MALLEE CATCHMENT
TECHNICAL BULLETIN

Technical Bulletin # 14

Disaggregation of the Victorian Mallee land systems

Above: Jim Rowan and John Martin provided valuable insights into the terrain and soils of the Mallee. Their input was fundamental to the landform mapping. Photo: Mallee CMA.

Above: Jim Rowan providing the project team with his extensive knowledge of the Mallee's geo-morphology. Photo: Mallee CMA.

This technical bulletin provides a summary of the methodology used in the '*Disaggregation of the Victorian Mallee Land Systems*' project. This project has provided landform data at a resolution that can be used for effective modelling and assessment of land management issues, such as wind erosion and salinity.

The 'Disaggregation of the Victorian Mallee Land Systems' project has developed finer-scale landform definition across the agricultural landscapes of the Mallee region, with the final output being a digital map of landform components. This new land component data will enable improved assessment of land management issues, such as wind erosion and salinity, as well as providing the Mallee Catchment Management Authority (CMA) with the ability to predict where these issues may pose a potential threat to regional and local assets.

Mapping has occurred through a series of project phases that commenced in 2007 - each phase being targeted at specific sub-regions within the Mallee to progressively refine the delineation of landforms for the entire region.

This technical bulletin summarises the project: the rationale; methodology developed to derive the mapping; the development of land units resulting from the mapping; and the potential future uses and benefits of this new information.

The Department of Primary Industries (DPI) Future Farming Systems Research (FFSR) Division was engaged by the Mallee CMA to undertake this project with funding provided initially by the Australian Government's National Action Plan for Salinity and Water Quality (NAP) and in recent years, by the Australian Government's Caring for our Country and DPI.

Background

Soil types across the aeolian landscapes of the Victorian Mallee are diverse and the properties and behaviours they exhibit determine agricultural performance and

At a glance

- The mapping of landform components on agricultural land in the Mallee has been completed.
- The landform mapping is a new resource that will enable the Mallee CMA to monitor and asses land management issues with greater certainty and focus.
- Land units that delineate landscapes of similar landform patterns have been created that will assist the Mallee CMA in directing its investment.

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mallee catchment management authority

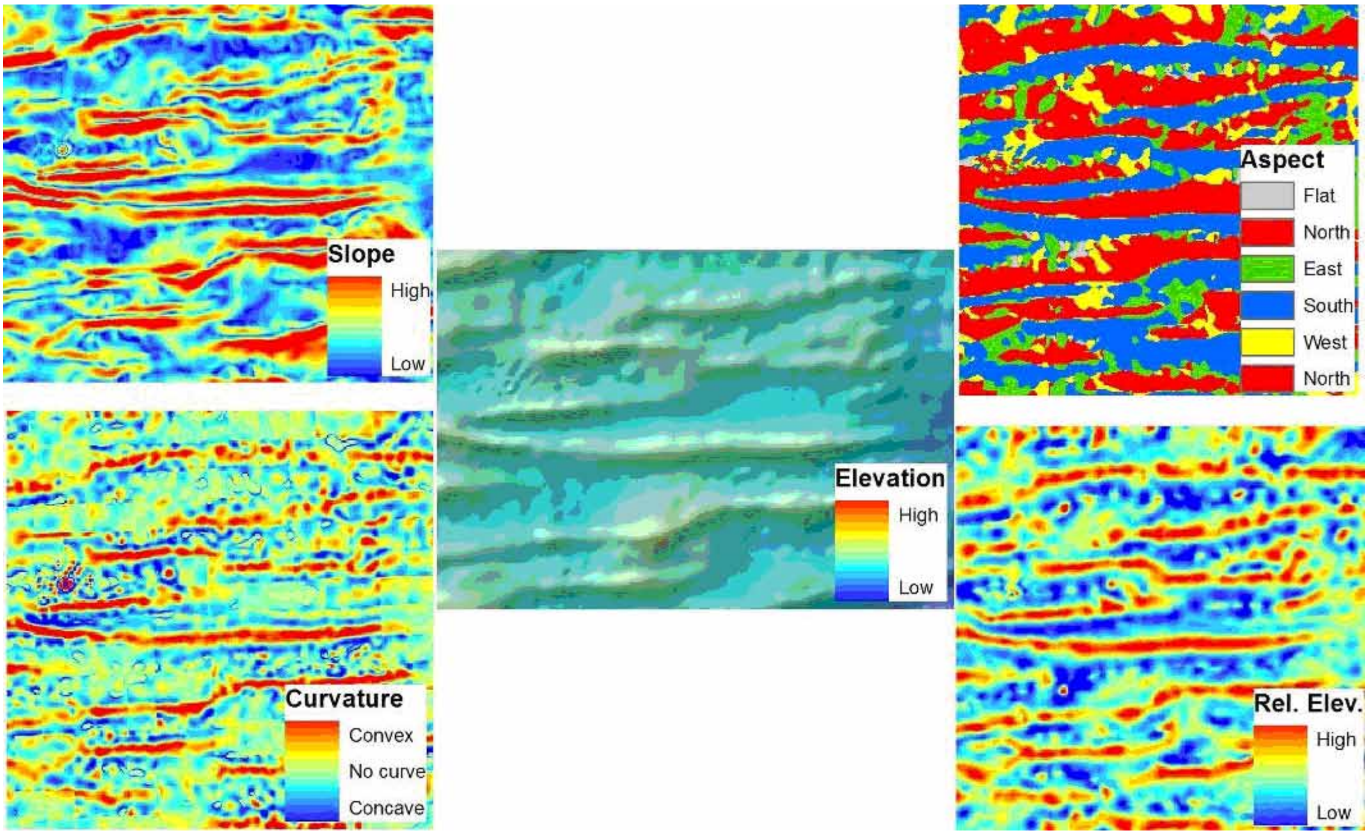

Figure 1. Mosaic of surface derivatives (slope, curvature, relative elevation, and aspect) generated from the Digital Elevation Model (centre). The same view presented in each image is of a linear dune in the Central Mallee land system.

sustainable land management. There is a recognised relationship between terrain and soil type and therefore the landform components of these landscapes serve as a basis for defining 'likely' soil occurrence.

Until now, the description of the Mallee land systems provided by Rowan and Downes (1963) has served as the most used terrain interpretation of the Victorian Mallee. The land systems defined in that report provided broad-scale information about landform components (dimensions and distribution). At a scale of 1:250,000 this land system mapping does not map individual landforms within the landscape.

The availability of a Digital Elevation Model (DEM) at a 10 metre resolution across the Mallee has supported the efforts to improve the terrain mapping in the region (Figure 1). A DEM is a spatial dataset that records the topography for environmental modelling purposes. Before the advent of DEMs, landforms were delineated manually using field surveys or aerial photograph interpretation.

The Disaggregation of the Victorian Mallee Land System's project has developed finer scale landform mapping that will support future soil mapping applications across the agricultural landscapes of the Mallee. This refined mapping will provide data input to:

- enhance the accuracy and precision of modelling; and
- monitor land degradation with greater certainty.

Method

The approach combines a variety of spatial modelling techniques based on an assessment of the ability of modelling techniques to map target landform components identified within the existing broad-scale land systems of the region. Expert knowledge of the distribution and topographic profile of these landforms, as described by Rowan and Downes (1963), has guided the mapping.

As the mapping technique has been refined over subsequent phases of the project, it has been re-applied to completed land systems to improve the mapping and to ensure internal consistency within the final mapping products.

Landform component mapping

The approach used combined automated terrain modelling, terrain surface derivatives and expert knowledge to interpret and classify the DEM into target landforms (Figure 2).

Two topographic indices – UPNESS from the Fuzzy Landscape Geographical Information System (FLAG) model (Roberts et al 1997) and the Multi-resolution Valley Bottom Flatness (MrVBF) index (Gallant and Dowling, 2003) - were chosen as the primary indices for the automated landform classification. Integrating the strengths of both indices, MrVBF in mapping depositional areas of the landscape and FLAG for erosional landscapes, provided a first cut division of the terrain. Expert knowledge of the regional geomorphology (i.e. landform types, landscape evolution, distribution, landform shape and dimensions) from

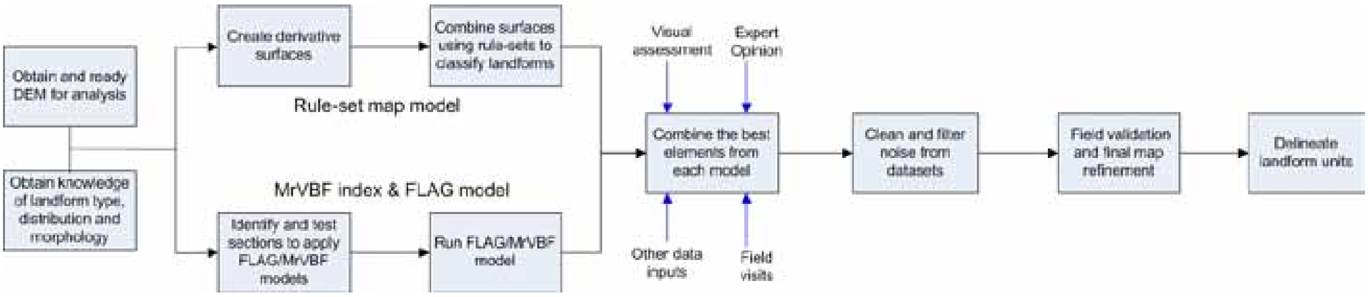

Figure 2. A chart summarising the methodology of the land system disaggregation.

practising and retired soil and landscape surveyors was used to interpret the DEM modelling and to guide the landforms classification. Their expertise and experience combined with the technology produced reliable landform classification relevant to land management in the region.

Land unit mapping

Landform components are seldom distributed at random, but generally occur in patterns because there are few independent variables (i.e. climate, parent material). One or more variables is often constant over a broad area, with other features of the environment dependent on it. The landform mapping provided an opportunity to delineate homogenous areas of terrain at a finer scale than the original land system mapping. These areas are referred to as land units. Mapping these land units recognises that within the existing extent of the land systems there is variability in landform patterns.

Table 1: A list and description of the landforms mapped within the Mallee.

Landform component	Description
East-west linear dunes	The dunes generally range from 80 to 120 m wide and 500 m to 3 km in length. They occur throughout the region except in the south east. Dune relief is commonly 5 to 10m.
Hummocks and rises on plains	Rises found on the undulating plains include hummocks, lunettes, ridge remnants and other gentle landscape undulations. These rises are variable in their dimension and distribution. Some rises occur locally and appear to have a north-south orientation. It is proposed these rises could be referred to as local north-south ridges. The land units help distinguish the types of rises present in a region.
Strandline ridges	Ridges are elongated linear features with a NNW–SSE orientation that vary in size and relief. Often the ridges occur as a complex unit with a relatively flat crest (elevated plateaux). They can be anywhere from under 1 km (remnant ridges) to up to 50 km in length.
Ridge crests	These are the crests of ridges, or rises that occur on flat ridge tops and hummocks on the ridge slopes.
Prominent lunettes	Prominent sickle-shaped rises that are found on the eastern sides of existing and former lakes. They vary in breadth and height and often occur as a sequence formed from variations in the lake extent.
Prominent former lakebeds	Flat, depressed and often circular areas they have associated lunettes on their eastern flanks.
Lunettes associated with ridges	These lunettes have been identified as part of a ridge landscape complex and occur with a prominent former lakebed to their west. The crescent shaped lunettes allow this feature to be identified in parallel with an abutting ridge.
Undulating plains	These are undulating areas between rises such as hummocks, dunes and ridges. They include the gentle slopes grading from rises and in the dune country they are commonly referred to as swales.
Flat plains	These are broad areas of plain with a slope less than 0.5%. Flat plains in the Culgoa land system contain gilgaied light clays.
Flood plains	Low plains that occur in the Ned's Corner, Lindsay Island and Tyrrell Creek land systems. They are associated with internal drainage basins or the Murray River.
Low plains	Low plains have been mapped in the Millewa and Boigbeat land systems. They are the lowest flat areas that occur between hummocks.
Raak plains	These are low plains associated with groundwater discharge and drainage basins. Saltpans occupy the lowest sites on the plains while slightly higher areas are overlain by a fine textured red soil.
Terraced plains	Palaeolacustrine plains in the Millewa land system and the Central Mallee land system north of Lake Tyrrell have been classified into Upper and Lower terraced plains. Upper terraced plains have shallow sandy loams overlaying a limestone layer, refered to as Bungunnia limestone, while lower terraced plains overlay red clays.
Copi islands	Low mounds scattered on Raak plains composed of sand, copi (white powdered gypsum), gypsum and occasionally limestone.
Scarp	The relatively steep slope leading from surrounding high plains to the flood plains of Lindsay Island or Ned's Corner land systems.
Lakes	Existing natural waterbodies or areas that occasionally hold water.
Channels	Streambeds that transport water constantly or periodically.

Figure 3: Eastern slope of a small hummock in the Boigbeat land system.

The delineation of land units has primarily been based on the spatial pattern of mapped landforms. It has, however, also incorporated other inputs such as the Geomorphological Mapping Units (GMU), salinity mapping and a visual analysis of a hill-shade of the DEM.

Figure 2 presents a summary workflow of the methodology. A full description of the methods developed can be found in associated project reports.

Results

Landform components

The final project output is a raster dataset derived from merging each of the individual land system mappings. This dataset covers all private land in the Mallee as well as public land in Ned's Corner, Tyrrell Creek, Lindsay Island and Raak land systems. Seventeen landforms have been classified and mapped which are briefly described in Table 1, and an example of the landform mapping for the Tempy land system is provided in Figure 5.

Landform component validation

Field validation of the landform components map was undertaken in July 2010. It involved a stratified sampling of 30 points, each representing a 10 metre cell of the original DEM, randomly generated for eight of the landform components. In total, 250 points were field validated and each sample point was visually assessed for its fit within the identified landform class. Both the location of the sample point and the context of the surrounding landscape were used to inform the landform classification assessment.
The validation exercise revealed that the mapping had an accuracy of 84% for eight of the landform components. A full outline of the validation results can be found within the report.

Land units

A total of 40 land units have been defined across all the land systems of the Mallee, including some areas of public land. They represent mapping at a nominal scale of 1:100,000 (Table 2).

The land units delineate areas of repeating landform component patterns. They will provide the Mallee CMA with areas for priority investment to monitor, assess and manage regional land management issues.

Land units also assist in distinguishing the morphological variation in land formations that have been classified as the same landform component. For example, the difference in size and shapes of hummocks between the Millewa and Boigbeat land systems as described by Rowan and Downes(1963).

Descriptions of the land units can be found in the associated project report.

Table 2: Land systems have been divided into landform units to facilitate priority investment.

Land Systems	Number of land units
Berrook	3
Big Desert	2
Biogbeat	3
Central Mallee	10
Culgoa	2
Hopetoun	1
Lindsay Isalnd	4
Millewa	3
Ned's Corner	3
Raak	1
Tempy	4
Tyrrell Creek	3
Wycheproof	1

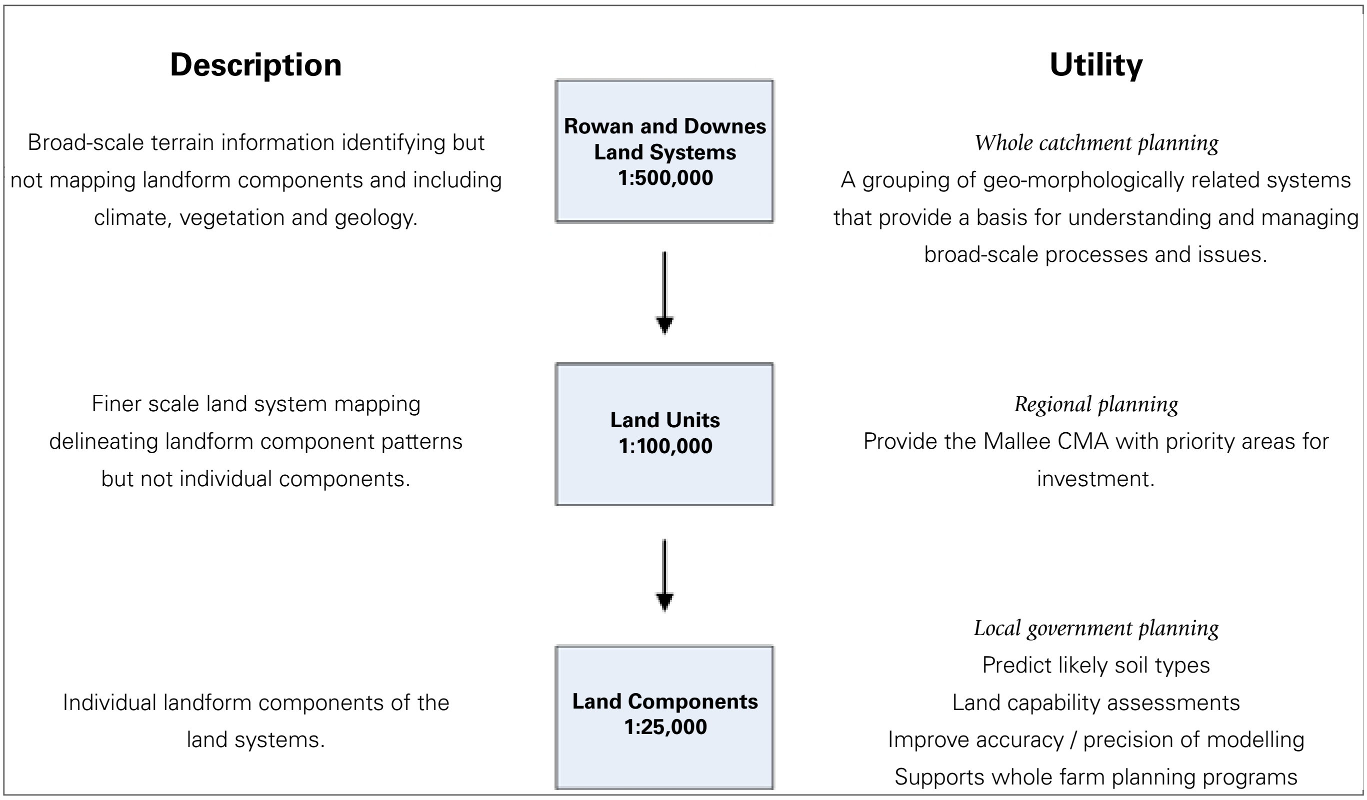

Figure 4. The disaggregation has vastly improved the scale of terrain mapping in the Mallee.

Implications

The landform dataset produced by the project will:

- Enable natural resource management agencies, such as the Mallee CMA, to monitor and assess land management issues with greater certainty and focus. Land units produced from the project will assist in targeting resources towards particularly vulnerable landscapes;
- Improve the accuracy and precision of modelling by the scientific community and provide a valuable input into the creation of digital soil maps;
- Provide land owners and the farming industry with terrain information at paddock and landscape scale that correlates with production capability and land degradation risk. This will assist the industry to make decisions about how to best manage soils through appropriate land use and land management, while maximising potential productivity. It also significantly supports whole farm planning programs such as the Environmental Management and Action Planning project (EMAP);
- Assist all levels of government in planning and policy decisions to effectively address land degradation/ land use conflict.

Acknowledgements

The Mallee CMA and the DPI project team would like to thank retired soil scientists Jim Rowan and John Martin for sharing their immense knowledge of the geomorphology and soils of the Mallee area. We would also like to acknowledge the participation and involvement of DPI colleagues across north-west Victoria in field validating and sharing their knowledge of the region.

Further Information

The information for this bulletin has been taken from "*Disaggregation of the Land Systems of the Victorian Mallee*". A copy of the this report can be downloaded from the Mallee CMA web site:

www.malleecma.vic.gov.au

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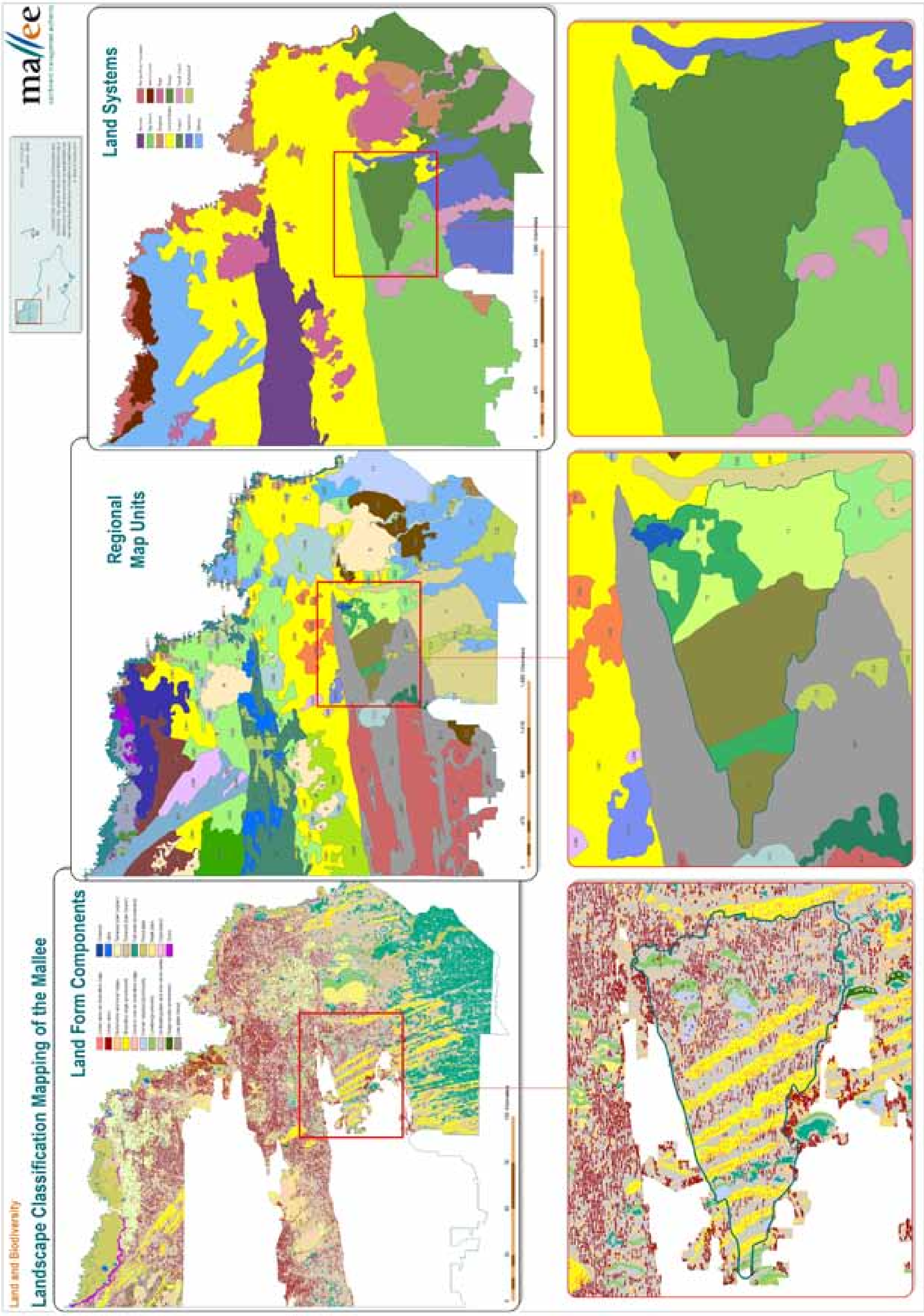

Figure 5. Landscape Classification Mapping of the Mallee.

Project Partners

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