

Soil acidity status report 2019

Draft

Kangaroo Island NRM Region



Key points:

- **Soil acidity on KI has increased in severity and extent over last 20 years, but started to improve in last 5 years**
- **Estimated value of lost agricultural production on KI due to acid soils is approx. \$1.5M per year**
- **78% (162,000ha) of KI's agricultural land has surface soil acidity (0-10cm depth)**
- **73% has sub-surface acidity (10-20cm)**
- **56% has sub-soil acidity (below 20cm)**
- **Further 7% (14,000 ha) of agricultural land could become acidic in next 10-50 years**
- **Lime use in 2019 was about 29,000t, the highest recorded**
- **Last 10 years average lime use was about 6% above acidification rate on acid soils**
- **Soil acidity will continue to increase unless lime use rates remain above current acidification rate of 14,000 tonnes per year**
- **Estimated further 331,000 tonnes lime needed to raise pH of acidic surface soils above 5.5, and 51,000 tonnes to treat acidic subsurface soils**

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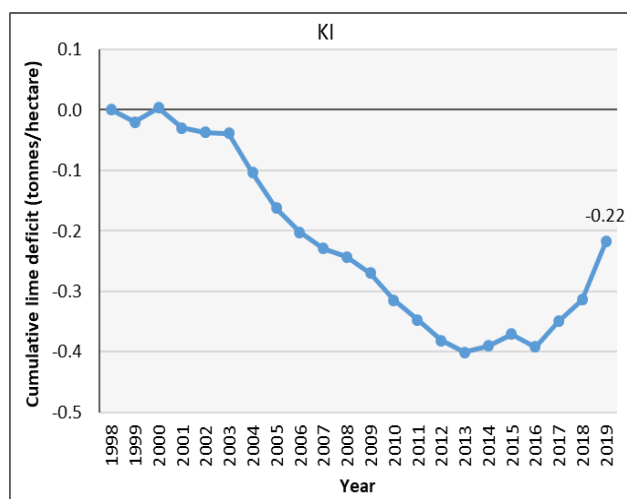
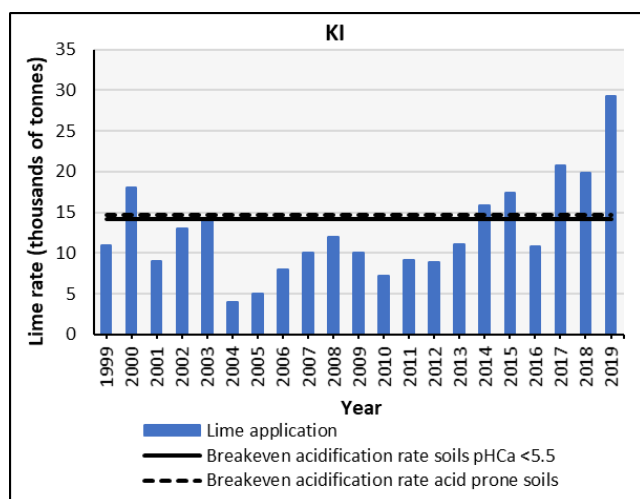
Summary (Soil acidity status report 2019 – KI NRM Region)

Extent and severity

- Approximately 78% (162,000ha) of the region's agricultural land has surface soil acidity. A similar extent of land (151,000 ha; 73%) has sub-surface acidity (approx. 10-20 cm depth) and 56% (116,000 ha) has subsoil acidity (below approx. 20-30 cm depth).
- A further 7% (14,000 ha) of agricultural land could become acidic in the next 10 – 50 years, particularly under highly productive cropping or pasture systems, if not adequately treated. This would increase the area of acid prone soils up to about 176,000 hectares by year 2065.
- In areas known or suspected to be acidic, surveillance monitoring soil tests taken in 2011-12 showed 71% of both surface soils (0-10cm) and 10-20cm depth samples were below pH_{Ca} 5.0. Nearly all (97%) surface soil tests were below pH_{Ca} 5.5.
- In a broader sample of 0-10cm depth soil pH tests on KI from the PIRSA Kingscote office 2010- 2019, 54% of tests were below pH_{Ca} 5.0, and 17% below pH_{Ca} 4.5.
- Soil pH testing has also shown that acidification (including subsoils) is occurring at a faster rate than previously measured where agricultural production is increasing.
- The estimated value of lost agricultural production in the KI region due to acid soils is approximately \$1.5 million per year.

Lime requirement and lime use

Breakeven acidification rate on soils below pH _{Ca} 5.5	14,000 tonnes/year
Breakeven acidification rate on all acid prone soils	15,000 tonnes/year
'Catch-up' lime requirement for acid soils to reach pH _{Ca} 5.5 surface / 5.0 subsurface	382,000 tonnes



- In 2019, about 29,000 tonnes of lime was used on KI, the highest recorded. The estimated lime requirement to balance the breakeven annual acidification rate for surface soils below pH_{Ca} 5.5 on agricultural land in the KI region is 14,000 tonnes of lime equivalent. Based on lime sales data, the estimated average annual lime use rate in the KI region for the last 10 years was 15,000 tonnes, which is 6% above this breakeven level. In the last 5 years, lime use increased to 38% above the breakeven. Annual lime use has varied over the monitoring period, and has mainly been below the breakeven acidification rate, but has been consistently above this level since 2017. The estimated breakeven acidification rate on all acid prone soils is about 15,000 million tonnes of lime per year.

- Since 1998, the cumulative lime deficit on acidic soils (i.e. lime use less than lime needed) reached about 60,000 tonnes of lime equivalent in 2013, but has since improved to about 34,000 tonnes, or about 0.22 t/ha on acid soils.
- Based on the potential increase in the area of acid prone soils (10 – 50 year timeframe from 2015), the annual amount of lime required to treat acidification on soils $pH_{Ca} < 5.5$ would proportionally increase, from the current 14,000 tonnes of lime equivalent to around 15,000 tonnes over this period.
- Apart from lime required to treat annual soil acidification, approximately 382,000 tonnes of lime is needed to raise the pH of currently acidic soils to a productive pH level (pH5.5 surface/5.0 subsurface). This includes approximately 331,000 tonnes of lime for acidic topsoils and about 51,000 tonnes of lime for acidic subsurface soils (10-20cm depth).

Kangaroo Island Region NRM Plan 2017-2027

Under Goal 4, Objective 4.2 states that 'The physical, chemical and biological health of agricultural soils is maintained and improved over time'. Strategy 4b is to 'Promote the application of lime sands to agricultural soils to reduce soil acidification and increase production'.

- Available data since 1999 suggest that acidification has worsened overall on KI, but in the last 3 years lime use has increased well above the estimated acidification rate, so is starting to address this objective. Lime use rates of at least 14,000 tonnes per year on agricultural land (to balance acidification and increase pH of existing acid soils to productive level) would need to be sustained to achieve this objective in the long term.

Awareness and knowledge of acidity

- Land manager surveys indicate fairly good awareness of the soil acidity issue on KI but less awareness of sub-surface acidity.
- There is some misunderstanding of the causes of and treatments for acid soils among respondents with acid soils, and a third of respondents did not know the critical pH range for acidity. About two thirds of landholders with acid soils are doing regular soil testing.
- Landholders have indicated mainly financial reasons for not liming, i.e. most consider the cost of lime is too high despite that lime on KI is the cheapest in SA.
- Most managers (83%) with acid soils said they had sought information on treating soil acidity. Of those who have limed, 80% of managers limed on the basis of soil pH test results, while 24% did this on advice from consultants.

Future implications and strategies

- Lime use rates have doubled over the past 5 years and are now slightly above the acidification rate, but current lime use rates would need to be sustained into the future or increased to overcome the accumulated lime deficit and prevent further soil acidification.
- Subsurface acidity is an established, widespread problem that is much harder to treat than topsoil acidity, and will continue to worsen where surface acidity is not adequately treated.
- pH stratification (an accumulation of lime in the topsoil and slow movement into the soil below, causing development of distinct 'layers' of pH) is an increasing issue under no-till cropping and pastures, particularly where acid sensitive crops and pasture species are grown¹.
- To achieve the KI NRM Plan target relating to soil acidity, liming rates that are at least equal to the acidification rate on all acid prone soils have to be sustained.

¹ PIRSA, Rural Solutions, Soils Team. Acidity studies including pH micro variation, surface-subsoil interactions and preliminary information on lime movement. Interim Report – June 2018

Background Information

1. Introduction

In SA's agricultural systems, acid soils are generally defined as having a pH_{Ca} (i.e. measured in calcium chloride) of less than 5.5.

The majority of agricultural land in the Kangaroo Island Region are prone to soil acidity (Section 2). Natural soil acidification rates are accelerated by the growing and removal of agricultural products. Higher acidification rates occur in high rainfall areas, on sandy textured soils, and where there are high levels of production. Increased use of nitrogen fertiliser and higher yielding crops have increased the rate of acidification and extended the areas where soils are now affected.

If soil acidity is not ameliorated by sufficient application of liming products, the consequences are:

- loss of production and financial returns, particularly for acid-sensitive plants
- progressive acidification of subsurface and subsoil layers, which are much more costly to ameliorate
- reduced uptake of soil water that can lead to rising water tables and increased soil salinity
- increased leaching of iron, aluminium and some other nutrients from the soil, potentially contaminating surface and ground water.
- Severely limited soil biological activity.

Acidic topsoils can be treated by the surface application of lime products, whereas acidic subsoils are more difficult and expensive to treat.

The estimated value of lost agricultural production in the KI region due to acid soils is approximately \$1.5 million per year (\$0.6M crops, \$0.9M pastures). Statewide, this estimate is at least \$83 million to \$86 million. This estimation is based on current gross margins for crops and grazing enterprises in each region, using 2016 crop types by area and estimated yields (PIRSA). This takes into account cropping and grazing intensity, and uses available experimental yield loss data for crops and pasture species according to pH/acid soil sensitivity. The estimated area of acid soils by pH range in each region is used as per the estimation of 'catch-up' lime requirement in section 5.

The development of acidity in susceptible agricultural areas of Kangaroo Island previously unaffected has been recognised for some time. High-production farming practices will continue to acidify these areas and the extent of acidic land will increase unless adequate ongoing treatment is implemented.

Kangaroo Island Region NRM Plan 2017-2027

Kangaroo Island's Strategic Natural Resources Management Plan 2017-2027 has a specific strategy to address soil acidification.

Under Goal 4, Objective 4.2 states that 'The physical, chemical and biological health of agricultural soils is maintained and improved over time'. Strategy 4b is to 'Promote the application of lime sands to agricultural soils to reduce soil acidification and increase production'.

This document aims to summarise the current status and trends of soil acidity on agricultural land on Kangaroo Island, by presenting and discussing available land resource information, recent soil pH test data, survey data on landholders' awareness of, attitudes towards and treatment of acid soils. It also provides some strategies for addressing this issue.

2. Land resource summary

The area of surface soils (0-10cm depth) currently acidic or likely to become acidic in the next 5 to 10 years is approximately 78% (162,000 ha) of the cleared land on Kangaroo Island. This is about 8% of the acid soils in the state. An estimate of the current area of acidic soils with pH_{Ca} less than 5.5 based on recent soil pH testing is given in section 3. In addition to surface acidity, there are about 151,000 ha (73%) on KI with sub-surface acidity (10-20 cm depth) and 116,000 ha (56%) with subsoil (below approx. 20-30 cm depth) acidity.

Figure 1 shows the extent of current and potential acidity (in next 10 to 50 years) on agricultural land on Kangaroo Island.

It is estimated that a further 14,000 ha (7%) of cleared land on KI has the potential to become acidic in the longer term future, ie 10 – 50 year timeframe, assuming that current farming production practices continue and if these soils are not treated.

Highly productive, intensive cropping systems with high nitrogen inputs cause the highest acidification rates so this land is most at risk of future acidification, even though the current soil pH may be close to neutral (e.g. pH_{Ca} 6 - 7). This will occur more quickly on soils with low pH buffering capacity (ie sandy textured soils).

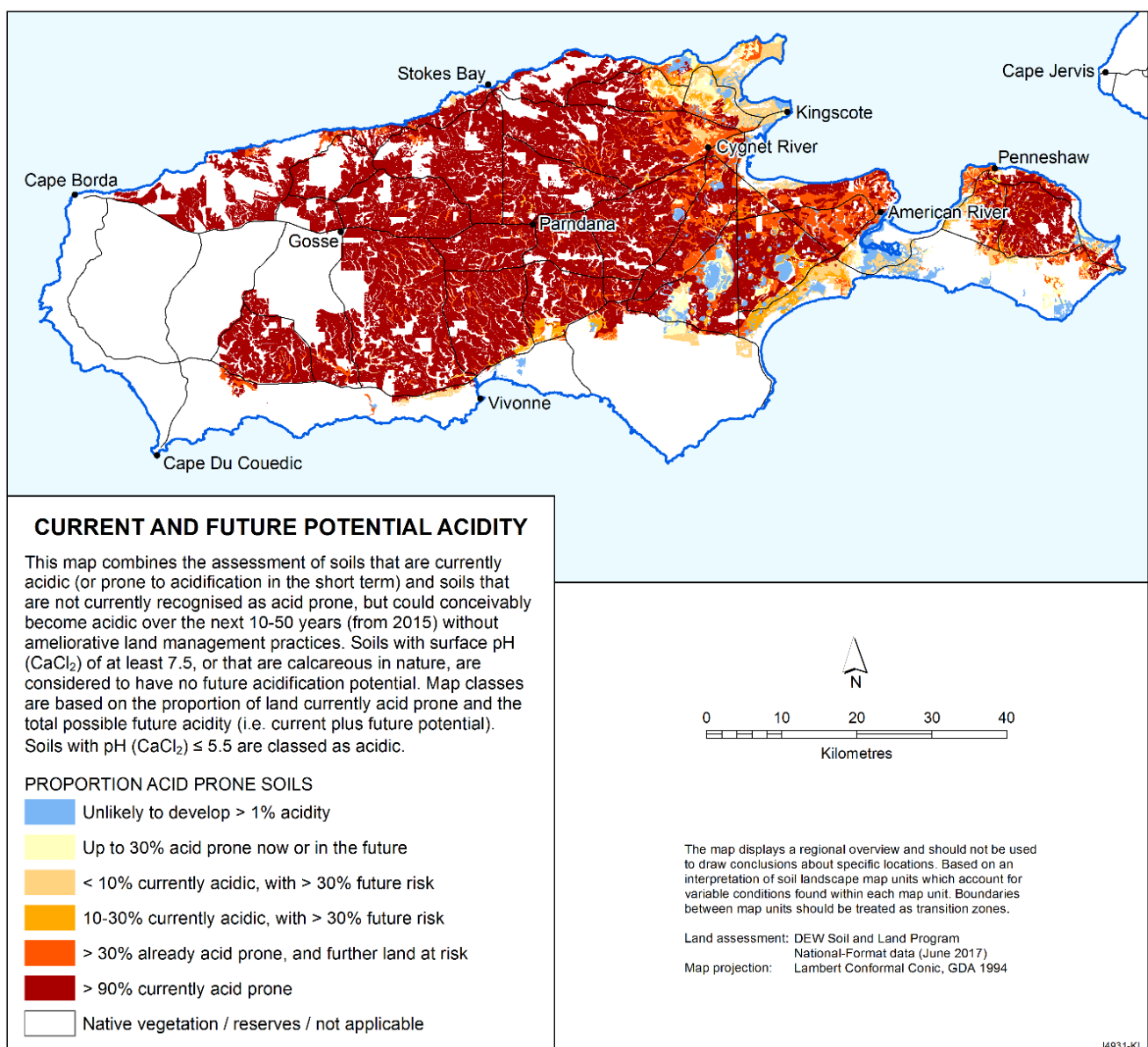


Figure 1 Estimated extent of current and potential acidity in next 10 to 50 years on agricultural land on Kangaroo Island

3. Soil pH test data

Recent soil pH test data sets help show the current extent of acidic soils on Kangaroo Island².

During 2011-2012, soil pH was sampled from 86 surveillance monitoring sites on KI, mostly in acid prone areas where there was a lack of recent soil test data. Nearly all of surface soil (0-10 cm depth) tests (97%) and 10-20 cm depth tests (95%) were below pH_{Ca} 5.5. In both these layers, 71% had a pH_{Ca} of less than 5.0, and an average pH_{Ca} of 4.8. Notably, 14% of surface soil tests and 5% of 10-20 cm tests were highly acidic, ie pH_{Ca} of less than 4.5.

These results and a representation of these surface soil pH tests on maps of acid prone land are shown in Appendix 1 and 2.

There are also nearly 2400 surface soil pH tests held at PIRSA Rural Solutions SA's Kingscote office soils database which have been analysed for the period 2010 - 2019. The pH data has been summarised by Hundred location in Appendix 3. Analysis of this data showed that 83% of surface soil samples had a soil pH_{Ca} of less than 5.5, 54% had a soil pH_{Ca} of less than 5.0, and 10% were highly acidic with a pH_{Ca} of less than 4.5. The average soil pH_{Ca} was 5.1, the lowest pH_{Ca} value recorded was 3.9 and the highest was 8.5.

Soil pH testing at monitoring sites under highly productive cropping systems has also shown that acidification in the surface soil and at depth is occurring at a much faster rate than previously measured.

² Brian Hughes, Rebecca Tonkin, Brett Masters, Lyn Dohle, Andrew Harding & Mary-Anne Young (2017) Review Of Soil Acidity Monitoring Sites SA's Agricultural Soils Department of Environment, Water and Natural Resources Government of South Australia

4. Knowledge, awareness and attitudes of landholders regarding soil acidity: information relevant to the KI NRM Region

DEW has commissioned a series of telephone surveys of agricultural land managers in SA (broadacre dryland cropping and livestock/dairy) between 2000 and 2017 to obtain data on soil and land management practices used in their farming systems, and their understanding of soil acidity.

Over the period of the surveys, around 40-80% of surveyed land managers on KI considered that they have acid soils. In the 2017 survey, 55% of respondents with acid soils considered they also have sub-surface soil acidity.

About two thirds of survey respondents with acid soils indicated they did regular soil testing.

In the 2014 survey, around two thirds of managers with acid soils could correctly identify the critical soil pH for acidity in the range pH 4.5 – 6.0 (regardless of test method).

The land manager survey data also indicate there is some misunderstanding about the causes of and treatments for soil acidity (Figure 2). For example, in the 2017 survey, some (28) respondents mistakenly considered that gypsum can be used to treat acidity, and 58% of respondents also wrongly thought that superphosphate was a direct cause of acidity. There was, however, a high level of recognition that it is beneficial to apply lime before any signs of production decline occur. Results were similar in previous surveys.

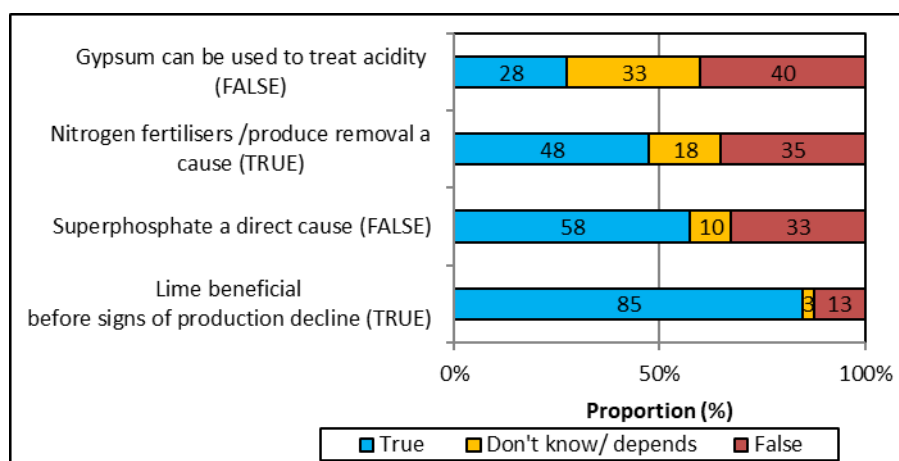


Figure 2. Proportion of true/false responses given to statements about causes and treatments of soil acidity, land managers with acid soils on KI, 2017 survey

Most (92%) of managers with acid soils said they had applied lime to at least some of their acid soil areas at some time. They were asked what prompted them to lime. Figure 3 shows that a large proportion of managers limed on the basis of soil pH test results, while about a quarter did this on advice from consultants.

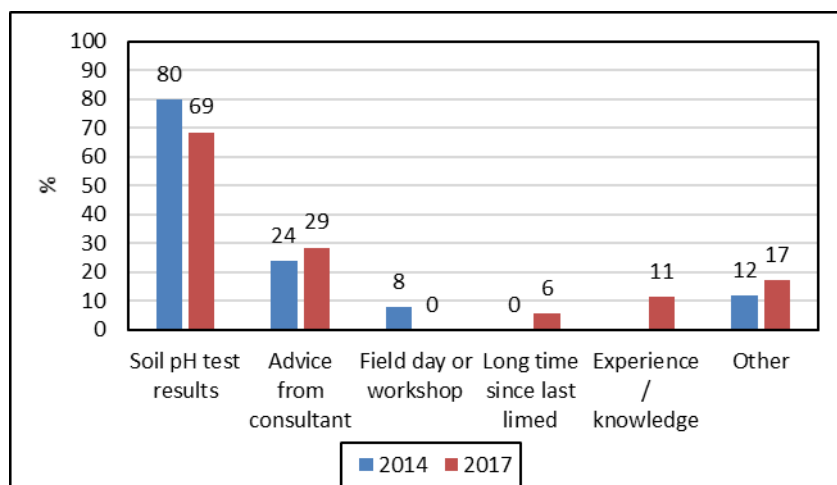


Figure 3. Reasons that prompted managers with acid soils to apply lime, KI, 2014-2017 surveys.

About 80% of managers with acid soils said they have sought information on treating soil acidity. Figure 4 shows the more common sources were an agronomist/consultant or DEWNR/PIRSA staff.

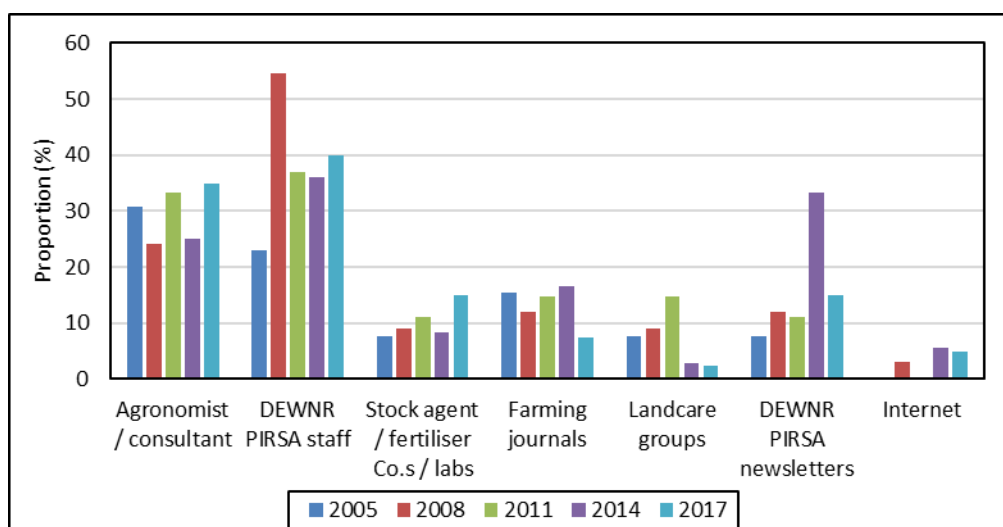


Figure 4. Sources of information sought for treating soil acidity by managers with acid soils, KI Region.

In surveys since 2011, about a third of respondents with acid soils said they had used other options to manage acid soils, including using acid tolerant plants, adapting fertiliser strategies, and clay spreading.

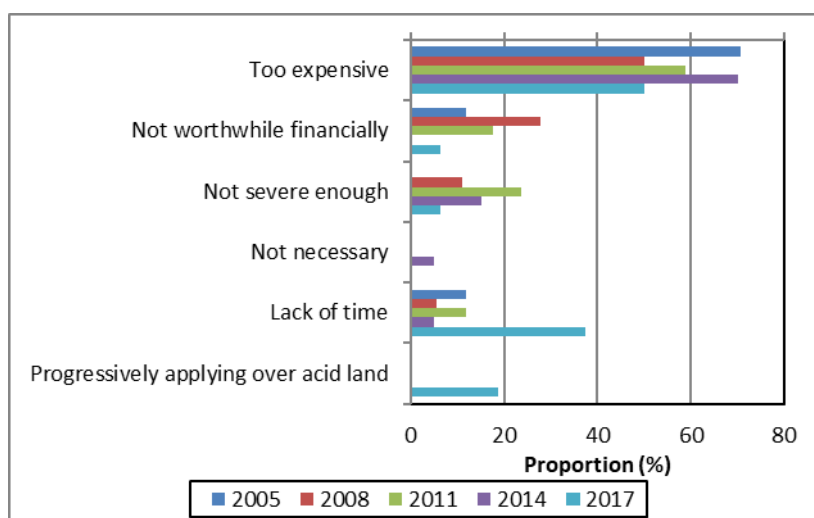


Figure 5. The most common reasons given for not liming by KI landholders with acid soils

Respondents reported that the main reasons for not liming some or all of their acid soils were related to the cost of lime (Figure 5). This is despite the fact that lime on KI and its freight costs are the cheapest in SA. It is generally recognised however that it is not so much the cost of lime as such but that land managers tend to place liming as a lower priority among annual farming input costs compared to fertiliser, chemicals etc. A significant number in the 2017 survey said they didn't have the time to apply lime, while some noted they are progressively liming their land (from year to year).

5. Treatment of soil acidity

Lime sales and estimated soil acidification rate

DEW collates data from lime resellers regarding the estimated amount of lime applied to ameliorate soil acidity on agricultural land on KI. This lime sales data (tonnage) is compared to an estimation of the amount of lime that would be required to neutralise the annual acidification rate of soils. The acidification rate is estimated from a number of parameters, including soil type, annual rainfall, and the extent and intensity of agricultural production systems that contribute to soil acidification through removal of alkaline products in crops and pastures and the use of nitrogen fertilisers.

The annual acidification rate in the KI region was recently revised using the latest available data. This included the results of surveillance and monitoring soil pH test data sampled from acid prone soil areas in 2011-12 (section 3). The potential extent that soil acidity in acid prone areas could be treated by claying with clay material containing free lime was estimated as part of this calculation. Estimated acidification rates for different land use categories is given in Appendix 4. The following data only applies to surface (0-10 cm) soil acidification. The additional amount of lime needed to treat sub-surface acidification has not been estimated.

(1) The estimated breakeven acidification rate on acidic soils, i.e. currently with a surface pH_{Ca} of less than 5.5.

This represents soils that are already acidic and currently need lime application to treat acidification, to avoid production loss and degradation of the soil resource. This is approximately 14,000 tonnes of lime equivalent per year, or about 91 kg lime per hectare per year on currently acidic soils.

(2) The estimated acidification rate on acid prone soils.

This includes soils already acidic, and those that are acidifying but pH levels have not yet declined to 5.5. At this stage it would not be economic to apply lime to these soils. This is approximately 15,000 tonnes of lime equivalent per year, or about 91 kg lime per hectare per year on acid prone soils. This is only marginally higher than the breakeven for current acid soils, because data indicates most soils in acid prone areas on KI are below pH 5.5.

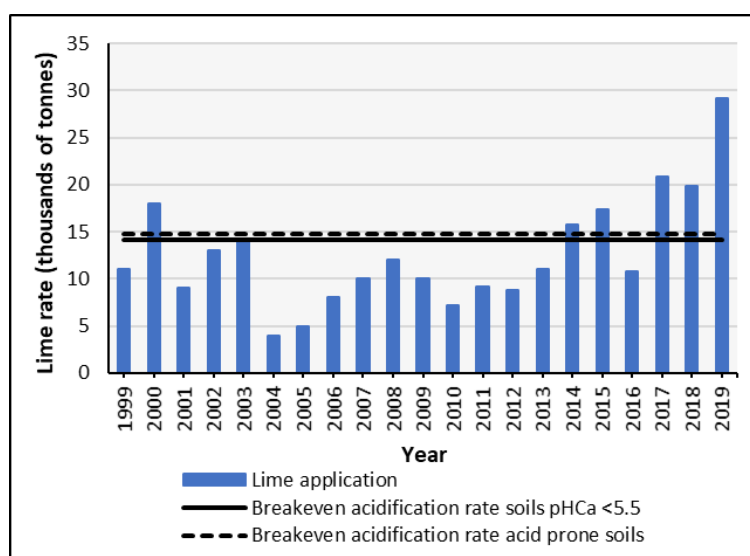


Figure 6 Estimated application of lime ('000 tonne) per year on agricultural land on Kangaroo Island 1999 to 2019 with the breakeven acidification rate for all acid prone soils and the breakeven acidification rate for currently acidic soils with pH_{Ca} of less than 5.5.

Note: Year on chart represents actual corresponding financial year (ie '2015' = 2014-15)

Figure 6 shows estimated annual lime use on KI since 1999, with the acidification rate rates for currently acid soils and all acid prone soils. Annual lime use has varied over this period, has been mainly below the breakeven acidification rate for acid soils, but has been significantly above this level since 2017. The lime use in 2019 was the highest recorded since monitoring began.

The following table summarises the estimated lime use on KI over different time periods as a percentage of the breakeven acidification rate for acid soils. The average annual lime use rate in the KI region for the last 10 years was 15,000 tonnes, which is slightly (6%) above the breakeven acidification rate. Over the last 5 years, average lime use increased to 38% above the breakeven.

Monitoring period ending 2019	Average lime use '000 t/y	Breakeven acidification rate acid soils '000 t/y	Average lime use % of breakeven
Last 5 years	20	14	138
Last 10 years	15	14	106
Last 20 years	13	14	89

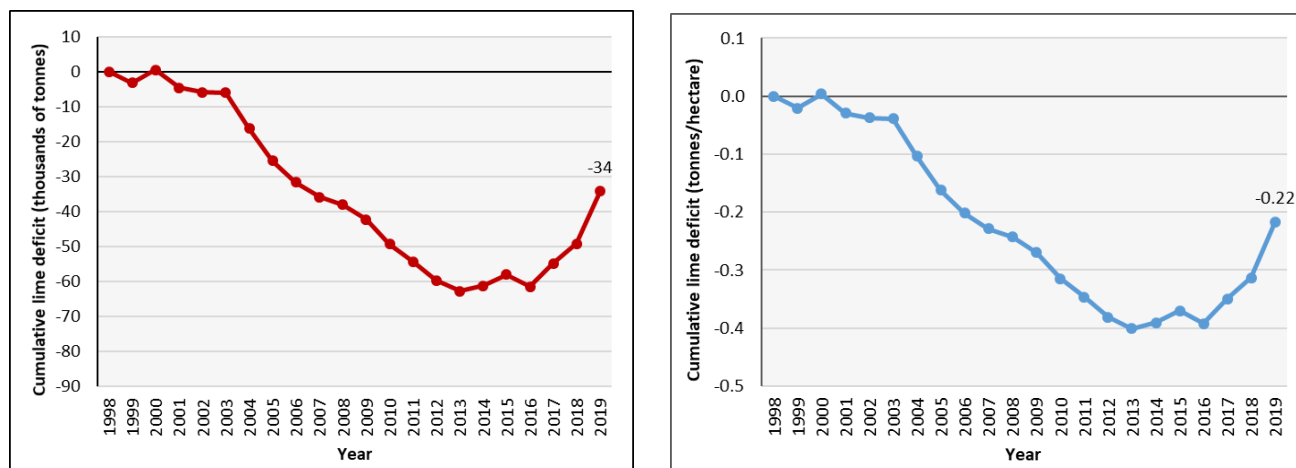


Figure 7. Estimated net acidification (ie cumulative lime deficit) since 1998: Left chart – thousands of tonnes of lime equivalent; Right chart – tonnes lime equivalent per hectare of acid soil pHCa < 5.5, on KI from 1998 to 2019.

Figure 7 shows the estimated net acidification, or cumulative lime deficit on KI since the start of the lime sales data collection in 1999 (nominal baseline year 1998). This is the yearly lime use minus the estimated breakeven acidification rate on acid soils pHCa < 5.5 (i.e. lime applied minus lime required). Over this period, the net acidification accumulated to about 60,000 tonnes of lime equivalent by 2013, but has improved since then to 34,000 tonnes (or about 0.22 tonnes per hectare of acid soil) as lime use rates have increased above the lime requirement. The cumulative lime deficit prior to 1998 has not been estimated.

Potential acidification

It has been estimated that a further 7% (14,000 ha) of cleared land on KI has the potential to become acidic in the longer term (next 10 – 50 years from 2015), if acidification is not adequately treated (Section 2).

This would increase the area of acid soils from the current 162,000 hectares to about 176,000 hectares by year 2065 (representative scenario shown in Figure 8). If this occurs, the annual amount of lime required to treat acidification on soils pH_{Ca} <5.5 would proportionally increase, from the current 14,000 tonnes of lime equivalent to around 15,000 tonnes over this period. If significant land use changes occur (e.g. increased cropping) this target would be higher.

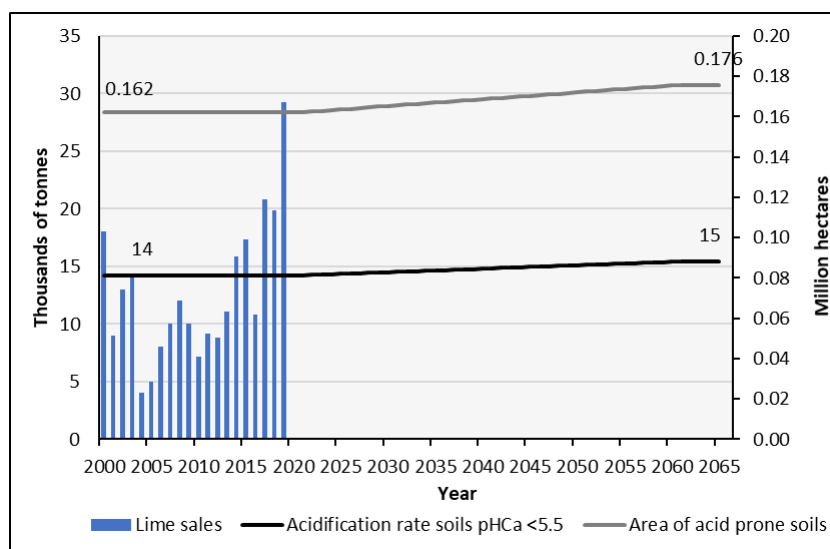


Figure 8. Annual lime use, representation of projected potential increase in acidification rate on soils below pH CaCl 5.5 and potential increase in area of acid prone soils on KI from 2015 to 2065

Lime needed to raise pH of soils already acidic

In addition to the amount of lime required to treat the annual acidification rate, more lime needs to be applied to raise the pH of existing acidic soils to above the critical level for crop and pasture production. The extent and pH level of current acid soils (surface and subsurface) on agricultural land on KI has been recently re-estimated based on the surveillance and monitoring site soil pH test data sampled in acid prone areas over the last 10 years (Section 3). The pH buffering capacity of soils in acid prone areas according to soil texture spatial data has also been incorporated into this estimate.

The 'catch-up' lime requirement to raise the pH of existing acid topsoils to pH_{Ca} 5.5 and subsurface soils (10-20cm depth) to pH_{Ca} 5.0 on KI is approximately 382,000 tonnes of lime. This includes about 331,000 tonnes of lime to raise the pH of all acidic topsoils, plus a further 51,000 tonnes of lime to ameliorate acidity in acidic subsurface soils.

Lime treatment

Precision soil pH mapping of paddocks is increasingly used in the region to enable lime application according to pH variation within a paddock. This can improve the cost effectiveness of liming to treat acid soils. Trial work with precision soil pH mapping commenced on KI in 2013. Commercial operators now visit KI to undertake precision mapping of pH (as well as other soil nutrients) to enable lime rates to be targeted and varied according to pH variation within a paddock. Precision pH mapping has worked well with dryland cropping soils but there have been problems sampling some pasture soils to appropriate depths due to compaction and soil strength.

A set of acid soils/liming calculator 'tools' for land managers has been recently developed through the DEW soil acidity program. These can be used to estimate the financial loss due to acid soils; the most cost effective lime source/rate options; and the longer term 'maintenance' lime requirement for any crop/pasture situation.

6. Climate change implications

The possible effect of climate change on soil acidification in the Kangaroo Island Region is difficult to predict because it would depend on changes in land use and land management that might occur.

In general, indications are that climate change will cause a decline in annual rainfall and warmer temperatures.

In medium to low rainfall areas, this is likely to result in reduced soil acidification rates due to less plant growth, less nitrogen fertiliser used, less nitrogen leaching and a smaller amount of product removal.

However, in higher rainfall grazing areas, soil acidification rates could increase, if there is a land use change to cropping where more nitrogen fertilisers and grain legumes are used; or if more nitrogen fertilisers are applied to pastures.

Conversely, if projected increases in summer rainfall encourage a greater amount of deeper rooted, non-legume perennial plants to be grown, this could increase nitrate uptake from the subsoil, reducing the leaching of nitrogen, a factor in soil acidification.

Whatever changes to soil acidification may occur over time due to climate change, current soil acidification is a high priority in acid-prone areas in the KI region and need to be addressed to prevent it from worsening and reducing production.

7. Links to state-wide soil acidity strategy

The issues and strategies described in this snapshot report relate to a state-wide draft strategy prepared by DEW "Strategy for Managing Soil Acidity on South Australia's Agricultural Soils".

The aim of this strategy is:

Degradation of South Australia's agricultural soils by acidification is halted by restoring or maintaining soil pH to at least 5.0 (measured in CaCl₂).

8. Key issues for the future

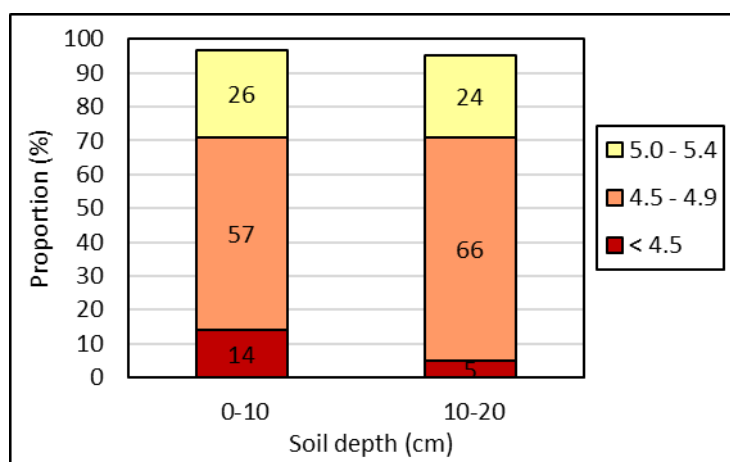
Key issues to address in future soil acidity programs in the Kangaroo Island Region are:

- Awareness - landholders aware of and informed of the problems of acid soils, critical pH, and crop sensitivity
- Subsoil/sub-surface Issues – subsoil/subsurface (i.e. 10-20cm, 20-30 cm) pH testing needs to be undertaken and encouraged because conventional soil testing only determines the surface soil pH, and once it develops, subsoil acidity is difficult to treat
- pH stratification after liming - understanding of pH stratification (an accumulation of lime in the topsoil and slow movement into the soil below, causing development of distinct "layers" of pH) is required under cropping and pasture systems. Techniques that enhance the movement of lime such as lime source, rate, other liming agents, biological process (eg dung beetles) and strategic tillage will need to be evaluated to determine the best approach to move lime more quickly into subsurface layers where stratification is happening, and where sensitive crops are being established (e.g. lentils, beans, lucerne)
- Paddock Variation - systems which enable mapping of paddock variation in pH have been recently evaluated and demonstrated so that liming treatments can be targeted to variation of pH within a paddock
- Cost:Benefit of Treatment- While the cost of treating acid soils is relatively cheap compared to other parts of Australia, the issue of cost vs perceived benefits from treatment needs to be further addressed, so landholders will recognise the longer term benefits of investing in adequate liming
- Offsite and Irreversible Issues - A study assessing the off-site and irreversible soil degradation issue linked to soil acidity in the KI Region should be developed to provide information to encourage treatment of acidity.

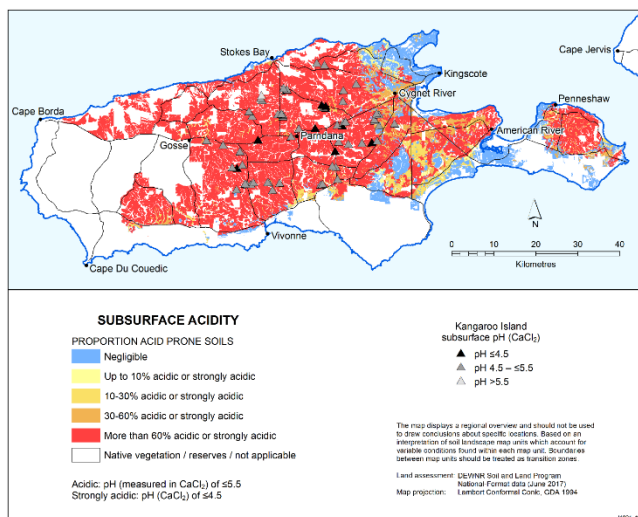
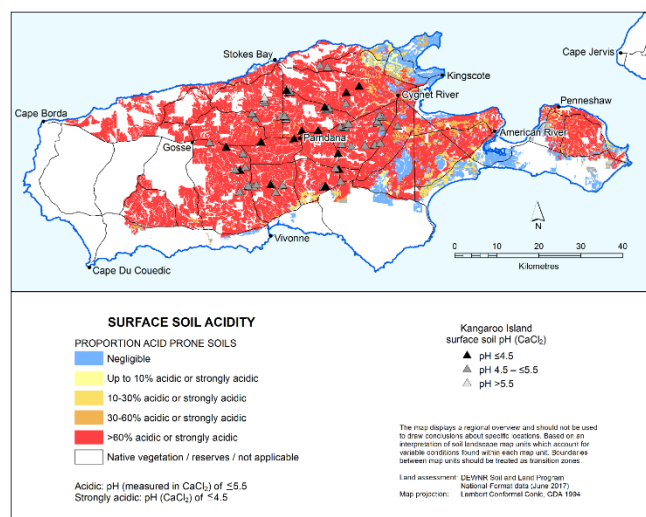
Appendices

Appendix 1: Results of surveillance/monitoring soil pH testing in acid prone areas of KI in 2011-12

Depth (cm)	No. of samples	% pHCa <4.5	% pHCa <5.0	% pHCa <5.5	Lowest pHCa	Highest pHCa	Mean pHCa
0-10	86	14	71	97	4.2	6.2	4.8
10-20	62	5	71	95	4.3	5.7	4.8

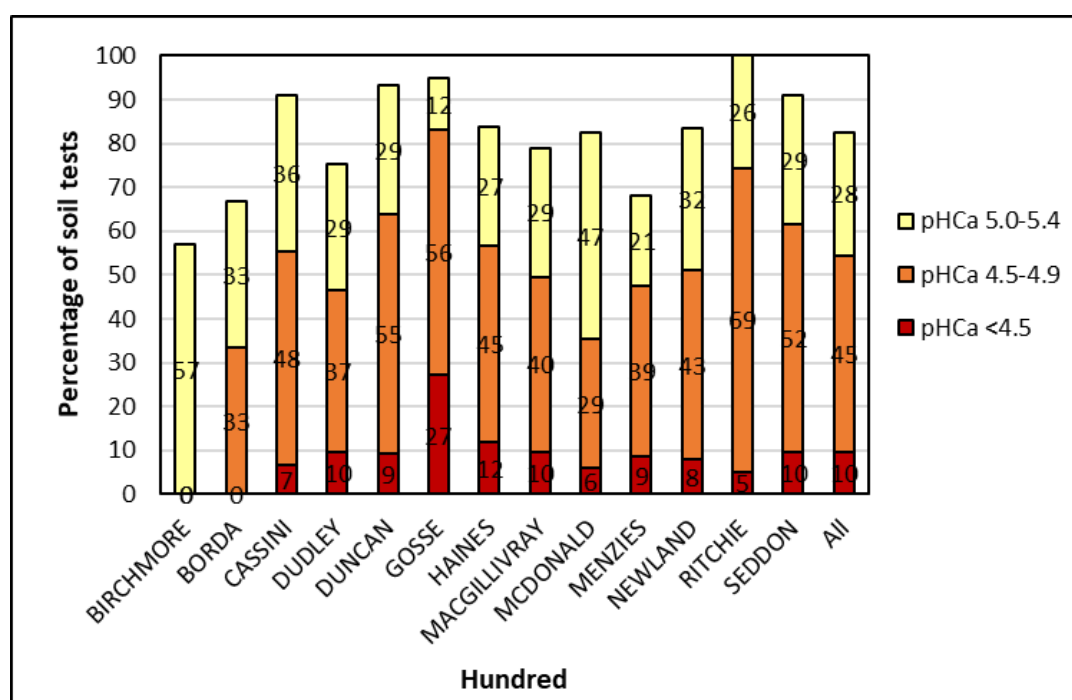


Appendix 2: Maps showing location of 2008-10 surface (0-10 cm depth) and sub-surface (10-20cm depth) soil pH tests overlain on mapped areas of current acid prone soils on Kangaroo Island (most recent test result at each site shown).



Appendix 3: Results of surface soil (0-10 cm) pH_{Ca} tests from the PIRSA Kingscote office soil test database from 2010 to 2019

Hundred	Number of samples	Mean pH _{Ca}	Lowest pH _{Ca}	Highest pH _{Ca}	% pH _{Ca} <4.5	% pH _{Ca} <5.0	% pH _{Ca} <5.5
BIRCHMORE	14	5.4	5.0	6.1	0	0	57
BORDA	9	5.3	4.8	6.4	0	33	67
CASSINI	132	4.9	4.2	7.0	7	55	91
DUDLEY	242	5.2	4.1	7.6	10	47	75
DUNCAN	308	4.9	3.9	7.0	9	64	93
GOSSE	59	4.7	4.0	6.5	27	83	95
HAINES	228	5.0	4.2	7.5	12	57	84
MACGILLIVRAY	404	5.1	4.1	7.8	10	50	79
MCDONALD	17	5.2	4.4	6.2	6	35	82
MENZIES	345	5.4	4.0	7.7	9	48	68
NEWLAND	276	5.0	4.2	8.5	8	51	83
RITCHIE	39	4.8	4.3	5.3	5	74	100
SEDDON	310	4.9	4.0	7.7	10	62	91
All	2383	5.1	3.9	8.5	10	54	83



Appendix 4: Estimated acidification rates for land use types

Acidification rates based on available data for different land uses and intensities in the KI region that were used to estimate the annual acidification rate.

Land use	Category / intensity	Acidification rate (kg/ha/y lime equiv)	Comments
Cropping	Continuous cropping	250	
	Intensive cropping	200	
	Cropping / Grazing	100	
Grazing	Intensive grazing	150	
	Good (moderate intensity) grazing	100	
	Extensive grazing	40	
	Non-arable grazing	30	
	Irrigated pasture	150	
Forestry		50	Limited data
Horticulture	Greenhouse	0	
	Annual	500	Mainly seed potatoes high N use
	Fruit	100	
	Vines/ Olives	50	

Glossary

Acid prone soils - (or 'acid soils' based on soil characterisation survey data) soils that are currently or imminently prone to becoming acidic (next 5 – 10 years). The actual pH level for any soil depends on management (production intensity, liming history etc).

Future acidification potential – soils not currently acidic but have the potential to become acidic in the medium to long term (next 10 – 50 years). These are soils that are not calcareous and have a current estimated pH_{Ca} less than 7.5, and are likely to be acidifying over time under agricultural use.

Currently acidic soils – estimated to have current pH_{Ca} less than 5.5 based on recent (2008 - 2015) targeted soil testing programs as described in section 3.

Soil pH_{Ca} – soil pH measured using a standardised method of a suspension of 1:5 soil:0.01 molar calcium chloride solution (Rayment, GE & Higginson, FR 1992, *Australian Laboratory Handbook of Soil and Water Chemical Methods*. Inkata Press, Melbourne. (Australian Soil and Land Survey Handbook, vol 3)).