Land Evaluation Programme - PIRSA Land Information

Introduction

Economically and environmentally sustainable land use relies on using and managing land according to its potential and limitations. An understanding of soils and the landscapes in which they occur is fundamental when making decisions about land use and land management. PIRSA Land Information has assembled a package comprising a data base and a set of procedures which provides regional level information about soils and landscapes, their properties, limitations and potentials. The package is being used in a variety of ways by different organizations to underpin broad scale land use planning and management.

The package comprises three components, each of which is supported by geographic information system (GIS) technology:

- land system / soil landscape mapping
- attribute data base
- crop potential assessment

Land System / Soil Landscape Mapping

Maps depicting landscape features and soil associations have been compiled for the agricultural districts of South Australia. They are based on standard map sheets - usually 1:100,000, but 1;50,000 for the South East, Kangaroo Island and the Mount Lofty Ranges. The mapping coverage is shown in Figure 1.

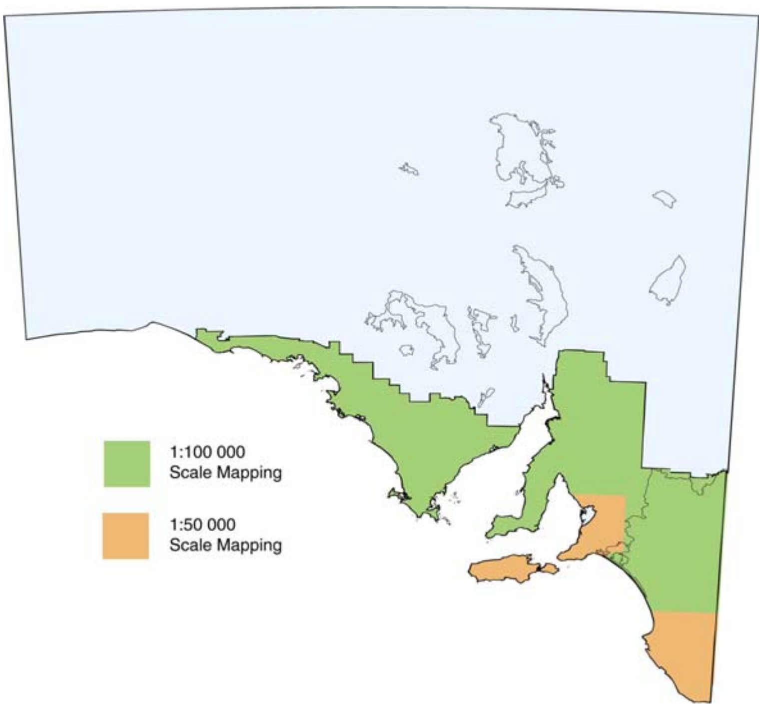

Figure 1 Soil landscape mapping coverage

The main mapping units are Land Systems. These are broad landscape features within which there are recurring patterns of geology, topography, soils and vegetation. They have local geographic names abbreviated to three letters.

Each Land System comprises one or more Soil Landscape Units. These are recognizable topographic features formed on a particular geological material or group of materials. They include a limited and defined range of soil classes. They therefore have similar land qualities and land use potential. The Soil Landscape Units are labelled with three (sometimes four or five) character codes. The first character indicates the geological setting and broad soil grouping. These are summarized in Table 1. The second and third characters describe component soil associations and topographic features respectively.

The maps and land descriptions were compiled using 1:40,000 scale aerial photography, existing geology and soil maps, and data collected during field investigations. The field work was designed to provide a general indication of the soils and other features of the various landscapes identified by aerial photograph interpretation. The field assessments included morphological descriptions to depths of between 50 and 200 cm, depending on the nature of the soil, and site descriptions in accordance with the standards set out in the Australian Soil and Land Survey Field Handbook (McDonald et al 1990). Soil profiles were classified according to the Australian Soil Classification (Isbell, 1996). Laboratory determinations of pH and electrical conductivity were made on selected samples form the field survey. More detailed chemical analyses were undertaken on samples from almost 700 representative sites across the state.

The key features of the mapping coverage are:

- There is a seamless coverage of the agricultural districts of the state. Each map sheet joins its neighbours, including across map boundaries where there is a change of scale.
- The information can be presented as land systems for small scale applications (eg an entire region such as Eyre Peninsula can be comfortably plotted on an A3 page), or as soil landscapes where more detail is required.
- Text descriptions to accompany the maps are based on land systems. Each land system is summarized in terms of its geology, topography and key soils. For each soil landscape unit within the land system, there are notes on topographic features, component soils, and key factors affecting land use and management.
- For each of the 700 representative sites used for soil characterization, there is a two page fact sheet including location details, profile description, table of laboratory analyses and notes on properties relevant to agricultural land use. Most fact sheets include profile and landscape photographs.
- All mapping data is stored on PIRSA Land Information's GIS in Arc Info format. When mapping units are digitized, they are called polygons. GIS can be used to:
    - generate maps of standard sheets, or any other specified coverage.
    - calculate statistics (areas etc) of polygons or groups of polygons.
    - assign values for specific attributes (eg rockiness) to polygons via look-up tables.
    - overlay other spatial data sets (eg rainfall) to produce maps and calculate statistics (for example, areas of particular soil types within specified rainfall zones).

Table 1

First Character of Soil Landscape Unit Label

Geomorphology		Soil Landscape
Soils formed on basement rock.	**A**	Non arable hills & rises with shallow stony soil & variable rock outcrop.
	B	Low hills & rises with mainly acid to neutral, loam to clay loam texture contrast soil.
	C	Low hills & rises with mainly acid to neutral, sandy to sandy loam texture contrast soil.
	D	Low hills & rises with mainly sandy to loamy, texture contrast soil with calcareous subsoil.
	E	Low hills & rises with mainly neutral to alkaline gradational soil, calcareous soil and/or shallow stony soil.
Soils formed on deeply weathered material with ironstone.	**F**	Plateaux, rises & low hills with mainly acid to neutral sandy to loamy texture contrast or gradational soil with ironstone.
Soils formed on unconsolidated sandy to clayey sediments.	**G**	Rises & plains with mainly neutral to alkaline, sandy texture contrast soil with calcareous subsoil.
	H	Rises & plains with mainly loamy texture contrast or gradational soil.
	I	Rises & plains with mainly calcareous soil.
	P	Rises, plains & low hills with mainly acid to neutral, sandy texture contrast soil or deep sand.
	T	Rises & plains with mainly neutral to alkaline clay loamy to clayey soil
Soils formed on outwash sediments derived from basement rock highs.	**J**	Plains & gentle slopes with mainly deep texture contrast soil with calcareous subsoil.
	K	Plains & gentle slopes with mainly deep calcareous soil or gradational/clayey soil with calcareous subsoil.
	L	Plains & gentle slopes with mainly deep neutral to acid soil.
Soils formed on relict coastal dunes.	**M**	Relict coastal dunes with shallow soil on calcrete, sandy texture contrast soil and/or deep sand.
Soils formed on marine/lagoonal clay or limestone.	**N**	Corridor plains between relict coastal dunes (**M**) with mainly neutral to alkaline, sandy texture contrast soil or shallow soil on limestone.
	V	Plains with mainly neutral to alkaline gradational or texture contrast soil, often marginally saline.
Soils formed on calcrete.	**Q**	Plains & rises with mainly shallow calcareous soil (or mixed calcareous & non-calcareous soil) on calcrete.
	R	Plains & rises with mainly shallow non-calcareous soil on calcrete.
Soils formed on soft/rubbly calcareous sediments.	**S**	Plains & rises with mainly loamy calcareous soil.
	Y	Plains, rises & dunes with mainly shelly sand to sandy loam.
Dune fields.	**O**	Dune/swale systems with mainly acid to neutral, bleached siliceous sand on dunes.
	U	Dune/swale systems with mainly neutral to alkaline, unbleached siliceous sand with calcareous subsoil on dunes.
Coastal land.	**W**	Beaches, dunes, swamps, back plains, mud & samphire flats, shellgrit flats, tidal flats, mangroves & coastal cliffs.
Modern watercourse/freshwater wetland.	**X**	Flats, terraces & watercourses with modern alluvial soil; freshwater wetlands with swamp soils; and associated landforms.
Saline land.	**Z**	Saline land, saline to brackish lakes & lagoons, and associated gypsum deposits & lunettes.
Soils formed on volcanic ash.	*****	Rises, plains & low hills mantled by volcanic ash .

Attribute Data Base

Each Soil Landscape Unit is classified with respect to a range of attributes which influence agricultural land use. An eight class system is used to rank each unit - Class 1 indicates a negligible level of limitation for the attribute in question, while Class 8 represents an extreme level of limitation. In practice, all eight classes are never used for a single attribute, as shown in Table 2 which summarizes the attributes and their class definitions. Rankings are determined through a combination of field observation and measurement, local knowledge, laboratory analyses and extrapolation from other areas with similar soil and landscape features.

These rankings are assigned to soil landscape units via look-up tables in GIS. Where there are significant but unmappable variations within soil landscape units (eg dunes and swales), each component is assigned a set of attributes, so that there may be two, three or even four individual sets of attribute data for a particular soil landscape unit. The relative extent of each component within the landscape is indicated by a proportion code.

The attribute data base is used to produce maps and data about specific features of the land, or about combinations of two or more specific features. The attribute data is also used as the basis of crop potential assessments.

Table 2

Classification System for Key Attributes

Waterlogging (Drainage) 1 Rapidly to well drained 2 Moderately well drained 3 Imperfectly drained (arable) 4 Imperfectly drained (semi-arable) 5 Poorly drained 7 Very poorly drained 8 Permanently inundated	**Depth to Water Table** (based on estimated maximum level maintained for at least two weeks per year) 1 >200 cm 2 100-200 cm 3 50-100 cm 4 0-50 cm 5 Above surface 0-3 mths 7 Above surface 3-10 mths 8 Above surface >10 mths
(PAWC) (Root Zone Water Holding Capacity) 1 High (>100 mm) 2 Moderate (70-100 mm) 3 Moderately low (40-70 mm) 4 Low (20-40 mm) 5 Very low (<20 mm)	**Recharge potential** (based on substrate porosity, soil water holding capacity and rainfall) 1 Low (impeding subsoil & subsolum) 2 Moderate (moderately permeable subsoil & subsolum) 3 High (highly permeable subsoil & subsolum)
Water Repellence 1 Non repellent. 2 Repellent 3 Strongly repellent	
Physical Condition - Surface (Seedling Emergence and Workability) 1 Satisfactory 2 Slight limitation (most soils are hard-setting) 3 Moderate limitation (most soils are dispersive) 4 Severe limitation (most soils are highly dispersive).	**Physical Condition – Subsoil** (Root Growth Conditions) 1 Satisfactory (problem subsoil deeper than 60 cm) 2 Slight limitation (problem subsoil 30-60 cm deep) 3 Moderate limitation (problem subsoil 20-30 cm deep) 4 High limitation (problem subsoil 10-20 cm deep) 5 Severe limitation (problem subsoil shallower than 10 cm)
Depth to hard rock or hard pan 1 >150 cm 2 100-150 cm 3 50-100 cm 4 25-50 cm 5 10-25 cm 6 <10 cm	**Fertility** (Nutrient Retention Capacity) Estimate based on texture, leaching capacity, acidification potential, carbonate and ironstone content. 1 High to very high 2 Moderate 3 Moderately low 4 Low 5 Very low
Toxic Elements - Al Extractable Aluminium (mg/kg) in upper 50 cm 1 <4 2 4 - 8 3 >8	**Toxic Elements – B** Depth to Boron > 15 mg/kg 1 >100 cm 2 50-100 cm 3 25-50 cm 4 10-25 cm 5 <10 cm
Toxic Elements - Na Depth to exchangeable sodium percentage >25% 1 >100 cm 2 50-100 cm 3 25-50 cm 4 10-25 cm 5 <10 cm	**Acid sulfate soils** 1 No potential for acid sulfate 4 Potential for development of patchy acid sulfate 5 Potential for acid sulfate

Table 2 (cont)

Classification System for Key Attributes

pH – Acidity Non Acidic: pH_{CaCl2} => 5.4 Acidic: pH_{CaCl2} = 4.5-5.4 Strongly Acidic: pH_{CaCl2} =< 4.5 1>1 Non acidic surface / alkaline subsoil 1>2 Non acidic surface / neutral subsoil 2>1 High buffering acidic surface / alkaline subsoil 2>2 High buffering acidic surface / neutral subsoil 2>3 High buffering acidic surface / acidic subsoil 2>4 High buffering acidic surface / strongly acidic subsoil 3>1 Low buffering acidic surface / alkaline subsoil 3>2 Low buffering acidic surface / neutral subsoil 3>3 Low buffering acidic surface / acidic subsoil 3>4 Low buffering acidic surface / strongly acidic subsoil 4>3 High buffering strongly acidic surface / acidic subsoil 4>4 High buffering strongly acidic surface / str. acidic subsoil 5>3 Low buffering strongly acidic surface / acidic subsoil 5>4 Low buffering strongly acidic surface / str. acidic subsoil	**pH - Alkalinity** Non Alkaline: pH_{CaCl2} =< 7 Alkaline: pH_{CaCl2} = 7-8.5 Strongly Alkaline: pH_{CaCl2} = >8.5 1>1 Non alkaline surface / non alkaline subsoil 1>2 Non alkaline surface / alkaline subsoil 1>3 Non alkaline surface / strongly alkaline subsoil 2>2 Alkaline surface / alkaline subsoil 2>3 Alkaline surface / strongly alkaline subsoil 3>3 Strongly alkaline below 10 cm / strongly alkaline subsoil 4>3 Strongly alkaline within 10 cm / strongly alkaline subsoi
Soil carbonates (surface) 1 No reaction to 1M HCl 2 Slight to moderate reaction to 1M HCl 3 Strong reaction to 1M HC1	**Soil carbonates (subsoil)** 1 >60 cm to strong reaction to 1M HCl 2 30-60 cm to strong reaction to 1M HCl 3 < 30 cm to strong reaction to 1M HCl
Salinity (induced by saline water table) 1 Low. 2 Moderately low. Raised subsoil salinity 3 Moderate. Raised surface salinity 4 Moderately high. Halophytes common 5 High. Halophytes only 7 Very high. Highly tolerant species only 8 Extreme. Bare salt pan Where salinity occurs in patches (eg saline seeps), subscript characters indicate proportion of land affected: o up to 2% patches of high to extreme salinity + 2-10% patches of high to extreme salinity x 10-50% patches of high to extreme salinity	**Dry saline land** (without water table) 1 Nil (<2 dS/m ECe) 2 Subsoil salinity only (2-4 dS/m ECe) 3 Moderate salinity throughout profile (4-8 dS/m ECe) 4 High salinity throughout profile (>8 dS/m ECe) 7 More than 50% bare ground Subscript ‘w’ indicates that a shallow water table is the main cause of salinity. Where highly saline land occurs in patches (“magnesia” ground), subscript characters indicate proportion of land affected: o up to 2% “magnesia” patches + 2-10% “magnesia” patches x 10-50% “magnesia” patches
Scalding 1 Nil. 2 0-5% land affected 4 5-10% land affected 5 10-50% land affected 7 >50% land affected	**Erosion Potential – Water** 1 Low. 2 Moderately low (modified surface mgt. needed) 3 Moderate (engineered works needed) 4 Moderately high (semi arable) 5 High (moderately steep - non arable) 6 Very high (steep - non arable) 7 Extreme (very steep - non-productive)

Table 2 (cont)

Classification System for Key Attributes

Erosion Potential – Wind

1	Low
2	Moderately low - modified surface management needed
3	Moderate – limited range of crops & rotations
4	Moderately high - semi arable
5	High - non arable
7	Extreme - non productive, perennial vegetation essential

Gullying (Includes gully, tunnel & stream bank erosion.)

1	Nil
2	Up to 5% of land affected
3	5-10% of land affected
4	10-20% of land affected (semi arable)
5x	Watercourse only (stable gully)
7	>20% of land affected (non productive)
7x	Watercourse only (unstable gully)

Landslip (Hillside mass movement, earthflow etc.)

1	Nil & no potential for landslip
4	Potential for mass movement - non present
5	Up to 5% of land affected
7	>5% of land affected

Rocks (Outcrop and stone affecting cultivation, access & abrasion.)

1	Nil
2	Some interference to tillage / excessive implement wear
3	Picking/rolling required
4	Semi-arable, <50% rock
5	Non arable but traversable
6	Non traversable
8	Rockland

Exposure

1	Nil-slight
2	Moderate (eg elevated inland areas).
3	High (eg coastal)

Flooding Potential

1	No
2	Yes

Potential rootzone depth for irrigated crops

A:	Sensitive crops (eg citrus, avocado)
B:	Intermediate crops (eg stone, pome fruits, almonds)
C:	Hardy crops (eg grape vines, olives)
D:	Annual root crops
E:	Annual above ground crops

1	>100 cm
2	80-100 cm
3	60-80 cm
4	50-60 cm
5	40-50 cm
6	30-40 cm
7	20-30 cm
8	<20 cm

Deep drainage
(based on depth to impermeable layer such as Blanchetown Clay or equivalent)

1	>150 cm
2	100-150 cm
3	50-100 cm
4	25-50 cm
5	<25 cm

Soil

Alpha-numeric codes refer to soil classes defined in Soils of South Australia’s Agricultural Lands” (draft PIRSA publication), and summarized in Table 3.

>30% indicates that the itemized soil class (es) occupy more than 30% of the area.
10-30% indicates that the itemized soil class (es) occupy 10-30% of the area.

Surface texture

S	Sand, loamy sand, clayey sand
LS	Loamy sand, clayey sand
SL	Sandy loam, light sandy clay loam
L	Loam , silt loam, fine sandy loam
SCL	Sandy clay loam
CL	Clay loam, silty clay loam, fine sandy clay loam
CN	Non cracking clay
CC	Cracking clay

Crop Potential Assessment

Introduction

The potential of land to sustain a specific crop type varies considerably. Overall, economics is as great a determinant of the potential for a given crop as are environmental factors. For example, infertile land in a low rainfall area may have low production potential, but if the returns from a particular crop are sufficiently high, it may be a better option than another crop with higher productive potential. These dynamic considerations contribute to the *suitability* of land for a particular use. Suitability is influenced by economics, climate, landscape, soil type, pest and disease incidence, water availability (for irrigated crops), social considerations and regulations. Suitability assessments therefore require a complex and multi-disciplinary approach, and vary over time - year by year for some crops.

The assessment methodologies described in this report deal only with the soil and landscape parameters which impact on the productivity and management requirements of different crops. This type of assessment describes the *capability* of land for a specific use, but because this term is widely mis-used, it is not applied in this report.

The assessment techniques were developed to be used in conjunction with the soil and landscape mapping data base compiled for the agricultural districts of South Australia between 1990 and 2000. Each mapped soil landscape unit has been classified with respect to a range of attributes which affect agricultural and horticultural land use. These attributes include susceptibility to waterlogging, acidity, salinity, rockiness and 33 more. By matching the values of these attributes with the requirements of specific crops, the relative potential of a particular soil landscape unit to sustain a particular crop can be predicted.

Classification system

A five class system is used to differentiate between land with high potential through to land with low potential. This system is loosely based on the FAO classification (1976), and closely resembles the Western Australian system of van Gool and Moore (1999). Table 3 sets out the generalized class definitions.

Table 3 Generalized definitions of crop potential classes

Class	General definition
Class A	Land with high productive potential and requiring no more than standard management practices to sustain productivity.
Class B	Land with moderately high productive potential and / or requiring specific, but widely accepted and used, management practices to sustain productivity.
Class C	Land with moderate productive potential and / or requiring specialized management practices to sustain productivity.
Class D	Land with marginal productive potential and / or requiring very highly specialized management skills to sustain productivity.
Class E	Land with low productive potential and /or permanent limitations which effectively preclude its use.

Classification tables have been prepared for each of 21 crop types to date (May 2000). For each crop, the tables consider those soil / landscape attributes which affect its productivity and management requirements. Class limits (criteria) are defined for each attribute depending on the sensitivity of the crop to that particular attribute; that is the criteria specify the degree to which a particular attribute impacts on a crop. The land use potential class is determined by the most limiting attribute.

For example, land which is prone to waterlogging for between two and six weeks is marginal (ie Class D) for grape vines. If, after comparing all of the other 36 attributes describing a particular soil landscape with the criteria, Class D is the most limiting, the land is assigned an overall rating of Class D. By a similar process, the same area of land is also Class D for potatoes. However, many soil landscapes classify differently for different crops. For example, land with extensive surface stone and sheet rock can be ripped for vines, and presents only a moderate limitation (ie Class C). However, for potatoes, extreme rockiness is a permanent limitation, so the same land is Class E for potatoes.

Linking the classification criteria to the mapping data base

Matching the requirements of a crop (as defined in the classification tables) with the properties of the land (as defined by the attributes attached to each soil landscape unit in the mapping coverage) is done electronically. Query routines have been set up which scan each set of attributes and compute a class number. For soil landscape units which are relatively uniform, this class translates to the entire unit, and the soil landscape map can be simply re-drawn into five classes for the crop in question.

However, much of the land in South Australia's agricultural districts is complex, in that significant variations in soil type or land surface features occur over short distances (eg dune - swale systems, stony rises on sandy plains etc). These variations are unmappable in regional scale assessments. Consequently, many mapping units comprise two or more components with variable crop potential. A proportional mapping approach has been used to account for this variability. This introduces a degree of complexity into the mapping product, so to maximize the utility of the maps, the number of land use potential classes shown on the map is reduced from five to three. Classes A and B are combined, as are classes D and E. Maps show the proportion of land with high to moderate potential. High potential includes Classes A and B. Moderate potential is Class C.

Classes are given a two character symbol.

The first character indicates the proportion of the mapping unit with moderate to high potential:

- V = very extensive (more than 60%)
- X = extensive (30-60%)
- L = limited (10-30%)
- M = minor (less than 10%)

The second character indicates the mix of high and moderate potential:

- A = mostly high potential
- B = moderate and high potential
- C = mostly moderate potential

Table 4 defines the classes used in proportional mapping of crop potential

Table 4 Class definitions for proportional mapping of crop potential

Symbol	Proportion of land with high or moderate potential	Mix of high and moderate potential
VA	More than 60% (V)	Mostly high (A & B)
VB	More than 60% (V)	Moderate and high (A, B & C)
XA	30-60% (X)	Mostly high (A & B)
XB	30-60% (X)	Moderate and high (A, B & C)
VC	More than 60% (V)	Mostly moderate (C)
XC	30-60% (X)	Mostly moderate (C)
LA	Less than 30% (L)	Mostly high (A & B)
LC	Less than 30% (L)	Mostly moderate (C)
MB	Less than 10% (M)	Moderate and high (A, B & C)

Crop types

Classification tables have been developed for 21 crops to date. These are grouped into four broad categories as follows:

- Field crops
  - Barley
  - Beans
  - Canola
  - Chickpeas
  - Field peas
  - Lentils
  - Lupins
  - Oats
  - Triticale
  - Wheat

- Perennial horticultural crops
  - Almond
  - Grape vine
  - Olive
  - Cherry

- Annual horticultural crops
  - Carrot
  - Onion
  - Potato

- Pastures
  - Lucerne
  - Sub. clover
  - White clover
  - Perennial rye grass

- Timber trees
  - Tasmanian blue gum

Variations within a crop type

No account is taken of particular varietal or cultivar differences which may affect sensitivity to a particular attribute - the approach is generalized. For example, certain lucerne cultivars may have improved tolerance of acidic soils, but as a general rule, lucerne is sensitive to acidity, so acid soils are classified accordingly.

Management considerations

A common observation relating to this type of generalized land classification is that a good manager can achieve equivalent or better production and resource protection outcomes from "low grade" land than a poor manager on "higher quality" land. This is undoubtedly true, but the purpose of the exercise is not to identify where certain activities should or should not occur, or how land should be managed, but rather to provide regional level information on the potential for specific crops managed according to accepted and recommended industry practices.

For example, wheat could be successfully grown on very poorly drained land if elaborate drainage systems were installed. However, this is not standard practice for wheat or any other field crop, so land subject to severe waterlogging is class E. By the same token, wheat production cannot be sustained on moderate slopes if seed bed preparation involves multiple destructive tillage passes and / or contour banks are not installed. Accepted practice specifies modifications to some conservation tillage and use of engineered works to control erosion, so moderately sloping land is class B.

Assessment Criteria

Tables specifying the classification criteria for each crop have been prepared. They all use the same template, so only one example (olives) is included in this document.

Land Classification Criteria - Olives

Land quality		What to measure or look for	Degree of limitation				
			Negligible Class A	Slight Class B	Moderate Class C	High Class D	Severe Class E
Effective rootzone depth	dc	Depth to impeding layer (crop type C)	> 80 cm dc = 1,2	60-80 cm dc =3	40-60 cm dc = 4,5	30-40 cm dc = 6	< 30 cm dc = 7,8
Deep drainage	b	Depth to impermeable clay (eg Qph)	> 150 cm b = 1	-	100 - 150 cm b = 2	50 - 100 cm b = 3	<50 cm b = 4,5
Waterlogging	w	Length of time that any part of the profile is saturated following heavy rain / irrigation	<1 day w = 1	Up to a week w = 2	1 to 2 weeks w = 3	2 to 6 weeks w = 4	> 6 weeks w = 5,7,8
Depth to water table	o	Estimate highest level maintained for at least two weeks per year	>200 cm o = 1	>100 cm o = 1-*	100-200 cm o = 2	50-100 cm o = 3	< 50 cm o = 4,5,7,8
Salinity (associated with water table)	s	Observe presence of halophytic plants (eg sea barley grass) OR	None present	Subsoil salinity	Scattered halophytes	Halophytes common	Mostly halophytes
		Measure conductivity of saturation paste extract (dS/m) in surface and subsoil Where “depth to water table (o)” =1 and “deep drainage (b)” =1:	< 2 (surface) < 4 (subsoil) s = 1	2 - 4 (surf) 4 – 8 (subs’l) s = 2	4 – 8 (surf) 8-16 (subs’l) s = 3	8 – 16 (surf) 16 – 32 (sub) s = 4	>16 (surf) >32 (subs’l) s = 5, 7, 8
		Where “depth to water table (o)” >1, and / or “deep drainage (b)” >1:	< 2 (surface) < 4 (subsoil) s = 1	2 – 4 (surf) 4 – 8 (subs.) s = 2	4 - 8 (surf) 8 - 16 (subs'l) s = 3	-	>8 (surface) > 16 (subs’l) s = 4,5,7,8
Patchy salinity (associated with water table)	s	Proportion of land affected by saline seepages	0 No "s" subscript	< 2% "s" subs't = o	2-10% "s" subs't = +	10-50% "s" subs't = *	-
Dry saline land	v	Measure conductivity of saturation paste extract (dS/m) in surface and subsoil. Where deep drainage is impeded (b=2,3,4,5):	< 2 (surface) < 4 (subsoil) v = 1	2 - 4 (surf) 4 - 8 (subs’l) v = 2	4 - 8 (surf) 8 – 16 (subsl) v = 3	8 - 16 (surf) 16-32 (subs'l) v = 4	>16 (surface) > 32 (subs’l) v = 7
		Measure conductivity of saturation paste extract (dS/m) in surface and subsoil. Where deep drainage is un-impeded (b=1):	< 4 (surface) < 8 (subsoil) v = 1,2	4 - 8 (surf) 8 - 16 (subs'l) v = 3	8 – 16 (surf) 16-32 (subs'l) v = 4	-	>16 (surf) > 32 (subs’l) v = 7
Patchy dry saline land	v	Proportion of land affected by dry saline (magnesia) patches	0 No "v" subscript	< 2% "v" subs't = o	2-10% "v" subs't = +	10-50% "v" subs't = *	-
Acidity	h	Measure pH $CaCl_2$ at surface & deep subsoil: Surface > Subsoil 1 = > 5.4 / 1= > 6.9 2,3 = 4.5 - 5.4 / 2 = 5.5 - 6.9 4,5 = < 4.5 / 3 = 4.5 - 5.4 4 = < 4.5	h = 1> 1, 1>2	h = 2>1, 2>2 3>1, 3>2	h = 2>3, 3>3	h=4>3, 5>3	h=2>4, 3>4, 4>4, 5>4
Alkalinity	i	Measure pH (water) at surface & deep subsoil: Surface > Subsoil 1 = < 8.0 / 1 = < 8.0 2 = 8.0 - 9.2 / 2 = 8.0 - 9.2 3 = > 9.2 (10-30) / 3 = > 9.2 4 = > 9.2 (0-10)	i = 1>1, 1>2	i = 1>3, 2>2, 2>3	i = 3>3	i = 4>3	-
Surface CO_3	ka	Reaction to 1M HCl	Nil to mod. ka = 1,2	Strong ka = 3	-	-	-
Subsoil CO_3	kb	Depth to strong reaction to 1M HCl	>30 cm kb = 1,2	< 30 cm kb = 3	-	-	-

Inherent fertility	n	Identify soil type	Mod. - v high n = 1,2	Mod. low n = 3	Low n = 4	Very low n = 5	-
Toxic elements	tb	Determine depth to boron levels of > 15 mg/kg	> 100 cm tb = 1	-	50-100 cm tb = 2	25-50 cm tb = 3	< 25 cm tb = 4,5
	ta	Measure extractable aluminium in root zone	<2 mg/kg ta = 1	2-4 mg / kg ta = 2	> 4 mg/kg ta = 3	-	-
	ts	Determine depth to exchangeable sodium percentage of > 25%	> 100 cm ts = 1	50-100 cm ts = 2	25-50 cm ts = 3	10-25 cm ts = 4	< 10 cm ts = 5
Rockiness	r	Estimate proportion of surface rock and stone	Nil – slight r = 1,2	Moderate r = 3	Semi arable r = 4	Non arable r = 5	Non traversable r = 6,8
Surface condition	c	Hardness / dispersiveness of surface soil	Non disp. c = 1,2	Dispersive c = 3	Str. dispersive c = 4	-	-
Subsoil structure	p	Determine depth to and nature of subsoil. eg Depth to dispersive clay:	> 60 cm p = 1	30-60 cm p = 2	20-30 cm p = 3	10-20 cm p = 4	<10 cm p=5
Scalding	z	Assess the percentage of land affected	None z = 1	Up to 5% z = 2	5 - 10% z = 4	10 - 50% z = 5	> 50% z = 7
Water repellence	u	Measure time taken for drop of water to be absrbed into soil	Instantly (non repellent) u = 1	Repellent, str. repellent u = 2,3	-	-	-
Water erosion potential	e	Refer handbook for water erosion classes	Low, mod. low, moderate e = 1,2,3	Moderately high to high e = 4,5	-	Very high e = 6	Extreme e = 7
Wind erosion potential	a	Refer handbook for wind erosion classes	Low, mod. low, moderate a = 1,2,3	Moderately high to high a = 4,5	-	Extreme a = 7	-
Gully erosion	g	Assess percentage of land affected	< 5% g = 1,2	5-10% g = 3	10-20% g = 4	-	> 20% g = 7, 5*,7*
Mass movement	l	Estimate area affected or at risk	None present, slope < 30% l = 1	-	None present, slope > 30% l = 4	Up to 5% of land affected l = 5	> 5% of land affected l = 7
Exposure	y	Estimate degree of wind exposure	Nil – slight y = 1	Moderate y = 2	High (coast) y = 3	-	-

If most severe ranking = 2, and this ranking is due to any three of d, b, w, s, o, v, p, n then downgrade to Class 3

If most severe ranking = 3, and this ranking is due to any three of d, b, w, s, o, v, p, n then downgrade to Class 4

If most severe ranking = 4, and this ranking is due to any three of d, b, w, s, o, v, p, n then downgrade to Class 5