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Natural Resources
SA Murray-Darling Basin

SAMDB NRM Region Soil Carbon Baseline Report (for the period 1989-2017)

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1 Executive Summary

This report establishes a baseline for soil organic carbon (OC) in the South Australian Murray-Darling Basin Natural Resource Management (SAMDB NRM) region. Soil OC levels and proportion of soil samples analysed within low, medium and high OC levels for soil texture, land use and NRM region were defined over time 1989-2017.

Key findings:

Soil Texture

Overall, 49% of topsoil samples are in the high, 35% in the moderate and 16% in low OC range.

Average OC for SAMDB topsoil textures

Sand	0.87%
Loamy sand	1.26%
Sandy loam	1.86%
Loam	2.25%
Clay loam	2.15%
Clay	2.14%

Time

Due to sample numbers available for interrogation, there is high confidence in OC results for 1989-2007 but low confidence for >2008. However, OC results post 2008 can be used as a guide to trends.

From the rolling 3 year mean

- 0.07% p.a. increase in OC from 1989-2007
- confirmed increasing OC trend 2008-2017

Over 5 year time frames increasing proportion of samples in the high OC range.

Land use and NRM District

Pasture has the highest average OC values with the majority of samples (85%) in the high OC range.

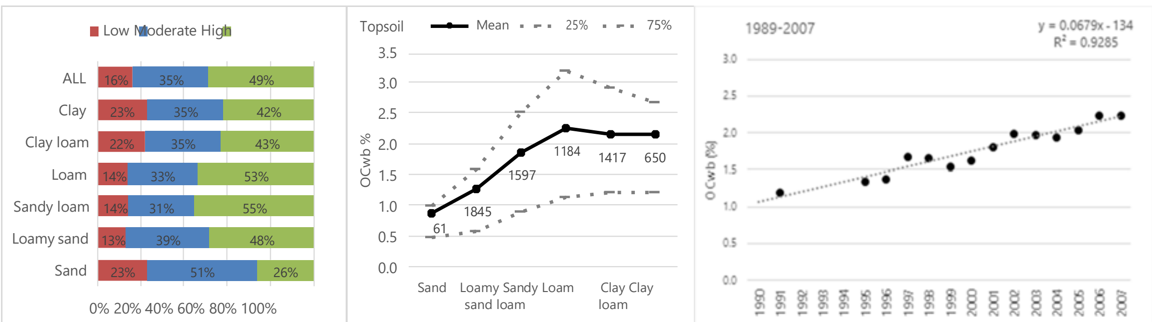
The other land uses have lower but similar average OC values. Cropping and vegetables have the greatest proportion of samples (55-59%) in the moderate OC range whilst orchards and vineyards have a large proportion of samples (36%) in the low OC range.

OC values for NRM District are largely influenced by rainfall and land use.

Opportunity to increase OC

If there are no limitations to rainfall and land use there is potential to increase OC values in:

- sands from the moderate to high range
- clay loam to clays from the low to moderate and moderate to high range
- cropping and vegetable from the moderate to high range
- orchards and vineyards from the low to moderate range and moderate to high range
- subsoil although it can be difficult to influence organic matter inputs at this depth



Key graphical OC summaries for soil texture (Figures 7 and 8 in report) and rolling 3 year mean displaying the trend for increasing OC 1989-2007 (Figure 5 in report). .

2 Introduction

At the global scale, the most significant threats to soil function are erosion, nutrient imbalance (including acidity) and loss of soil organic carbon (FAO and ITPS, 2015). Many countries use these 'threats' as indicators of soil condition defining the proportion of land below desirable levels.

This report establishes a baseline for soil organic carbon (OC) in the South Australian Murray-Darling Basin Natural Resource Management (SAMDB NRM) region. Soil OC levels and proportion of soil samples analysed within low, medium and high OC levels for soil texture, land use and NRM region were defined over time 1989-2017.

Soil OC provides key ecosystem services including provision of food and fibre, habitats of biodiversity, climate regulation, water filtration and purification (Trivedi *et al*. 2018). Within the soil matrix OC plays a critical role, creating aggregates of soil particles, stabilising structure, increasing water infiltration and overall water holding capacity, storing and releasing nutrients, and improving cation exchange and buffering capacity. Where soils are below a desirable level, increasing soil OC improves soil health, resilience, productivity and offsets greenhouse gas emissions.

The amount of OC in soil is the balance between the rate of input (plant residue, composts or manures) and output (CO_2 release from microbial decomposition, leaching and soil erosion). There are a number of factors that individually or in combination affect the total amount and distribution of OC in the profile, including soil type, climate, topography and soil biota. The potential of a soil to increase OC depends on the possibility of increasing OC inputs so they exceed outputs, the conversion of OC inputs into more stable forms of OC for long-term storage and the capacity of the soil to store more OC (will depend if OC equilibrium has been reached).

The SAMDB NRM region covers more than 5.6 million hectares with approximately 2.5 million hectares of cleared agricultural land. Annual rainfall ranges between 250 and 800+ mm and influences the amount of organic matter that can be grown and incorporated into the soil. In 2008, the major agricultural land uses were grazing of modified pastures (25%), grazing of natural vegetation (21%) and cropping (19%). Irrigated agriculture comprised 2% of the regions land use and occurs adjacent to the Murray River and Angas Bremer catchments in the Eastern Mt Lofty Ranges and parts of the Murray Mallee (SAMDB NRMB, 2015). Soils vary by location but there is a dominance of sandy textured surface soils covering 66% of the area (1.7 million hectares).

The amount of stored OC varies among soil types and is largely due to the clay concentration that influences the capacity for plant productivity and protection of OC from microbial breakdown (Baldock and Skjemstad 1999). Therefore, lighter texture surface soil (sand to sandy loam) is expected to have lower OC values than heavier textured soil (loam to clay).

3 Background

It is difficult to identify changes to soil organic carbon in the absence of long-term soil monitoring sites. Interrogation of soil analyses results can provide substitute organic carbon (OC) baseline and condition indicators.

Due to the absence of long-term soil monitoring sites in the SAMDB NRM region, soil analytical results predominantly from the State Government's Analytical Crop Management Laboratory (ACML) service (1989-2007), along with results from private companies and NRM projects, were collated into a single dataset[1]. Selection of suitable data was based on records with OC, postcode[2], sampling date, sampling depth and where recorded included soil texture and land use. Duplicate records were identified and removed.

OC analysis was by wet oxidation, Walkley Black method - the most common test offered by laboratories in Australia. This test provides an approximate measure of soil organic carbon (SOC) due to an incomplete reaction in the oxidation of the organic matter (~80% of TOC). However, it does not measure inorganic carbonates (inorganic C) that is often present in South Australian soils. High concentrations of inorganic C can make small changes in OC difficult to detect. The use of catalysed, high temperature combustion (Leco) is a requirement to measure soil C under the Carbon Farming Initiative (Australian Government 2018). However, this analytical method measures carbonates. Chemically removing carbonates increases the accuracy of the TOC measurement but is time consuming, costly and not commercially available.

Attributing baseline OC levels based on laboratory analysis introduces uncertainty due to different methods of sample collection, potential contamination of samples, use of different laboratories etc. However, the large number of samples from the ACML dataset[3] counteract the uncertainties resulting in high confidence in the baseline OC results (1989-2007). Alternatively, the accuracy of results collected from project areas[4] is high, however the small number of samples from this dataset, particularly from 2008, lead to low confidence that they are representative of the whole NRM region and consequently cannot be used for baseline figures over time. However, there is confidence that the data can be included for baseline values by soil type and land use and used as a guide for OC trends from 2008.

The combined dataset is robust with 7,395 soil samples with year of sampling recorded, 7,302 samples with soil texture recorded and 6,228 samples with land use recorded. Exploratory analysis determined average, minimum, maximum, 25th and 75th percentile values per: year, five-year time frame, land use and soil texture. The proportion

[1] There are likely to be written records of OC in the SAMDB prior to 1989 from old trial sites however due to time limitations this data was not able to be collated.

[2] Postcode was the one field common to the majority of records. However, the postcode could be the landholders postal address rather than the actual location of the property. It would be ideal to spatially represent the data by hundred or similar but unfortunately this level of detail is not available.

[3] Dataset characteristics ACML: unknown methods of collecting soil samples which may lead to a bias for OC values eg collection of a 0-5 rather than 0-10 cm sample; more confidence that the high number of samples is representative of the MDB region.

[4] Dataset characteristics smaller datasets: more confidence in accuracy of sample collection as most collected for use in projects; lower sample numbers result in uncertainty in representation of the whole MDB region.

of samples within low, moderate and high OC ranges were also determined. Simple linear regression was run to identify factors that explained the variance in OC.

Topsoil was classified as 0-10 cm for cropping and 0-15 cm for horticultural and grazing, 10 or 15-30 cm for subsurface and anything below 30 cm was classified as subsoil.

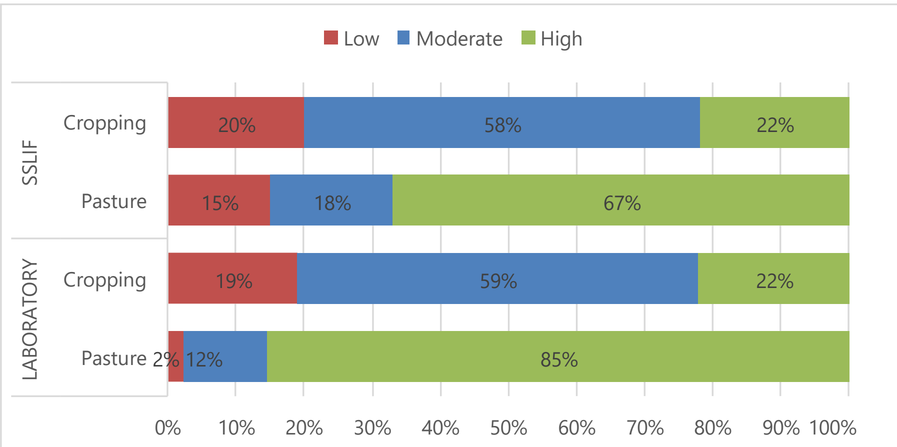
The greatest number of samples was in the topsoil layer as most soil tests were undertaken to determine macro nutrient concentrations. With greater awareness of the importance of chemical, physical and biological parameters on plant function from subsurface and subsoil layers, samples are increasingly being collected deeper in the soil profile. The low number of samples from subsurface and subsoil provide an indication of trends rather than a baseline for the region.

The Department for Environment and Water's, Science and Information Group provided draft regional soil carbon maps based on data from the State Soil and Land Information Framework (SSLIF) following the methodology in Young *et al*. 2017. These maps are currently under revision and have been included as a guide. The SSLIF is based on soil samples collected in the late 1990's to early 2000's. Topsoil OC values (%) from individual characterisation sites from the SSLIF within the SAMDB region were overlaid on the soil carbon stock map.

High confidence in soil texture and land use OC baseline from 1989-2017.
High confidence in OC baseline values for period between 1989-2007.
Low confidence for baseline OC values over period between 2008-2017 as a result of low number of samples analysed and not representative of the whole region. This data can be used as a guide to trends over time.

3.1 Comparison of combined dataset to State Soil Database - SSLIF

Characterisation sites in the state soil program (State Soil and Land Information Framework) have approximately 200 samples (compared to 7302 from laboratories) with the majority within cropping and pasture land uses. Comparison of topsoil samples within the OC range show similar trends for both data sources providing confidence in the results (Figure 1).



Number samples

60

123

2152

2259

Figure 1. Comparison in proportion of samples in the high, moderate and low OC range for samples from collated laboratory dataset and state soil and land information framework (SSLIF) characterisation sites.

4 Soil Carbon Resource and Condition

4.1 Regional Carbon Stock Maps - State Soil and Land Information Framework

Organic carbon (OC) maps provided by the Department for Environment and Water's, Science and Information Group provide a guide to the soil carbon stocks in the State's agricultural lands. There is large variability in the current OC stock (Figure 2 and Figure 3) in the 0-30 cm depth for the SAMDB NRM region, ranging from 2.5 t/ha (near Loxton) to > 50 t/ha (Eastern slope of the Mt Lofty Ranges within the Ranges to River NRM district). This variability is largely driven by soil texture, rainfall and land use. There is a theoretical opportunity to increase soil carbon stocks up to 15-20 t/ha (Figure 4) particularly in areas east of the Murray River. The opportunity on land west of the Murray River will require further investigation.

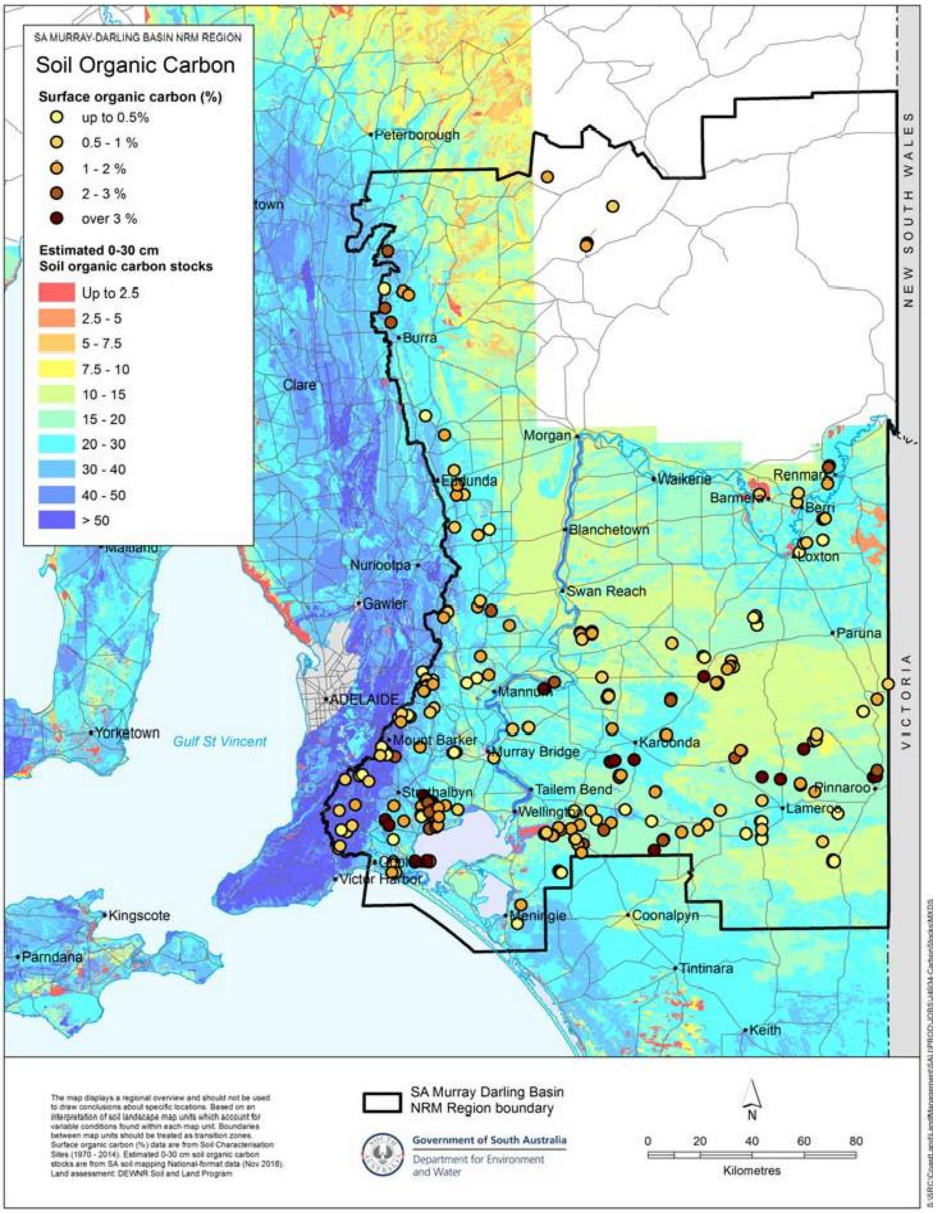


Figure 2. Calculated OC stock of the surface 0-30 cm overlaid with topsoil OC values (%) from individual characterisation sites from the SSLIF for the SAMDB region.

Source: Department for Environment and Water, Science and Information Group.

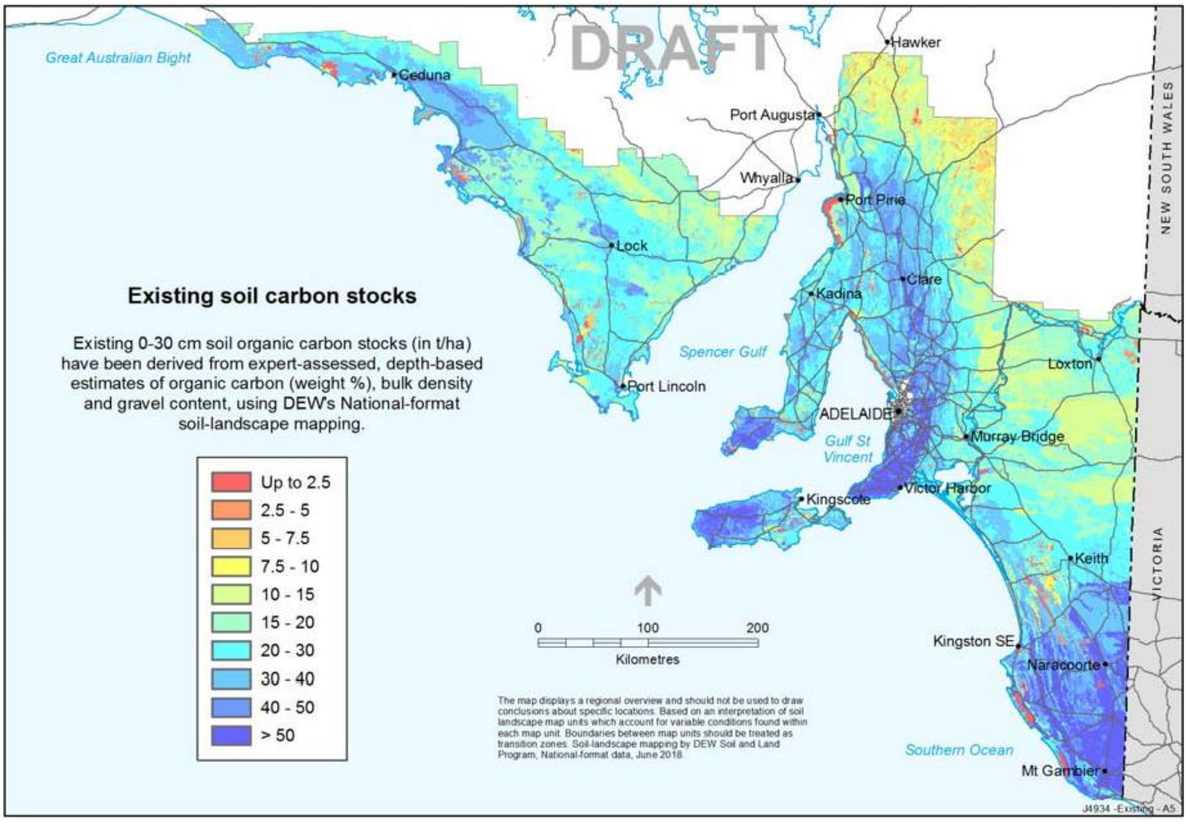


Figure 3. Calculated OC stock of the surface 0-30 cm from data collected in the SSLIF (1990's-early 2000's).
Source: Department for Environment and Water Science and Information Group.

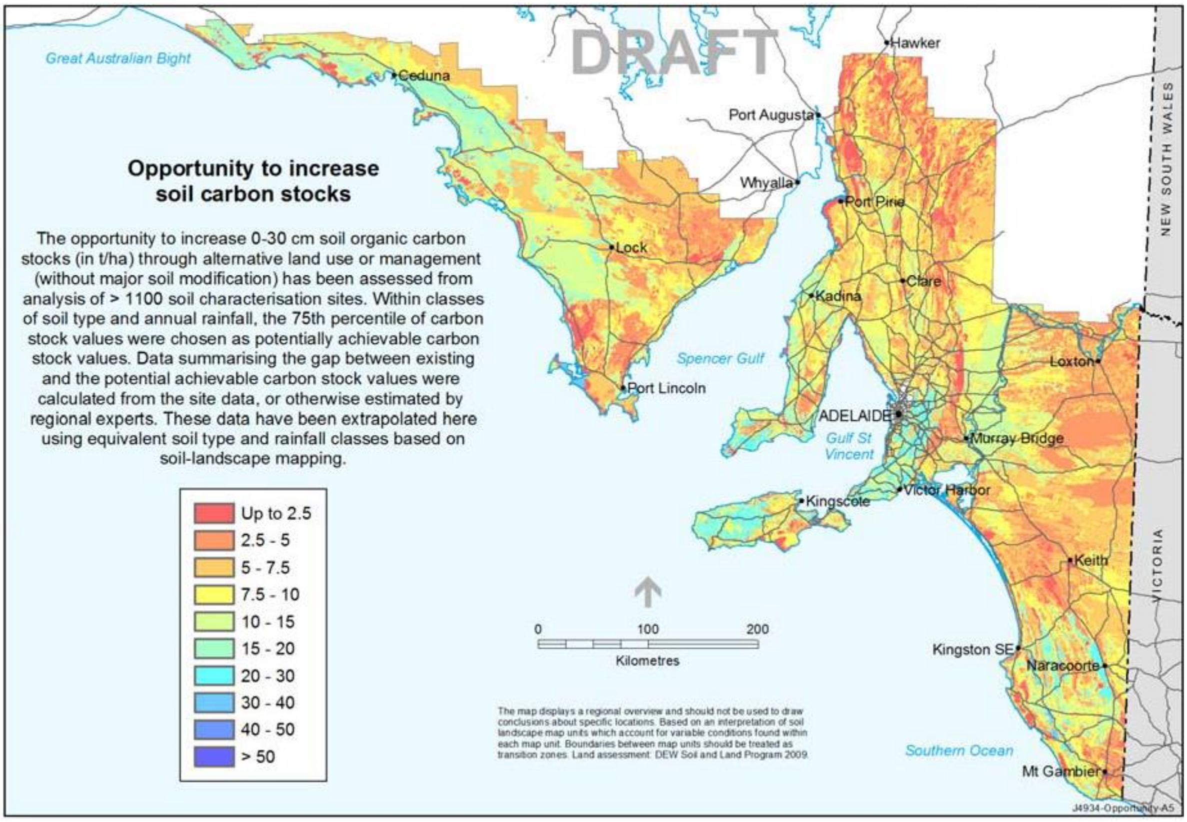


Figure 4. Calculated opportunity to increase OC stock in the 0-30 cm.
Source: Department for Environment and Water Science and Information Group.

4.2 Baseline and trends of soil carbon levels

As a result of the number of samples included in this analysis, there is strong confidence in the OC baseline for soil texture, land use and time frame 1989-2007, but lower confidence for OC baseline for time frame 2008 onwards. When OC trends are displayed over time, data is separated by pre and post 2008 but is not necessary for soil texture or land use.

4.2.1 Time

OC in the topsoil (0-10 or 0-15 cm) show a general increasing trend in OC levels over time (Figure 5). Strong annual fluctuations are evident. To minimise the seasonal effect, the mean of three years of data were used (Figure 6). The rolling three year mean demonstrated an annual OC increase of 0.07% for 1989 to 2007. Although the actual OC values are not accurate for 2008-2017[5], the trend line also shows an increase over time.

Further interrogation of the dataset over time for soil texture and land use was conducted for 5 year timeframes. There is an increasing trend in OC values over time with an increasing proportion of samples shifting from the low and moderate to high OC range (Figure 7 and Figure 8).

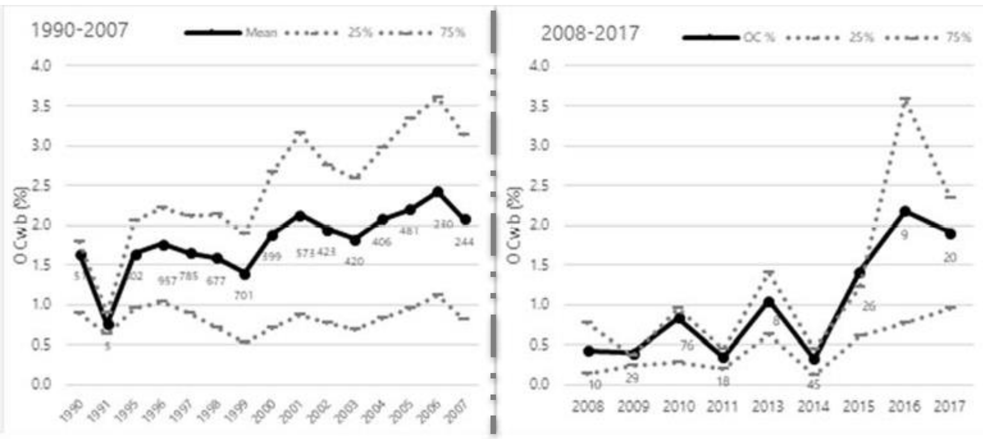


Figure 5: Annual topsoil OC trends showing average OC, number of samples, upper (75%) and lower (25%) bands. *Data is separated into 1990-2007 where there is high confidence in baseline OC values and 2008-2017 where there is low confidence in baseline due to low sample numbers. However, the trends from post 2008 can be used.*

Due to sample numbers available for interrogation, there is high confidence in OC results for 1989-2007 but low confidence for >2008. However, OC results post 2008 can be used as a guide to trends.

From the rolling 3 year mean

- **0.07% p.a. increase in OC from 1989-2007**
- **confirmed increasing OC trend 2008-2017**

Over 5 year time frames increasing proportion of samples in the high OC range.

[5] Due to the low number of laboratory analysis available for this time period

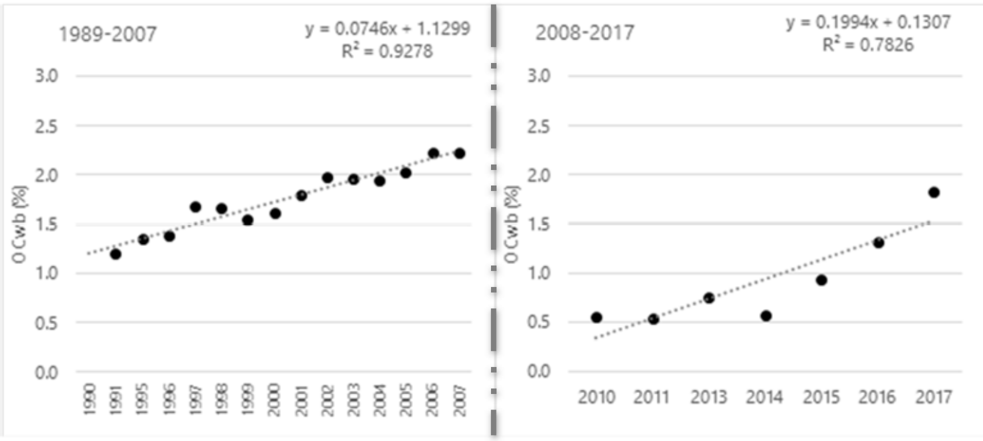


Figure 6: Rolling 3 year mean to minimise seasonal effects displaying the trend for increasing OC over time.
Data is separated into 1990-2007 where there is high confidence in baseline OC values and 2008-2017 where there is low confidence in baseline due to low sample numbers. However, the trends from post 2008 can be used.

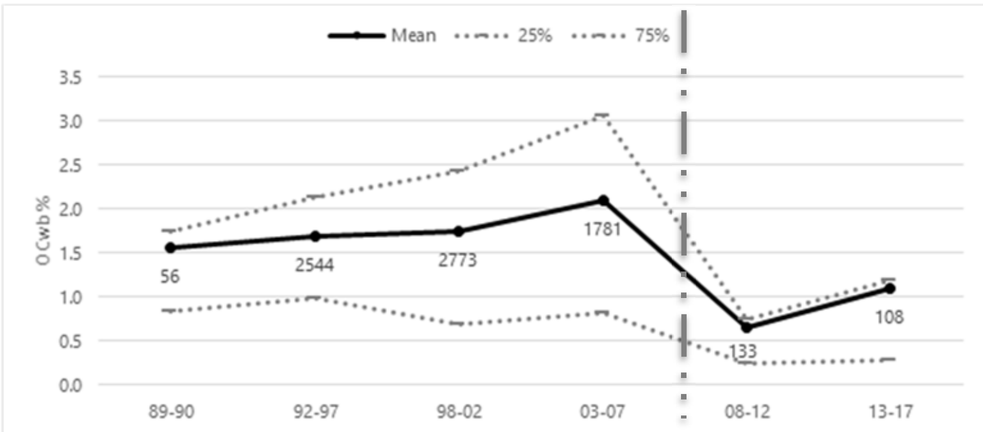


Figure 7: Five year OC trends average OC, number of samples, upper (75%) and lower (25%) bands.
Data is separated into 1990-2007 where there is high confidence in baseline OC values and 2008-2017 where there is low confidence in baseline due to low sample numbers. However, the trends from post 2008 can be used.

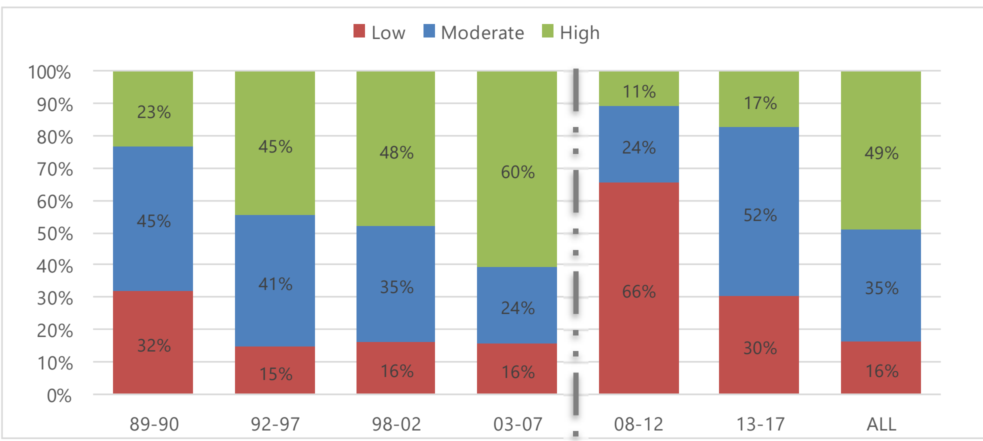


Figure 8: Proportion of texture samples in the high, moderate and low OC range over five-year timeframe.
Data is separated into 1990-2007 where there is high confidence in baseline OC values and 2008-2017 where there is low confidence in baseline due to low sample numbers. However, the trends from post 2008 can be used.

4.2.2 Texture

Soil texture (clay content) largely determines the potential OC storage in soil. The potential is greater for clay than sandy soils. This is an important consideration for the lighter textured topsoils that make up 66% of the SAMDB NRM region. Therefore, it is critical to consider soil texture when defining OC standards. OC standards for low, medium and high OC ranges exist for the topsoil layer of South Australian agricultural soil (Table 1).

Table 1: OC standards for the topsoil layer of South Australian agricultural soil with consideration of soil texture (Standards B. Hughes PIRSA).

	Sand to Loamy sand	Sandy loam	Loam	Clay loam to Clay
Low	< 0.4	< 0.6	< 0.8	< 1.1
Moderate	0.5 - 0.9	0.7 - 1.3	0.9 - 1.7	1.2 - 1.9
High	> 1.0	> 1.4	> 1.8	> 2.0

On average for all soil textures (7302 samples) compared to the OC standards with texture considered, approximately half were in the high range (49%) with 35% in the moderate and 16% in the low range (Figure 9). Further analysis by topsoil texture found a similar proportion of topsoil samples in the high OC range for textures loamy sand to clay (~50%). However sand has 26% in the high and 51% in the moderate range and clay loam to clay have 23% in the low and 35% in the moderate range.

If there are no limitations to rainfall and land use there is potential to increase OC values in :

- **in sands from the moderate to high range**
- **in clay loam to clays from the low to moderate, and moderate to high range**

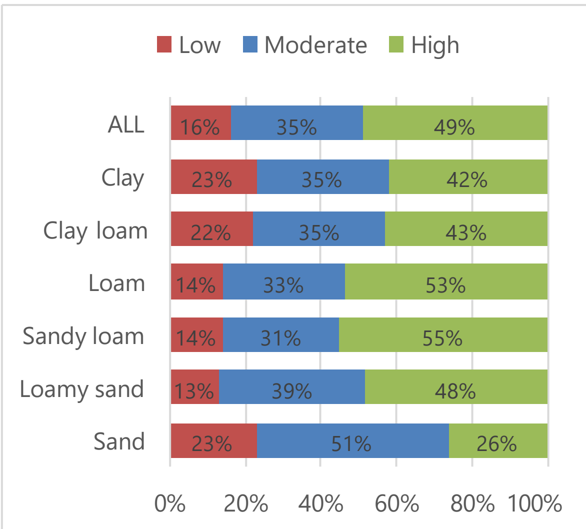


Figure 9: Proportion of texture samples in the high, moderate and low OC range.

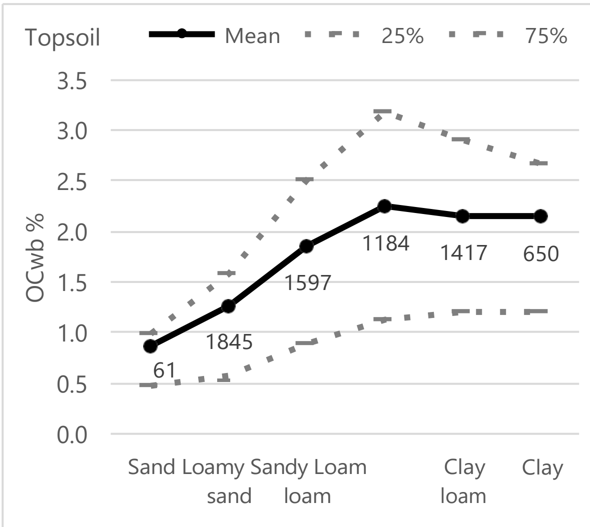


Figure 10: OC benchmark by texture for all soil depths displaying average OC, number of samples, upper (75%) and lower (25%) bands

As expected, OC values in the whole soil profile increased with increasing texture (clay content). Average OC values were lowest in sand (0.87%) and highest in loams (2.25%) with a plateau or slight decline in OC for clay loam (2.15%) to clay top soil (Figure 10, Appendix Table 2). The lower OC values in the clay loam to clay soils may be influenced by rainfall that is limiting OC inputs to the soil.

4.2.3 Texture x soil depth

Soil depth influences OC values as OC decreases with soil depth. Different factors affect OC in the surface and subsoil, environmental and management factors strongly influence OC in the surface 10 cm whereas soil type and water availability more influential below 20 cm.

Topsoil and subsurface layers have a positive response to OC with increasing clay concentration (texture). The highest OC value is in the loam for the topsoil and clay loam for the subsurface (Figure 11). There is insignificant change to OC values in the subsoil that likely reflects the lower inputs of organic matter to this depth.

There is an opportunity to increase OC values in the subsoil as the soil matrices are not saturated by OC. However, it can be difficult to influence organic matter inputs at this depth particularly in areas where rainfall limits biomass growth and hence organic inputs.

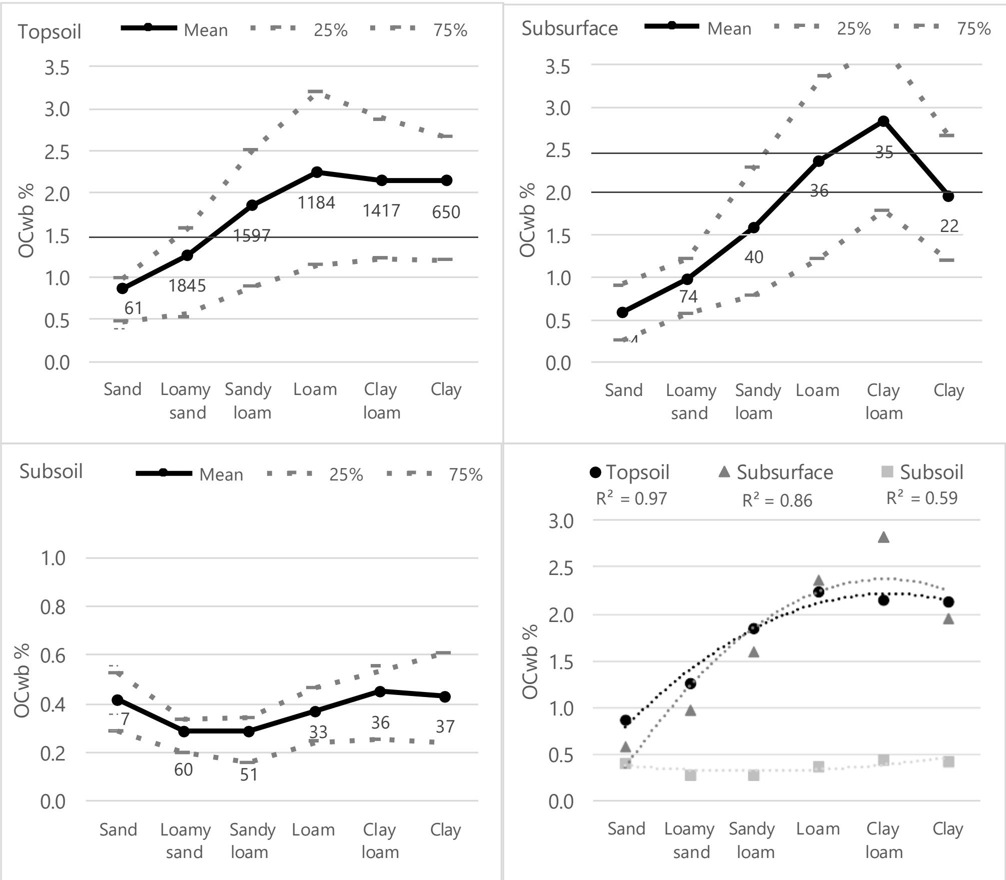


Figure 11: OC baseline average OC, number of samples, upper (75%) and lower (25%) bands for soil layers topsoil, subsurface, subsoil and the model of best fit for OC by soil layer.

4.2.4 Soil Carbon by agricultural industry / land use

A review by Sanderman *et al.* (2010) established that under Australian conditions, conversion of native land for agriculture has resulted in 40 to 60% loss of soil OC. Increases in OC have been demonstrated under improved management of cropland[6] (such as improved rotation, adoption of no-till or stubble retention) compared to traditional tillage based management but Sanderman *et al*. state:

- the greatest theoretical potential for C sequestration within existing agricultural systems will likely come from large additions of organic materials (manure, green wastes, biochar), maximising pasture phases in mixed cropping systems, shifting from annual to perennial species in permanent pastures,
- the greatest gains are expected from more radical management shifts such as conversion from cropping to permanent pasture, retirement and restoration of degraded land.

Pasture has the highest average OC values with the majority of samples (85%) in the high OC range (Figure 12 and Figure 13). Cropping and vegetables have similar OC values (but considerably lower than pasture), with the greatest proportion of samples (55-59%) in the moderate OC range. Although the average OC value is similar for orchards and vineyards to cropping and vegetables, there was a greater proportion of samples (36%) in the low OC range.

There is an opportunity to:

- **maintain but unlikely to significantly increase OC values in pasture**
- **increase OC in cropping and vegetables through a shift from moderate to high OC range**
- **increase OC in orchards or vineyards through a shift from low to moderate and moderate to high OC range**

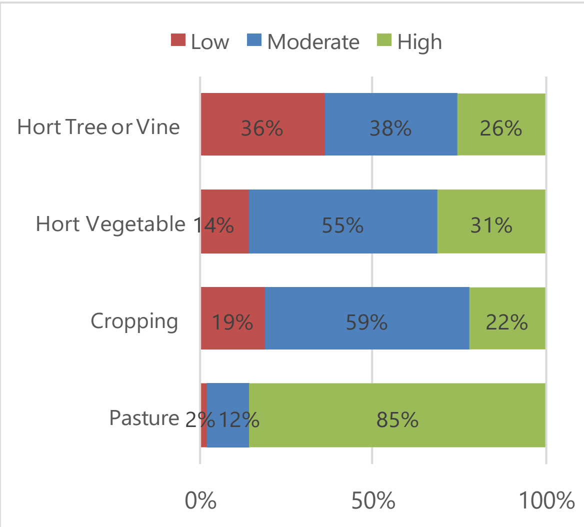


Figure 12: Proportion of samples in the high, moderate and low OC range for dominant land uses

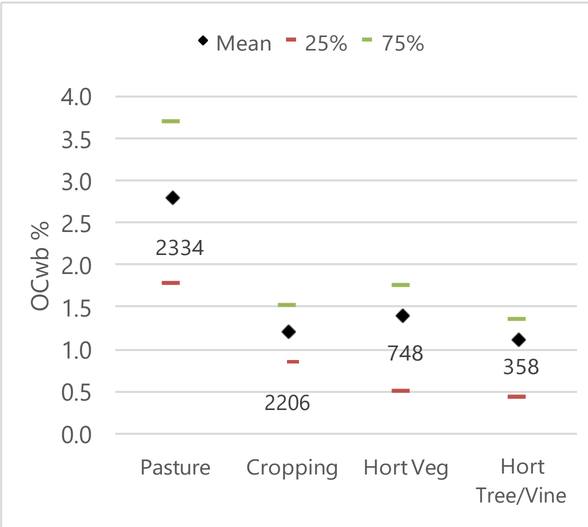


Figure 13: OC baseline average OC, number of samples, upper (75%) and lower (25%) bands for land use

[6] Early studies on conserving or increasing soil OC under Australian cropping conditions identified the importance of conservation tillage (e.g. no-till with stubble retention) versus conventional tillage. However, little to no differences in OC were found in areas with rainfall below 500 mm because of limitations to biomass production.

4.2.5 Rainfall / Postcode

Water availability has a major influence on OC inputs in Australia, where both the total amount and distribution of annual rainfall is important. Where water availability is limiting, biomass production is reduced, affecting OC input into soil. Organic matter decomposition is controlled by temperature and water availability and largest changes occur where total annual rainfall is between 400 to 600 mm.

Rainfall data was not available for the samples analysed. However, samples were grouped into postcode and NRM District (Figure 14). The proportion of samples in the OC range for representative postcodes[7] demonstrates the differences that occur in the four NRM Districts (Figure 15). Factors such as rainfall, soil texture and land use will strongly influence OC values.

There is an opportunity to:

- **maintain but unlikely to significantly increase OC values in Ranges to River**
- **increase OC in Rangelands through a shift from moderate to high OC range**
- **increase OC in Mallee and Coorong through a shift from low to moderate and moderate to high OC range**
- **increase OC in Riverland through a shift from low to moderate OC range**

Figure 14. SAMDB NRM Districts; Ranges to River, Mallee-Coorong, Rangelands, Riverland. Source: SAMDB 2015.

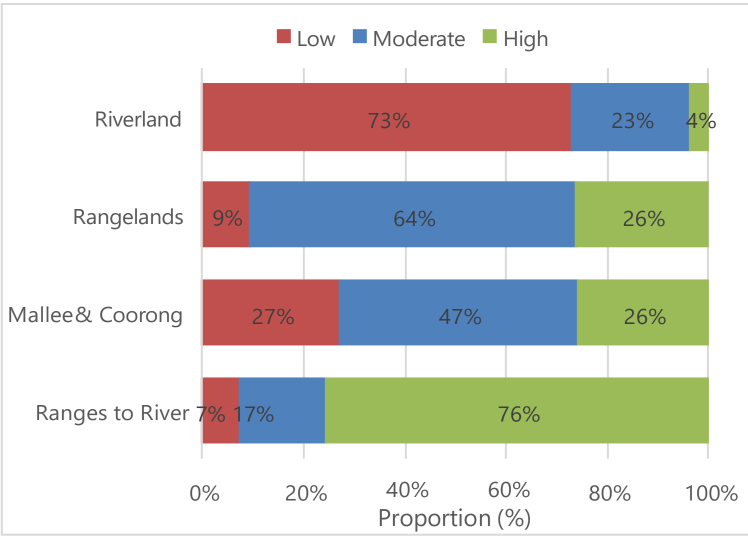


Figure 15. Proportion of representative samples in the high, moderate and low OC range for NRM District

[7] Representative postcodes were required to have data for all years 1989-2007

Trends over five year timeframe show variation within NRM Districts that is likely due to seasonal, soil type and land use influences (Table 2). Overall, Ranges to River and Rangelands decrease in proportion of samples in the low OC range whilst increasing the high OC range. Mallee and Coorong and Riverland show a decrease in proportion of samples in the low OC range with an increase in the moderate and high range for 1989-2002 (Figure 16). However from 2003-2007 there is an increase in the proportion of samples in the low OC range.

Table 2. Proportion of representative samples* in the high, moderate and low OC range for each NRM region over five year time frame. * *Only postcodes that had OC ranges for all four time frames are displayed.*

		Proportion in High OC Range 5 Year Time frame				Proportion in Low OC Range 5 Year Time frame			
NRM District	Postcode	89-90	92-97	98-02	03-07	89-90	92-97	98-02	03-07
Ranges to River	5153	67%	95%	98%	94%	0%	0%	1%	0%
	5201	100%	92%	94%	98%	0%	4%	4%	2%
	5210	100%	96%	93%	99%	0%	0%	0%	0%
	5214	50%	77%	75%	35%	50%	7%	0%	17%
	5244	67%	88%	65%	89%	0%	1%	10%	2%
	5255	0%	44%	48%	52%	38%	9%	15%	13%
Mallee & Coorong	5261	0%	55%	51%	27%	100%	6%	6%	5%
	5264	0%	58%	63%	86%	0%	1%	5%	0%
	5302	0%	43%	11%	0%	0%	21%	9%	100%
	5304	0%	8%	12%	0%	75%	28%	28%	50%
Rangelands	5374	33%	29%	53%	13%	17%	15%	0%	0%
	5413	0%	43%	43%	82%	17%	0%	0%	3%
	5417	0%	21%	19%	33%	0%	21%	19%	0%
	5454	0%	15%	50%	0%	0%	10%	0%	0%
	5491	0%	8%	33%	50%	50%	27%	11%	0%
Riverland	5330	0%	0%	3%	1%	100%	70%	30%	82%
	5333	0%	6%	3%	17%	100%	66%	69%	67%

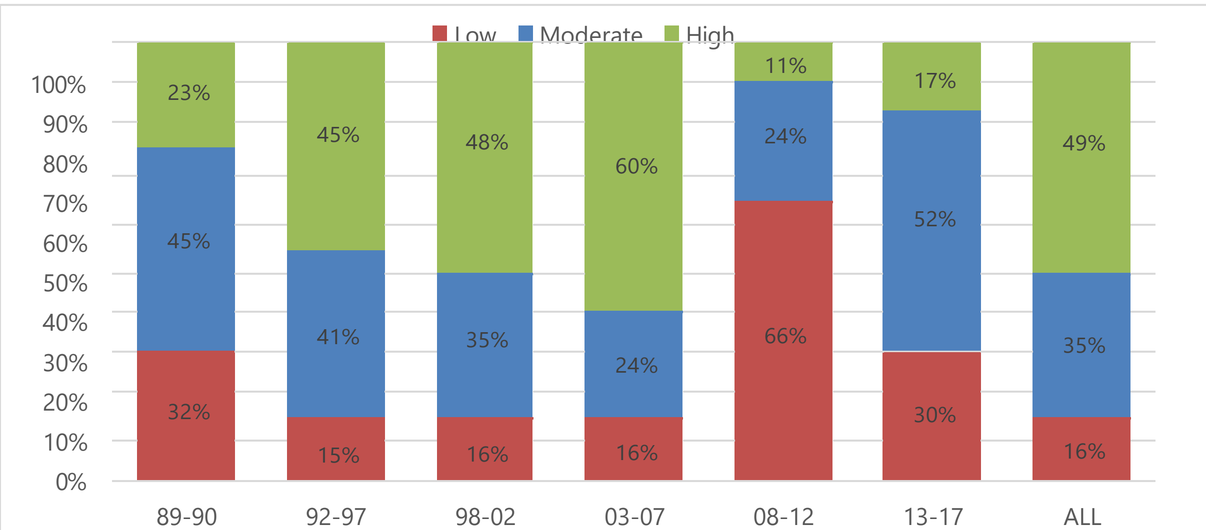


Figure 16. Proportion of samples in the high, moderate and low OC range for all NRM Districts

4.3 Discussion of factors

4.3.1 Influencing factors

Simple regression analysis of the chemical and geographic parameters in the combined dataset highlighted the degree of influence that individual factors exert on OC results. The degree of variance explained by individual factors[8] includes pH[9] (29%), postcode/rainfall (13%), nitrate-nitrogen (13%), phosphorus (8%) and cation exchange capacity (6%). Time and other chemical parameters exert minor influence individually explaining less than 3% of the variance in OC results.

Combining factors pH, phosphorus, nitrate-nitrogen and soil texture explained 50% of the variance in OC results. If soil texture is substituted for land use 57% of the OC variance is explained and 59% when postcode/rainfall is substituted.

This demonstrates there are other factors that explain the remaining 40% of variation in OC results. These factors require further investigation.

Factors that influence soil OC include:

- **Individually: pH (29%), postcode/rainfall (13%), nitrate-nitrogen (13%), phosphorus (8%), cation exchange capacity (6%)**
- **in combination: pH, nitrate-nitrogen and phosphorus with either soil texture, land use or postcode/rainfall explain nearly 60% of the variance in OC results.**
- **time had minor influence on explaining the variation in OC results**

4.3.2 Summarised responses from Department for Environment and Water Landholder Survey

The Department for Environment and Water (DEW) have commissioned telephone surveys of agricultural land managers in South Australia from 1999 to 2017 to collect data on soil and land management practices. The responses relevant for OC in the SAMDB are summarised from Forward, 2018.

Decreasing proportion of respondents concerned about

- soil structure decline from 33% in 2000 to 15% in 2014
- wind erosion from 48% in 2000 to 40% in 2014
- acidity from 26% in 2000 to 17% in 2014
- soil fertility from 64% in 2000 to 50% in 2014

Consistent concern about compaction ~ 25% of respondents.

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[8] Soil texture and land use could not be included in the individual regression as they are 'groups' rather than a continuum of data. They were able to be included as a grouping factor in combination with individual parameters.
[9] water and $CaCl_2$ method

In 2008, cropping represented 19% of the region (SAMDB NRM 2015). However in the telephone surveys, 80-83% of respondents had cropped the prior season[10]. This may influence the perception of land management issues for the SAMDB NRM region as grazing of modified pastures or native vegetation makes up the majority land use of 46%. Nevertheless, the decrease in respondents perception of soil structural issues are likely due to adoption of practices that protect the soil from erosion including tillage and stubble retention practices and a greater understanding of soil fertility.

5 Climate Impacts

The DEW telephone surveys identified measures that respondents have or will put in place to lessen the risk of impacts of climate change. There has been a shift in measures that respondents will use.

In 2014 measures included

- from altering crop varieties
- decreasing livestock
- change to cropping

In 2017 measures included

- maintaining soil cover and reducing disturbance
- adapting to more suitable or resilient land use for the system, increase/protect native vegetation
- increasing/modifying irrigation

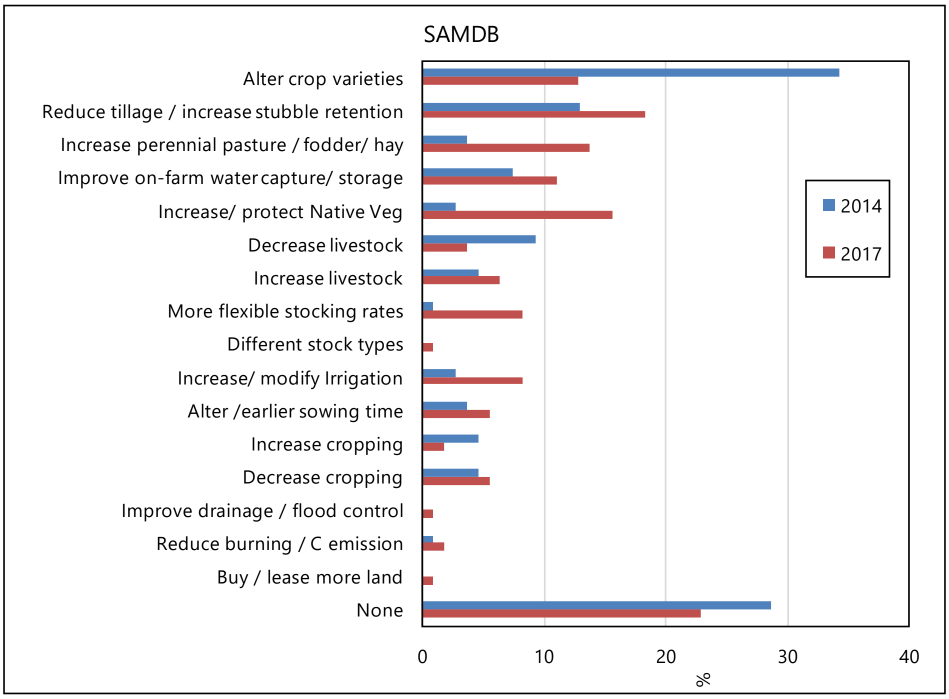

Figure 17. Measures telephone survey respondents have or will put in place to lessen the risk of impacts of climate change.

[10] average area of 680 hectares from 1999 to 2016 per respondent

6 Key Issues and Opportunities for future projects and programs

A number of knowledge and data gaps have been identified. Future ideas and projects include:

To improve the current baseline OC data

- Collation of data from trials or other sources pre 1989 to establish a baseline prior to application of improved soil management techniques (no-till, stubble retention etc.)
- Collation of soil analysis results post 2008 to increase confidence that OC levels over time are representative of the whole region
- Link median annual climatic factors such as combined annual or growing season rainfall to soil sample periods and corresponding to determine level of influence on OC levels
- Continued collation of data to provide a database for future baseline values
- Develop a proxy value for bulk density to enable calculation of OC stock for the combined laboratory dataset

For future baseline OC projects

- Establishment of long term monitoring sites that enable repeated monitoring over time for multiple parameters. Consideration to number of sites for rainfall zones x soil type x land use (and what potential rainfall land use may be in the future)

To improve understanding of OC storage capacity of soils

- Evaluating carbon fractions and the composition of particulate, humus and resistant by rainfall x soil type x land use. Understanding the distribution in the soil profile and generating the ability to predict soils that are stable, can change quickly with a change in management practice, are at OC equilibrium and those with the opportunity to increase OC.

7 Conclusion

Overall, 49% of topsoil samples are in the high, 35% in the moderate and 16% in low OC range. The average OC values for each soil texture fall within the high range for the standards in Table 1. There is an increasing trend for OC values equivalent to 0.07% p.a. from 1989-2007. There is a shift in the proportion of samples from the moderate to high OC range over time. Pasture has the highest average OC values with the majority of samples (85%) in the high OC range but may have low opportunity to further increase OC values.. If there are no limitations to rainfall and land use there is the opportunity to increase OC values through shifting the number of samples:

- in sands from the moderate to high range
- in clay loam to clays from the low to moderate and moderate to high range
- in cropping and vegetable from the moderate to high range
- in orchards and vineyards from the low to moderate range and moderate to high range

There is the opportunity to increase OC in subsoil although it can be difficult to influence organic matter inputs at this depth.

8 References

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9 Appendices

OC Values

AT1: Topsoil OC values grouped by 5 year timeframe

	Mean	25%	75%	SEM	CV	Number
89-90	1.56	0.85	1.75	0.16	77	56
92-97	1.69	0.98	2.13	0.02	61	2544
98-02	1.75	0.69	2.43	0.03	79	2773
03-07	2.10	0.83	3.06	0.04	74	1781
08-12	0.65	0.26	0.74	0.06	109	133
13-17	1.09	0.29	1.20	0.14	129	108

AT2: Topsoil OC values grouped by texture

	Mean	25%	75%	SEM	CV	Number
All						
Sand	0.77	0.41	0.88	0.08	93	79
Loamy sand	1.22	0.55	1.52	0.02	82	2001
Sandy loam	1.80	0.82	2.44	0.03	72	1714
Loamy sand	2.21	1.07	3.17	0.04	65	1273
Clay loam	2.12	1.17	2.87	0.03	63	1507
Clay	2.03	1.08	2.53	0.05	69	728
Topsoil						
Sand	0.87	0.47	0.98	0.10	90	61
Loamy sand	1.26	0.57	1.58	0.02	81	1845
Sandy loam	1.86	0.89	2.50	0.03	70	1597
Loam	2.25	1.13	3.19	0.04	63	1184
Clay loam	2.15	1.21	2.90	0.03	61	1417
Clay	2.14	1.20	2.66	0.06	66	650
Subsurface						
Sand	0.59	0.27	0.92	0.23	76	4
Loamy sand	0.98	0.58	1.21	0.07	64	74
Sandy loam	1.60	0.79	2.29	0.15	61	40
Loam	2.38	1.23	3.31	0.23	58	36
Clay loam	2.84	1.78	3.73	0.25	52	35
Clay	1.97	1.20	2.67	0.24	58	22
Subsoil						
Sand	0.42	0.29	0.53	0.07	42	7
Loamy sand	0.29	0.20	0.34	0.02	62	60
Sandy loam	0.29	0.16	0.34	0.03	76	51
Loam	0.37	0.24	0.47	0.04	61	33
Clay loam	0.45	0.26	0.54	0.05	64	36
Clay	0.43	0.24	0.61	0.05	64	37

AT3: Topsoil OC values grouped by land use

	Mean	25%	75%	SEM	CV	Number
Pasture	2.79	1.76	3.68	0.03	49	2334
Cropping	1.21	0.77	1.52	0.01	51	2206
Hort Vines	1.07	0.50	1.43	0.03	74	748
Hort Tree	0.84	0.34	1.10	0.04	93	358
Hort Veg	1.22	0.50	1.76	0.09	97	166
Hort Ann	3.03	1.64	3.76	0.36	60	26
Forestry	1.84	0.23	3.54	0.35	106	32

AT4: Topsoil OC values grouped by postcode for topsoil (0-10 or 0-15 cm)

	5 YR	Mean	25%	75%	Min	Max	Number	SD	SEM	CV
5153	89-90	2.63	2.15	3.15	1.60	3.60	3	1.00	0.58	38
	92-97	3.11	2.44	4.38	0.79	5.20	103	0.90	0.09	29
	98-02	3.70	3.05	4.38	0.71	6.42	103	0.91	0.09	25
	03-07	3.63	2.84	4.27	0.71	6.29	64	1.15	0.14	32
	08-12	2.91	2.55	3.19	2.37	3.64	3	0.65	0.38	22
5157	92-97	2.57	1.20	3.51	0.01	5.90	31	1.51	0.27	59
	98-02	3.52	2.80	4.36	0.71	6.43	31	1.34	0.24	38
	03-07	2.72	1.82	3.50	1.13	4.78	18	1.13	0.27	41
5171	89-90	6.20	6.20	6.20	6.20	6.20	1			
	92-97	0.59	0.59	0.59	0.59	0.59	1			
	98-02	2.28	0.92	3.47	0.72	4.39	10	1.37	0.43	60
	03-07	3.42	3.42	3.42	3.42	3.42	1			
5172	89-90	2.90	2.90	2.90	2.90	2.90	1			
	92-97	2.70	1.99	3.57	0.71	3.82	27	0.97	0.19	36
	98-02	3.12	2.25	3.61	1.38	5.02	17	1.14	0.28	37
	03-07	4.66	3.66	5.39	2.78	7.51	23	1.29	0.27	28
5201	89-90	5.55	5.50	5.60	5.50	5.60	2	0.07	0.05	1
	92-97	3.19	2.88	3.86	0.73	4.96	53	1.07	0.15	34
	98-02	4.10	3.18	5.06	0.72	6.41	51	1.36	0.19	33
	03-07	4.85	4.00	5.68	0.99	8.51	65	1.35	0.17	28
5210	89-90	1.80	1.80	1.80	1.80	1.80	1			
	92-97	2.79	2.13	3.32	0.77	5.39	91	0.93	0.10	33
	98-02	2.88	1.79	3.87	0.72	9.35	122	1.61	0.15	56
	03-07	3.10	0.25	0.41	1.18	7.18	140	1.08	0.09	35
	13-17	3.30	2.29	3.85	1.30	5.95	6	2.01	0.82	61
5211	92-97	3.71	2.98	4.59	1.62	4.85	13	0.94	0.26	25
	98-02	3.37	2.45	4.46	2.04	4.80	7	1.10	0.41	33
	03-07	2.53	1.57	3.30	1.26	4.86	13	1.05	0.29	42
5213	92-97	2.70	2.44	3.01	1.98	3.18	9	0.44	0.15	16
	98-02	3.38	2.73	3.87	2.66	4.47	6	0.69	0.28	21
	03-07	3.57	2.46	4.68	2.46	4.68	2	1.57	1.11	44
5214	89-90	1.45	1.10	1.80	1.10	1.80	2	0.49	0.35	34
	92-97	2.50	1.30	3.74	0.16	4.93	44	1.35	0.20	54
	98-02	2.01	1.34	2.34	0.91	4.47	52	0.91	0.13	46
	03-07	1.38	0.77	1.21	0.38	5.34	23	1.25	0.26	91
5235	92-97	1.52	1.06	2.00	0.49	2.41	36	0.56	0.09	37
	98-02	2.04	1.46	2.55	0.65	4.00	15	0.87	0.23	43
	03-07	2.31	2.14	2.47	1.41	3.31	12	0.44	0.13	19

	5 YR	Mean	25%	75%	Min	Max	Number	SD	SEM	CV
5236	92-97	2.98	2.51	3.53	2.41	3.83	5	0.62	0.28	21
	98-02	2.32	1.95	2.68	1.87	2.98	4	0.49	0.25	21
	03-07	1.71	1.14	2.33	0.83	2.60	6	0.70	0.28	41
	08-12	3.28	3.28	3.28	3.28	3.28	1			
	13-17	2.30	2.30	2.30	2.30	2.30	1			
5237	92-97	0.71	0.55	0.75	0.47	1.28	9	0.26	0.09	37
	98-02	1.26	0.98	1.55	0.63	1.71	4	0.45	0.23	36
	03-07	1.61	1.38	1.96	0.88	2.03	5	0.45	0.20	28
5238	92-97	0.69	0.49	0.89	0.28	1.03	9	0.26	0.09	37
	98-02	1.08	0.57	1.28	0.48	4.00	17	0.90	0.22	84
	03-07	2.39	1.15	3.40	0.42	5.05	8	1.63	0.58	68
5244	89-90	2.13	3.21	2.80	1.40	3.10	3	0.87	0.50	41
	92-97	2.41	1.53	2.84	0.47	4.81	84	0.78	0.08	32
	98-02	2.24	1.93	2.78	0.26	5.23	141	0.93	0.08	42
	03-07	3.05	1.61	3.62	0.53	6.91	66	1.06	0.13	35
	13-17	3.82	2.25	4.43	2.98	4.86	4	0.81	0.40	21
5250	92-97	2.06	1.77	2.38	1.73	2.54	3	0.43	0.25	21
	98-02	3.26	2.76	3.81	1.88	4.67	11	0.87	0.26	27
	03-07	2.77	1.78	3.61	1.67	3.76	9	0.88	0.29	32
5251	92-97	2.23	1.33	3.10	0.09	5.15	153	1.28	0.10	57
	98-02	3.10	2.13	4.11	0.92	6.60	124	1.29	0.12	42
	03-07	2.84	2.15	3.71	0.53	5.16	45	0.99	0.15	35
5252	92-97	2.21	1.61	2.72	1.02	3.99	50	0.74	0.10	33
	98-02	2.62	2.31	2.96	0.86	4.55	36	0.70	0.12	27
	03-07	3.13	2.42	3.81	1.72	4.49	34	0.81	0.14	26
5253	92-97	1.31	0.68	1.56	0.09	6.05	118	1.02	0.09	78
	98-02	1.49	0.87	1.71	0.20	6.31	116	1.04	0.10	70
	03-07	2.81	1.03	5.02	0.59	6.58	36	2.11	0.35	75
5254	92-97	1.37	1.18	1.58	0.90	1.98	20	0.30	0.07	22
	98-02	1.79	1.23	1.74	0.86	4.22	6	1.22	0.50	68
	03-07	0.58	0.36	0.54	0.29	1.62	16	0.43	0.11	74
5255	89-90	1.03	0.80	1.20	0.70	1.40	8	0.25	0.09	24
	92-97	1.58	0.89	2.00	0.16	8.68	298	1.06	0.06	67
	98-02	1.81	0.73	2.49	0.08	7.06	810	1.41	0.05	78
	03-07	1.98	0.93	2.78	0.14	8.47	519	1.42	0.06	72
	08-12	0.80	0.29	0.87	0.08	3.87	52	0.78	0.11	97
	13-17	1.53	1.20	1.94	0.59	2.14	8	0.51	0.18	34
5256	89-90	1.50	1.50	1.50	1.50	1.50	1			
	92-97	1.33	1.03	1.37	0.65	3.78	31	0.59	0.11	45
	98-02	1.44	1.11	1.53	0.66	4.17	20	0.71	0.16	49
5259	92-97	2.42	1.34	3.60	0.52	5.26	26	1.51	0.30	62
	98-02	1.97	1.11	2.82	0.78	3.53	4	1.18	0.59	60
5260	92-97	0.99	0.77	1.24	0.54	1.61	7	0.36	0.14	36
	98-02	1.16	0.72	1.54	0.61	2.43	10	0.58	0.18	50
	03-07	1.10	0.85	1.25	0.63	1.79	9	0.34	0.11	31
5261	89-90	0.65	0.60	0.70	0.60	0.70	2	0.07	0.05	11
	92-97	1.20	0.85	1.49	0.40	2.39	119	0.44	0.04	36
	98-02	1.23	0.94	1.50	0.27	2.38	63	0.39	0.05	32
	03-07	1.07	0.84	1.23	0.62	1.63	22	0.28	0.06	26
5264	89-90	0.90	0.70	1.10	0.70	1.10	2	0.28	0.20	31
	92-97	1.21	0.84	1.50	0.44	3.00	72	0.58	0.07	48
	98-02	1.39	1.10	1.65	0.42	2.48	19	0.51	0.12	37

	5 YR	Mean	25%	75%	Min	Max	Number	SD	SEM	CV
	03-07	1.47	1.06	1.76	0.60	2.65	14	0.60	0.16	41
5265	92-97	1.18	0.88	1.41	0.45	1.97	63	0.35	0.04	30
	98-02	1.14	0.86	1.53	0.72	1.64	6	0.37	0.15	33
	03-07	1.31	1.08	1.61	0.49	1.91	18	0.39	0.09	30
5266	92-97	1.38	0.86	1.60	0.66	4.60	27	0.77	0.15	56
	98-02	1.37	1.04	1.54	0.70	3.19	23	0.55	0.12	41
	03-07	1.12	0.87	1.19	0.60	2.32	12	0.42	0.12	38
5301	89-90	0.70	0.63	0.78	0.60	0.80	3	0.10	0.06	14
	92-97	0.77	0.61	0.95	0.33	1.40	24	0.25	0.05	33
	98-02	0.95	0.71	1.16	0.35	1.51	33	0.30	0.05	32
5302	89-90	0.65	0.60	0.70	0.60	0.70	2	0.07	0.05	11
	92-97	1.75	0.54	3.74	0.17	4.36	14	1.56	0.42	89
	98-02	0.91	0.66	1.16	0.36	1.68	55	0.31	0.04	34
	03-07	0.56	0.56	0.56	0.56	0.56	1			
	13-17	0.63	0.48	0.76	0.30	1.06	20	0.22	0.05	35
5303	92-97	0.91	0.77	1.07	0.69	1.13	8	0.17	0.06	19
	98-02	0.70	0.45	0.86	0.26	1.73	38	0.31	0.05	45
5304	89-90	1.03	0.75	1.30	0.70	1.70	4	0.46	0.23	45
	92-97	1.00	0.79	1.20	0.50	1.45	25	0.26	0.05	26
	98-02	0.76	0.49	1.05	0.31	1.38	25	0.30	0.06	40
	03-07	0.84	0.41	1.26	0.41	1.26	2	0.60	0.43	72
	08-12	0.60	0.45	0.75	0.45	0.75	2	0.21	0.15	35
	13-17	1.11	0.97	1.25	0.87	1.45	9	0.20	0.07	18
5306	92-97	0.78	0.65	0.92	0.39	0.98	8	0.22	0.08	28
	98-02	0.88	0.71	1.05	0.53	1.36	10	0.25	0.08	28
5307	92-97	0.66	0.55	0.76	0.30	1.30	43	0.21	0.03	32
	98-02	0.68	0.50	0.87	0.22	1.54	54	0.25	0.03	37
	03-07	0.90	0.64	0.88	0.39	2.34	24	0.50	0.10	56
5308	92-97	0.68	0.44	0.63	0.36	2.58	16	0.55	0.14	82
	98-02	0.60	0.51	0.63	0.35	1.19	16	0.19	0.05	32
5309	92-97	0.68	0.46	0.90	0.38	1.17	4	0.34	0.17	51
	98-02	0.68	0.47	0.79	0.43	2.15	16	0.42	0.10	61
	08-12									
5310	92-97	0.71	0.61	0.81	0.58	0.85	3	0.14	0.08	19
	98-02	0.86	0.73	0.94	0.63	1.28	8	0.20	0.07	24
	08-12									
5311	98-02	0.50	0.47	0.52	0.41	0.63	9	0.06	0.02	13
	13-17	1.27	0.93	1.61	0.93	1.61	2	0.48	0.34	38
5320	92-97	0.88	0.67	1.09	0.49	1.21	4	0.30	0.15	34
	98-02	0.57	0.34	0.71	0.30	1.01	6	0.26	0.11	46
	03-07	0.88	0.61	1.08	0.50	1.34	8	0.30	0.10	34
	08-12	0.81	0.66	0.96	0.66	0.96	2	0.21	0.15	26
5322	92-97	0.43	0.35	0.47	0.32	0.56	6	0.09	0.04	20
	98-02	0.45	0.35	0.48	0.29	0.91	18	0.16	0.04	35
	03-07	0.79	0.70	0.87	0.69	0.97	4	0.13	0.06	16
	08-12									
5330	89-90	0.30	0.30	0.30	0.30	0.30	1			
	92-97	0.70	0.41	1.04	0.20	1.59	23	0.40	0.08	57
	98-02	0.58	0.42	0.63	0.24	1.80	41	0.28	0.04	48
	03-07	0.39	0.20	0.45	0.09	4.28	90	0.45	0.05	117
	08-12	0.33	0.23	0.37	0.09	1.00	38	0.19	0.03	56
	13-17	0.51	0.43	0.59	0.41	0.63	3	0.11	0.06	22

	5 YR	Mean	25%	75%	Min	Max	Number	SD	SEM	CV
5332	92-97	0.54	0.41	0.64	0.13	1.08	8	0.27	0.10	50
	98-02	0.84	0.58	1.02	0.57	1.21	6	0.25	0.10	30
	03-07	0.67	0.53	0.81	0.53	0.81	2	0.20	0.14	30
5333	89-90	0.40	0.40	0.40	0.40	0.40	1			
	92-97	0.62	0.37	0.65	0.20	2.02	35	0.45	0.08	72
	98-02	0.49	0.28	0.64	0.05	2.59	144	0.36	0.03	72
	03-07	0.79	0.49	1.12	0.34	1.76	12	0.47	0.14	60
	08-12	0.89	0.77	0.99	0.67	1.18	5	0.19	0.08	21
5340	92-97	0.44	0.39	0.49	0.38	0.57	4	0.09	0.04	20
	98-02	0.65	0.46	0.77	0.36	1.05	8	0.23	0.08	35
	03-07	1.12	0.26	1.98	0.24	2.11	4	1.00	0.50	90
5341	98-02	0.73	0.45	0.92	0.20	2.17	30	0.40	0.07	54
	03-07	0.60	0.47	0.66	0.26	2.10	32	0.31	0.05	51
5343	98-02	0.54	0.47	0.62	0.44	0.63	7	0.08	0.03	14
	03-07	0.61	0.32	0.82	0.13	1.44	8	0.42	0.15	69
5345	98-02	1.18	0.55	1.70	0.46	2.93	9	0.82	0.27	70
	03-07	0.49	0.47	0.54	0.26	0.65	7	0.12	0.04	24
5351	92-97	1.94	1.94	1.94	1.94	1.94	1			
	03-07	2.10	2.01	2.30	1.49	2.45	7	0.31	0.12	15
5353	92-97	1.48	0.95	1.67	0.31	4.48	97	0.81	0.08	54
	98-02	1.39	0.78	1.88	0.38	3.20	54	0.73	0.10	52
	03-07	1.95	1.26	2.61	0.64	3.42	33	0.78	0.14	40
	13-17	1.05	0.90	1.19	0.90	1.19	2	0.21	0.15	20
5354	98-02	0.52	0.23	0.86	0.13	0.90	6	0.32	0.13	62
	03-07	0.40	0.31	0.49	0.31	0.49	2	0.13	0.09	32
5356	92-97	1.39	1.09	1.69	0.53	2.43	53	0.40	0.06	29
	98-02	1.30	1.06	1.53	1.06	1.53	2	0.33	0.24	26
	03-07	1.64	1.25	1.92	0.80	3.60	34	0.61	0.11	37
5357	92-97	0.93	0.41	1.69	0.27	1.73	5	0.72	0.32	77
	98-02	0.30	0.29	0.31	0.29	0.31	2	0.01	0.01	5
5374	89-90	1.55	1.20	1.80	1.10	2.00	6	0.34	0.14	22
	92-97	1.61	1.24	1.92	0.09	4.43	179	0.54	0.04	33
	98-02	2.00	1.81	2.25	1.44	2.48	17	0.28	0.07	14
	03-07	1.55	1.29	1.87	1.22	1.96	8	0.31	0.11	20
5381	92-97	1.51	1.03	1.79	0.87	3.69	20	0.71	0.16	47
	98-02	1.49	0.84	2.14	0.69	2.20	4	0.76	0.38	51
	03-07	1.50	1.09	1.91	1.04	2.47	4	0.66	0.33	44
5413	89-90	1.50	1.50	1.60	0.90	1.80	6	0.31	0.13	21
	92-97	2.01	1.59	2.52	0.92	4.09	53	0.69	0.10	35
	98-02	1.82	1.63	1.97	1.30	2.58	28	0.32	0.06	17
	03-07	2.21	2.08	2.46	0.64	3.32	34	0.49	0.08	22
5416	89-90	0.90	0.90	0.90	0.90	0.90	1			
	92-97	1.59	1.07	1.99	0.88	2.98	16	0.67	0.17	42
	98-02	1.52	1.23	1.80	1.01	1.91	4	0.39	0.19	25
	03-07	2.28	2.28	2.28	2.28	2.28	1			
5417	89-90	1.65	1.50	1.80	1.50	1.80	2	0.21	0.15	13
	92-97	1.48	1.07	1.48	0.90	4.97	47	0.84	0.12	57
	98-02	1.41	1.24	1.56	0.57	2.22	16	0.39	0.10	27
	03-07	1.87	1.65	2.12	1.62	2.25	3	0.33	0.19	18
5418	92-97	2.15	1.41	2.11	1.01	4.71	14	1.15	0.31	54
	03-07	1.66	1.66	1.66	1.66	1.66	1			
5419	89-90	1.10	1.10	1.10	1.10	1.10	1			

	5 YR	Mean	25%	75%	Min	Max	Number	SD	SEM	CV
	98-02	1.23	1.23	1.23	1.23	1.23	1			
	03-07	1.55	1.11	1.99	0.76	2.13	4	0.59	0.30	38
5420	92-97	1.09	0.92	1.27	0.54	2.05	47	0.27	0.04	25
	98-02	0.85	0.70	1.01	0.46	1.06	4	0.27	0.13	31
	03-07	3.11	1.84	4.21	0.48	6.19	8	1.85	0.66	60
5422	92-97	1.06	0.85	1.16	0.54	2.07	34	0.32	0.05	30
	03-07	2.38	2.27	2.50	2.18	2.53	4	0.15	0.08	6
5454	89-90	1.20	1.20	1.20	1.20	1.20	1			
	92-97	1.42	1.18	1.68	0.83	2.20	82	0.31	0.03	22
	98-02	1.94	1.61	2.27	1.61	2.27	2	0.47	0.33	24
	03-07	1.47	1.47	1.47	1.47	1.47	1			
5491	89-90	1.25	1.10	1.40	1.10	1.40	2	0.21	0.15	17
	92-97	1.35	1.09	1.54	0.64	3.30	166	0.36	0.03	26
	98-02	1.54	1.30	1.86	0.81	2.21	27	0.39	0.07	25
	03-07	1.81	1.54	2.08	1.38	2.18	8	0.31	0.11	17

AT5: OC values grouped by postcode for subsurface (10-30 or 15-30 cm) and subsoil (>30 cm)

		SUBSURFACE					SUBSOIL				
	5 YR	Mean	Min	Max	Count	SD	Mean	Min	Max	Count	SD
5153	98-02	0.59	0.59	0.59	1						
5157	98-02	4.14	2.47	5.81	2	2.36					
5171	89-90										
5201	03-07	3.87	3.87	3.87	1						
5210	98-02						0.36	0.23	0.72	6	0.19
5210	13-17	1.35	0.40	3.01	9	0.75					
5211	92-97										
5213	92-97										
5214	03-07	0.71	0.71	0.71	1		0.51	0.45	0.57	2	0.08
5235	98-02	1.50	1.50	1.50	1						
5236	13-17	0.59	0.59	0.59	1						
5244	98-02	1.27	0.69	1.72	4	0.43					
5251	03-07	2.62	2.45	2.79	2	0.24					
5252	98-02	1.97	1.97	1.97	1						
5253	03-07						0.57	0.51	0.63	2	0.08
5255	92-97						0.36	0.20	0.46	3	0.14
	98-02	1.79	0.21	4.15	60	1.00	0.38	0.08	1.60	95	0.24
	03-07	2.21	0.27	5.89	93	1.36	0.52	0.15	1.19	35	0.29
	13-17	0.91	0.70	1.07	3	0.19	0.37	0.19	0.55	2	0.25
5266	03-07	1.10	0.53	1.55	6	0.40					
5302	98-02	1.34	1.34	1.34	1						
	13-17	0.40	0.12	1.19	10	0.30	0.15	0.05	0.64	25	0.13
5303	98-02	1.20	1.20	1.20	1						
5304	03-07	0.20	0.20	0.20	1		0.16	0.15	0.17	2	0.01
5307	03-07	0.82	0.65	0.98	3	0.17					
5309	08-12						0.29	0.15	0.43	2	0.20
5310	08-12						0.13	0.13	0.13	1	
5320	03-07	0.75	0.40	0.99	5	0.22					

		SUBSURFACE					SUBSOIL				
	5 YR	Mean	Min	Max	Count	SD	Mean	Min	Max	Count	SD
	08-12	0.79	0.28	1.38	4	0.47					
5322	08-12						0.42	0.36	0.48	2	0.08
5330	98-02	0.22	0.22	0.22	1		0.10	0.10	0.10	1	
	03-07	0.24	0.16	0.34	6	0.07	0.20	0.13	0.33	6	0.08
	08-12						0.33	0.16	0.84	10	0.21
	13-17	0.35	0.35	0.35	1						
5333	98-02	0.37	0.24	0.52	4	0.13					
	98-02						0.20	0.14	0.26	2	0.08
5341	03-07	0.37	0.28	0.44	3	0.08	0.29	0.21	0.45	13	0.07
5343	03-07	0.71	0.43	0.98	2	0.39	0.31	0.22	0.39	2	0.12
5353	98-02	0.65	0.65	0.65	1		0.55	0.34	0.83	6	0.18
5354	98-02						0.41	0.25	0.52	7	0.11
5420	03-07	0.57	0.42	0.71	2	0.21	0.13	0.01	0.25	9	0.08
5491	98-02						0.41	0.28	0.58	4	0.13

PROPORTION OF SAMPLES IN THE LOW, MODERATE AND HIGH OC RANGE

AT6: Proportion of topsoil OC ranges for the SAMDB Region

	Proportion	Number
Low	16%	1112
Moderate	35%	2351
High	49%	3291
Total	100%	6754

AT7: Proportion of topsoil OC ranges by texture

	Low	Moderate	High	Number
Sand	23%	51%	26%	61
Loamy sand	13%	39%	48%	1845
Sandy loam	14%	31%	55%	1597
Loam	14%	33%	53%	1184
Clay loam	22%	35%	43%	1417
Clay	23%	35%	42%	650
All	16%	35%	49%	6754

AT8: Proportion of topsoil OC ranges by land use

	Low	Moderate	High	Number
Pasture	2%	12%	85%	2259
Cropping	19%	59%	22%	2152
Hort Vines	31%	44%	25%	578
Hort Tree	48%	26%	26%	262
Hort Veg	14%	55%	31%	121
Hort Ann	0%	23%	77%	26
Forestry	29%	10%	62%	21

AT9: Proportion of topsoil OC ranges by land use and texture

Land use	Texture	Low	Moderate	High	Number
PASTURE	Sand	0%	42%	58%	12
	Loamy sand	2%	13%	85%	565
	Sandy loam	1%	9%	90%	604
	Loam	2%	12%	87%	504
	Clay loam	5%	14%	81%	406
	Clay	5%	16%	79%	168
CROPPING	Sand	17%	67%	17%	12
	Loamy sand	14%	59%	27%	600
	Sandy loam	15%	54%	31%	478
	Loam	14%	68%	18%	317
	Clay loam	28%	57%	15%	515
	Clay	26%	60%	14%	230
HORT VINES	Sand	20%	80%	0%	5
	Loamy sand	20%	54%	27%	157
	Sandy loam	31%	49%	20%	120
	Loam	41%	33%	26%	82
	Clay loam	37%	37%	26%	150

	Clay	31%	36%	33%	64
HORT TREE	Sand	0%	43%	57%	7
	Loamy sand	45%	31%	25%	130
	Sandy loam	67%	21%	12%	57
	Loam	46%	23%	31%	26
	Clay loam	32%	14%	54%	28
	Clay	57%	29%	14%	14
VEGETABLE	Sand	0%	71%	29%	7
	Loamy sand	16%	65%	19%	31
	Sandy loam	17%	63%	20%	30
	Loam	8%	54%	38%	13
	Clay loam	13%	39%	48%	31
	Clay	22%	33%	44%	9
HORT ANNUAL	Loamy sand	0%	100%	0%	1
	Sandy loam	0%	29%	71%	7
	Loam	0%	29%	71%	7
	Clay loam	0%	14%	86%	7
	Clay	0%	0%	100%	4
FORESTRY	Loamy sand	67%	33%	0%	3
	Sandy loam	40%	0%	60%	5
	Loam	25%	0%	75%	4
	Clay loam	25%	0%	75%	4
	Clay	0%	20%	80%	5

AT10: Proportion of topsoil OC ranges by postcode for all years

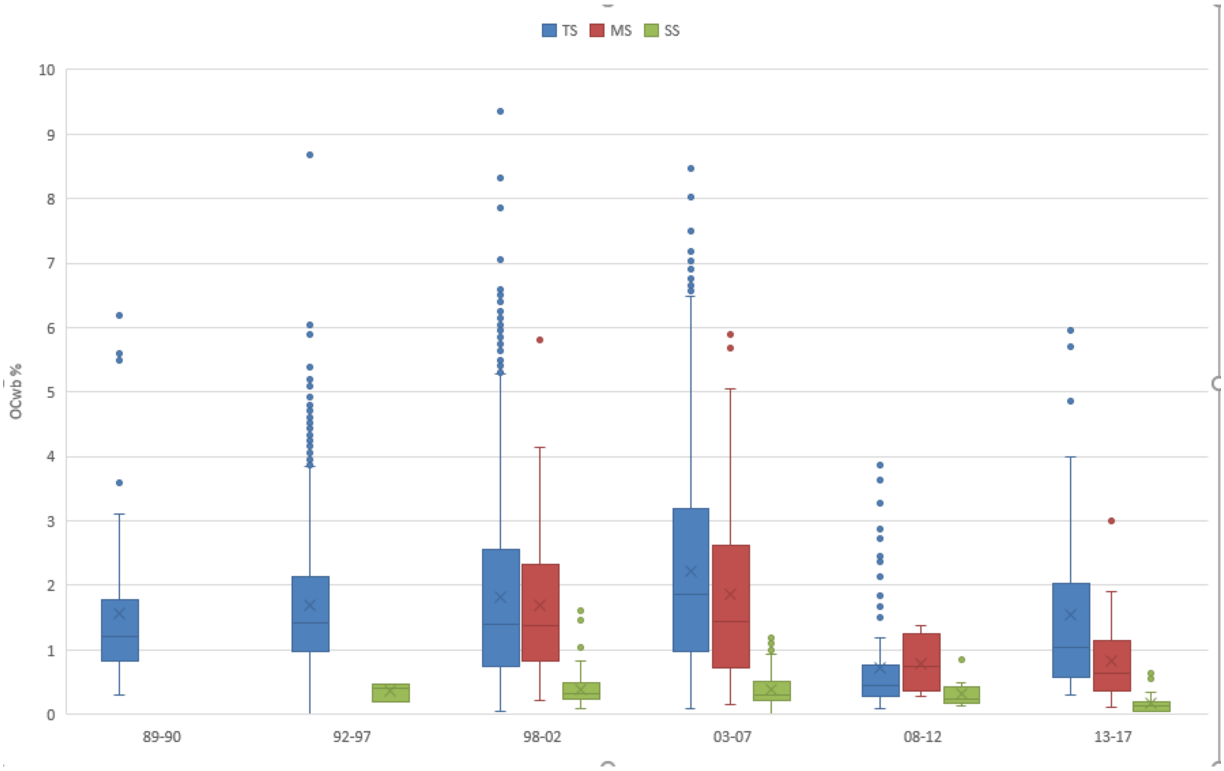
Postcode	Low	Moderate	High	Number
5153	0%	4%	96%	276
5157	5%	5%	90%	80
5171	0%	31%	69%	13
5172	0%	4%	96%	68
5201	3%	2%	95%	170
5210	0%	4%	96%	354
5211	0%	0%	100%	33
5213	0%	0%	100%	17
5214	7%	26%	68%	121
5235	2%	21%	78%	63
5236	0%	9%	91%	11
5237	28%	39%	33%	18
5238	15%	65%	21%	34
5244	5%	17%	77%	294
5250	0%	17%	83%	23
5251	9%	9%	82%	322
5252	0%	21%	79%	120
5253	16%	50%	33%	270
5254	31%	52%	17%	42
5255	15%	38%	47%	1683
5256	0%	37%	63%	52
5259	0%	20%	80%	30

Postcode	Low	Moderate	High	Number
5260	0%	58%	42%	26
5261	7%	43%	50%	206
5264	2%	36%	62%	107
5265	2%	66%	32%	87
5266	2%	34%	65%	62
5301	8%	85%	7%	60
5302	17%	67%	16%	89
5303	33%	63%	4%	46
5304	34%	57%	9%	58
5306	6%	78%	17%	18
5307	23%	65%	12%	121
5308	31%	63%	6%	32
5309	30%	65%	5%	20
5310	27%	64%	9%	11
5311	33%	67%	0%	9
5320	22%	67%	11%	18
5322	61%	36%	4%	28
5330	70%	28%	2%	188
5332	69%	31%	0%	16
5333	67%	28%	5%	197
5340	81%	13%	6%	16
5341	73%	24%	3%	62
5343	73%	27%	0%	15
5345	63%	31%	6%	16
5351	0%	0%	100%	8
5353	18%	42%	40%	184
5354	50%	50%	0%	8
5356	21%	65%	13%	89
5357	43%	57%	0%	7
5374	13%	56%	30%	210
5381	36%	39%	25%	28
5413	2%	46%	52%	121
5416	18%	55%	27%	22
5417	19%	60%	21%	68
5418	7%	53%	40%	15
5419	33%	50%	17%	6
5420	53%	36%	12%	59
5422	61%	26%	13%	38
5454	9%	76%	15%	86
5491	24%	64%	13%	203

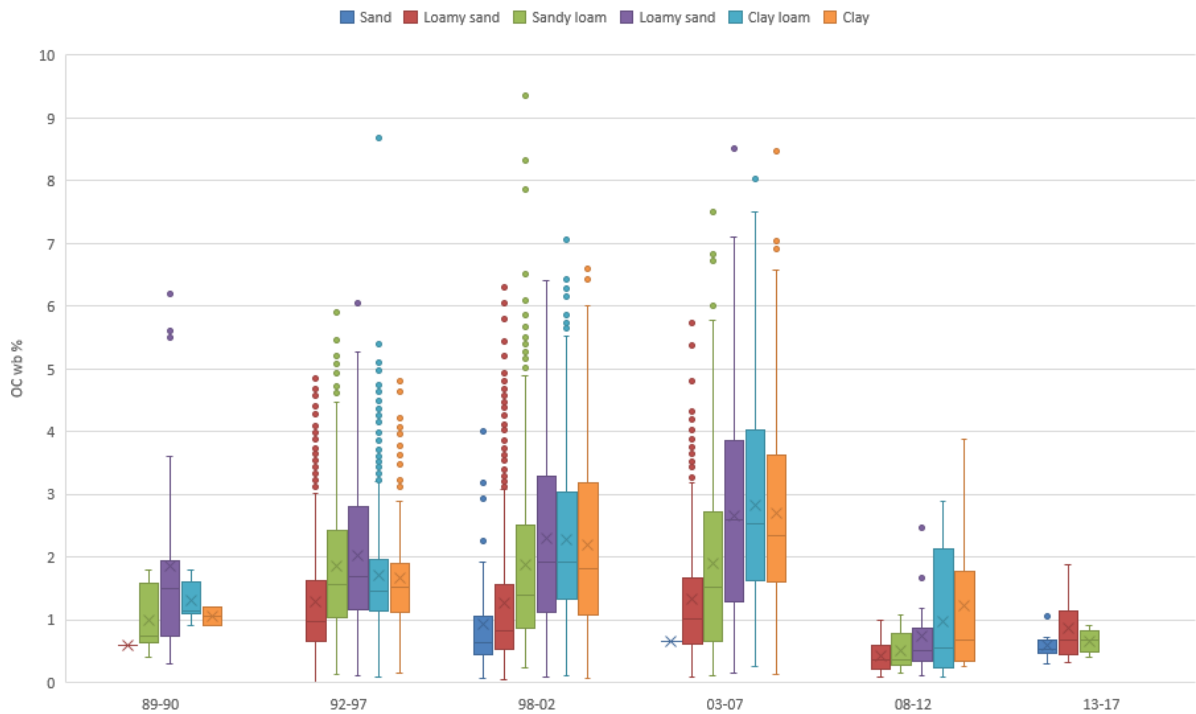
AT11: Proportion of topsoil OC ranges by postcode by 5 year time frame

	High Range				Low Range				
	89-90	92-97	98-02	03-07	89-90	92-97	98-02	03-07	Number
5153	67%	95%	98%	94%	0%	0%	1%	0%	276
5157		84%	90%	100%		13%	0%	0%	80
5171	100%		70%	100%	0%	0%	0%	0%	13
5172	100%	93%	94%	100%	0%	0%	0%	0%	68
5201	100%	92%	94%	98%	0%	4%	4%	2%	170
5210	100%	96%	93%	99%	0%	0%	0%	0%	354
5211		100%	100%	100%		0%	0%	0%	33
5213		100%	100%	100%		0%	0%	0%	17
5214	50%	77%	75%	35%	50%	7%	0%	17%	121
5235		72%	73%	100%		3%	0%	0%	63
5236		100%	100%	75%		0%	0%	0%	11
5237		0%	50%	80%		56%	0%	0%	18
5238		0%	12%	63%		33%	0%	25%	34
5244	67%	88%	65%	89%	0%	1%	10%	2%	294
5250		33%	100%	78%		0%	0%	0%	23
5251		74%	89%	93%		18%	1%	2%	322
5252		66%	89%	88%		0%	0%	0%	120
5253		29%	25%	75%		20%	15%	8%	270
5254		25%	33%	0%		5%	0%	75%	42
5255	0%	44%	48%	52%	38%	9%	15%	13%	1683
5256	100%	65%	60%		0%	0%	0%		52
5259		81%	75%			0%	0%		30
5260		43%	20%	67%		0%	0%	0%	26
5261	0%	55%	51%	27%	100%	6%	6%	5%	206
5264	0%	58%	63%	86%	0%	1%	5%	0%	107
5265		35%	50%	17%		2%	0%	6%	87
5266		52%	78%	67%		0%	0%	8%	62
5301	0%	4%	9%		67%	8%	3%		60
5302	0%	43%	11%	0%	0%	21%	9%	100%	89
5303		0%	5%			38%	32%		46
5304	0%	8%	12%	0%	75%	28%	28%	50%	58
5306		25%	10%			13%	0%		18
5307		7%	11%	21%		19%	31%	13%	121
5308		13%	0%			31%	31%		32
5309		0%	6%			25%	31%		20
5310		0%	13%			0%	38%		11
5311				0%				33%	9
5320		0%	0%	25%		50%	33%	0%	18
5322		0%	0%	25%		50%	78%	0%	28
5330	0%	0%	3%	1%	100%	70%	30%	82%	188

	High Range				Low Range				
	89-90	92-97	98-02	03-07	89-90	92-97	98-02	03-07	Number
5332		0%	0%	0%		75%	67%	50%	16
5333	0%	6%	3%	17%	100%	66%	69%	67%	197
5340		0%	0%	25%		75%	100%	50%	16
5341			3%	3%			60%	84%	62
5343			0%	0%			57%	88%	15
5345			11%	0%			67%	57%	16
5351		100%		100%		0%		0%	8
5353		31%	39%	67%		21%	20%	9%	184
5354			0%	0%			50%	50%	8
5356		8%	0%	24%		21%	50%	21%	89
5357		0%	0%			20%	100%		7
5374	33%	29%	53%	13%	17%	15%	0%	0%	210
5381		20%	50%	25%		30%	50%	50%	28
5413	0%	43%	43%	82%	17%	0%	0%	3%	121
5416	0%	31%	0%	100%	100%	19%	0%	0%	22
5417	0%	21%	19%	33%	0%	21%	19%	0%	68
5418		43%		0%		7%		0%	15
5419	0%		0%	25%	100%		0%	25%	6
5420		2%	0%	75%		55%	100%	13%	59
5422		3%		100%		68%		0%	38
5454	0%	15%	50%	0%	0%	10%	0%	0%	86
5491	0%	8%	33%	50%	50%	27%	11%	0%	203



AF1: Box and Whisker plot displaying the OC distribution by soil layer (top (TS), subsurface (MS) and subsoil (SS)) and 5-year time frame.



AF2: Box and Whisker plot displaying the OC distribution by soil texture and 5-year time frame.