Appendix A Criteria used in land degradation analysis

Soil compaction

Soil types were assessed for all attributes and a mean value assigned as the rating for soil compaction. Extreme values were also considered in the analysis and their potential to be the major limiting factor. Dry consistence of surface soil, organic carbon and surface condition were used as part of the analysis. Note that page references refer to the *Australian Soil and Land Survey Field Handbook* (McDonald et al. 1990) or *Soils - their properties and management* (Charman & Murphy 1991).

Dry consistence of surface soil (p. 138 - McDonald et al. 1990)

	Rating	Break force	Class
1	Low	Loose, very weak	< 2
2	Moderate	Moderately weak	2
3	High	Firm, very firm, strong, rigid	> 2

Organic carbon (p. 206 - Charman & Murphy 1991)

	Rating	% Carbon
1	Low	> 3
2	Moderate	1.5–3
3	High	< 1.5

Surface condition (p. 141 - McDonald et a.l 1990)

	Rating	Condition
1	Low	Self-mulching, loose
2	Moderate	Soft, firm (relative to Org C)
3	High	Hardsetting, surface crust, surface flake, cracking, fir (relative to Org C)

Overall rating for soil compaction

	Rating
1	Low
2	Moderate
3	High

Wind erosion

The susceptibility of land to wind erosion is a function of soil erodibility, the probability of erosive winds when the soil is dry and the exposure of the land component to wind (Lorimer 1985).

Rating for wind erosion

	Soil type	Rating
1	Surface soil has a strong blocky structure (aggregates > 0.8 mm), or is apedal and cohesive or has a dense layer of stones, rock or gravel	Very low
	Surface soil has strong fine structure (aggregates < 0.8 mm)	Moderate
	Surface soil has a weak-moderate structure or is apedal and loose	Go to 2
2	Surface soils with organic matter > 20%	High
	Surface soils with organic matter 7-20%	Moderate
	Surface soils with organic matter < 7%	Go to 3
3	Surface soils with the following textures:	
	Fine-medium sands	Very high
	Loamy sands	High
	Sandy loams, silty loams	High
	Loams, coarse sands	Moderate
	Clay loams	Low
	Clays	Very low

Sheet and rill erosion

The following table has been adapted from Elliott and Leys (1991). The erodibility index for a range of soil properties closely relates to the susceptibility of soils to erosion by water, and in the tables below, the same soil properties have been used (texture, structure grade, topsoil depth and dispersibility (Emerson aggregate test)) which are then related to slope to determine a rating for susceptibility. The final rating for susceptibility to sheet/rill erosion is read from the erodibility of the topsoil and the slope of the area.

Erodibility index

Soil parameters			Soil dispersibility		
Texture group (A1)	**Structure grade (A1)**	**Horizon depth (A1 + A2)**	**Very Low - Low E3(1), E3(2), E4,E5, E6, E7, E8**	**Medium - High E3(3), E3(4), E2**	**Very High E1**
Sand	apedal	< 0.2 m	M		
		0.2-0.4 m	L		
		> 0.4 m	L		
Sandy loam	apedal	< 0.2 m	M	H	
		0.2-0.4 m	L	M	
		> 0.4 m	L		
	weakly pedal	< 0.2 m	H	E	
		0.2-0.4 m	M	V	
		> 0.4 m	M		
Loam	apedal	< 0.2 m	M	H	
		0.2-0.4 m	L	M	
		> 0.4 m	L		
	weakly pedal	< 0.2 m	H	E	
		0.2-0.4 m	M	V	
		> 0.4 m	M		
	peds evident	< 0.2 m	H	E	
		0.2-0.4 m	H		
		> 0.4 m	H		
Clay loam	apedal	< 0.2 m	M	H	
		0.2-0.4 m	L	M	
		> 0.4 m	L		
	weakly pedal	< 0.2 m	H	E	
		0.2-0.4 m	M	V	
		> 0.4 m	M		
	peds evident	< 0.2 m	H	E	
		0.2-0.4 m	H	E	
		> 0.4 m	M		
Light clay	weakly pedal	< 0.2 m	H	E	E
		0.2-0.4 m	M	V	E
		> 0.4 m	M	V	E
	peds evident	< 0.2 m	M	V	E
		0.2-0.4 m	M	H	E
		> 0.4 m	M	H	E
	highly pedal	< 0.2 m	H	E	
		0.2-0.4 m	M	V	
		> 0.4 m	M	V	

L - Low M - Moderate H - High V - Very high E - Extreme

Soil parameters			Soil dispersibility		
Texture group (A1)	**Structure Grade (A1)**	**Horizon depth (A1 + A2)**	**Very Low - Low E3(1), E3(2), E4,E5, E6, E7, E8**	**Medium - High E3(3), E3(4), E2**	**Very High E1**
Medium to heavy clay	weakly pedal	< 0.2 m	M	H	E
		0.2-0.4 m	M	H	V
		> 0.4 m	M	H	V
	peds evident	< 0.2 m	H	E	E
		0.2-0.4 m	M	V	E
		> 0.4 m	M	V	E
	highly pedal	< 0.2 m	H	E	E
		0.2-0.4 m	M	V	E
		> 0.4 m	M	V	E

Susceptibility of soil to sheet and rill erosion (using topsoil erodibility from above)

Slope %	Topsoil erodibility (from table above)				
	Low	**Moderate**	**High**	**Very high**	**Extreme**
< 1 %	Very low	Very low	Low	Low	Moderate
1-3 %	Very low	Low	Moderate	Moderate	High
4-10%	Low	Moderate	Moderate	High	Very high
11-32%	Moderate	Moderate	High	Very high	Very high
> 32%	Moderate	High	Very high	Very high	Very high

*Note: Topsoil erodibility is determined from the texture, structure, depth and dispersibility of the topsoil. The susceptibility of the topsoil to sheet and rill erosion relates to the combined effect of slope and topsoil erodibility.

Gully and tunnel erosion

No single factor can adequately represent the susceptibility of an area to the gully erosion process. A number of factors are involved and each should be scored independently and then the sum of the scores can be related back to a 5-class rating.

It should be noted that plains or landforms of significant area with low slopes and little upland surface water contribution (e.g. level plains, vast floodplains) have been rated in depth to rock/hardpan as low (2) or very low (1) for this attribute. These deep soils are relatively unlikely to experience flow gradients that will significantly contribute towards gully and tunnel erosion susceptibility.

Susceptibility to gully and tunnel erosion

Criteria	Description	Score
Slope	< 1%	1
	1-3%	2
	4-10%	3
	11-32%	4
	> 32%	5
Subsoil dispersibility	E1	5
	E2, E3(3), E3(4)	4
	E3(1), E3(2)	3
	E4, E5	2
	E6, E7, E8	1
Depth to rock/hardpan	0-0.5 m	1
	0.6-1.0 m	2
	1.1-1.5 m	3
	1.6-2.0 m	4
	> 2.0m	5
Subsoil structure	Apedal, massive	1
	Weak	
	fine < 2 mm	3
	moderate 2-10 mm	2
	coarse > 10 mm	1
	Moderate	
	fine < 2 mm	4
	moderate 2-10 mm	3
	coarse > 10 mm	2
	Strong	
	fine < 2 mm	5
	moderate 2-10 mm	3
	coarse > 10 mm	1
	Apedal, single grained	5
Lithology of substrate	Basalt	1
	Volcanic	2
	Rhyodacite	2
	Granite	4
	Alluvium	3
	Colluvium	5
	Tillite	4
	Ordovician sandstone/mudstone	5
	Silurian sandstone/mudstone	4

Rating for susceptibility to gully erosion:	Class	Total score
	1. Very low	6-10
	2. Low	11-13
	3. Moderate	14-16
	4. High	17-20
	5. Very high	21-25

Soil sodicity (topsoil or subsoil)

Sodicity is a measure of the exchangeable sodium in relation to other exchangeable cations. It is expressed as the Exchangeable Sodium Percentage (see ESP). A sodic soil contains sufficient exchangeable sodium to interfere with the growth of plants, including crops. A soil with an ESP greater than 6 is generally regarded as being a sodic soil in Australia (Northcote and Skene 1972). ESP levels are further classified in the *Australian Soil Classification* (Isbell 1996).

The sodicity level of a soil can be quantitatively tested in the laboratory by determining the proportion of sodium (Na%) present in the Cation Exchange Capacity (see CEC). That is:

$$\text{ESP (or Na\%)} = \frac{\text{sodium}}{\text{calcium} + \text{magnesium} + \text{sodium} + \text{potassium}} \times 100$$

This provides an Exchangeable Sodium Percentage value which determines the sodicity of the soil.

If the ESP value is:

ESP value	Description	Subsoil description
<6	Non-sodic	Non-sodic
6–15	Sodic	Subnatric
15–25	Strongly sodic	Mesonatric
>25	Very strongly sodic	Hypernatric

Soil pH (topsoil or subsoil)

Soil pH provides a measure of soil acidity and soil alkalinity on a scale of 0 (extremely acidic) to 14 (extremely alkaline), with a pH of 7 being neutral. It gives an indication of the availability of plant nutrients and relates to the growth requirements of particular crops. Acid soils are usually deficient in necessary nutrients e.g. calcium and magnesium, while alkaline soils are often high in boron, affecting plant production.

The criteria used for soil $pH_{(water)}$ for topsoil and subsoil is:

- $pH_{(water)} < 5.5$ = acidic
- $pH_{(water)} > 5.5$ and < 8.0 = neutral
- $pH_{(water)} > 8.0$ = alkaline