State of the catchments 2010

Soil condition

Murray region

State Plan target

By 2015 there is an improvement in soil condition.

Background

Soil condition is the ability of soil to deliver a range of essential services, including habitat for soil biota, nutrient cycling, water retention and primary production. Soil condition is commonly referred to as 'soil health' by land managers; however the term 'soil condition' is used in this report to ensure consistency with other targets. For this report, current condition is compared to reference or natural condition using program baseline data, existing data and expert knowledge.

A detailed technical report describes the methods used to derive the information contained in this report. At the time of publication of the *State of the catchments (SOC) 2010* reports, the technical reports were being prepared for public release. When complete, they will be available on the DECCW website: www.environment.nsw.gov.au/publications/reporting.htm.

Note: All data on natural resource condition, pressures and management activity included in this SOC report, as well as the technical report, was collected up to January 2009.

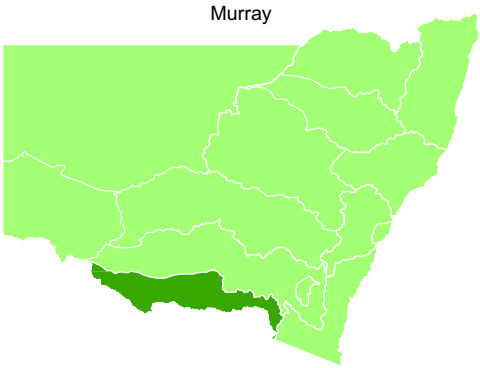
Soil condition monitoring program

The principal current objective of the program is to create a baseline against which future changes in soil condition can be measured.

Soil condition has been assessed for 124 priority soil monitoring units (SMUs) across the state. An SMU is a large tract of land with a predictable pattern of soils, where changes in soil condition and land management can be observed. Up to 10 SMUs were jointly selected within each region by DECCW and catchment management authority (CMA) staff, based upon their area, importance, pressures and vulnerability.

A network of permanent monitoring sites is being established within the SMUs across the state. Fieldwork commenced in June 2007 and, state-wide, 830 sites have been sampled as of this reporting date. This report focuses on current condition and uses soil monitoring data available from 700 of those sites and laboratory data available for 500 sites. Data collection and laboratory testing is continuing. The report is a brief summary of available results. A separate technical report contains more detailed information on methods and references.

Map of the catchment



The distribution of SMUs in the Murray region is shown in Figure 1. The SMUs collectively covered 16,945 km^2 or about 48 per cent of the catchment.

Assessment

Within each SMU, up to 10 representative soil monitoring sites were established. Thirty-five sites were established in the Murray region. Where possible, sites were paired to reflect differences in land-use on similar soils.

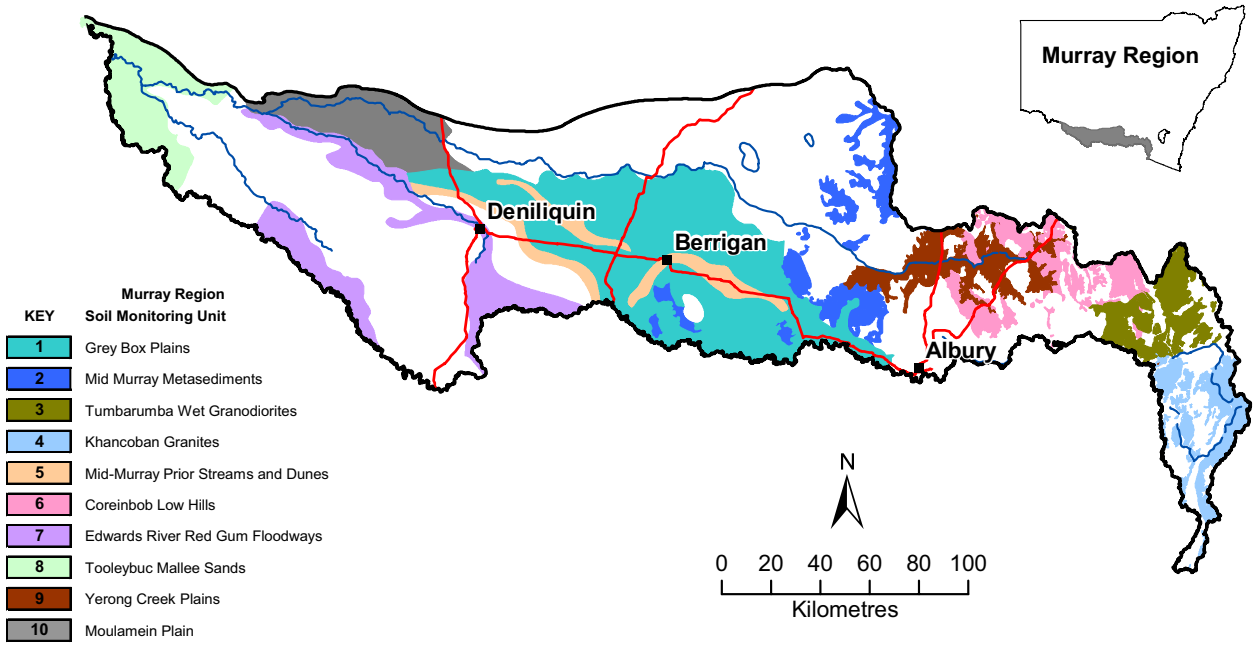


Figure 1 Location and extent of SMUs in the Murray region

Condition

Soil condition indicators are measured soil properties that respond to soil pressures. Indicators were assessed using a combination of field observations, field measurements and laboratory analyses. Details concerning the indicators and evaluation methods are found in the technical report.

Soil condition indicator classes are based on the degree of deterioration of soil function against a reference or 'natural' condition, determined from measurements in undisturbed sites, published literature and modelling.

The ***soil condition index*** is a measure of the condition of the soil compared to reference conditions. It is the average value of all relevant condition indicator classes within an SMU or region. Results of the assessment of the soil condition index for each SMU in the Murray region are given in Table 1 and in the map in Figure 2.

To show the ***range*** of values, a pie chart is provided in Table 1 to indicate the proportion of classes. Trend in condition is not available as only baseline data at one point in time has been collected as of the date of this report. As a surrogate, an ***expected trend*** in soil condition is provided, based on the degree to which land management is within capability (see the land management state of the catchments (SOC) report). ***Data confidence*** is based on how the age, compliance with baseline protocols, replication and representativeness of the data can be used to determine current condition.

Table 1 Soil condition of SMUs in the Murray region

Soil monitoring unit	Soil monitoring unit name Soil types and monitored land use	Average soil condition index[a]	Range of indices[b]	Expected trend in soil condition[c]	Lowest scoring soil condition indicators and index[d]		Data sources[e] and confidence[f]
1	**Grey Box Plains** Grey Epipedic Vertosols and Subplastic Red Chromosols. Cropping and unimproved pasture.	4.4		↔	Soil salinity	3.3	K, S and B Medium
2	**Mid Murray Metasediments** Red Dermosols. Unimproved pasture.	3.7		↔	Sheet erosion, Soil structure, Soil salinity	3.0	K, S and B Low
3	**Tumbarumba Wet Granodiorites** Yellow Chromosols and Brown Kurosols and shallow Rudosols. National Park and unimproved pasture.	3.5		↔	Acidity, Organic carbon	2.5	K, S and B High
4	**Khancoban Granites** Yellow and Brown Chromosols and Kurosols. National Park and unimproved pasture.	3.6		↔	Acidity	2.5	K, S and B High
5	**Mid Murray Prior Streams and Dunes** Arenic Rudosols and Crusted Vertosols. Unimproved pasture and cropping.	4.0		↓	Organic carbon	3.3	K, S and B Medium
6	**Coreinbob Low Hills** Red Kandosols and Red Chromosols and Kurosols. Unimproved pasture.	2.9		↔	Sheet erosion, Soil structure, Soil salinity	2.0	K, S and B Medium
7	**Edwards River Red Gum Floodways** Self-mulching Brown and Crusty Grey Vertosols. Forest and unimproved pasture.	3.9		↓	Organic carbon	2.5	K and S Low
8	**Tooleybuck Mallee Soils** Calcic Calcarosols and Grey Chromosols. Rangelands.	3.6		↓	Soil structure	2.0	K and S Low
9	**Yerong Creek Plains** Brown and Red Dermosols. Unimproved pasture. Cropping and pasture.	3.2		↓	Soil structure	1.0	K and S Low
10	**Moulamein Plain** Self-mulching Grey Vertosols and Black Chromosols. Rangelands.	3.3		↓	Wind erosion	1.6	K and S Low

Legend for Table 1

a Soil condition index:

4.6 – 5.0	Very good	No loss of soil function. Either no deterioration or an improvement on reference condition
3.6 – 4.5	Good	Slight loss of soil function. Noticeable but not significant deterioration against reference condition
2.6 – 3.5	Fair	Noticeable loss of soil function. Noticeable deterioration against reference condition
1.6 – 2.5	Poor	Significant loss of soil function. Considerable deterioration against reference condition
<1.5	Very poor	Profound loss of soil function. Severe deterioration against reference condition
	No data	Not included for change monitoring. Information available in support documents

b Range of indices: pie chart shows variation in soil condition indices for the different indicators in each SMU

c Expected trend in soil condition, based on degree to which land is managed within its capability:

↑	Soil condition is improving
↔	Soil condition shows no change
↓	Soil condition is declining

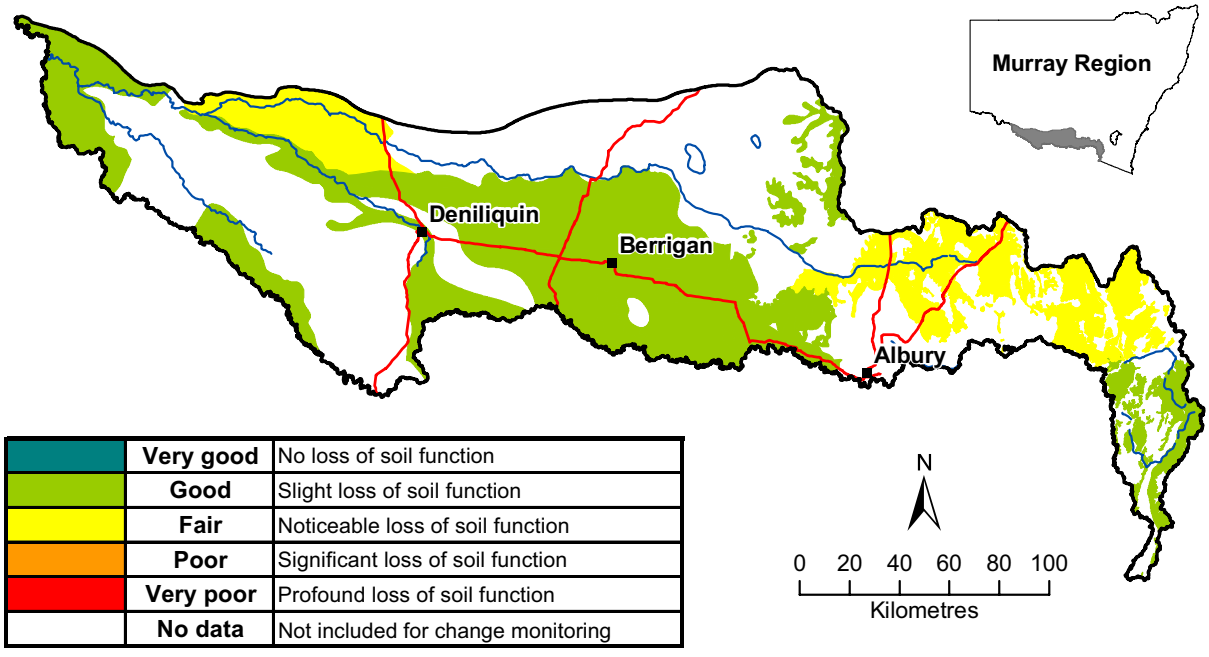
d Lowest scoring soil condition indicators and index: gives the indicator(s) of most concern in the SMU, with the associated index

e Data source:

B	Baseline data for soil condition – from field and laboratory measurements
S	New South Wales Soil and Land Information System (SALIS)
K	Expert knowledge, publications, maps and reports
M	Modelled data

f Data confidence:

High	Derived from representative sites in the baseline study, compared with data from SALIS and evaluated using expert knowledge
Medium	Derived from incomplete baseline and/or SALIS and has been evaluated using expert knowledge
Low	Derived from modelling or expert knowledge



	Very good	No loss of soil function
	Good	Slight loss of soil function
	Fair	Noticeable loss of soil function
	Poor	Significant loss of soil function
	Very poor	Profound loss of soil function
	No data	Not included for change monitoring

Figure 2 Soil condition index for SMUs within the Murray region

Table 2 shows soil condition, by indicator for all SMUs in the Murray region. A pie chart is provided to show the proportion and ***range*** of classes. As for Table 1, ***expected trend*** is based on the degree to which land management is within capability (see land management SOC report). ***Data confidence*** is based on how the age, compliance with baseline protocols, replication and representativeness of the data can be used to determine each indicator.

Table 2 Soil condition indicators in the Murray region

Soil condition by indicator	Soil condition indicator index[a]	Range of indices[b]	Expected trend in soil condition[c]	SMUs with poor or very poor condition[d]	Data sources and confidence[e]
Erosion - sheet Water erosion, predominantly rain splash and non-concentrated flows. Erodes topsoil and reduces terrestrial and aquatic ecosystem function and productivity.	3.9		↔	6	K, M and B Medium
Erosion - gully Water erosion of topsoil and subsoil by concentrated overland flows. Reduces land management options and reduces terrestrial and aquatic ecosystem function and productivity.	4.4		↔	-	K and B High
Erosion - wind Wind erosion of topsoil and subsoil by the actions of wind. Reduces land management options and reduces terrestrial and aquatic ecosystem function and productivity.	4.1		↔	10	K, M and B Medium
Acidity Soil pH is a major indicator of soil chemical health. Declines without adaptive management practices such as addition of sufficient lime. Associated with erosion, structure and carbon decline.	3.4		↔	3, 4, 6, 9, 10	K, S and B Low
Organic carbon Prime biological determinant of soil health. Sensitive to land management practices including those that sequester carbon by plants from the atmosphere.	3.1		↔	3, 6, 7, 8, 9	K, S and B Low
Soil structure Architectural arrangement of soil particles and voids. Governs soil water and gas exchange. Prime determinant of soil physical health.	2.7		↔	6, 8, 9, 10	K, S and B Medium
Soil salinity Build up of salt in the soil or on the ground surface. Potential to cause profound terrestrial and aquatic ecosystem damage including massive erosion.	3.8		↔	6	K and B Low
Soil condition index for Murray region	3.6				
State soil condition index	3.7				

Legend for Table 2

a Soil condition indexes are scored using the same methods as Table 1

b Range of indices: pie chart shows variation in indices for the different SMUs for each indicator

c Expected trend in soil condition, based on degree to which land is managed within its capability:

- ↑ Soil condition is improving
- ↔ Soil condition shows no change
- ↓ Soil condition is declining

d SMUs with poor or very poor condition: gives the SMU numbers (see Figure 1) for which the indicator in question is rated poor or very poor (<=2.5)

e Data source and confidence: see legend for Table 1

Pressures

Land management practices are the primary pressure on soil condition and are dealt with in the SOC report on land management within capability.

Management activity

The management activity for the soil condition theme and the land management within capability theme is very similar, as both centre around promoting the adoption of sustainable land management practices by landholders.

Increasing the area of land being managed within its capability is one of NSW's natural resource management (NRM) targets as outlined in the NSW State Plan.

Addressing the target within the Murray region involves initiatives and programs at the state and regional levels that will ultimately bring about the adoption of best land capability-sensitive management practices by landholders.

State level

The NSW Government guides NRM through various legislation, policies, strategies and programs.

Legislation

The *Catchment Management Authorities Act 2003* established the 13 CMAs and continues to outline their broad responsibility for NRM in their regions. The *Soil Conservation Act 1938* provides for the conservation of soil resources; however, its role in effective soil management has diminished over time. Various other Acts provide direct and indirect mechanisms for soil protection and management, including the *Protection of the Environment Operations Act 1997, Environmental Planning and Assessment Act 1979, Native Vegetation Act 2003* and the *Crown Lands Act 1989*.

Policies and strategies

The State Soils Policy (1987) outlines important principles for the protection and management of NSW soils. It was recently reviewed and is undergoing public consultation. Other significant state policies and strategies include:

- Total Catchment Management Policy (1987) – aims to ensure the coordinated use and management of land, water, vegetation and other natural resources on a catchment basis
- Sustainable Agriculture Policy (1998) – aims to facilitate a change in agricultural production in NSW towards ecologically and economically sustainable practices and farming systems
- NSW State Salinity Strategy (2000) – aims to slow down the increase in salinity and lay the foundations for future salinity management
- State Environmental Planning Policy (SEPP) Rural Lands (2008) – aims to facilitate the orderly and economic use and development of rural lands for rural and related purposes.

Programs

A number of relevant programs operate at the state level:

- *Monitoring, evaluation and reporting (MER) program* – DECCW is responsible for continuing its MER program and completing a baseline across all CMAs relating to soil condition and

land management. The Australian Department of Agriculture, Fisheries and Forestry (DAFF) is funding a pilot program for national monitoring of water and wind erosion, soil acidification and soil carbon. The SoilWatch soil condition performance monitoring kit is being developed to complement and supplement MER surveillance monitoring throughout the state.

- *Soil and land-use mapping* – much of eastern and central NSW is covered by soil landscape mapping at 1:100,000 or 1:250,000; this is primarily undertaken by DECCW. Reconnaissance scale soil or land system mapping covers other areas. A program of detailed land-use mapping across the state is nearing completion.
- *Assessment systems* – a number of soil and land assessment systems have recently been developed which will ultimately lead to more sustainable land management. These systems, which have primarily been developed by DECCW, include:
  - a system to assess the impact of various land management actions on soil condition
  - a land and soil capability (LSC) assessment system, with draft mapping completed across NSW
  - a soil and landscape constraint assessment system
  - the Tools2 (SLICK) modelling system, which allows for assessment of the impact on soils from different management options.
- *Information exchange and advice* – soil and landscape information and land management advice is provided through various publications, maps and databases (see www.environment.nsw.gov.au/soils/index.htm). The NSW Soil and Land Information System (SALIS) is run by DECCW and is intended as the single soil database for soil information in NSW. The Natural Resource Atlas (www.nratlas.nsw.gov.au) is used to access publicly available soil profile information. The NSW Land Management Database is being developed and distributed to CMAs throughout the state. Extension services that encourage sustainable land management practices by landholders are undertaken widely by Industry & Investment NSW (I&I) staff throughout the state.
- *Research* – research programs aimed at improving soil condition, productivity and sustainable land management practices are carried out by various national and state institutions, including Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities, I&I, DECCW, rural industry bodies (eg Grains Research Development Corporation).

Regional level

The Murray Catchment Action Plan (CAP) is the key document that coordinates and drives the effort to improve natural resources across the region. The CAP describes the whole-of-Government approach to soil condition and sustainable land management and sets the direction for investment in NRM over the next 10 years. The Murray CAP can be found at www.murray.cma.nsw.gov.au/catchment/catchment-action-plan.html.

The CAP includes specific targets, with specific areas (hectares), that will address the broader state targets. These targets are achieved through the following:

Data collection

This involves the development of a baseline of soil information and collection of land management data over individual properties. Data will be subsequently entered into the NSW Land Management Database.

Planning

Priority issues are identified, such as:

- refinement of priority salinity provinces for targeted salinity investment
- development of soil priority zones using MCAS-S (multi-criteria analysis shell)
- development of priority water erosion zones using SEDNET modelling and multi-criteria analysis
- development of a soil landscape map based on wind erosion data to determine priorities for wind erosion incentives.

Also identified are locations for improved land management and associated investment.

Collaboration

Partnerships are formed with farming organisations, industry groups, relevant government agencies (particularly DECCW, I&I, the Land and Property Management Authority), tertiary institutions, Landcare and similar community groups and individuals. Collaborative activities include:

- community stream sampling project – by June 2008, 36 priority streams had been monitored for EC, temperature, pH and turbidity
- roadside Wind Erosion Survey and Community Dust Watch project – by June 2008, two 'dust track' machines and 500 groundcover monitoring points had been established. An additional instrument was purchased and is located in the east of the catchment coverage to provide greater coverage
- irrigation accreditation courses, irrigation whole-farm plans, irrigation area stormwater and wastewater management systems and salinity discharge management (conducted with Murray Irrigation Limited in Land and Water Management Plans).

Awareness and skills raising

Training days and workshops, such as salinity conferences, are held. SoilWatch kits have been developed for landholders and various guidelines and information sheets have been produced on various topics.

The 2008–09 Conservation Farmer of the Year Awards (Slopes and Plains) was included as part of the regional awards, as well as the cross-regional annual awards.

Landholder participation is encouraged in soil improvement activities.

Contracts and programs with landholders

Contracts have been developed with landholders to modify and improve land management practices.

Incentive programs, aimed at improving land management practices, have also been implemented. Outcomes included:

- protection and treatment of severe gully erosion on 1390 hectares (ha), covering over 33 kilometres
- protection and treatment of streambank erosion on more than 4360 ha, covering over 89 kilometres
- establishment of stock containment areas to protect soil from erosion, on over 170,000 ha.

Continued monitoring and evaluation

Monitoring programs to assess progress towards the targets will continue under CMA and DECCW programs. These include:

- soil benchmarking project – by June 2008, 107 sites had been monitored and 22 different soil condition attributes tested, including MIR assessment of labile carbon, as part of a collaborative program with the University of Western Australia and Land and Water Australia
- soil testing, undertaken by 400 landholders, as part of a community-based project called Healthy Soils – Healthy Landscapes
- nationally funded DAFF Soil Carbon Research Program , a collaborative CSIRO and DAFF project (spanning two years) that aims to establish 200 sites in the Murray catchment.

Other initiatives include:

- revegetation with strategically targeted woody vegetation – by June 2008, over 240 ha
- establishment of perennial pastures – by June 2008, over 23,100 ha
- establishment of plantation forestry for recharge control
- reduced salt concentration in saline runoff from discharge areas – by June 2008, over 250 ha
- Slopes to Plains Project – by June 2008, 13 programs funded based on improved soil management practices
- investment in the Soil Health Slopes to Plains Program 2008–09 – 19,921 ha (Plains) and 14,725 ha (Slopes) exceeding the management target of 10,000 ha (Plains) and 4250 ha (Slopes).

Further details and examples of many of these activities are reported in recent annual reports of the CMA.

Other regional or local based bodies and programs that aid in improved land management include:

- local councils, through their compliance with the *Local Government Act 1993* and local or regional planning instruments such as local environmental plans and regional environmental plans
- Landcare groups that facilitate improved landholder knowledge and on-ground works, such as:
  - Fowlers Wagra Landcare group's perennial pasture establishment and soil testing project
  - Corowa Landcare's establishment of 80 ha of saltbush on 10 demonstration sites
  - West Hume Landcare's four formal workshops and field days to promote best management relating to cropping and livestock systems
  - Green Gully Landcare's tile drainage and salinity mitigation project
- universities that undertake research programs in the region, such as:
  - Charles Sturt University research investigation into quantifying soil processes that contribute to acidification in cropping and grazing systems
  - Evergraze, a collaboration between Charles Sturt University and I&I that researches optimal pasture management
- Murray–Darling Freshwater Research Centre that researches areas such as the impacts of wakeboarding on erosion.

Further reading

DECCW 2009, *Protocols for Soil Condition and Land Capability Monitoring,* prepared by Greg Bowman, Greg Chapman, Brian Murphy, Brian Wilson, Brian Jenkins, Terry Koen, Jonathan Gray, David Morand, Glenn Atkinson, Casey Murphy, Andrew Murrell and Humphrey Milford, Department of Environment, Climate Change and Water NSW, Sydney.

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