Land management within capability, a NSW monitoring, evaluation and reporting project

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Abstract
A project was undertaken in 2007-2009 to determine the extent to which rural land was being managed within its capability, ie, sustainably, throughout NSW, Australia, as part of a monitoring, evaluation and reporting (MER) program. The intention was to provide a baseline of this parameter with which to compare with the situation in 2015 and beyond, to ascertain whether there is trend towards improvement or decline in sustainable land management throughout the state. As at May 2009, 850 representative monitoring sites had been established throughout 124 soil monitoring units (SMUs) over the state's 13 Catchment Management Authorities (CMAs). A process was developed that quantitatively compared the impact of land management actions being practiced with the capability, or physical potential, of the land to support those actions. Results were analysed to derive *Land Management within Capability (LMwC)* indices for individual and combined land degradation hazards for each SMU, CMA and the entire State. Seventy seven percent of SMUs were found to be managed unsustainably for at least one hazard. Organic carbon decline, structure decline and acidification were found to be the hazards being managed least sustainably throughout the state.

Key words
Land management, capability, sustainable, hazards, indices.

Introduction
The management of land within its physical capability is vital for the sustainable use of soil and land resources. Failure to manage land in accordance with its capability may result in a degradation of resources both on and off site, leading to a decline in natural ecosystems, agricultural productivity and infrastructure functionality. This will result in a loss of capacity of natural resource systems to carry out the functions required to support a modern society and economy. One of the 13 NRM targets set by the NSW Natural Resources Commission in this state's Monitoring, Evaluation and Reporting (MER) project was that: *by 2015 there will be an increase in the areas of land managed within its capability*. This program is aimed at ascertaining whether that target is met (Gray *et al*. in press). It complements another MER target aiming for an improvement in soil condition by 2015 (Chapman *et al*. in press).

Methods
The overall methodology involved a comparison of the estimated impact of current land management actions against the physical capability of the land and soil at a set of sample sites to derive *Land Management within Capability (LMwC)* indices. The resulting process, which has not been attempted elsewhere, is summarised in Figure 1 and more fully described in Gray *et al.* (in press).

Collection of data
The primary source of data was derived by establishing up to 100 monitoring sites within 10 prioritised Soil Monitoring Units (SMU) in each of NSW's 13 Catchment Management Authority (CMA) regions. At each monitoring site, detailed soil data was collected and the landholder interviewed about land management practices. As of May 2009, 850 sites were established and 497 landholder surveys returned. This data was supplemented by expert knowledge data systematically collected from DECCW and CMA staff.

Evaluation of capability of land at sites
The capability at each site was evaluated using the Land and Soil Capability (LSC) developed by DECCW. This scheme is an eight-class capability system that considers in detail a range of potential land degradation issues including water erosion, structure decline, acidity, organic carbon decline, salinity and others (Murphy *et al*. 2008). It uses a set of decision tables to evaluate the LSC Class for each site using available landscape, soil and climate data. Site data was applied to these tables to derive LSC values for each land degradation issue at each site.

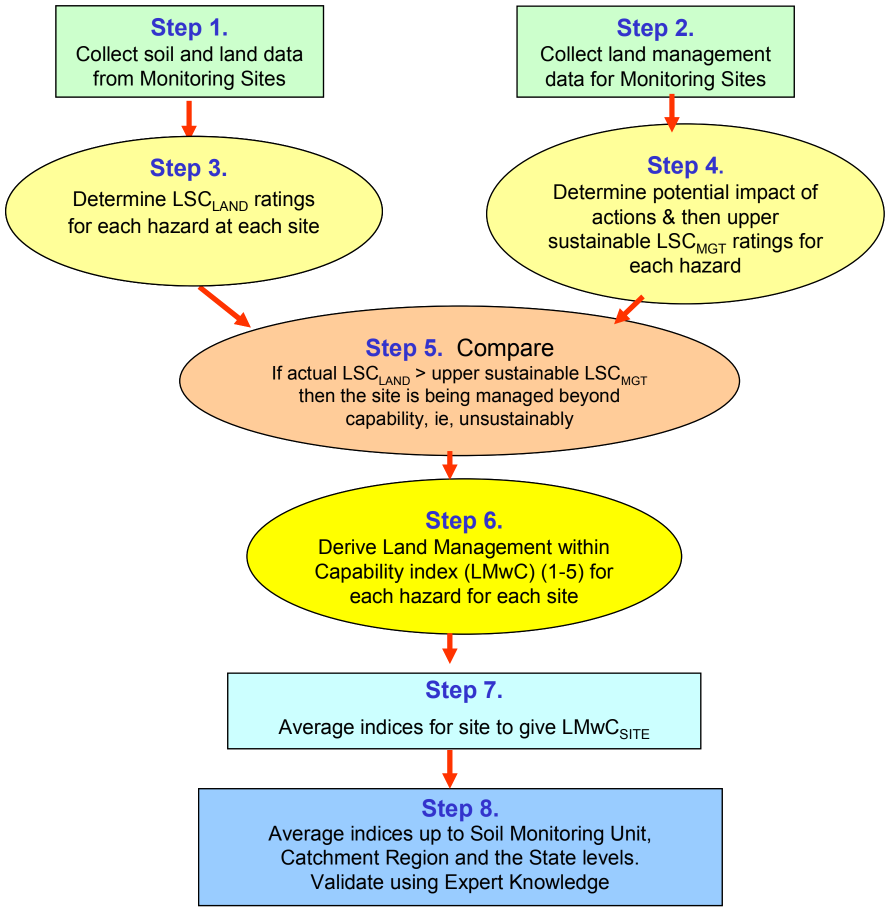

Figure 1. The land management within capability assessment process

Evaluation of land management actions at sites

A framework was developed that considers the potential impact of a range of land management actions on the individual land degradation hazards that comprise the LSC classification (eg, sheet erosion, structure decline, etc). This was developed by a working group of experts using literature values, first principles and field experience. The framework allowed individual actions at a site to be rated as having a low to very high impact on soil condition and allocated a corresponding upper sustainable LSC Class (see example in Table 1). In general, the higher the impact, the better the capability of the land must be for the activity to be practiced sustainably. The combined influence of each action was averaged out to give the "upper sustainable LSC" class for each hazard.

Table 1. Example derivation of upper sustainable LSC class

Land management practice	Specific action	Sheet erosion		Gully erosion		Wind erosion		Structure decline		Acidification	
		Impact	Upr Sust. LSC	Impact	Upr Sust. LSC	Impact	Upr Sust. LSC	Impact	Upr Sust. LSC	Impact	Upr Sust. LSC
Tillages prior to sowing	0	M-L	5	M-L	5	M-L	5	M	4	-	-
	1	M	4	M	4	M	4	VH	2	-	-
	2	H	3	H	3	H	3	EH	1	-	-
	3	VH	2	VH	2	VH	2	EH	1	-	-
	4	VH	2	VH	2	VH	2	VH	2	-	-
	>4	EH	1	EH	1	EH	1	EH	1	-	-
Length of bare fallow	0	M-L	5	M-L	5	M-L	5	M-L	5	M-L	5
(stubble & plant free) (in days)	1-7	M	4	M	4	M	4	M	4	M-L	5
	8-28	H	3	H	3	H	3	H	3	M	4
	29-90	VH	2	VH	2	VH	2	VH	2	H	3
	90-180	EH	1	EH	1	EH	1	EH	1	VH	2
	>180	EH	1	EH	1	EH	1	EH	1	VH	2

Impact	Upper sustainable LSC	Impact	Upper sustainable LSC
Extremely high (EH)	1	Moderate to low (M-L)	5
Very high (VH)	2	Low (L)	6
High (H)	3	Very low (VL)	7
Moderate (M)	4	Extremely low (EL)	8

Comparison of upper sustainable LSC for management with actual LSC of site

The upper sustainable LSC class for each land management action was compared with the actual LSC class of the land at each site. Where the upper sustainable LSC of the land management action was higher than the actual LSC of the land, the site was considered to be managed beyond its capability (see Figure 2). For example, a hot burn of stubble followed by multiple tillage with a two-way disc will have a very high impact on sheet and rill erosion, and the associated upper sustainable LSC Class for these land management actions may be 1. To carry out these actions on land which has LSC Class 3 or 4 will clearly be using the land beyond its capability.

Derivation of LMwC indices

Results for each capability issue from each site were combined across each SMU, then for the entire CMA to gain a single index, the *land management within capability (LMwC*) index for that hazard (see Figure 2). These are then combined to give an overall LMwC index for all issues for the CMA area and ultimately the State. The LMwC indices provide a broad indication of the level of sustainable land management in each CMA and across the State

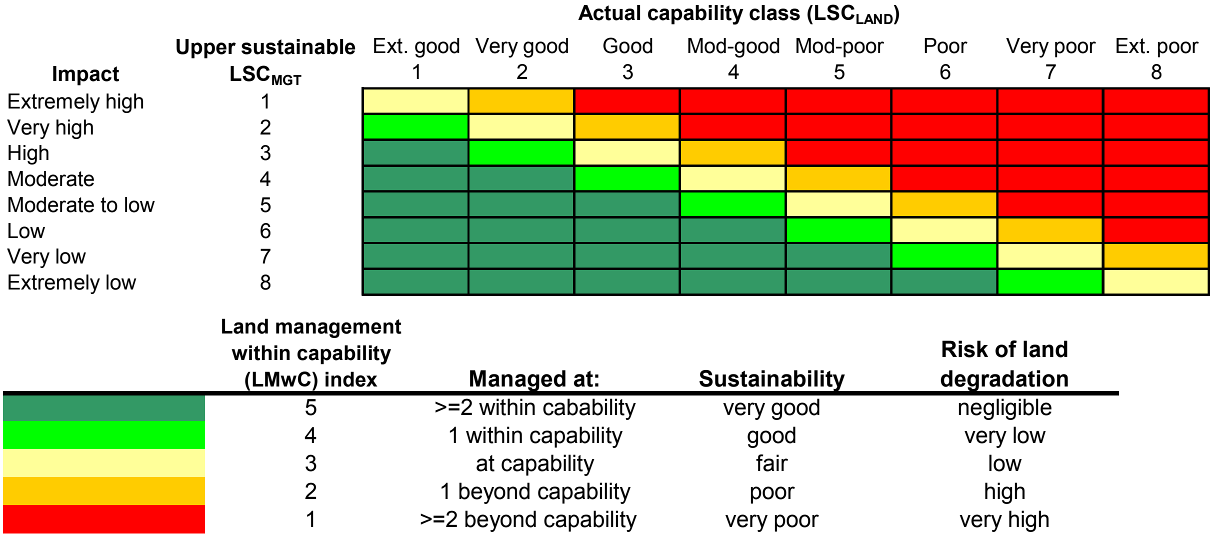

Figure 2. Derivation of LMwC indices

Results

Results from the project were prepared for each of the 13 catchment regions in *State of the Catchment* reports. Results are presented on a (i) SMU basis and (ii) land degradation hazard basis. A hypothetical example output is shown in Figure 2. On a state-wide basis it was revealed that the hazards of organic carbon decline, structure decline and acidification were being managed the least sustainably. Seventy seven percent of SMUs were found to be managed unsustainably for at least one hazard. Full results will be presented in the NSW 2009 *State of Environment* Report (NSW Government in press).

Discussion

The results provide an indication of which regions and hazards are of most concern in relation to sustainable land management across NSW. They also reveal the specific land management actions that are potentially causing the most problems and needing to be addressed. The results to date will be compared with results derived from a similar process in 2015, to ascertain whether the target of an increase in the area of the state managed within capability has been met.

There are a number of caveats on the reliability of these results that should be considered during their interpretation. These include: the incomplete data set; the relatively small sample size for state coverage, and; possible bias in the collaborating landholders towards those with more sustainable land management operations than typical landholders.

Capability Hazard	Land Management within Capability Index[a]	Range of Indices[b]	Current Pressure Trend[c]	SMUs with High Pressure (<=2.5)[d]	Data Source & Confidence[e]
Erosion - Sheet Erosion of topsoil by overland flows. Generally a consequence of insufficient ground cover.	3.2		↔	8	B & K High
Erosion - Gully Erosion of topsoil and subsoils by concentrated overland flows Generally a consequence of insufficient ground cover and changes to runoff and infiltration patterns.	2.9		↑	5, 6, 8	B & K Low
Erosion - Wind Erosion of soils by the action of wind. Generally a consequence of insufficient ground cover and inappropriate tillage practices.	4.0		↑	-	B & K Low
Acidification Trend towards increasingly acid soils, leading to reduced chemical health. A consequence of inappropriate management such as over intense use, allowing excessive leaching, over use of nitrogen fertilisers and insufficient use of lime.	2.9		↑	8, 9	B & K Medium
Organic Carbon Decline The loss of soil organic matter with resulting decline of physical and chemical condition. A consequence of over intense use with insufficient return of biomass to the soil.	2.9		↔	8, 10	B & K Low
Structure Decline Degradation of the physical structure of the soil, reducing the potential for water movement and plant growth. A consequence of practices such as over-cultivation, compaction by heavy vehicles and stock, and insufficient plant root growth.	2.7		↔	2, 3, 7, 10	B & K Low
Acid Sulfate Soils Mismanagement can lead to release of highly acid waters into the ecosystem. This can arise from the exposure of buried potential ASS layers to oxygen such as from lowering of watertable by drainage.	3.0		↔	-	B & K Medium
Salinity/Water logging Build up of salt or saturated soils on ground surface. A consequence of rising groundwater tables following a reduction of deep rooted perennial plants.	3.2		↓	7, 9, 10	B & K High
Overall Index : Catchment	3.1				
State	3.0				

a Land Management within Capability (LMwC) Index

4.6 – 5.0	Very low	Very low pressures on sustainable land management, negligible risk of degradation and probable improvement of soil and land resources.
3.6 – 4.5	Low	Low pressures on sustainable land management, very low risk of degradation to soil and land resources.
2.6 – 3.5	Moderate	Moderate pressures on sustainable land management, low risk of degradation to soil and land resources.
1.6 – 2.5	High	High pressures on land management relative to capability, high risk of degradation to soil and land resources
<1.5	Very high	Very high pressures on land management relative to capability, very high risk of degradation to soil and land resources
	No data	Not included for change monitoring. Information may be available in support documents

Figure 2: LMwC in an example region – by hazard

The information is expected to help guide Catchment Management Authorities and other NSW land management agencies in natural resource management decision making, for example in allocating resources and designing intervention strategies and programs. The concept of using land and soil capability assessments to guide land management practices has the potential to be expanded and significantly contribute to sustainable land management across the state.

References

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