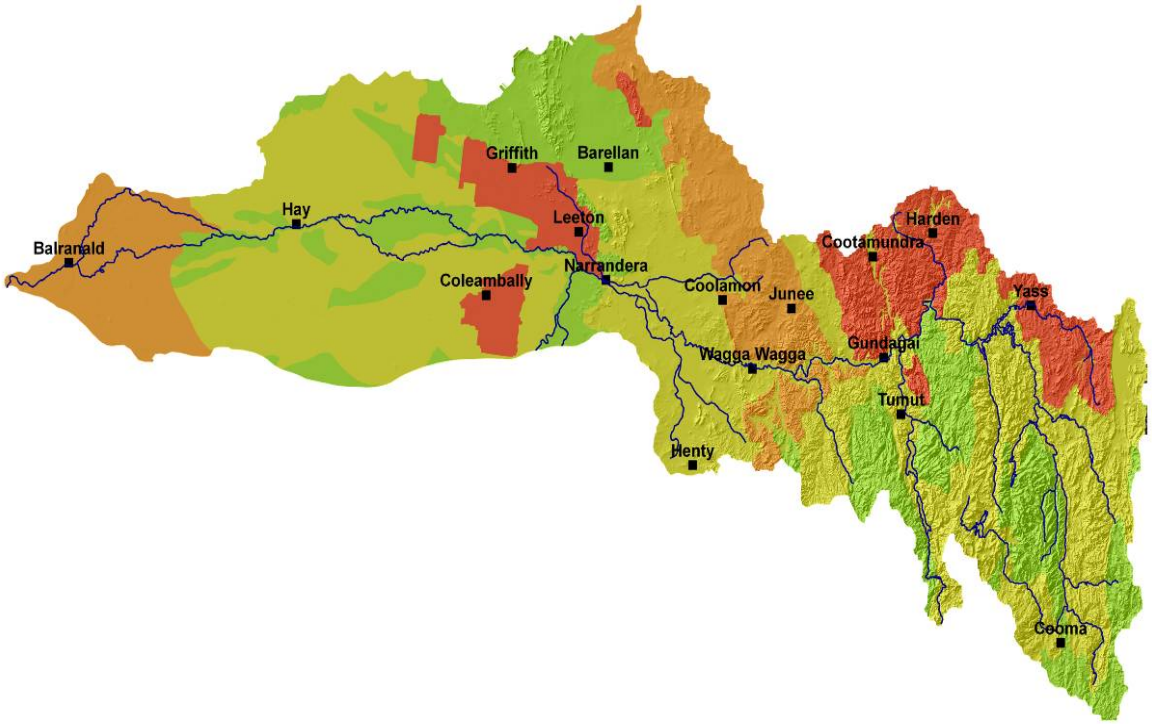
Department of Primary Industries

Salinity hazard report for Catchment Action Plan upgrade - Murrumbidgee CMA



Publisher: NSW Department of Primary Industries

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First published February 2013

Print ISBN: 978 1 74256 457 9

Web ISBN: 978 1 74256 458 6

This document should be cited as: Muller, R., Jenkins, B.R., Cook, W., Littleboy, M., Nicholson, A., Moore, C.L., Wooldridge, A. and Winkler, M. 2012, *Salinity hazard report for Catchment Action Plan upgrade - Murrumbidgee CMA*, NSW Department of Primary Industries, Sydney.

More information

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Acknowledgments

We gratefully acknowledge funding from the Catchment Action NSW Program for this project. Thanks are also given to Sandy Grant form NSW Office of Environment and Heritage for GIS support. Thanks are also given to Jan Wightley from NSW Department of Primary Industries for assistance with editing and document control.

Cover image: Salinity hazard map of Murrumbidgee catchment management area.

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Contents

1 Introduction

1.1 Background

The eleven NSW Catchment Management Authorities (CMAs) are required to update their Catchment Action Plans (CAPs) in a process to be completed by early 2013. The CAPs are required to be "Whole of Government" in order to provide greater coherence between policies and plans as they develop strategic direction at regional levels. CAPs must align with or take into account common elements of agency activity, and require a high level of co-ordination.

A cross agency team has been employed to produce a salinity tool for CAP updates, as a Salinity Hazard for CAP Updates project. This project has been funded by Catchment Action NSW and delivers state-wide information.

The project work associated with this report was carried out prior to the formation of the new Local Land Services (LLS) areas. The boundaries used for hazard identification in this report relate to the CMA boundaries as they were prior to October 2012.

The primary output of the Salinity Hazard for CAP Updates project is a broad scale salinity hazard spatial coverage and report for each CMA. This report is produced for the Murrumbidgee Catchment Management Authority (CMA) for use in upgrading its Catchment Action Plan (CAP). The Murrumbidgee CAP is a cabinet approved document which outlines the investment priorities and delivery targets for natural resource management (NRM) across the Murrumbidgee CMA area. The Murrumbidgee CMA is currently reviewing and upgrading the CAP which was developed in 2005-06.

Salinity information is required to guide the ten year strategic plan (CAP), to prioritise actions, and to target specific landscapes with spatially explicit management actions on ground. The CAPs must

- Comply with the NRC Standards for Quality Natural Resource Management (the Standard)
- Demonstrate "Adaptive Management"
- Deal with emerging issues such as the MDBA Basin Plan / Strategic Land Use Plans etc.
- Consider the resilience of landscapes and systems.

This project will utilise state-wide data sets and collect and integrate Hydrogeological Landscape (HGL) information where it exists. The project has the potential to be expanded to a detailed HGL project targeted at the areas identified in the state-wide approach.

This document describes the hazard posed by salinity for different parts of the Murrumbidgee CMA catchments. The associated Salinity Hazard for CAP Updates map is a specific product for CAP planning. It is appropriate at the catchment scale. More detailed investigations are required for sub-regional works.

1.2 Resilience

The Natural Resource Commission (NRC) has released The Framework for Assessing and Recommending CAPs (2011). A key component of this document is a shift towards resilience thinking. This approach influences CAP targets, partnerships and the type of knowledge that the Murrumbidgee CMA should draw on to analyse, understand and communicate how the landscape functions.

"Resilience thinking aims to identify a small number of important variables that control the way a complex landscape system is functioning, and the thresholds within which the system can continue to function in a desired way" (NRC 2011).

Salinity is one of the 'important variables' that control the function, thresholds and resilience of landscapes. The five salinity hazard classes used as part of this Salinity Hazard for CAP

Updates project provide a simple system for understanding how salinity influences landscape resilience.

The following is the Resilience definition of the Stockholm Resilience Centre (Walker et al. 2004; Folke *et al*. 2010). It is the definition adopted for the Salinity Hazard for CAP Updates project.

"The capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function and feedbacks and therefore identify, that is, the capacity to change in order to maintain the same identity."

Salinity is an important variable in landscape systems and is often a determining factor in the capacity of the landscape to absorb change. It has a three-pronged impact on landscapes namely land salinisation, in-stream salt load and in-stream salt concentration. Any of these can of themselves or in concert impact on landscape resilience.

"Management can then be designed to maintain a functioning system either by remaining within thresholds or transforming to a desirable (or least undesirable) alternative stable state" (NRC 2011).

Salinity as a major landscape degradation issue can determine the nature of thresholds and tipping points. If thresholds within landscapes are to be understood and managed then salinity must be understood and managed in a landscape context.

The drivers, variables, thresholds, priority actions and gap analysis for salinity are provided in Appendix 1.

2 Methodology

2.1 Overview of the descriptors

Each hazard area identified in the project has a descriptor which includes a hazard ranking, a location diagram and description, a statement on the significance of the salinity hazard in that unit, a resilience statement, a confidence statement and the decision rules used to derive the hazard ranking.

Hazard ranking

Areas are given a salinity hazard ranking – Very High, High, Moderate, Low and Very Low. Rankings are determined from a number of variables including salt stores, salinity outbreaks, water quality, salt loads, onsite and offsite impacts, presence of acid sulfate soils, presence of highly sodic soils, aquifer systems and groundwater depth. More detail on the datasets used to derive the hazard rankings for the Murrumbidgee CMA catchment are given in Section 2.2.

Location diagram

A simple overview of where the hazard areas occur within the CMA catchment. Hazard areas are coloured using the following colour scheme.

Table 1 Salinity hazard colour scheme

Attribute	Range	Colour	RGB Colour Scheme
Salinity Hazard	Very High	Red	255, 50, 0
	High	Orange	255, 150, 0
	Moderate	Yellow	230, 230, 0
	Low	Green	150, 230, 0
	Very Low	Blue	0, 200, 255

This colour scheme is also used in the hazard descriptor headers and in the Salinity Hazard for CAP Updates map (Figure 1). The Very Low Hazard rank is not used as no very low hazard areas were found within the Murrumbidgee CMA.

Overview / location

General statements on the terrain and geological characteristics of the hazard area, and where it is located.

Significance

Salinity characterises such as salt stores, salinity outbreaks, water quality, onsite and offsite impacts, and other land degradation issues that may be relevant to salinity processes. Information is presented in a tabular format with hazard indicators in one column and corresponding ratings in the adjoining column. A blank space in the rating column indicates that no suitable information was available to make a rating assessment for that particular hazard indicator and for that hazard area.

Resilience statement

Factors that drive salinity development and the salinity related variables which control, impact or influence the resilience of landscapes.

Confidence

High, moderate or poor. A qualifier is provided where relevant (e.g. poor due to lack of field investigation).

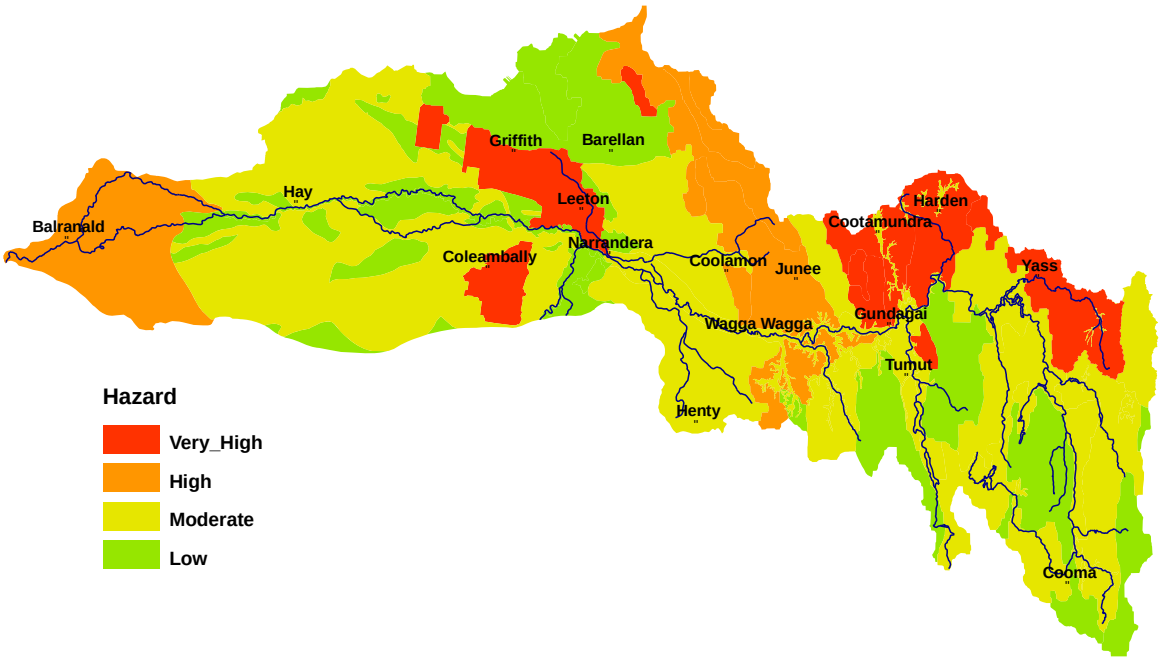
Decision rules

Decision rules for why a particular hazard rating was assigned (e.g. hazard is very high due to observed salinity, unstable sodic soils, shallow groundwater, poor water quality and salt load in streams).

2.2 Overview of the salinity hazard for CAP updates map

The Salinity Hazard for CAP Updates map (Figure 1) shows the broad salinity hazard distribution across the Murrumbidgee CMA. It is appropriate for planning at a CMA catchment scale. More detailed investigations are required to target sub-regional works.

Figure 1 Salinity hazard for CAP update map for the Murrumbidgee CMA area



Boundaries for the salinity hazard for CAP updates project in the Murrumbidgee were derived from several existing datasets:

- Groundwater Flow Systems in the Murrumbidgee Region (van der Lely 2001), shown here in Figure 2, formed the basis for the line-work for the mid and upper Murrumbidgee catchment.
- Depth to Watertable mapping shown as in Figure 3 was utilised to derive the boundaries for the lower catchment. Spatial data used was derived from datasets generated for the 2003 State Salinity Hazard project (DLWC 2003, unpub.).

Figure 2 Groundwater flow systems map of the Murrumbidgee region (van der Lely 2001)

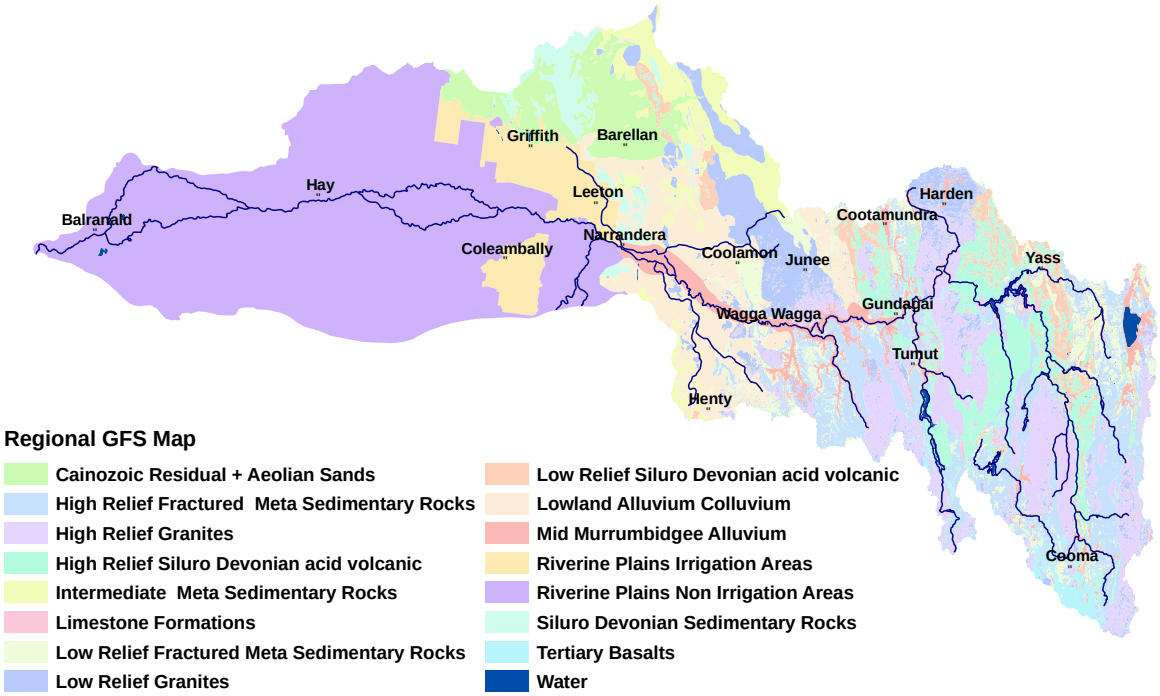
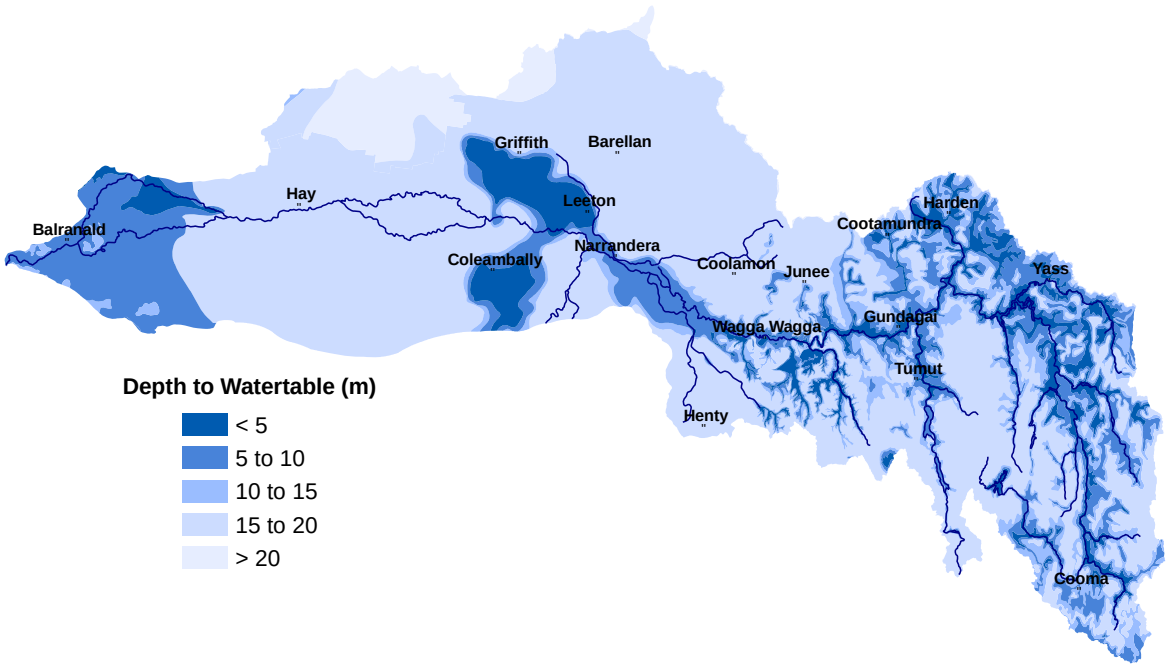
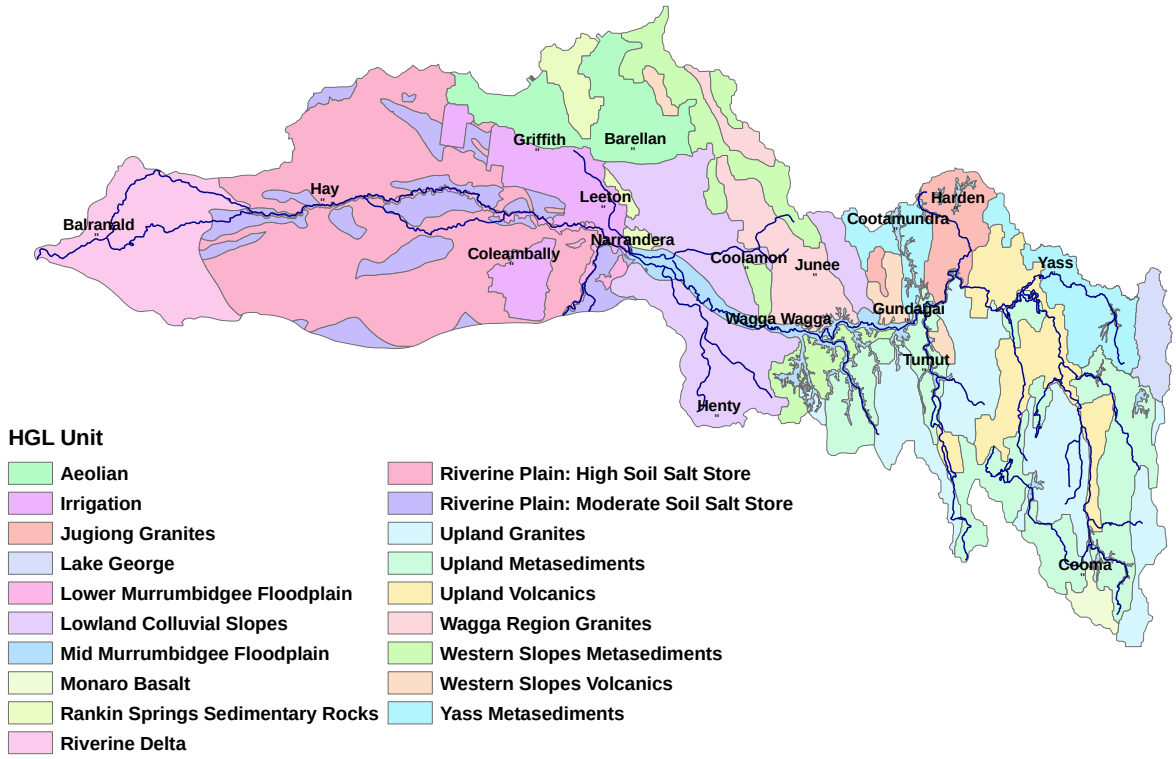


Figure 3 Depth to watertable (DLWC 2003, unpub.)



The line-work from these two datasets was combined and processed to smooth irregular boundaries and eliminate small polygons, resulting in the generation of the final Salinity Hazard for CAP Updates boundaries (Figure 4).

Figure 4 Final salinity hazard for CAP updates boundaries



The derivation of the hazard rankings for each of the hazard descriptor was based on a number of existing spatial datasets:

- Depth to Water Table (Figure 3) – based on water level data extracted for the DIPNR Groundwater Database (GDS) and filtered to consider only aquifers less than or equal to 30 m below the ground surface. Spatial data used was derived from datasets generated for the 2003 State Salinity Hazard project (DLWC 2003, unpub.).
- Soil Salt Store (Figure 5) - derived from salinity data contained in the NSW Soil and Land Information System (SALIS) to generate a soil salt store layer to be used for the 2003 State Salinity Hazard project (DLWC 2003, unpub.).
- Mean Stream Salinity (Figure 6) – based on 2CSalt modelling used for the Salinity Audit of Upland catchments of the New South Wales Murray–Darling Basin (Littleboy 2006; DECC 2009).
- Groundwater Salinity (Figure 7) – based on groundwater quality data extracted for the DIPNR Groundwater Database (GDS) and Triton water quality database. Data was filtered to only consider aquifers less than or equal to 30 m below the ground surface. Spatial data used was derived from datasets generated for the 2003 State Salinity Hazard project (DLWC 2003, unpub.). Groundwater ranges correspond to the following values (AWRC 1976):
    - Fresh <500 mg/L
    - Marginal 500–1000 mg/L
    - Brackish 1000–3000 mg/L
    - Saline >3000mg/L
- Stream Salt Load (Figure 8) – based on 2CSalt modelling used for the Salinity Audit of Upland catchments of the New South Wales Murray–Darling Basin (Littleboy 2006; DECC 2009).

Figure 5 Soil salt store (DLWC 2003, unpub.)

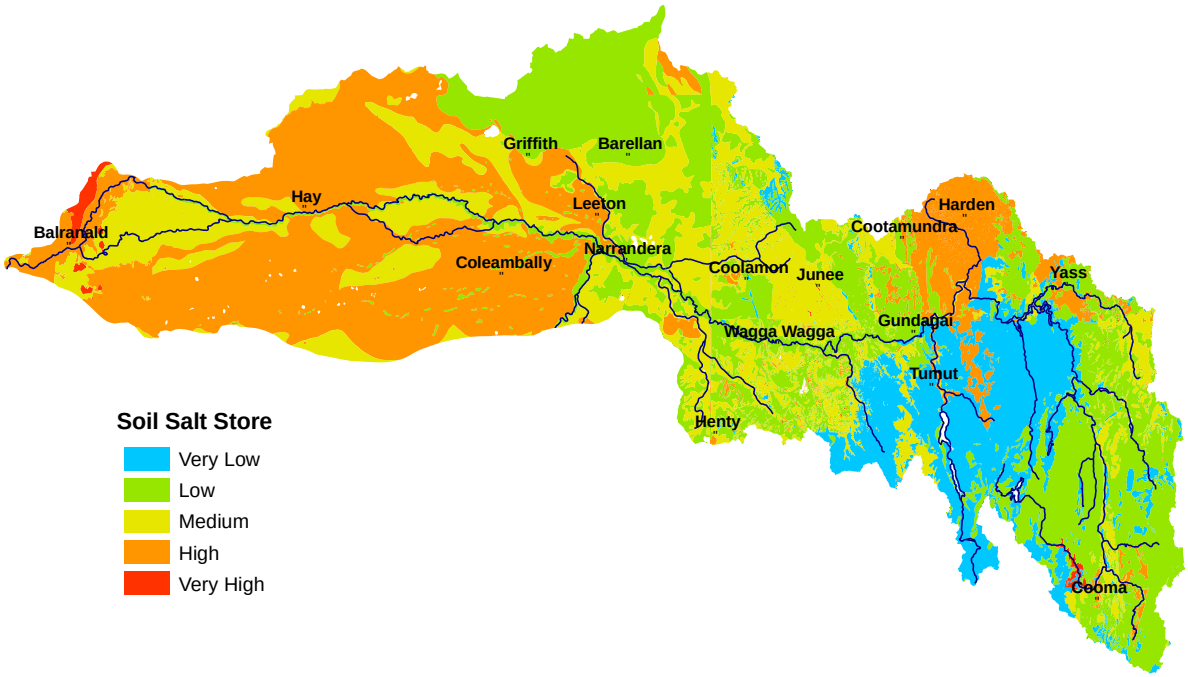


Figure 6 Mean stream salinity (Littleboy 2006: DECC 2009)

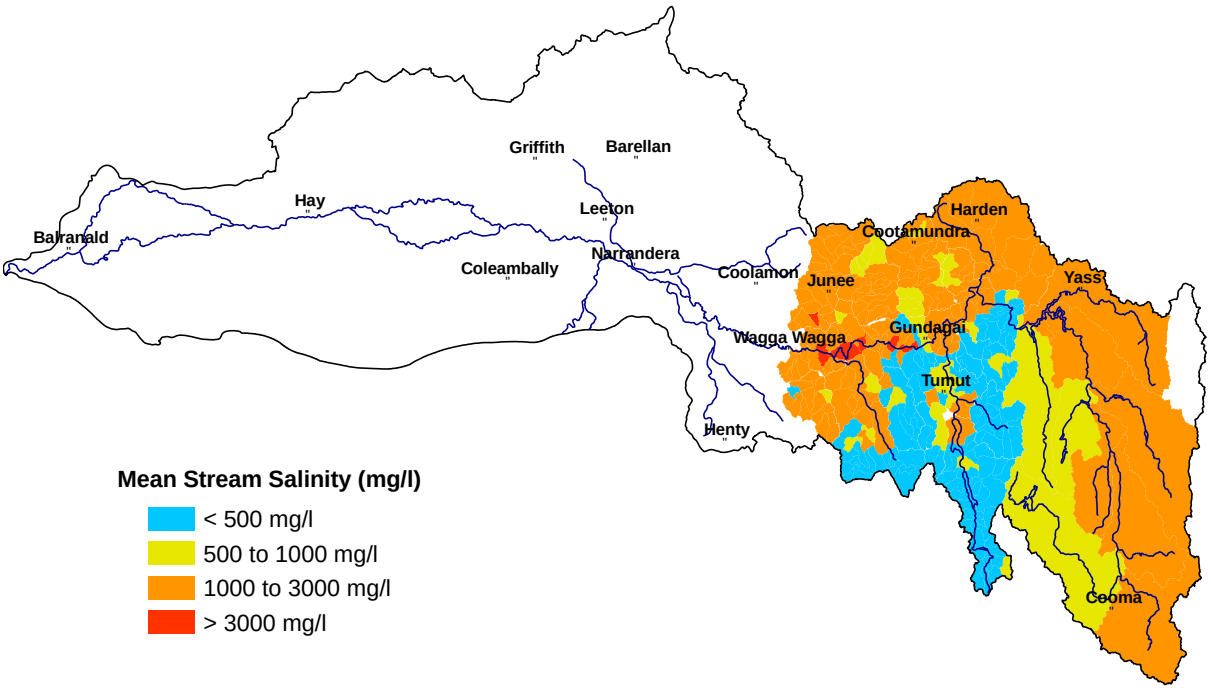


Figure 7 Groundwater salinity (DLWC 2003, unpub.)

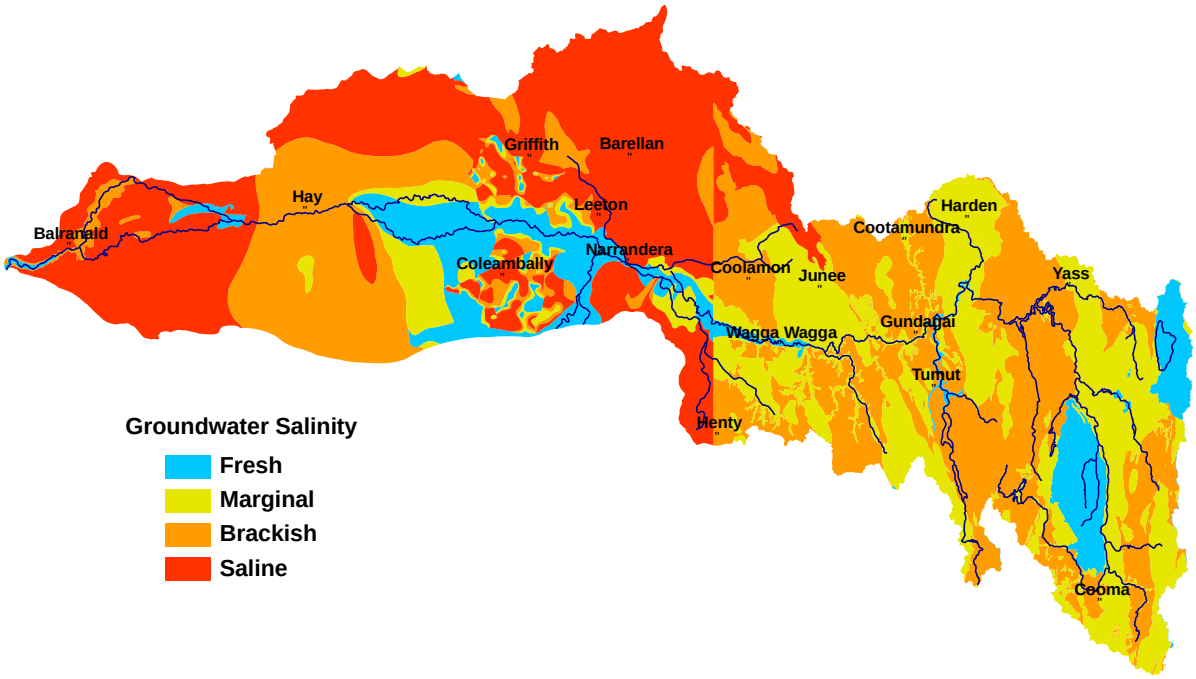
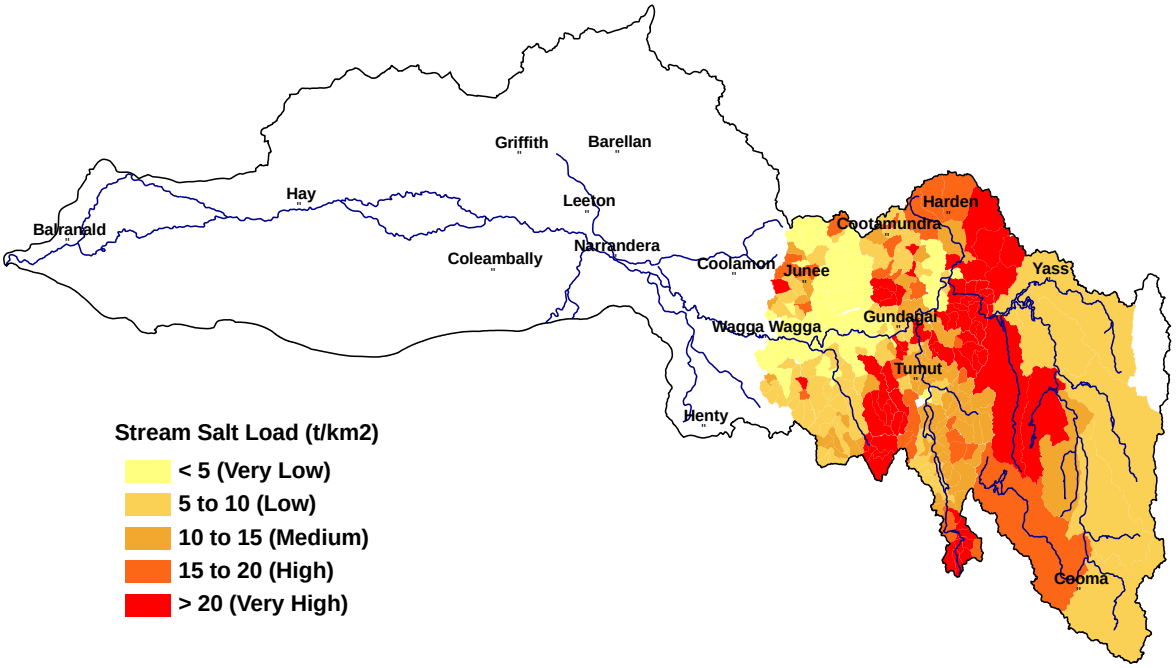


Figure 8 Stream salt load (Littleboy 2006; DECC 2009)



In addition to the datasets above, consideration was given to the following:

- presence or absence of known dryland salinity outbreaks
- influence of local or regional groundwater systems
- climatic impacts

- any other relevant modifiers impacting on the hazard area.

Where specific salinity related information exists for a particular area, that information has been referenced. For example, the Monaro Basalt area is covered by Soil Landscapes (Tulau, 1994) and the Ecosystems of the Monaro (Costin, 1954). Both of these texts have been used to help rank the Salinity Hazard of this area.

Some important datasets were not used as part of this assessment as they were either not suitable at the broad scale of this assessment (e.g. Page *et al*. 1996) or are currently under review (e.g. Davy 2005). These documents and others would be considered in any follow up Hydrogeological work.

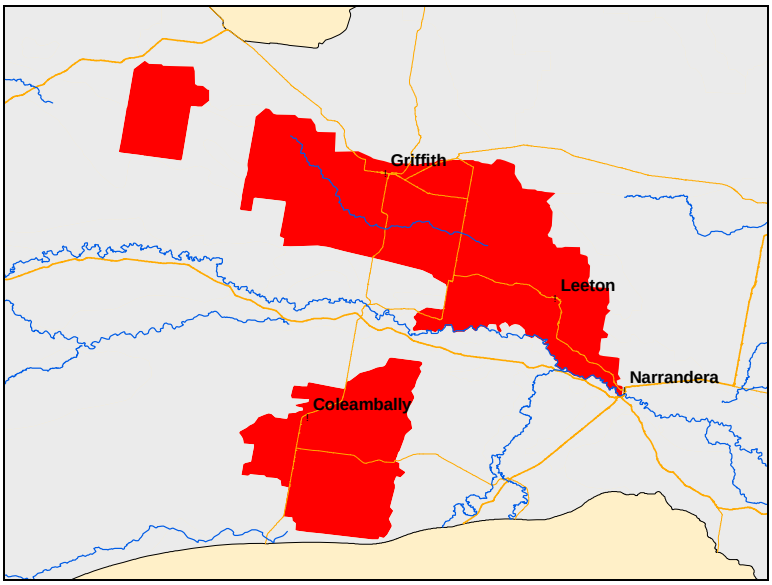
In the Murrumbidgee CMA, Salinity Hazards ranged from Low to Very High. No Very Low hazard areas were identified as all areas have at least some indication of salinity.

3 Descriptors

3.1 Very high hazard – Area 1

VH1	Irrigation	Hazard:	Very High

Figure 9 Location diagram of very high hazard area 1



Overview / location

This category comprises designated irrigation areas on alluvial sediments within the Murrumbidgee CMA area. It includes irrigation areas down stream of Narrandera and the towns of Coleambally, Leeton and Griffith.

Significance

Hazard Indicators	Rating
Soil salt stores	High and very high
Water quality (estimated stream salinity)	
Water quality (groundwater)	Saline
Groundwater (depth)	Shallow
Dryland salinity	
Stream load	
Local v regional	Regional

Climate	Climate not a factor due to artificial hydraulic loading.
Modifier	Self mulching black and grey clay soils
Overall Hazard	**Very High**

Resilience statement

Inappropriate irrigation practices are the main driver for salinity development. Salinity related variables impacting the resilience of this landscape are water table depth and groundwater quality.

Confidence

High

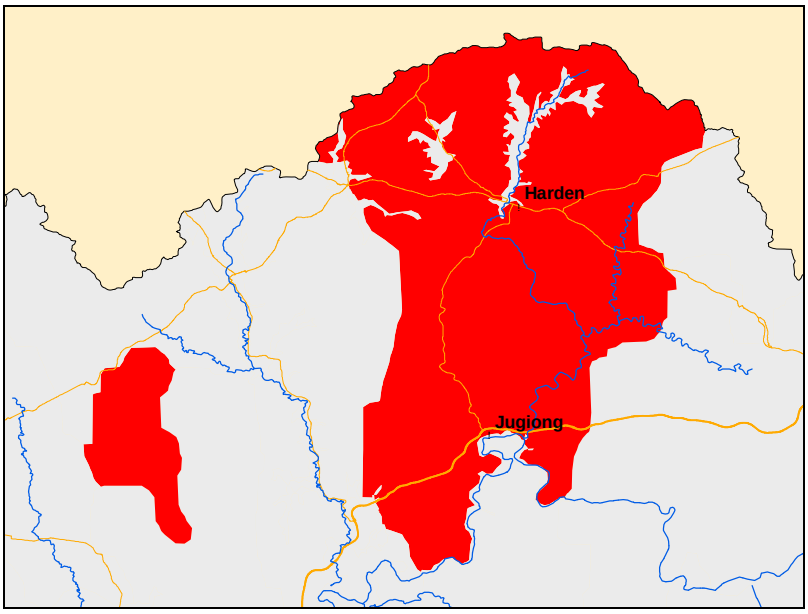
Decision rules

Very High hazard rating is based on high hydraulic loading from irrigation and related shallow water tables with elevated EC readings and very high soil salt stores.

3.2 Very high hazard – Area 2

VH2	Jugiong Granites	Hazard:	Very High

Figure 10 Location diagram of very high hazard area 2



Overview / location

This category comprises granitic rocks and includes the towns of Harden and Jugiong.

Significance

Hazard Indicators	Rating
Soil salt stores	High
Water quality (estimated stream salinity)	Moderate to high
Water quality (groundwater)	Marginal
Groundwater (depth)	Shallow
Dryland salinity	Observed
Stream load	High to very high
Local v regional	Local

Climate	600-800 mm
Modifier	
Overall Hazard	**Very High**

Resilience statement

Inappropriate cropping practices, inappropriate grazing management and loss of perenniality are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are perenniality, water table depth, groundwater quality, salt load in streams and stream EC.

Confidence

High due to HGL investigations in parts of Jugiong catchment. (Nicholson *et al*. 2011)

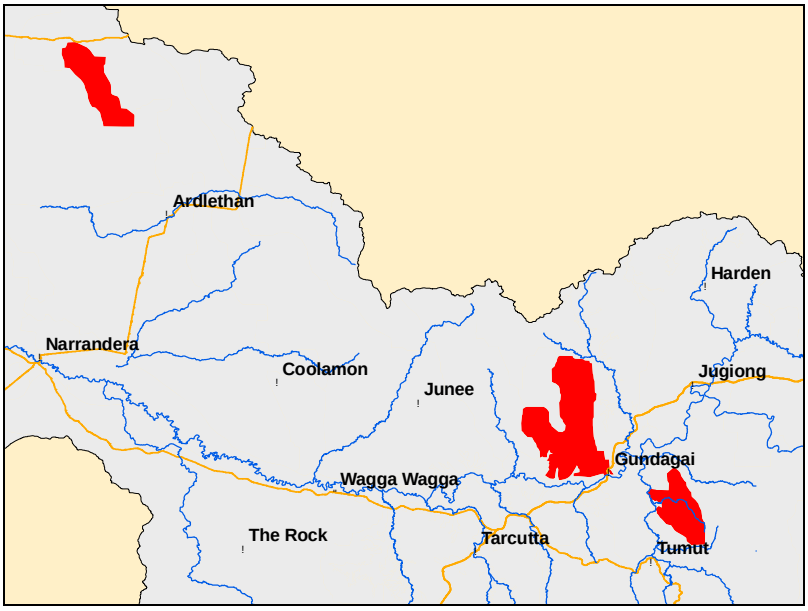
Decision rules

Very High hazard rating is based on high to very high salt loads, shallow water tables, elevated EC readings and high soil salt stores.

3.3 Very high hazard – Area 3

VH3	Western Slopes Volcanics	Hazard:	Very High

Figure 11 Location diagram of very high hazard area 3



Overview / location

This category is composed of volcanic rocks and includes the localities of Reno, Brungle Creek and Bongongalong. Narriah occurs within the western most portion of this unit.

Significance

Hazard Indicators	Rating
Soil salt stores	Low
Water quality (estimated stream salinity)	Very high
Water quality (groundwater)	Marginal to brackish
Groundwater (depth)	Generally shallow
Dryland salinity	Observed
Stream load	Very high

Local v regional	Local
Climate	450-600mm
Modifier	
Overall Hazard	**Very High**

Resilience statement

Inappropriate grazing management, loss of soil via erosion and loss of soil health (physical, biological, chemical) are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are the extent of land salinity, water table depth, groundwater quality, salt load in streams and stream EC.

Confidence

Moderate. Salinity observed and some field investigation.

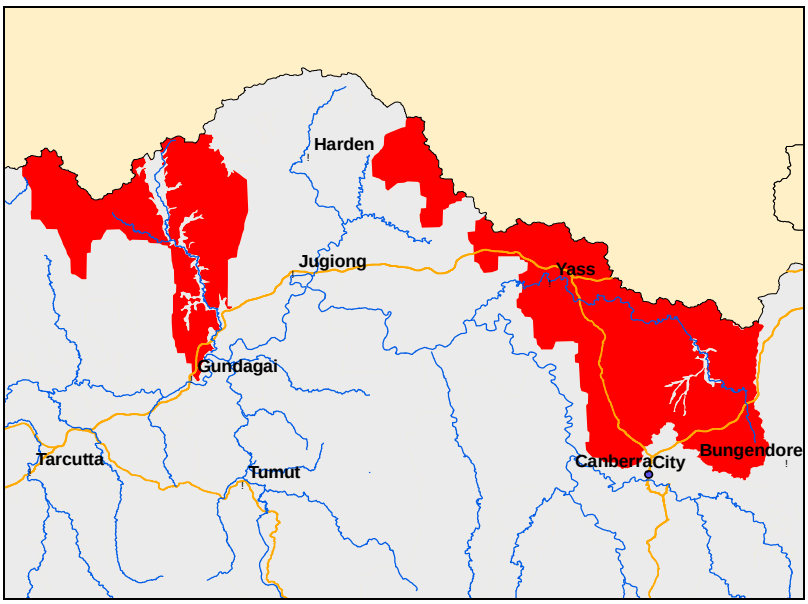
Decision rules

Very High hazard rating is based on high to observed salinity outbreaks, very high salt loads, shallow water tables, and elevated EC readings.

3.4 Very high hazard – Area 4

VH4	Yass Metasediments	Hazard:	Very High

Figure 12 Location diagram of very high hazard area 4



Overview / location

This category comprises Ordovician metasedimentary rocks. It includes the towns of Yass, Cootamundra and Murrumbateman.

Significance

Hazard Indicators	Rating
Soil salt stores	High
Water quality (estimated stream salinity)	High to very high
Water quality (groundwater)	Marginal to brackish
Groundwater (depth)	Shallow
Dryland salinity	Observed and common

Stream load	Moderate
Local v regional	Some regional structures
Climate	450-600mm
Modifier	
Overall Hazard	**Very High**

Resilience statement

Inappropriate grazing management, loss of soil via erosion, decreasing depth to water table and/or rising groundwater and loss of soil health (physical, biological, chemical) are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are the soil stability (erosion, gullying, sodic soil), extent of land salinity, water table depth, groundwater quality, salt load in streams and stream EC.

Confidence

High due to observation and field investigation.

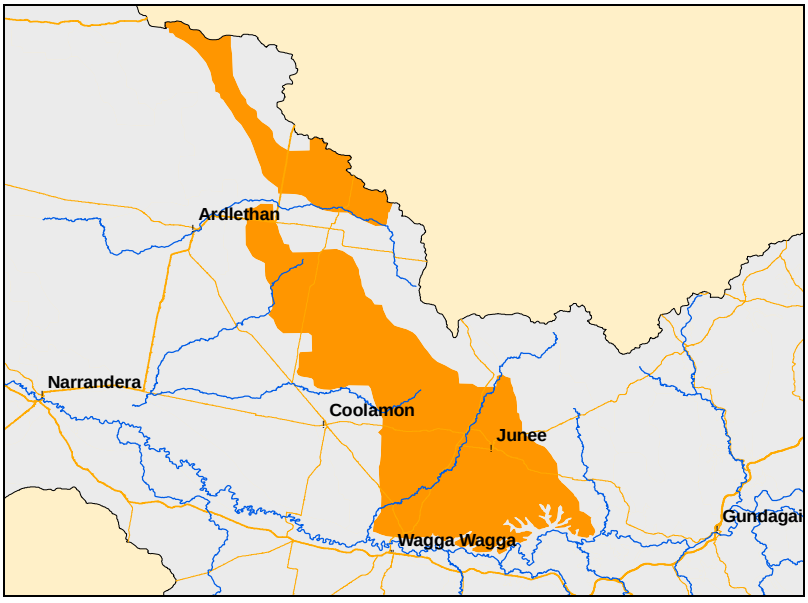
Decision rules

Hazard is very high due to observed salinity, unstable sodic soils, shallow groundwater, poor water quality and salt load in streams.

3.5 High hazard – Area 1

H1	Wagga Region Granites	Hazard:	High

Figure 13 Location diagram of high hazard area 1



Overview / location

This category comprises granitic rocks and includes the towns of Junee and Ariah Park.

Significance

Hazard Indicators	Rating
Soil salt stores	Medium
Water quality (estimated stream salinity)	
Water quality (groundwater)	Marginal
Groundwater (depth)	Deep

Dryland salinity	Observed
Stream load	
Local v regional	Local
Climate	< 600mm
Modifier	
Overall Hazard	**High**

Resilience statement

Increasing urbanisation, inappropriate planning and construction methods for salinity, decreasing depth to water table and/or rising groundwater, inappropriate grazing management and cropping practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape in urban and peri-urban areas of Wagga Wagga and Junee are water table depth and planning control and policy related to salinity hazard. In agricultural areas the key variable is perenniality.

Confidence

Moderate due to lack of data and minimal field reconnaissance.

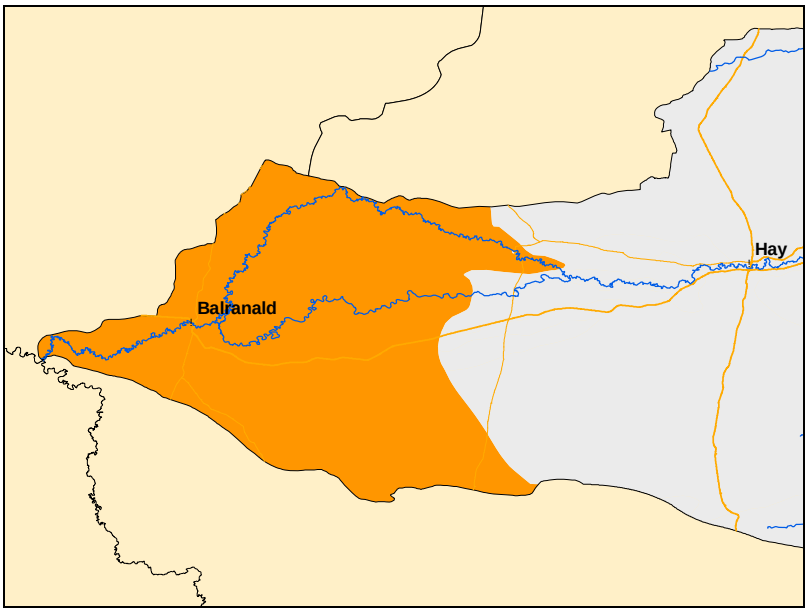
Decision rules

Hazard is high due to abundant urban impacts and observed salinity in rural areas.

3.6 High hazard – Area 2

H2	Riverine Delta	Hazard:	High

Figure 14 Location diagram of high hazard area 2



Overview / location

This category comprises Cenozoic alluvium of the lower Murrumbidgee riverine plain. It includes the town of Balranald and the Great Cumbung Swamp.

Significance

Hazard Indicators	Rating
Soil salt stores	Moderate to very high
Water quality (estimated stream salinity)	

Water quality (groundwater)	Brackish to saline
Groundwater (depth)	Shallow
Dryland salinity	
Stream load	
Local v regional	Regional
Climate	< 450 mm
Modifier	
Overall Hazard	**High**

Resilience statement

Inappropriate grazing management and inappropriate cropping practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are shallow water tables and total grazing pressure.

Confidence

Poor due to limited field investigation.

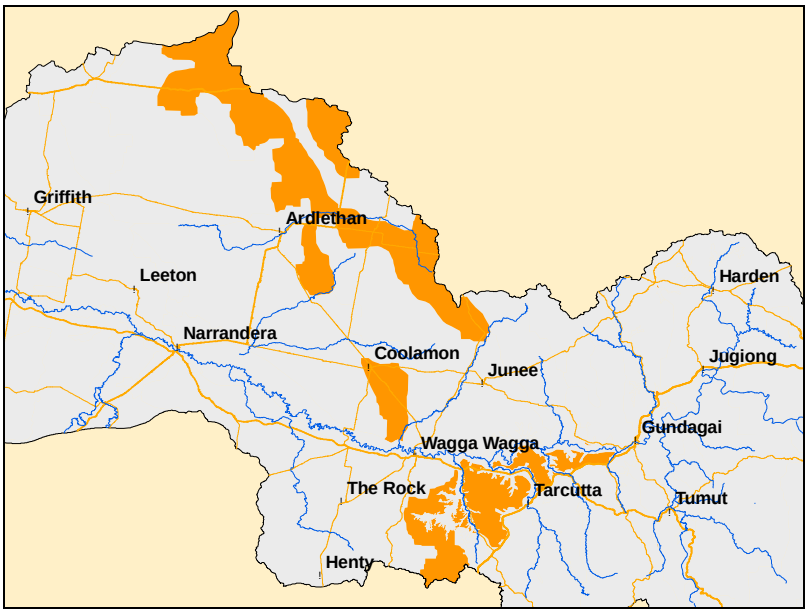
Decision rules

The hazard is high due to observed salinity and poor water quality.

3.7 High hazard – Area 3

H3	Western Slopes Metasediments	Hazard:	High

Figure 15 Location diagram of high hazard area 3



Overview / location

This category comprises Ordovician metasedimentary rocks. It includes the towns of Tarcutta, Ariah Park and Coolamon.

Significance

Hazard Indicators	Rating
Soil salt stores	Variable
Water quality (estimated stream salinity)	Very low to moderate

Water quality (groundwater)	Brackish
Groundwater (depth)	Generally deep with some perching
Dryland salinity	Observed
Stream load	Low to moderate
Local v regional	
Climate	450-600 mm
Modifier	
Overall Hazard	**High**

Resilience statement

Inappropriate grazing management and inappropriate cropping practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are total grazing pressure, groundcover percentage and lack of perenniality.

Confidence

Moderate due to observed salinity and some field investigation.

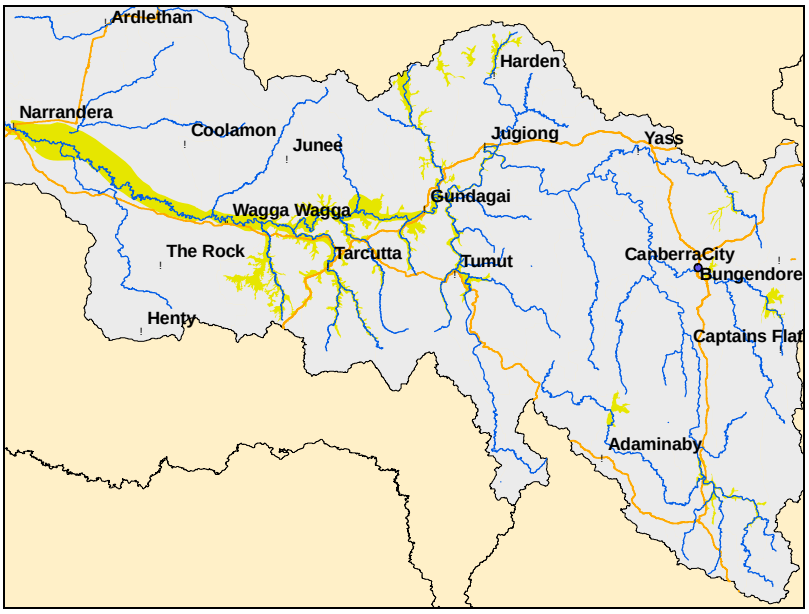
Decision rules

The hazard is high due to observed dryland salinity and brackish groundwater.

3.8 Moderate hazard – Area 1

M1	Mid Murrumbidgee Floodplain	Hazard:	Moderate

Figure 16 Location diagram of moderate hazard area 1



Overview / location

This category comprises Cenozoic alluvium of the Murrumbidgee River, tributaries and associated floodplains. It includes the city of Wagga Wagga.

Significance

Hazard Indicators	Rating
Soil salt stores	Low
Water quality (estimated stream salinity)	Variable

Water quality (groundwater)	Saline
Groundwater (depth)	Shallow
Dryland salinity	Rare
Stream load	Very low
Local v regional	Regional
Climate	
Modifier	Fresh flows from Burrinjuck Dam occur in Murrumbidgee River
Overall Hazard	**Moderate**

Resilience statement

Inappropriate vegetation management and inappropriate irrigation practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are water table depth and a lack of perenniality.

Confidence

Poor. Limited data and field investigation.

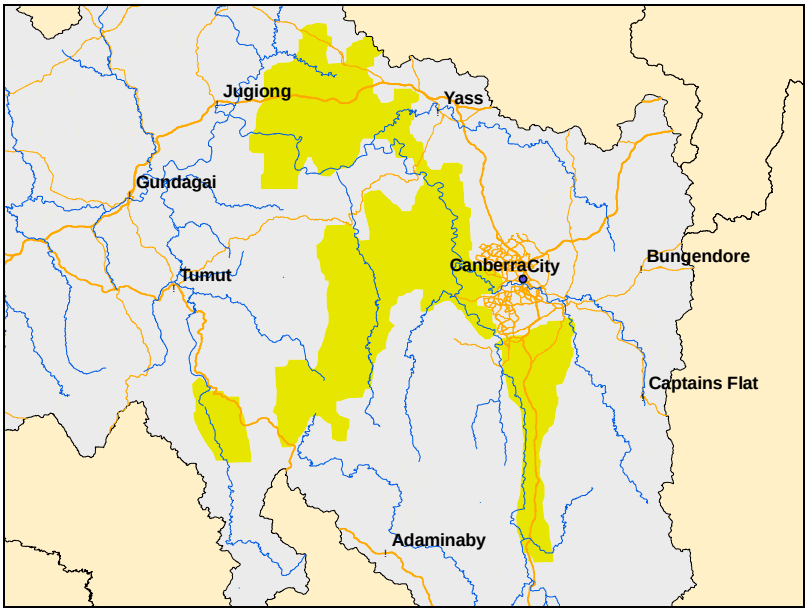
Decision rules

The hazard is moderate due to saline shallow groundwater depth balanced out by low salt stores and very low stream load.

3.9 Moderate hazard – Area 2

M2	Upland Volcanics	Hazard:	Moderate

Figure 17 Location diagram of moderate hazard area 2



Overview / location

This category is composed of volcanic rocks. It includes the upper Murrumbidgee River valley, the town of Michelago and some of Canberra's southern suburbs.

Significance

Hazard Indicators	Rating
Soil salt stores	Low to moderate

Water quality (estimated stream salinity)	Moderate
Water quality (groundwater)	Marginal
Groundwater (depth)	Shallow along the Upper Murrumbidgee valley
Dryland salinity	Observed
Stream load	Variable
Local v regional	Regional structures
Climate	>600 mm
Modifier	
Overall Hazard	**Moderate**

Resilience statement

Inappropriate vegetation management and inappropriate irrigation practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are water table depth and a lack of perenniality.

Confidence

Poor. Limited data and field investigation.

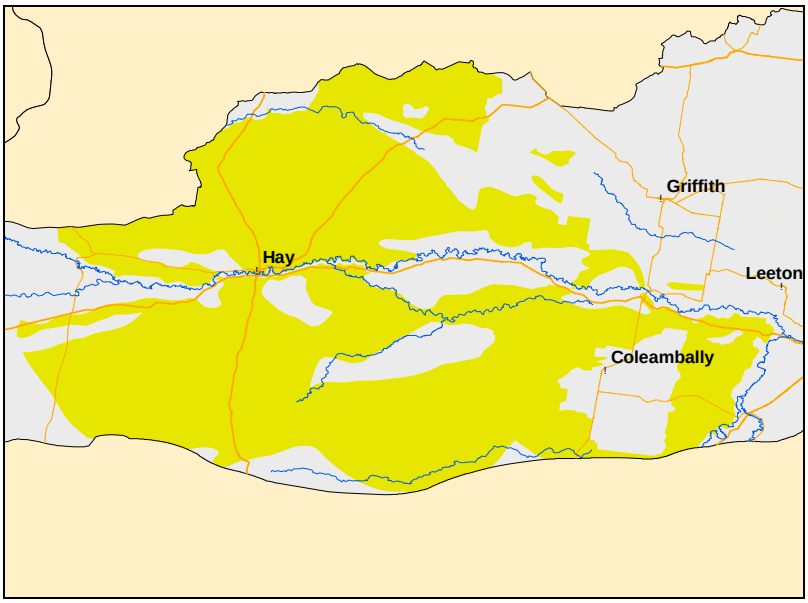
Decision rules

The hazard is moderate due to saline shallow groundwater depth balanced out by low salt stores and very low stream load.

3.10 Moderate hazard – Area 3

M3	Riverine Plain: High Soil Salt Store	Hazard:	Moderate

Figure 18 Location diagram of moderate hazard area 3



Overview / location

This category comprises Cenozoic alluvium of the lower Murrumbidgee riverine plain. It includes the town of Hay and the localities of One Tree, Booroorban and Gunbar.

Significance

Hazard Indicators	Rating
Soil salt stores	High

Water quality (estimated stream salinity)	
Water quality (groundwater)	Saline
Groundwater (depth)	Deep
Dryland salinity	
Stream load	
Local v regional	Regional
Climate	<450 mm
Modifier	Heavy clay soils
Overall Hazard	**Moderate**

Resilience statement

Inappropriate grazing management, vegetation management and irrigation practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are groundwater quality and periods of low groundcover percentage.

Confidence

Poor due to limited field investigation.

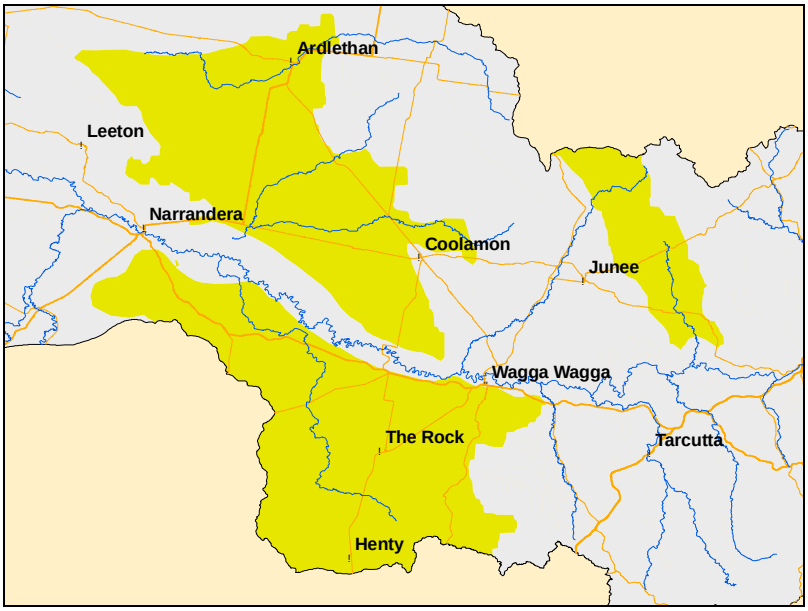
Decision rules

The hazard is moderate. Although the groundwater is generally saline and soil salt stores are high, these are balanced by deep groundwater depth, heavy clay soils (high buffering capacity) and low rainfall.

3.11 Moderate hazard – Area 4

M4	Lowland Colluvial Slopes	Hazard:	Moderate

Figure 19 Location diagram of moderate hazard area 4



Overview / location

This category comprises colluvial and alluvial sediments. It includes the towns of Henty, The Rock and Ardlethan.

Significance

Hazard Indicators	Rating

Soil salt stores	Low to moderate
Water quality (estimated stream salinity)	
Water quality (groundwater)	Saline
Groundwater (depth)	Deep
Dryland salinity	Observed
Stream load	
Local v regional	Local
Climate	<450 mm
Modifier	
Overall Hazard	**Moderate**

Resilience statement

Inappropriate grazing management, vegetation management and irrigation practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are groundwater quality and periods of low groundcover percentage.

Confidence

Poor due to limited field investigation.

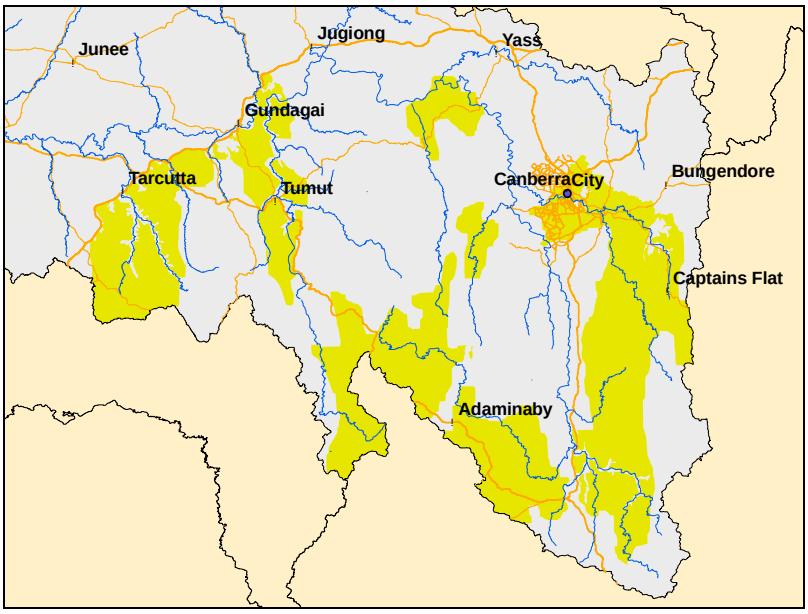
Decision rules

The hazard is moderate due to saline but deep groundwater and observed dryland salinity.

3.12 Moderate hazard – Area 5

M5	Upland Metasediments	Hazard:	Moderate

Figure 20 Location diagram of moderate hazard area 5



Overview / location

This category comprises Ordovician metasedimentary rocks. It includes the city of Queanbeyan.

Significance

Hazard Indicators	Rating
Soil salt stores	Low t

Water quality (estimated stream salinity)	Low to moderate
Water quality (groundwater)	Marginal
Groundwater (depth)	Variable
Dryland salinity	Observed
Stream load	Generally low
Local v regional	Regional structures
Climate	>600 mm
Modifier	
Overall Hazard	**Moderate**

Resilience statement

Inappropriate grazing management, vegetation management and clearing practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are total grazing pressure, groundcover percentage and degree of soil degradation. This hazard area includes the cities of Queanbeyan and Canberra. Increasing urbanisation and inappropriate planning and construction methods are drivers in and around these areas.

Confidence

Moderate due to some investigation including Soil Landscape mapping (Hird 1991;Jenkins 1993, 2000 and in prep: Wild and Jenkins in prep).

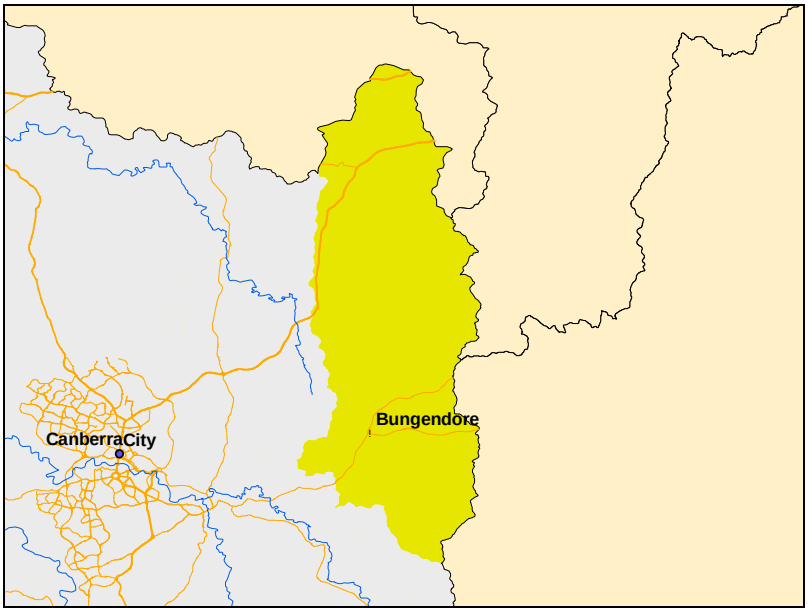
Decision rules

The hazard is moderate due to high observed dryland salinity and regional structures.

3.13 Moderate hazard – Area 6

M6	Lake George	Hazard:	Moderate

Figure 21 Location diagram of moderate hazard area 6



Overview / location

This category comprises granitic and volcanic fractured rock and lacustrine sediments of the internally draining Lake George basin. Towns present include Bungendore and Collector.

Significance

Hazard Indicators	Rating
Soil salt stores	Low to high t
Water quality (estimated stream salinity)	Low to high
Water quality (groundwater)	Moderate
Groundwater (depth)	Variable
Dryland salinity	Observed
Stream load	Variable
Local v regional	Local and regional
Climate	>600 mm
Modifier	Closed basin at Lake George
Overall Hazard	**Moderate**

Resilience statement

Inappropriate grazing management and vegetation management are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are total grazing pressure, groundcover percentage, soil stability and degree of soil degradation. This hazard area includes the towns of Bungendore and Collector, both of which include new housing estates. Increasing urbanisation and inappropriate planning and construction methods are drivers in and around these towns.

Confidence

Moderate due to some investigation including Hydrogeological Landscape mapping on the Braidwood map sheet (Jenkins *et al* 2010) which includes the eastern margin of this hazard area, and Soil Landscape mapping (Hird 1991; Jenkins 2000).

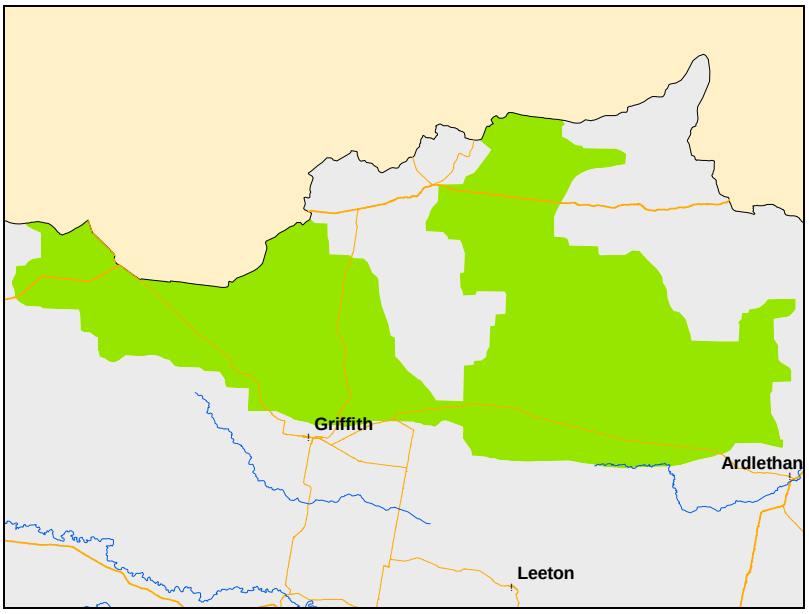
Decision rules

The hazard is moderate due to localised high salt stores and saline groundwater. However, the basin is internally draining and salt stores are not readily mobilised.

3.14 Low hazard – Area 1

L1	Aeolian	Hazard:	Low

Figure 22 Location diagram of low hazard area 1



Overview / location

This category comprises aeolian sediments and relict landform features and soil materials derived from Cenozoic sediments. It includes the towns of Goolgowi and Barellan.

Significance

Hazard Indicators	Rating
Soil salt stores	Low to high t
Water quality (estimated stream salinity)	Low to high
Water quality (groundwater)	Moderate
Groundwater (depth)	Variable
Dryland salinity	Observed
Stream load	Variable
Local v regional	Local and regional
Climate	>600 mm
Modifier	Closed basin at Lake George
Overall Hazard	**Low**

Resilience statement

Inappropriate grazing and cropping practices are the drivers for salinity development. Salinity related variables impacting the resilience of this landscape are groundcover percentage and total grazing pressure.

Confidence

Low. Limited available data or investigation.

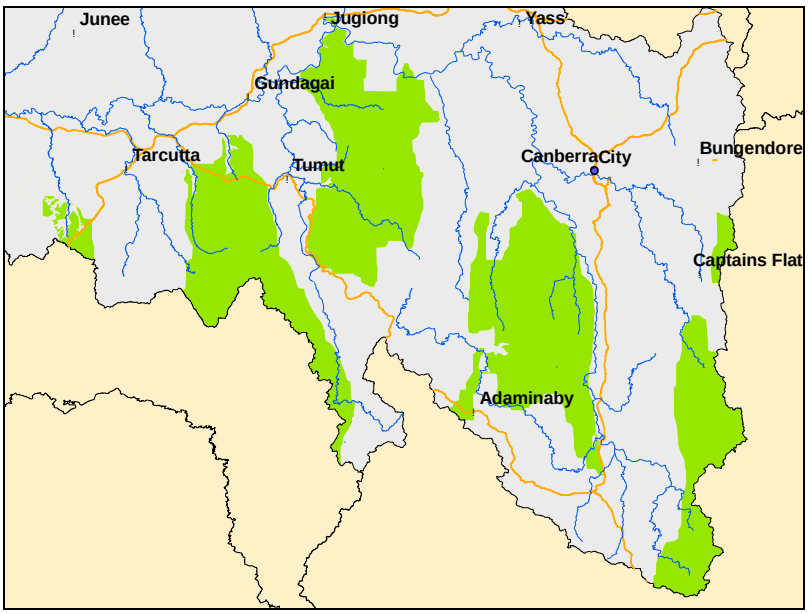
Decision rules

The hazard rating is low. Although groundwater salinity is high the depth to water table is relatively deep and soils are deep and sandy.

3.15 Low hazard – Area 2

L2	Upland Granites	Hazard:	Low

Figure 23 Location diagram of low hazard area 2



Overview / location

This category comprises granitic rocks and includes the towns of Adelong and Batlow, plus the Tinderry Ranges, Clear Range and the Namadgee National Park.

Significance

Hazard Indicators	Rating
Soil salt stores	Very low to low
Water quality (estimated stream salinity)	Variable
Water quality (groundwater)	Fresh
Groundwater (depth)	Deep
Dryland salinity	
Stream load	Moderate
Local v regional	Local
Climate	>800 mm
Modifier	Freely draining sandy soils
Overall Hazard	**Low**

Resilience statement

Inappropriate grazing management, vegetation management and clearing practices are the main drivers for salinity development. Salinity related variables impacting the resilience of this landscape are total grazing pressure, groundcover percentage and degree of soil degradation.

Confidence

Moderate due to some investigation including Soil Landscape mapping (Chen & McKane 1996; Jenkins 1993, 2000 & in prep: Wild and Jenkins in prep).

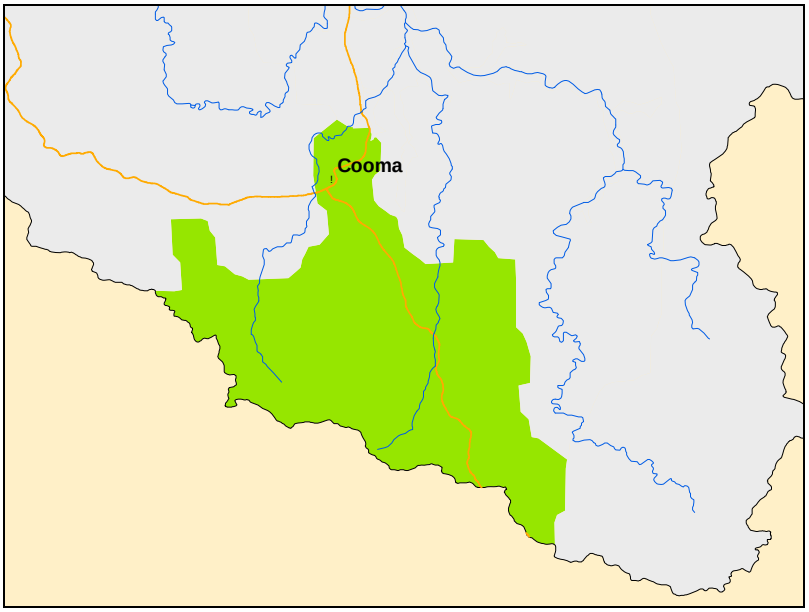
Decision rules

The hazard is low due to deep groundwater levels, high rainfall and freely draining soils.

3.16 Low hazard – Area 3

L3	Monaro Basalt	Hazard:	Low

Figure 24 Location diagram of low hazard area 3



Overview / location

This category comprises low relief and low slope areas found on the Cenozoic basalt of the Monaro Plain. It is located on the Southern Tablelands to the north and west of Nimmitabel and includes the town of Cooma.

Significance

Hazard Indicators	Rating
Soil salt stores	Low
Water quality (estimated stream salinity)	Fresh
Water quality (groundwater)	Fresh
Groundwater (depth)	Shallow due to perched water tables
Dryland salinity	Moderate
Stream load	Low
Local v regional	Local
Climate	Sub-alpine
Modifier	
Overall Hazard	**Low**

Salt stores are low but are not readily mobilised. Salinity outbreaks are small, localised and numerous. Water quality is typically fresh. There is wind erosion associated with small deflation basins. There are minimal off-site impacts.

Clay contents are high and together with the composition of the clay result in soil that withholds moisture from plants. The limited moisture available to plants may be a driving factor in the dominance of grasses (Costin, 1954). The growing season is limited due to severe winter frosts and summer moisture deficit.

Resilience statement

Inappropriate grazing practices are the driver for salinity development. Salinity related variables impacting the resilience of this landscape are groundcover percentage, total grazing pressure and climatic variability.

Confidence

Moderate to high. Salinity has been mapped and observed (Jenkins *et al*. 2012; Muller *et al*. in prep). Soil landscape mapping has been undertaken for the Cooma 1:100 000 map sheet (Tulau 1994)

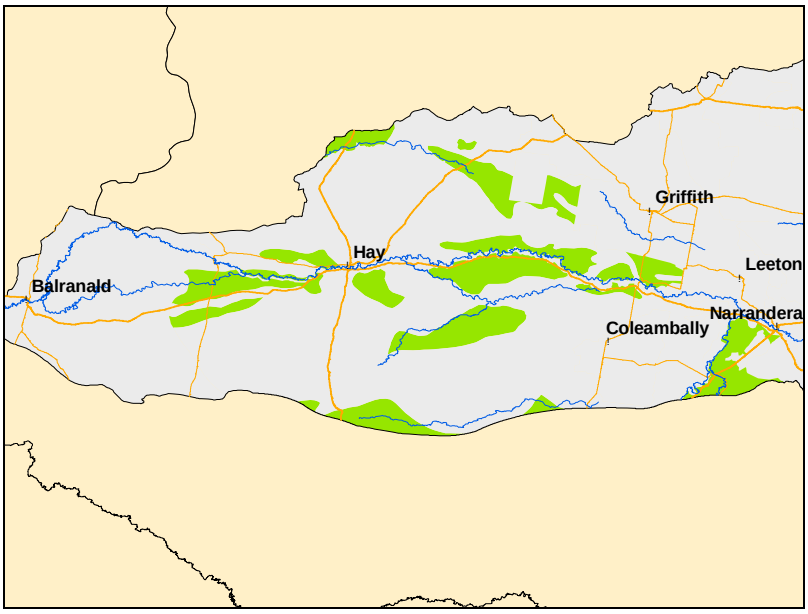
Decision rules

Low hazard rating is based on HGL assessment which recognised moderate levels of land salinity but low in-stream salt loads and low water EC (fresh water) (Muller *et al*. in prep).

3.17 Low hazard – Area 4

L4	Riverine Plain: Moderate Soil Salt Store	Hazard:	Low

Figure 25 Location diagram of low hazard area 4



Overview / location

This category comprises Cenozoic alluvium of the lower Murrumbidgee riverine plain. It includes the villages of Carrathool and Morundah and the locality of Kooroongal.

Significance

Hazard Indicators	Rating
Soil salt stores	Moderate
Water quality (estimated stream salinity)	
Water quality (groundwater)	Saline
Groundwater (depth)	Deep
Dryland salinity	
Stream load	
Local v regional	Regional
Climate	<450 mm
Modifier	
Overall Hazard	**Low**

Resilience statement

Inappropriate cropping, grazing and irrigation practices are the drivers for salinity development. Salinity related variables impacting the resilience of this landscape are groundcover percentage, total grazing pressure, climatic variability and groundwater quality.

Confidence

Low. Limited available data or investigation.

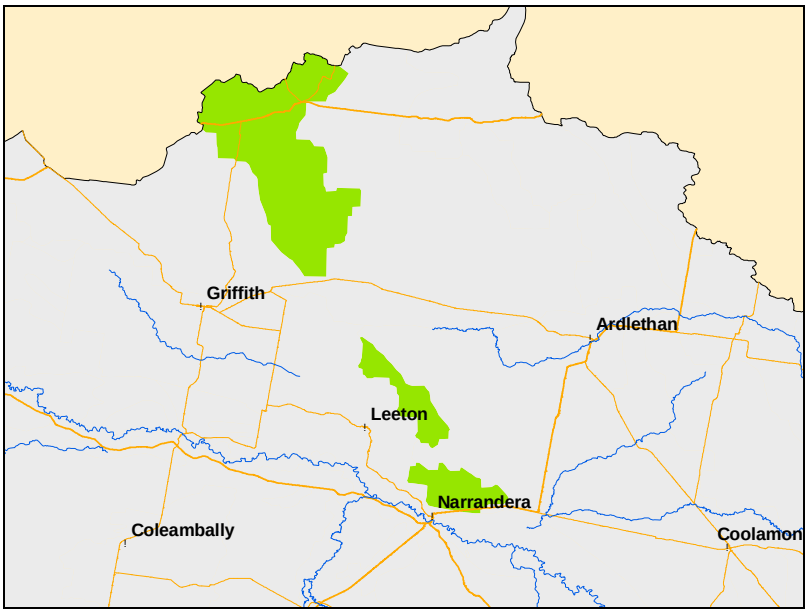
Decision rules

Hazard is low due to moderate soil salt store, deep water groundwater levels and low rainfall.

3.18 Low hazard – Area 5

L5	Rankins Springs Sedimentary Rocks	Hazard:	Low

Figure 26 Location diagram of low hazard area 5



Overview / location

This category comprises sedimentary rocks and includes the village of Rankins Springs.

Significance

Hazard Indicators	Rating
Soil salt stores	Low
Water quality (estimated stream salinity)	
Water quality (groundwater)	Marginal to brackish
Groundwater (depth)	Deep
Dryland salinity	
Stream load	
Local v regional	
Climate	<450 mm
Modifier	
Overall Hazard	**Low**

Resilience statement

Inappropriate cropping and grazing practices are the drivers for salinity development. Salinity related variables impacting the resilience of this landscape are groundcover percentage, total grazing pressure and climatic variability.

Confidence

Low. Limited available data or investigation.

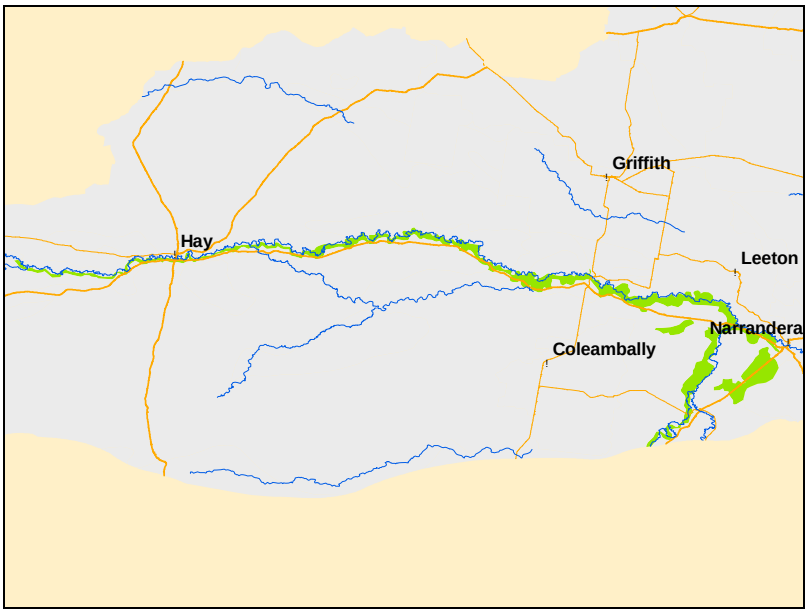
Decision rules

Hazard is low. Although soil salt stores are high, there is low availability due to heavy clay soils and low rainfall.

3.19 Low hazard – Area 6

L6	Lower Murrumbidgee Floodplain	Hazard:	Low

Figure 27 Location diagram of low hazard area 6



Overview / location

This category comprises Quaternary alluvium and includes the town of Darlington Point and the villages of Tocanmain, Corobimilla and Euroley.

Significance

Hazard Indicators	Rating
Soil salt stores	Low
Water quality (estimated stream salinity)	Variable
Water quality (groundwater)	Fresh to marginal
Groundwater (depth)	Shallow
Dryland salinity	None observed
Stream load	Variable
Local v regional	Regional
Climate	<450 mm
Modifier	Water quality and stream load affected by up-stream events
Overall Hazard	**Low**

Resilience statement

Upstream events and resulting flows and inappropriate irrigation and grazing practices are the drivers for salinity development. Salinity related variables impacting the resilience of this landscape are perenniality, groundcover percentage, total grazing pressure, inflows of saline water and/or salt loads from upstream and climatic variability.

Confidence

Poor due to limited field investigation.

Decision rules

Hazard is low due to low to moderate soil salt store and generally low availability due to heavy clay soils and low rainfall.

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Appendix 1: Factors influencing resilience in Murrumbidgee CMA

Table 2 Factors influencing resilience in Murrumbidgee CMA

Drivers	Main Variables	Thresholds	Priority Actions	Evidence gaps/needs
• Increasing urbanisation • Inappropriate planning and construction methods for salinity • Inappropriate grazing management • Inappropriate vegetation management • Inappropriate cropping practices • Inappropriate irrigation practices • Decreasing depth to water table and/or rising groundwater pressures • Clearing of native vegetation • Loss of perenniality • Loss of soil via erosion • Loss of soil health (physical, biological, chemical)	• Water table depth • Groundcover percentage • Total grazing pressure • Perenniality • Soil stability (erosion, gullying, sodic soil) • Degree of soil degradation • Type of salt (salt species) • Extent of land salinity • Stream EC • Salt load in streams • Extent of potential acid sulfate soils • Climatic variability • Planning control and policy related to salinity hazard • Groundwater quality	• Land salinity develops when groundwater is within 2 m of surface • Threshold for soil salinity impacts: 2 dS/m ECe • Threshold for soil stability ESI = EC/ESP <0.02 instantaneous dispersion on wetting; <0.05 unstable (Murphy & McKenzie 2007) • Groundcover 70% • Riparian vegetation can buffer saline discharge into streams • Point where increasing recharge exceeds plant water uptake (water balance) • Loss of soil A horizon (topsoil) • Exposure and wetting of sodic soils • Exposure of acid sulfate soil (anaerobic to aerobic) • Stream salinity thresholds: human consumption (preferred) = 500 mg/L (800 EC); ecological system function threshold will depend on asset to be protected • Land management within capability / land management not within capability threshold • Building of infrastructure (irreversible)	• Water management (irrigation and flow regime) • Appropriate grazing management • Discharge management • Soil health management • Vegetation management for production • Vegetation management for ecosystem services • Soil amelioration • Urban design catering for salinity • Riparian management • Planning related to salinity hazard • Policy related to salinity hazard	• Salinity investigations in a landscape context not complete across entire CMA area • Salinity landscape management system to a landscape facet scale required for appropriate, targeted management • MERI • Time series groundwater data • Time series stream EC data • Time series load data (including flow data) • Water use of systems used in agricultural practices • Surface-groundwater connectivity information • Salinity-sedimentation relationship information • Land use change data • Salinity outbreak data (out of date and incomplete) • Continuous spatial soil coverage (unpublished or incomplete) • Spatial Land management within Capability (LMwC) (only partial coverage)