites for validation of remote sensing where modified SLATS methods are used, prior permission would have to be sought from landholders for entry of field personnel on to their property to conduct assessments. At present, landholders are unaware of the location of the DWLBC field survey monitoring transects and sites, and this ensures that there is no influence or bias on how they manage their paddocks. The sites are therefore taken to be a representative sample of typical management practices across the sampling units. Experience with other soil monitoring programs where landholders are aware their paddocks are being monitored has shown that this can influence their management decisions (e.g. farmers tend to more regularly lime paddocks monitored for soil acidity). Incorporation of SLATS monitoring at any of these sites would potentially influence landholders' management decisions on monitored paddocks and bias the site data. Therefore it is not desirable that existing DWLBC field survey sites, or land (properties) along existing transects be used for remote sensing ground validation sites for the ACLUMP project.

Table 2. Summary comparison of DWLBC field survey observations with SLATS site assessment methods

SLATS method		DWLBC field survey for erosion hazard
Assessment	Method used	Comparison with SLATS
Landform	Visual	All sites characterised broadly as flat/slope/dune and for inherent susceptibility to erosion (wind/water topography rating).
Slope %	Clinometer	All sites characterised for inherent susceptibility to water erosion (water topography rating).
Aspect	Visual	-
Soil colour – wet/dry for different soil conditions	Munsell chart	-
Rock colour	Munsell chart	-
Biomass (kg/ha)	Visual	- (Relative biomass assessed with “Cover Rating” but not measured).
Grass height (cm)	Tape measure	Height distribution classes of crop/pasture cover assessed with Cover Rating – visual estimate.
Fire	Visual	Wildfires rare in agricultural areas, no specific facility to record in surveys. Burning of crop/pasture residues assessed in “Burning” rating.
Faunal activity and type – animals, termites etc.	Visual	Impact of grazing animals on soil condition assessed along with mechanical actions as part of “disturbance rating” and “cover rating”.
Crust brokenness – relative categories	Visual	- (soil looseness broadly assessed in “disturbance” rating)
Erosion features – rills etc.	Visual	Wind erosion and sheet/rill water erosion assessed in “erosion severity” ratings
Deposited material – relative amount	Visual	-
Soil microtopography – e.g. smooth, depressions	Visual	-
Surface nature – e.g. hard, loose	Visual	Relative soil looseness assessed in “disturbance” rating
Dominant species by biomass % – ground/ mid/ over-storey	Visual assessment?	- (not much applicability in agricultural areas; crop type noted in “current phase”)
Over-storey height	Visual estimate, clinometer at 20m	- (not much applicability in agricultural areas)
Tree basal area	7 points on transects - calibrated optical wedge	- (not much applicability in agricultural areas)
Total dry standing matter	Vegetation quadrat cuts	- (Relative biomass assessed with “Cover Rating” but not measured).
Ground cover % measurement – bare soil, rock, green attached leaf, dead attached leaf, litter, cryptogam	300 points on 3 x 100m transects	- (Groundcover % not measured, but is broadly estimated as part of “Cover Rating”)
Mid-storey cover measurement – green leaf, dead leaf, branch	300 points on 3 x 100m transects	- (not much applicability in agricultural areas)
Over-storey cover measurement – green leaf, dead leaf, branch	300 points on 3 x 100m transects	- (not much applicability in agricultural areas)

Existing or future field monitoring sites in agricultural areas of SA that are used with other soil monitoring programs (eg. proposed national soil organic carbon and acidity project sites) could be evaluated for their suitability to also be used as SLATS monitoring sites, once clear site selection criteria/priorities are determined.

2.3 DWLBC RANGELANDS PASTORAL LEASE MONITORING PROGRAM

2.3.1 OVERVIEW

The current rangelands pastoral lease monitoring program in SA was established during 1990–2000 by the then Pastoral Management Branch of the Department for Environment and Heritage. Fixed photopoint monitoring sites were progressively established on each of the 219 pastoral properties (328 leases) in SA during this period, and baseline on-ground assessments were conducted that included assessment of vegetation and soil condition and photographs.

The requirements in the Pastoral Land Management and Conservation Act 1989 was the primary driver for the initiation of this land condition monitoring program. This Act required all pastoral lands in SA to be assessed (between 1990 and 2000), for a baseline monitoring system to be installed, and for areas of concern to be identified. It also provided for continuing tenure to be conditional upon the land being maintained or improved. The Act required all monitored sites to be reassessed every 14 years to monitor long term trends in land condition. A reassessment program has recently commenced.

The monitoring data is used by DWLBC to report at the lease scale (under the Act) to the Pastoral Board, and lease scale reports remain confidential to the Pastoral Board and the lessee. This data is also used at a national level to provide information on landscape changes over time for the Australian Collaborative Rangeland Information System (ACRIS). ACRIS is a partnership between the Western Australia, South Australia, Northern Territory, Queensland, New South Wales and Australian Governments. The ongoing collaboration is a result of the first phase of the National Land and Water Resources Audit (the Audit).

The structure of site monitoring in this program comprises:

- Photopoint (quantitative) monitoring sites on all pastoral leases, which includes quantitative measurement of ground cover
- Land Condition Index (LCI) monitoring sites, mainly on sheep-grazed leases south of the dog fence – qualitative assessment of vegetation condition relative to land in the district, no measurement of ground cover
- Grazing gradient (Bastin et al., 1998) was trialled on a number of northern cattle leases using Landsat Thematic Mapper™ imagery to estimate relative ground cover and vegetation condition
- Targeted paddock assessments where particular land management actions may be deemed appropriate to improve land condition or rehabilitate degradation.

The photopoint monitoring sites have relevance to the proposed ACLUMP national ground cover monitoring project, and the following details refer to these monitoring sites.

2.3.2 PROGRAM INTENT

Long term monitoring of land/vegetation condition on rangelands pastoral leases in SA using on-ground assessments at fixed photopoint sites to meet the requirements of the Pastoral Land Management and Conservation Act 1989.

2.3.3 DATA STORAGE

The Arid Lands Information System (ALIS) is an innovative system that combines spatial and textual data into a seamless web-based interface. It replaces the Pastoral Management Information System (PMIS) developed for the initial assessment and inspection program in the early 1990's. This system was the repository for all station, paddock and site data collected during the lease assessments and inspection program by the Pastoral Program. In the last two years this information has been gradually migrated from PMIS to ALIS, enabling staff to access the information from a web-based interface. ALIS can capture, consolidate and report on rangelands assets including biological, physical, cadastral, tenure and other related information, with users able to create, edit and save data in real time over the web. Further enhancements and development will continue over the next two years to meet the requirements of the pastoral lease assessment and inspection program. Information is available at the following link:

<http://e-nrims.dwlbc.sa.gov.au/alis/>

2.3.4 EXTENT

The pastoral lease monitoring program photopoint sites extend over all of the 328 rangelands pastoral leases in SA, covering an area of approximately 40 million hectares (Figure 2).

2.3.5 NUMBER OF SITES

Approximately 5500 photopoint monitoring sites were established in the baseline monitoring program in 1990–2000, and their location is shown in Figure 2.

Most permanently stocked paddocks on pastoral leasehold lands have at least one photopoint monitoring site. Sites were also installed on conservation reserves and national parks.

Sites were located approximately 1.5 km from permanent water points on sheep properties (i.e. south of the dog fence) and 3km on cattle properties. Sites were chosen to represent typical vegetation types on the property that would give good indication of grazing impact, and represent a sound stratified sample of rangelands on the lease. Sites were generally installed near established tracks.

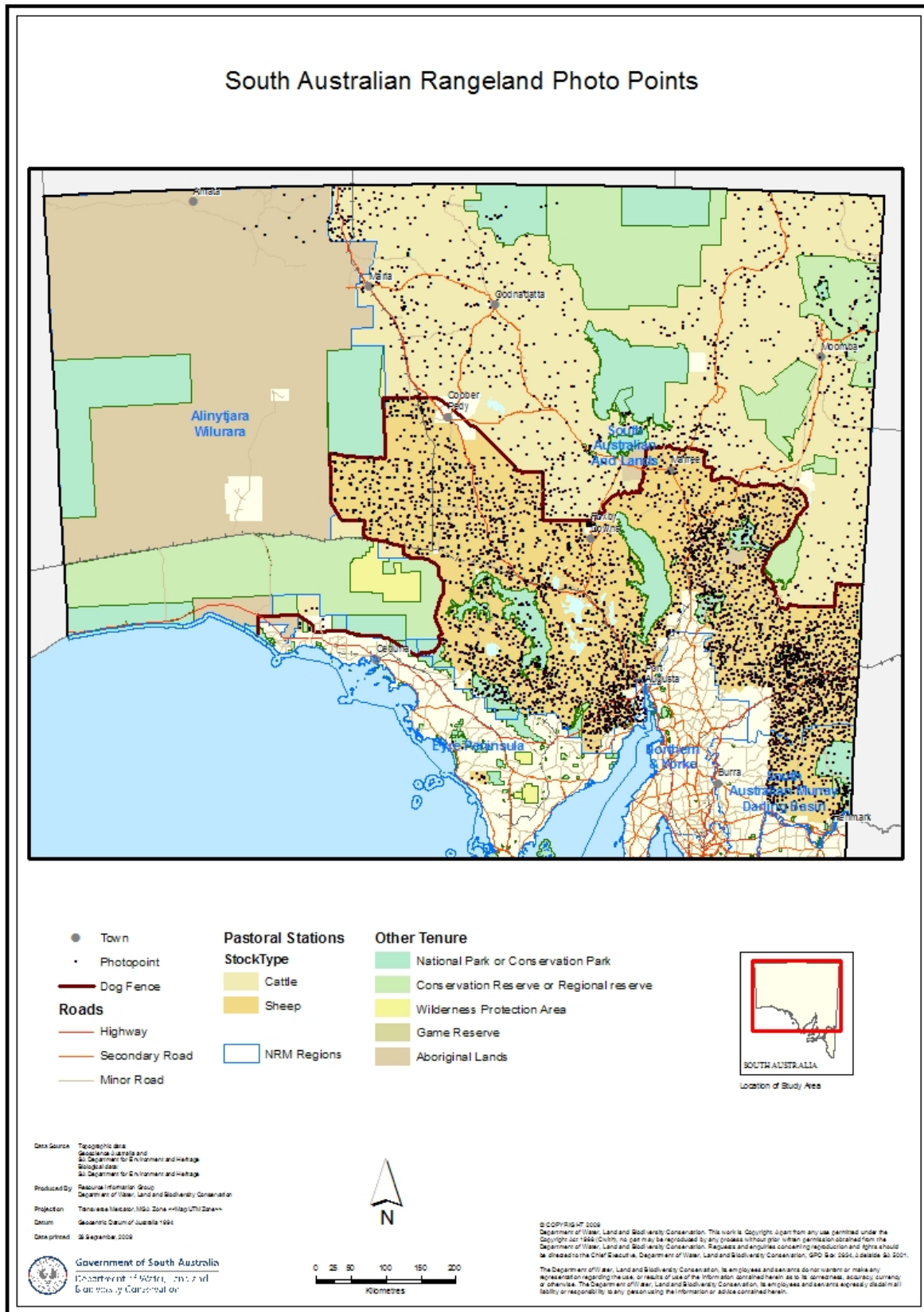


Figure 2. Pastoral lease photopoint monitoring sites in South Australia.

2.3.6 CURRENT MONITORING

The rangelands pastoral lease monitoring program is currently conducted by the Pastoral Program, Land Management unit within DWLBC.

A summary of the attributes assessed at photopoint monitoring sites in the 1990–2000 monitoring program is shown in Table 3.

Table 3. Summary of attributes and data recorded at pastoral lease photopoint monitoring sites

Attributes and data recorded	Method
Site location/identification details	Site located by marker peg and GPS coordinates
Photo taken at fixed photopoint	
Site condition rating – overall ranking	5 categories very poor – excellent
Land system and landform details	Visual/map units
Erosion severity and type ranking	6 categories nil – extreme
Vegetation – species present, dominant species, growth/grazing features, rainfall	Visual
Crown separation ratio	7 classes
Perennial plant species density and age structures	Jessup transect - 20 sample units in 400m ² transect
Percentage cover – live plant species, litter, lichen, stone, gravel, bare; includes overstorey where present	Step points along Jessup transect line, at least 500 “hit” points
Fire scars	Visual
Vertebrates – evidence of recent presence	Visual
Soil description – detailed assessment	Soil survey standards

2.3.7 SITE ASSESSMENT SCHEDULE

One of the provisions of the Pastoral Land Management and Conservation Act 1989 is to assess the condition of the land comprised in each pastoral lease at intervals of not more than 14 years and, given a satisfactory assessment, restore the lease to a 42-year term with variations to the lease conditions as appropriate. The first round of assessments began in 1990 with the completion of the first group of leases in early 1991 and the completion of the whole program in 2000. The second assessment program began in 2005 with the aim of completing all assessments by 2014, thereby meeting the statutory 14-year requirement. The program is currently underway in the North East Pastoral district and reporting has been completed for two districts, Kingoonya and Gawler Ranges.

As part of the ongoing Pastoral Inspection Program, many sites are revisited during the lease inspection, where data is collected and updated in ALIS.

2.3.8 COMPARISON WITH SLATS

The methods used in SA’s pastoral lease photopoint monitoring sites (DWLBC 2002) are similar to the SLATS methods, summarised in Table 4. Virtually all the attributes with SLATS are recorded at the photopoint sites, although slightly different assessment methods are used in many cases. The SA photopoint sites do not measure total dry standing matter, nor grass height.

Table 4. Summary comparison of SA pastoral lease monitoring photopoint site assessment with SLATS site assessment methods

SLATS method		SA pastoral lease photopoint monitoring site assessment
Assessment	Method used	Comparison with SLATS
Landform	Visual	Yes
Slope %	Clinometer	Yes – clinometer
Aspect	Visual	-
Soil colour – wet/dry for different soil conditions	Munsell chart	Soil colour (Munsell) recorded for all horizons, wet/dry for surface and A ₂ horizon in soil description
Rock colour	Munsell chart	-
Biomass (kg/ha)	Visual	-
Grass height (cm)	Tape measure	-
Fire	Visual	Yes
Faunal activity and type – animals, termites etc	Visual	Yes (vertebrates)
Crust brokenness – relative categories	Visual	- (pans assessed with soil description)
Erosion features – rills etc	Visual	Erosion severity assessed using 6 class scale
Deposited material – relative amount	Visual	- (soil deposition incorporated into erosion severity classes)
Soil microtopography – eg. smooth, depressions	Visual	- (similar to soil surface condition assessed with soil description)
Surface nature – eg. hard, loose	Visual	-
Dominant species by biomass % – ground/ mid/ over-storey	Visual assessment?	Similar – species density measured by Jessup transect, including mid/over storey
Over-storey height	Visual estimate, clinometer at 20m	-
Tree basal area	7 points on transects - calibrated optical wedge	Similar – crown separation ratio assessed
Total dry standing matter kg/ha	Vegetation quadrat cuts	-
Ground cover % measurement – bare soil, rock, green attached leaf, dead attached leaf, litter, cryptogam	300 points on 3 x 100m transects	Yes – step point transect >= 500 hits
Mid-storey cover measurement – green leaf, dead leaf, branch	300 points on 3 x 100m transects	Yes – step point transect
Over-storey cover measurement – green leaf, dead leaf, branch	300 points on 3 x 100m transects	Yes – step point transect

2.3.9 POTENTIAL USE WITHIN PROPOSED NATIONAL LAND COVER PROGRAM

The pastoral lease photopoint monitoring methods have similarity to SLATS, but would not provide data that is consistent with SLATS sites, and as such, would not be suitable.

The existing photopoint monitoring sites could be utilised for SLATS monitoring, but this would need to be separate and additional to the ongoing pastoral lease monitoring program to which DWLBC is committed. The schedule for re-assessment of photopoint monitoring sites is on a 14 year cycle so would provide little opportunity for collection of SLATS data at any individual sites on an ongoing basis.

3. CONCLUSIONS AND RECOMMENDATIONS

The DWLBC field survey program for erosion hazard in the agricultural cropping regions collects regular roadside observations of groundcover at an extensive range of field sites, but this does not provide fractional groundcover percentage measurements (as a minimum of data) that are required for the ACLUMP project ground reference sites. It is undesirable for the field survey sites to be utilised for SLATS ground reference sites, because landholders are currently unaware of the monitoring transects, and on-farm monitoring activity could influence their management decisions, potentially jeopardising the representativeness of monitoring data in the DWLBC program. SLATS ground reference site monitoring in agricultural areas would need to be a separate program to the existing DWLBC field survey program.

In the agricultural areas of SA, other existing or proposed field monitoring sites (eg. proposed national soil organic carbon and soil acidity monitoring project) could be considered for their suitability as ground reference sites. Apart from this, new monitoring sites could be established to meet the requirements of the ACLUMP project.

The DWLBC Pastoral Lease Rangelands photopoint monitoring program also has an extensive network of groundcover monitoring sites, and uses a site assessment methodology that is similar to SLATS. The site re-assessment schedule however is over a 14 year cycle, which would provide little opportunity for collection of site data required for the proposed ACLUMP project. In other respects the photopoint sites could be suitable to be utilised for this purpose, but a separate, additional monitoring program would be required for SLATS ground reference site data.

Another option may be to assess the suitability of ground based testing sites proposed to be established under the national TERN (Terrestrial Ecosystems Research Network)/AusCover (Distributed National Landcover Remote Sensing Data Facility) program.

APPENDICES

A. DWLBC FIELD SURVEY ASSESSMENTS

Current rotational/management phase

Category	code	definition
Fallow (cultivated)	f	Evidence of cultivation or mechanical disturbance of soil (includes un-emerged sown crop)
Chemical Fallow (sprayed)	cf	Evidence of herbicide used
Pasture	p	Any pasture type including stubble after March survey
Stubble	s	First year crop stubble - March survey only
Crop	c	Any emerged crop if unable to differentiate (eg. May/June surveys)
Cereal	c	In October survey or when crops can be differentiated
Grain Legume	gl	In October survey or when crops can be differentiated
Canola (and other oilseeds)	ca	In October survey or when crops can be differentiated

Topographic Rating - Wind (soil x land type)

Relative site characterisation for inherent susceptibility to wind erosion. In March 2006 newly georeferenced sites were characterised by roadside observation by staff with expertise in soil science and land capability/agriculture, together with independent on-site assessment of a random selection of sites. Categories are relevant for wind erosion prone land .eg.

- dune swale country in Eyre Peninsula/Murraylands/Upper South east
- other known areas, e.g. Calcareous loams at Booleroo (Northern and Yorke Agricultural region).

Land type	Wind Erosion Topography Rating
Loam/clay flat/slope/rise	1 (Essentially no risk)
Sandy or calcareous loam flat/slope/rise	2 (Low/moderate risk)
Sandy flat/slope	3 (Moderate high risk)
Low sandhills (<5m)	4 (High risk)
Mod/Large sandhills (>5m)	5 (Very high risk)

Topographic Rating - Water (Slope)

Relative site characterisation for inherent susceptibility to water (sheet/rill) erosion. Sites were characterised as per wind erosion topography rating.

Water erosion topography rating	Slope
1	0-3%
2	3-6%
3	6-12%
4	12-24%
5	> 24%


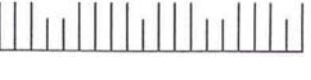
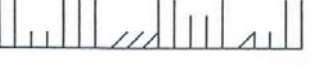

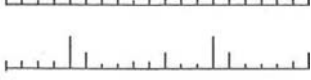
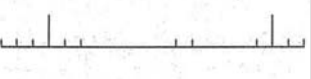


Disturbance Rating (Cultivation/Grazing) - formerly called “detachment”

Category	Code	Description
No significant disturbance	1	No significant disturbance apparent*
Partial disturbance	2	Disturbance of some of the soil surface by: <ul style="list-style-type: none"> No-Till/Zero Till sowing (narrow point/disc) First working with blade plough, prickle chain or harrow Grazing livestock Land cultivated at least once: <ul style="list-style-type: none"> Which has consolidated due to rain and/or new growth (not sandy soils) Which is very cloddy and has some residue present Which has moderate to high residue levels on surface, some likely to be anchored Land with new crop sown with full cut, up until late tillering, that has partially consolidated due to rain and/or plant growth Crops beyond tillering stage where cover too poor for complete stability or consolidation is only partial or patchy (eg. drought or erosion affected soils)
Complete disturbance	3	Complete soil disturbance by cultivation, heavy grazing or both

* the presence of livestock or evidence of grazing at the site does not necessarily signify “partial disturbance” unless obvious soil disturbance is observed.

Cover Rating

Surface cover rating - combined dry and green material (and stones) protecting the soil surface. Descriptions updated May 2009. Residue height is primary determinant on wind erosion susceptible sites; surface cover percentage is the primary determinant on water erosion susceptible sites.




Rating	Height (wind erosion)	Cover % (water erosion)	
1	Residues 40cm or higher.	75 to 100%	
	Bulk: Very high level of plant matter Anchorage: Majority of cover is anchored and stable, not easily washed or blown away.		
2	Residues between 10cm and 40cm.	Even coverage of approx. 75 to 100%	
	Bulk: high amount of plant matter, most of which is standing Anchorage: Majority of cover is anchored.		
3	Residue height variable from less than 10cm to 40cm.	More variable cover of approx. 75 to 100%	
	Bulk: moderate to high but more variable across the paddock Anchorage: Cover often slightly flattened and damaged		
4	Residues 2cm-10cm, but of moderate bulk. Residues a mixture of upright and flattened.	50 to 75% cover, residue colour dominates	
	Bulk: Moderate Anchorage: Majority of residues are anchored, although often flattened or damaged.		
5	2cms of relatively even but thin residue cover remain. or, cover variable from sparse 40cm to less than 2cm cover	50 to 75% cover, Residue colour still dominates	
	Bulk: Low, damaged through moderately heavy grazing or traffic by animals and/or machinery. Anchorage: majority of residues are anchored, most residues are damaged.		
6	Height is variable and less than 10cm high to bare	Soil colour dominates, 25 to 50% cover	
	Bulk: Low amounts of plant material. Anchorage: some residues are anchored; most are damaged through grazing or cultivation.		
7	Mostly bare although some residues can be seen. Grazed or cultivated virtually bare.	Soil colour dominates, 1 to 25% Scattered residues (and/or rocks) remain.	
	Bulk: Low amounts of plant material. Anchorage: Any residues probably unanchored.		
8	Nil cover (bare)	0% cover	
	Bulk: Nil Anchorage: Nil		

Sample of cover rating photostandards

Cover/Fallow Photo-Standards





Wind Severity (Wind Erosion Severity)





Rating	Severity	Description	
1	Nil, or Insignificant	Nil	
2	Minor	Only minor evidence of erosion. Small areas in crop or rangeland. No crop damage or extremely rare. Slight but observable levelling of ridges or soil surface and some associated dusting may occur.	
3	Moderate	Evidence of significant sweeping on sandy soils particularly rises. Dusting occurs associated with levelling of ridges/smoothing of soil surface, minor fenceline deposition. Obvious soil surface movement and dusting in rangelands. Occasional small areas of crop damage.	
4	High	Evidence of severe erosion of sandhills and significant sweeping on flats in cropland or rangeland. Levelling of ridges/smoothing and gouging of soil surface in places in crop or rangeland, and associated frequent/severe dusting. Erosion is usually extended over months of bare soil. Significant fenceline deposition. Significant crop damage.	
5	Severe	Extreme stage of 4. Extended period of bare soil or strong wind has meant massive soil sweeping and deep gouging of surface in places.	

Sheet Rill Severity (Sheet/Rill Water Erosion)

[Rills < 30cm deep]

Rating	Severity	Description	
1	Nil, or, Insignificant	Nil. < 1 t/ha	
2	Minor	Very little erosion. Some sporadic evidence of soil movement but not obvious. (1 - < 5 t/ha soil loss). In rangelands-shallow soil deposits in sediment traps.	
3	Moderate	Significant erosion and obvious soil movement/washing. 5-6 cm deep rills 4-5m apart or equivalent. (5 - < 10 t/ha soil loss). In rangelands-partial exposure of roots and evidence of soil deposits in sediment traps.	
4	High	Severe erosion. Significant soil movement/washing and obvious deposition in flats, swales, fencelines or creeks/gullies. 5-6cm deep rills 2m apart or equivalent. (10 - <25 t/ha soil loss). In rangelands-exposure of roots and subsoil, pedestalling. Substantial soil deposits in sediment traps	
5	Severe	More extreme than 4. Severe erosion. 5-6cm deep rills <2m apart or equivalent. (> 25 t/ha soil loss).	

Residue Burning

<p>Nil</p>	<p>n</p>	
<p>Minor Burn (<25%)</p> <p>Typically the header or harrow rows</p>	<p>mb</p>	
<p>Partial Burn (25-50%)</p> <p>Usually more widespread patches</p>	<p>pb</p>	
<p>Complete Burn (> 50%)</p> <p>Complete burn over the majority of paddock</p>	<p>cb</p>	

UNITS OF MEASUREMENT

Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol	Definition in terms of other metric units	Quantity
day	d	24 h	time interval
gigalitre	GL	10^6 m^3	volume
gram	g	10^{-3} kg	mass
hectare	ha	10^4 m^2	area
hour	h	60 min	time interval
kilogram	kg	base unit	mass
kilolitre	kL	1 m^3	volume
kilometre	km	10^3 m	length
litre	L	10^{-3} m^3	volume
megalitre	ML	10^3 m^3	volume
metre	m	base unit	length
microgram	μg	10^{-6} g	mass
microlitre	μL	10^{-9} m^3	volume
milligram	mg	10^{-3} g	mass
millilitre	mL	10^{-6} m^3	volume
millimetre	mm	10^{-3} m	length
minute	min	60 s	time interval
second	s	base unit	time interval
tonne	t	1000 kg	mass
year	y	365 or 366 days	time interval

GLOSSARY

- ACLUMP.** Australian Collaborative Land Use Mapping Program
- ACRIS.** Australian Collaborative Rangeland Information System.
- Aggregation.** Clumping together of fundamental soil particles due to interparticle bonding.
- ALIS.** Arid Lands Information System.
- ALUM.** Australian Land Use and Management classification.
- Arid.** Climate or region which lack sufficient rainfall for crop production or extensive sown pastures, usually defined as annual average rainfall less than 250mm.
- AusCover.** Distributed National Landcover Remote Sensing Data Facility.
- AussieGrass.** A simulation model developed to predict and monitor historical grass production and ground cover in regions of Australia.
- Biomass (agr).** The quantity of living material present at a given time within a given area.
- Blowout.** A closed depression formed in the land surface as a result of wind erosion removing material and depositing it in an accumulation adjacent to the resulting trough.
- BRS.** Bureau of Rural Sciences. Government of Australia.
- Clod.** A large, compact and coherent soil aggregate produced artificially, usually by ploughing or digging soils that are either too wet or too dry for normal tillage operations.
- Cryptogams.** Plants that reproduce by spores, including algae, lichens, mosses and ferns, which can grow on the soil surface, providing stabilisation against erosion.
- CSIRO.** Commonwealth Scientific and Industrial Research Organisation
- DECC NSW.** Department of Environment and Climate Change, New South Wales.
- Direct Drill.** Method of sowing a crop in a one-pass operation (without prior cultivation).
- DWLBC.** Department of Water, Land and Biodiversity Conservation. Government of South Australia.
- EP.** Eyre Peninsula Region.
- Erosion.** Natural breakdown and movement of soil and rock by water, wind or ice. The process may be accelerated by human activities.
- Erosion hazard.** The susceptibility of a parcel of land to the prevailing agents of erosion. It is dependent on a combination of climate, landform, soil, land use and land management factors.
- Fallowing.** The management practice of leaving land in an uncropped state for a period of time prior to sowing another crop. Its purpose is to allow for the accumulation and retention of water and mineralized nutrients in the soil, and generally to also allow for weed control. Where this is done by mechanical means eg. tillage it is termed mechanical or tilled fallowing, and where it is done by application of herbicides it is termed chemical fallowing.
- Georeferenced.** Spatially located by GPS coordinates, for example.
- GIS (geographic information system).** Computer software allows for the linking of geographic data (for example land parcels) to textual data (soil type, land value, ownership). It allows for a range of features, from simple map production to complex data analysis.
- GPS.** Global positioning system.
- Ground cover.** Any material on the soil surface, including plants, their residues, rocks, manure etc.
- Gully.** An open incised erosion channel in the landscape generally greater than 30cm deep.
- Herbicide.** A chemical substance used for killing plants, usually weeds.

Inherent erosion susceptibility. The intrinsic susceptibility of a parcel of land to the prevailing advents of erosion. It is dependent on a combination of climate, landform and soil factors. (equivalent to *erosion risk* defined in Glossary of terms used in soil conservation, Houghton and Charman 1986, Soil Conservation Service of NSW)

KI. Kangaroo Island Region.

Land. Whether under water or not and includes an interest in land and any building or structure fixed to the land.

Land system. An area or group of areas commonly delineated on a map, through which there is a recurring pattern of topography, soils and vegetation.

Land zone. Level of land classification above land system.

LCI. Land condition index

LCMP. Land Condition Monitoring Program.

Mediterranean climate. Climate regime characterized by hot dry summers and cool wet cool winters.

ML. Murraylands Region, a sub-regional area in the SA Murray Darling Basin NRM Region.

MLR. Mount Lofty Ranges.

Model. A conceptual or mathematical means of understanding elements of the real world which allows for predictions of outcomes given certain conditions. Examples include estimating storm runoff, assessing the impacts of dams or predicting ecological response to environmental change.

MODIS. Moderate Resolution Imaging Spectroradiometer, a satellite remote sensor on board both TERRA and AQUA, two NASA EOS platforms.

NCST. National Committee for Soil and Terrain

NLWRA. National Land and Water Resources Audit.

Natural Resources. Soil; water resources; geological features and landscapes; native vegetation, native animals and other native organisms; ecosystems.

Natural Resources Management (NRM). All activities that involve the use or development of natural resources and/or that impact on the state and condition of natural resources, whether positively or negatively.

NCLUM. National Committee for Land Use and Management.

No-Till. Method of sowing crop in a one-pass operation using narrow seeder points or disc openers.

NRM Plan. State Natural Resources Management Plan.

N&Y. Northern and Yorke Region.

Pasture. Grassland used for the production of grazing animals such as sheep and cattle.

PC. Personal computer.

PDA. Personal Data Assistant.

Photopoint. Fixed location where photographs can be taken repeatedly over time to show changes in vegetation or land condition, for example.

PMIS. Pastoral Management Information System.

QA. Quality assurance

Rangelands. Land used for extensive grazing of sheep, cattle or other domestic stock, which is typically native or naturalized pasture.

Remote sensing. The collecting of information about an object or phenomenon by the use of sensing devices not in physical or intimate contact with the subject under investigation, such as aerial photography, satellite imagery, electro-magnetic survey, radar imagery.

Rill. A small channel, cut by concentrated runoff, through which water flows during and immediately after rain. Defined as up to 30cm deep, and can be easily obliterated by tillage operations.

SA. South Australia.

SE. South East Region.

Semi arid. Climate or region which lack sufficient rainfall for crop production or extensive sown pastures, usually defined as annual average rainfall of greater than 250mm but less than 375mm in southern areas of Australia.

SLATS. Statewide Land Cover and Trees Study.

Soil erodibility. The susceptibility of soil to the detachment and transportation of soil particles by erosive agents, due to the intrinsic characteristics of the soil, independent of factors such as climate, topography land use and plant cover that can affect erosion.

Stubble. The straw residue that remains after a grain crop has been harvested.

TERN. Terrestrial Ecosystems Research Network

Tillage. The use of various types of implements for the mechanical preparation of the soil to facilitate the growth of a crop or pasture, ie to prepare the seedbed, manage weeds or vegetative residues etc.

Transect. A projection across the land's surface along which samples or measurements are recorded.

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