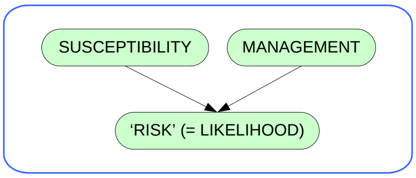
Victorian Catchment Indicators Project



http://www.dse.vic.gov.au/ins-clpr/vcio/index2.htm

The project had two phases, mapping mismatch between land use and land capability and reporting of a land use impact index.

The Mismatch between Land Use and Land Capability (1999-2001)

Development of the LUIM began in "The Mismatch between Land Use and Land Capability" project funded by the Victorian Catchment Management Council (VCMC). Information was required for State of the Environment (SoE) reporting on the area of land affected in Victoria by different forms of degradation. Resources were not sufficient to measure the actual area of degraded land using on ground survey techniques, so a risk assessment approach was developed by DPI.

The aims of the project were to:

1. develop a method for identifying the inherent risk of land and water degradation and the induced or accelerated degradation risk associated with existing or proposed land management practices, and
2. provide a robust and spatially explicit performance indicator for land management across Victoria.

Key project achievements:

- An approach was developed for identifying where there is a mismatch between land use and land capability.
- The LUIM risk framework was developed.
- The LUIM software was produced.

Elements

A framework for land use impact assessment was developed that incorporated measures of unsustainability with traditional methods of land evaluation to identify the mismatch between agricultural land management and land capability (Smith and McNeill 2001). The framework was based on an approach developed by Smith and McDonald (1998).

The LUIM was developed as a tool to implement the risk framework. The Threatening Impacts Model (TIM) (Smith, McDonald and Thwaites 2000) was found to have much of the functionality required. DPI commissioned Dr Carl Smith, who originally designed the TIM as part of his PhD, to develop the LUIM. The first version of the LUIM was produced in 2001, in collaboration with the Catchment Management Decision Support Systems Group at Melbourne University.

The definition of risk in the first version of the LUIM was not the same as has now been adopted in the LUIM risk framework (Figure 1). Risk, in the sense it is used here, is really equivalent to likelihood rather than risk.

SUSCEPTIBILITY × MANAGEMENT = 'RISK'

Each threatening process was rated for its reversibility and this rating was incorporated into the practice classification.

Process

There were four main steps required in the method:

1. Identify and rate susceptibilities.
2. Identify land management practices.
3. Rate the relationship between land management and susceptibilities.
4. Classify management practice and land management recommendations.

Identification of the threatening process and rating landscape components for susceptibility requires spatial information and an understanding of landscape processes. Each map unit or landscape component required a susceptibility rating for each threatening process.

Land management options available to land users, best practices and commonly used practices were identified through interviews with regional experts, land managers and resource management professionals. Relationships between land management practices and threatening processes were defined through consultation and expert workshops. The relationships were based on expert knowledge of the nature and strength of the relationship between threatening processes and land management practices, and the reversibility of any land degradation that may result.

Three types of management practice—threatening process relationships were used in this LUIM:

1. Beneficial Relationships (B).
2. Adverse relationships (A).
3. Neutral relationships (N).

Beneficial and Adverse relationships were further broken into Strong (S), Moderate (M), and Weak (W).

Two types of susceptibility—threatening process relationships were used in this LUIM:

1. Reversible (R). Reversible susceptibilities were further broken into Reversible in the short-term (RS), Reversible in the medium-term (RM) and Reversible in the long-term (RL).
2. Irreversible (I).

The LUIM was used to identify land management practices that were likely to lead to long-term or irreversible damage and those that were likely to avoid degradation (best practices).

This early version of the LUIM used Access databases to store susceptibility and land management relationship information, and to process the results. An example of the LUIM user interface (Figure 7) shows the relationships between land management practices (Stbun – Stubble burnt, Cntil – conventional tillage, Clfal – Cultivation fallow) and susceptibilities (Stru_De – Soil structure decline, Wat_Er – Water erosion, Win_Er – Wind erosion). A measure of the expert’s certainty in their understanding of the relationship between the degradation issues (susceptibilities) and land management practices was also recorded for each combination.

The LUIM had an import-export function that allowed the user to import spatial data for analysis and then export the model results. The user could view results for individual land units (Figure 8). Results were exported as text files that could be linked to spatial data layers in order to map risk.

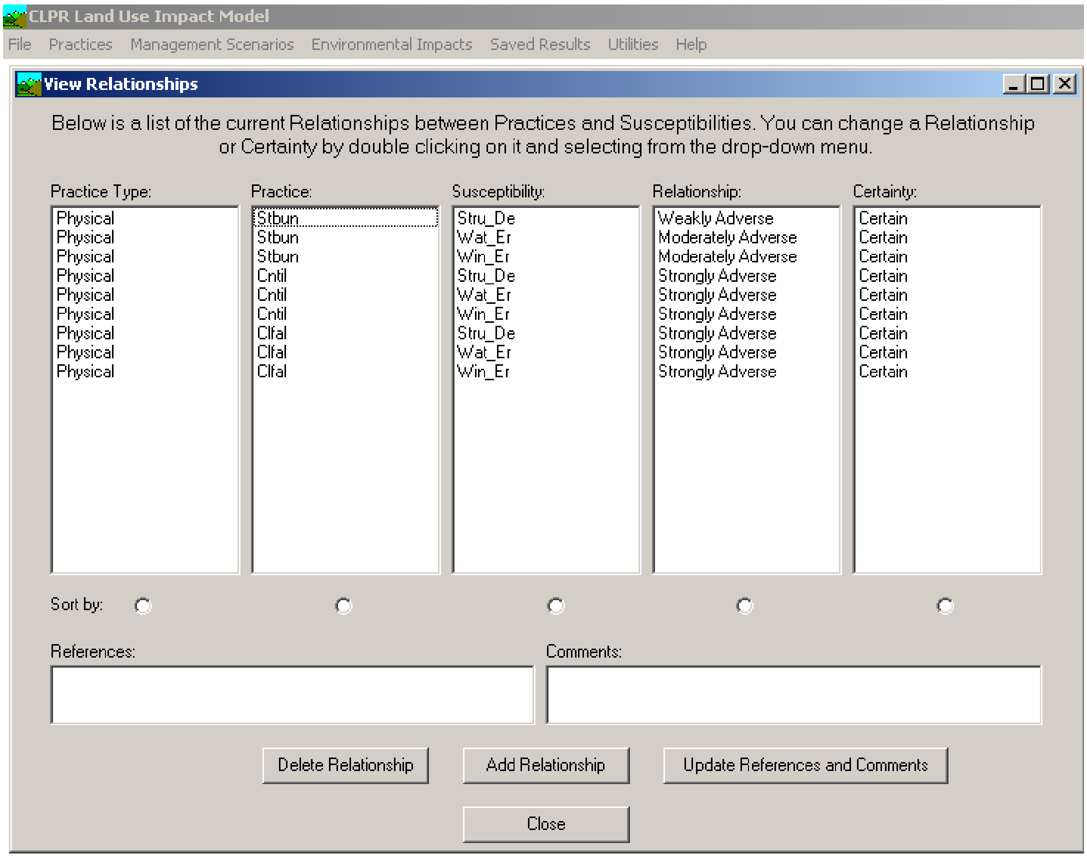


Figure 7 Example of the original version of the LUIM user interface, showing relationships between land management practices and susceptibilities defined through consultation with experts.

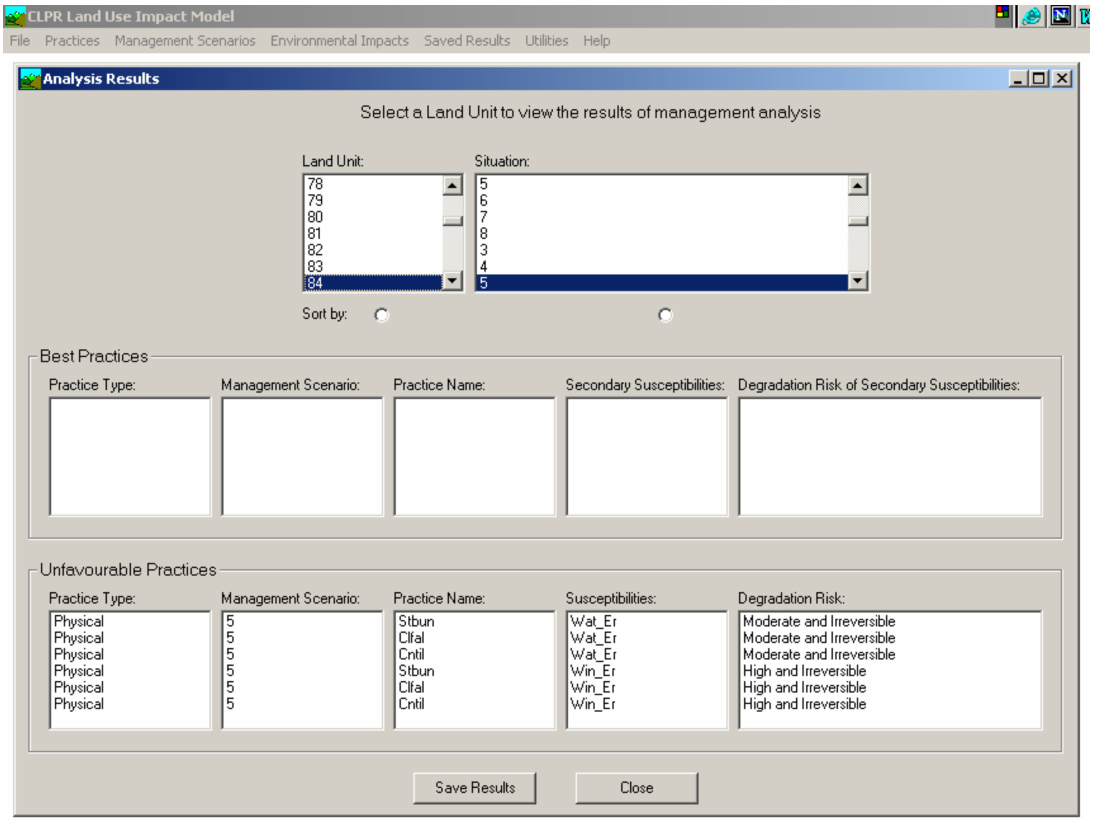


Figure 8 Example of the original version of the LUIM risk results for individual land units.

Land Use Impact Index and the Victorian Catchment Indicators project (2000-2001)

The Victorian Catchment Indicators project (State of Victoria 2001) produced a set of indicators of catchment condition. The Land Use Impact Index indicator was developed to report on the predicted change in catchment condition over time. Functionality was added to the LUIM to enable the LUIM to be used for the land use impact index.

Key achievements

Key achievements in this project were:

- The Land Use Impact Index was developed to report on the predicted change in catchment condition over time.
- The ABS Extension was developed as an extension to the LUIM, to implement the land use impact index.
- A web based reporting product was developed.

Elements

The key requirements of the assessment method were that it should:

- be transparent,
- be repeatable,
- use currently available data,
- enable reporting on trends in catchment condition, and
- be spatial and allow managers to identify priority areas for action.

The LUIM had the capacity to report on the likelihood of degradation occurring for map units under specific land management scenarios. Likelihood could be used as a surrogate for a measure of condition. Extra functionality was required to enable land management practice information, sourced from the ABS agricultural census, to be used to define the management for the census year. The extra functionality was added to the LUIM as an extension called the ABS Extension.

Five degradation issues were assessed:

1. water erosion,
2. wind erosion,
3. soil structure decline,
4. soil acidification, and
5. ground water recharge.

The risk terminology used for this project, was adopted from the LUIM risk framework developed in the 'Mismatch between land use and land capability project' described above.

Process

There were two main components for development of the land use impact index:

1. Identification of the key threats and land management practices to be assessed.
2. Development of ABS Extension to adapt the LUIM as a tool for producing information for the land use impact index

For each of the five degradation issues, specific management practices were assessed (Table 2). Practices were chosen that were thought to be key causes of land degradation. A principal criterion for creation of the inventory of practices was that the practice change could be reported in future years using the ABS agricultural census data. All of the practices in Table 2 were reported in the ABS agricultural census at the time of development of the indicators.

Table 2 Land management practices assessed for each threatening process.

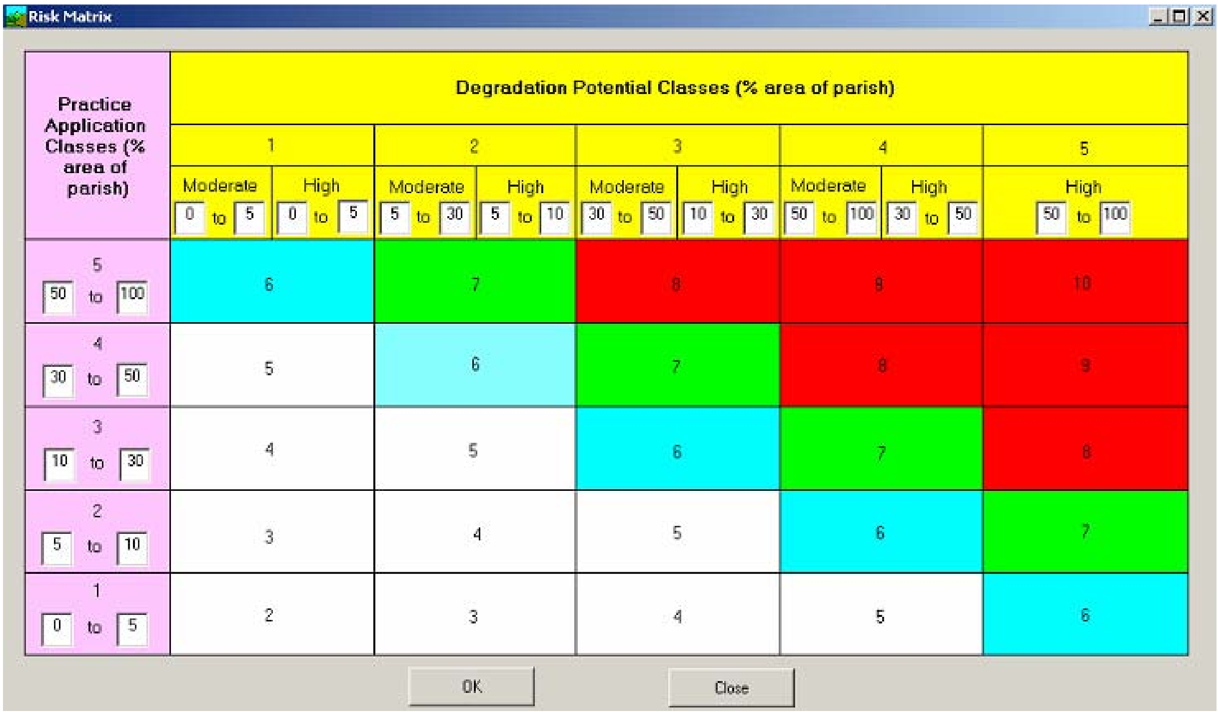
Threatening process	Land management practices
Wind and Water erosion	Conventional tillage
	Cultivation fallow
	Stubble burnt
Soil structure decline	Conventional tillage
	Cultivation fallow
	Stubble burnt
Soil acidification	Lime use
	Use of acidifying fertilisers
	Annual grass and legumes
	Lupins and other legume crops
	Hay/silage taken off-site
Groundwater recharge	Annual grass and legumes
	Shallow rooted crops
	Cultivation fallow

The land use impact index required a very specific type of output. This involved using the Australian Bureau of Statistics (ABS) agricultural census data for different years. Rather than modifying the basic structure of the LUIM, a program called the ABS Extension was developed. The ABS Extension, used in conjunction with the LUIM, produced the land use impact index information required for the catchment condition indicators. The Index functionality was kept separate from the LUIM, to keep the LUIM as a more general model that could be used in diverse applications.

The LUIM was used to apply the relationships between land degradation susceptibilities and management practices to the spatial data. Areas where practices were classified as positive or with a low degradation potential were excluded from further assessment.

The ABS Extension was then used to determine the land degradation risk for each practice in relation to each degradation issue. The available ABS data were reported as combined statistics for different land management practices at Parish scale. The land susceptibility was mapped at 1: 250 000, using Land Systems data. For any map unit (in this instance a Parish) there was a mix of practices and there could also be land with different susceptibilities. The spatial uncertainty of these data are accommodated in the current version of LUIM through the use of a Bayesian belief network, but were dealt with differently in this project using a risk matrix.

The matrix (Figure 9) was adapted from the NRE Risk Management Strategic Framework and Process, V.1 (1999) and combined the degradation potential rating with the practice application data to derive a risk rating for each map unit. The modified risk matrix (Figure 9) ranked degradation risk according to the combination of area of degradation potential, degradation potential rating (moderate or high) and area of unfavourable practice application within a land unit.



Practice Application Classes (% area of parish)	Degradation Potential Classes (% area of parish)				
	1: Moderate 0 to 5; High 0 to 5	2: Moderate 5 to 30; High 5 to 10	3: Moderate 30 to 50; High 10 to 30	4: Moderate 50 to 100; High 30 to 50	5: High 50 to 100
5: 50 to 100	6	7	8	9	10
4: 30 to 50	5	6	7	8	9
3: 10 to 30	4	5	6	7	8
2: 5 to 10	3	4	5	6	7
1: 0 to 5	2	3	4	5	6

Figure 9 The ABS Extension risk matrix screen.

Results

The results from the LUIM and ABS extension were used to estimate the area of land likely to experience degradation for that census year. The agricultural census information from successive years would be used to indicate the change over time in the area of land in Victoria at risk from land and water degradation resulting from practice change. Maps and graphs were produced for the land use impact index for two census years 1995 and 1997.

The results of the modelling were published on the Victorian Catchment Indicators web page (http://www.dse.vic.gov.au/ins-clpr/vcio/index2.htm) and in a report (State of the Environment 2001). Products published for the catchment indicators program include: risk maps for the five degradation issues (Figure 9); pie charts showing the percentage of land in each risk category (Figure 11); and a graph showing the change in the area of land in each risk category over time (Figure **12**).

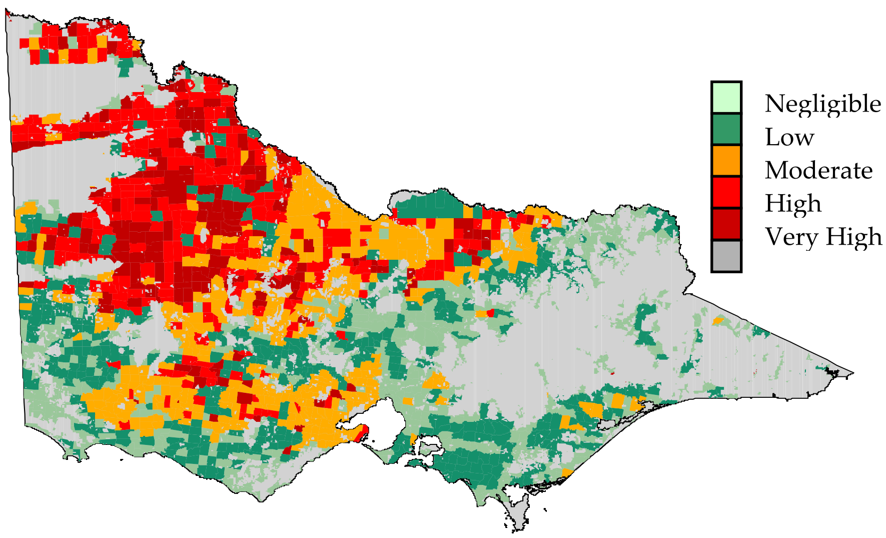


Figure 10 Risk of accelerated soil structure decline due to current management practices on agricultural land in Victoria.

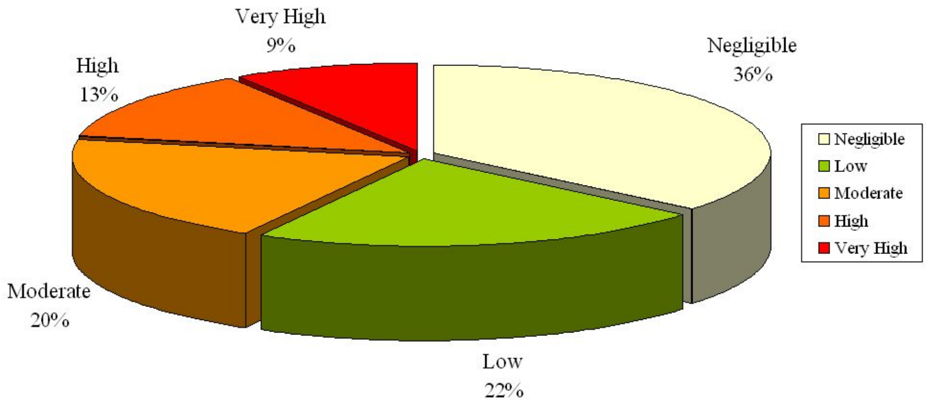


Figure 11 Percentage of agricultural land at risk of accelerated soil structure.

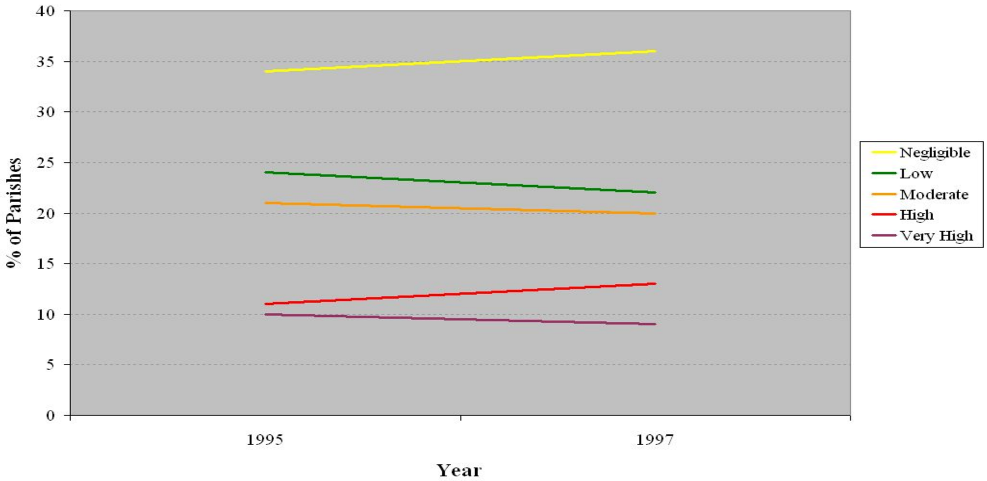


Figure 12 The change in the percentage of area at risk from accelerated soil structure decline in Victoria between 1995 and 1997.