INTRODUCTION

The land systems method involves an ecological approach, integrating environmental features often mapped singly, e.g. rainfall, geology, topography, soils and indigenous vegetation. The mutual distribution of these is not random. Patterns occur, governed by climate, geology and landform which interact over time to influence the distribution of soils and vegetation. Patterns are sought by air photo interpretation, satellite imagery and field observation.

A land system is a complex mapping unit that it contains a pattern of land components each of which has little variation in climate, lithology (rock type), landform, soil and indigenous vegetation. The land component is regarded as a unit of management for broad-scale uses such as dryland farming and forestry.

Over the years there has been steady progress in classifying land features an in understanding their dynamics. In particular, studies of soil/landform history have improved prediction of the nature, distribution and behaviour of soils, the study of soils in the field being largely an extension of geomorphology. Also relevant are developments in botany, agronomy and meteorology and studies of processes such as erosion, salting and acidification of soils.

Mapping is now aided by high quality aerial photographs, stereoscopes, and other kinds of remote sensing.

Surveys involving detailed field work, laboratory analysis of soils, and land systems mapped scales of 1:100 000 to 1:250 00, have covered about two-thirds of the State. Many of these published studies (listed in the references) describe the individual components of each land system. Appendix 1 contains an example of a land system description – Wolfscrag – taken from the Campaspe River catchment study. The land system table and block diagram illustrate the content and distribution of each component.

For this report land systems of Victoria have been remapped at a consistent scale of 1:250 000 by combining detailed land studies, reconnaissance surveys and field studies, and addition mapping. A new system of identification had been developed, and as described below, these land systems have been grouped into a set of geomorphic units.

Correlation

Over 700 land systems have been mapped, and the task of correlating them into larger units was a formidable one, nor previously attempted. The Atlas of Victoria contained 50 broad land types at the scale 1:2 m (Rowan 1982). A land type may have contained several defined land systems but these were not mapped or referenced.

In remapping the land systems, a hierarchy was needed for comprehension, as well as broad classification for each feature. Precedence was given to geomorphology because of the control exerted by landform pattern and geomorphic history on the dependent features, particularly soils.

The scheme selected begins with 6, then 9 geomorphic units, then 29 smaller units (Table 1). Within each, land systems are classified according to the independent features landform, lithology and climate (Table 2).

The dependent variables are vegetation and soils, and brief descriptions of these are given in Table 5 for each land system. Where land systems were mapped in earlier studies, the original land system names are cited, and detail can be obtained via the references.

Table 1 - GEOMORPHIC UNITS OF VICTORIA

Central Victorian Uplands	East Victorian Uplands	1.1	Dissected uplands
		1.2	Dissected plateau (Wllington uplands)
		1.3	High plains (Dargo, Bogong, etc)
	West Victorian Uplands	2.1	Dissected uplands (Midlands, etc)
		2.2	Prominent ridges (Grampians)
		2.3	Dissected tableland (Dundas Tableland)
		2.4	Dissected tableland (Merino Tableland)
South Victorian Uplands		3.1	Dissected fault blocks (Otway Ranges)
		3.2	Moderately dissected block (Barrabool Hills)
		3.3	Moderately dissected ridge (Mornington Peninsula
		3.4	Dissected fault blocks (S. Gippsland Ranges)
		3.5	Dissected outlier (Wilsons Promontory)
Murray Basin Plains	Riverine Plain	4.1	Present floodplain (Murray Valley)
		4.2	Older alluvial plain (Shepparton)
	Mallee Dunefield	5.1	Low calcareous dunes (Ouyen)
		5.2	High siliceous dunes (Big Desert/Sunset)
	Wimmera Plain	6.1	Clay plains (Nhill)
		6.2	Ridges and flats (Goroke)
		6.3	Low siliceous dunes (Little Desert)
West Victorian Volcanic Plains		7.1	Undulating plain (Western District)
		7.2	Stony Undulating plain (Western District)
South Victorian Coastal Plains		8.1	Ridges and flats (Follett)
		8.2	Dissected plain (port Campbell)
		8.3	Sand and clay plain (Moorabin)
		8.4	Fans and terraces (Western Port)
		8.5	Barrier complexes (Discovery Bay/Gippsland Lakes)
South Victorian Riverine Plains		9.1	Present floodplains (Gippsland)
		9.2	Intermediate terraces (Gippsland)
		9.3	High terraces and fans (Gippsland)

Processes

An assessment has been made of the soil deterioration processes to which the land in each land system is considered susceptible (Table 5). Susceptibility refers to an inherent quality as distinct from often-used terms such as hazard which combine natural tendencies with management regimes. The processes tend to operate slowly today in unused Victorian land types, but it is becoming apparent that rates have been episodic, depending on factors such as climate change or earth movements. For example, water erosion seems to have been rapid in the Central Victorian Uplands some 25 000 years ago. Again, salting was widespread in the Mallee during periods as recent as 15 000 years ago, and this led to dune construction.

There is a need to identify the processes significant in a particular type of land and to understand relationships between rates of process operation, land factors and management practices. Appendix 2 summarizes these factors for several common forms of deterioration.

Table 2 - KEY TO LAND SYSTEMS

Landform

C	Coastal dune
E	East-west dune
F	Present floodplain
G	Gentle to moderate hill
I	Irregular dune
L	Lunette
P	Plain above flood plain
R	Stranded beach ridge, usually trending NNW-SSE
S	Steep mountain and hill
W	Weakly elongated dune
Y	Gypseous dune

Lithology (rock type)

c	Coarsely-textured unconsolidated deposits
f	Finely-textured unconsolidated deposits
g	Granites and gneisses
l	Limestone
s	Sedimentary rocks
v	Volcanic rocks
z	Saline finely-textured deposits

Climate (mean annual rainfall)

2	200-300 mm
3	300-400 mm
4	400-500 mm
5	500-600 mm
6	600-700 mm
7	>700 mm; temperate
8	>700 mm; montane
9	>700 mm; sub-alpine

Subscripts

These distinguish land systems with similar landform, lithology and climate, but different soils and vegetation.

Land factors in sheet erosion by water, for example, include vegetative cover, slope gradient and length, rainfall intensity, soil permeability and soil detachability. These may be affected by practices such as clearing of deep-rooted vegetation, cultivation and grazing. Lands on the hilly drier parts of the State are often at risk, and susceptibility in such areas is increased by soils which accept rainfall slowly because of surface sealing, hardsetting topsoils and slowly permeable subsoils. Sheet erosion may promote gullying and flooding downslope.

Use of data in planning

Integrated surveys were originally designed for soil conservation planning agriculture, but as they identify fundamental differences between types of land, their application has widened to include various other uses such as town and regional planning, forestry, water supply catchment protection, and services such as effluent disposal. The land systems approach has been adopted by the Land Conservation Council in its public land use planning process, as a basis for selecting representative areas for the national and State parks, and reference areas systems.

Land capability assessment. Productivity and stability are determined by both land type and land management so that, to compare the performance of lands, management must be specified. In land capability assessment lands are rated by their capacity to produce goods or services at a certain level, and to sustain the use in the sense that the land will not deteriorate. For a particular use, average current management is specified and lands are rated on that basis. In agriculture, for example, steep hill with shallow soils and high erosion hazards have a poor rating whereas the best rating is for stable lower slopes with fertile soils. The approach is based on limitations, and these may be observable land characteristics such as soil depth or slope gradient, estimates such as erosion hazard or off-site effects such as siltation of waters (Rowe *et al* 1980).

Selection of soil conservation practices. The situation is becoming more complex as more processes limiting soil stability and fertility are recognized. However, this improved understanding brings the prospect of predicting management regimes that will improve productivity and stability, and also reduce inputs by curtailing adverse processes.

Consider for example, a land type/land use situation as a Mallee sand dune used for cereal cropping and grazing. From a knowledge of the effects of land characteristics on process rates it is possible to deduce that the sandy soil is susceptible to several processes that impair its physical, chemical and biological status, and that seepage from the dune contributes to salting on nearby flats. Processes occurring, and appropriate remedies can listed.

Processes	Remedies
Wind erosion	Over 30% vegetative cover, alive or dead
Loss of humus	Transpiring vegetation
Leaching of nutrients (for example phosphorous, nitrogen)	Transpiring
Deep percolation of water	Deep-rooted species

Various conclusions about appropriate management can be drawn. It is clear that argonomic requirements for the control of salting are relatively stringent in that deep-rooted species are required in the rotation. Long bare fallowing promotes all the adverse processes, while periods under green crop and pasture are restorative. Cultivation techniques such as minimum tillage and stubble retention are required, and periods when growth is suppressed should be minimized.

In the case of the cropped Mallee sand dune, deficiencies in technology are apparent. Under cropping and annual pastures it is not possible to have continuous transpiring cover because of climatic limitations. In addition, there is a lack of suitable pasture species, Lucerne being the only deep-rooted species readily available. The annual medics often used are shallow-rooted, and more use could be made of the moderately deep-rooted cereals for grazing.

Limitations to Use of Data

Boundaries on the maps separate land systems each of which contains a number of land components that may differ greatly in land use potential and land management requirements.

The maps are based on assessments of the physical features of land, including climate. They can be used to identify different types of land and the hazards associated with land use, and as a major input to decisions about the land's suitability for a use, assuming an average level of land management. Improved management practices or other inputs can reduce the hazard under a particular used in some circumstances.

The boundaries represent readily-identified changes in the land. Where an important environmental feature changes gradually, the boundary placement is arbitrary, and for example some boundaries that follow rainfall isohyets are dashed.

The maps are designed for interpretation at a regional level only, and not for specific sites. The map scale has necessitated some generalization of boundary placement. Enlargement of the map scale does not increase accuracy and may be misleading.

The land systems mapping based mainly on published data (see Appendix 3 and Map 1). However accuracy varies with factors such as the date of each study, the availability of information at that time and the degree of detail obtained. Accordingly no responsibility is taken for imprecise boundary location or errors in description.

The land system description in Appendix 1, from the Campaspe River catchment study (C on Map 1) represents the quality of the detailed published studies (see Figure 1). Land systems descriptions from the less detailed studies are not as comprehensive, and some do not describe land components.

Figure 1 – Reliability Diagram