eco-civic regionalisation for rural new south wales

nrrm civimetrics

version 1.1

David Brunckhorst

Phillip Coop

Ian Reeve

an eco-civic regionalisation for rural new south wales

final report to the nsw government

February 2004

nrm civimetrics

acknowledgements

Project management:	Brendan Doyle
ArcView programming:	Phillip Morley
ABS data processing:	Karl Bock
Survey management:	Karl Bock Justine Graham
Survey data processing:	Karl Bock Phillip Morley
Telephone interviewing:	Hamish Love Kate Rhook Annemieke van der Meulin Nadaja Kobelke Michael Coleman
Administrative support	Cath Coleman Debbie Creed

version

The civic, biophysical and eco-civic regionalisations in the figures of this report, and in the CD accompanying this report, may be referred to as version 1.1.

contents

supplementary figures

appendices

foreword

Department of Lands

Land Administration & Management
Property & Spatial Information

The Department of Lands (Lands) through its Land and Property Information Division is a key source of titling, valuation, surveying, mapping and related land and property information for New South Wales. It provides key information services to individuals, businesses, government agencies and non-profit organisations throughout NSW, Australia and internationally. One of its key tasks is to provide spatial data to government to assist in policy development, strategic resource allocation and coordinated government service delivery.

Governments and decision makers, across the globe constantly grapple with the spatial patterns represented by complex, interacting social and ecological systems. Such local to regional systems of, for example, soils, water resources, climate, land uses, communities, transport and communications interact to shape the face of rural Australia reflecting, both pressures of change and future needs and opportunities. To encourage sustainable development, improved government service delivery, viable rural communities and to plan for wise natural resource management, policy makers need to understand the local to regional scales of communities of interest, spatial scales of their engagement with civic issues and the interactions with their natural resource base.

Understanding the multiple scales of dynamic interactions of people, place and resources across these regional landscape systems is essential to good policy and governance. Indeed, there has been a dearth of policy-linked research effort both, in Australia and overseas into this very important interface between social and ecological data sets, their spatial attributes and, the integration and use of such data in policy and strategic program outcomes to meet multi-objective targets at local, regional, State and National levels. Such work forms an integral part of producing a Spatial Data Infrastructure (SDI) for NSW, which is a priority for Lands.

It was against this background that the Department of Lands engaged the Institute for Rural Futures to undertake the "eco-civic" spatial information regional study. The Institute for Rural Futures team led by Professor Brunckhorst has developed techniques to spatially understand and map the intersects and relationships between social, economic and physical geospatially referenced data to produce "eco-civic" regional data sets. This work, which has been recognised as world leading was initially developed through research funding from Land and Water Australia.

This initial research work, which was based in the northern sector of NSW was used to define new techniques and approaches to produce, for the first time, the whole (geo-referanced) picture of integrated multi-scaled hierarchies of the best representation of communities of interest and their similar underlying resource bases across regional NSW. The next challenge is to take this innovative work and include it as part of the suite of data and considerations in reaching key decisions that affect the people and resources of regional NSW.

This has been a major collaborative undertaking by Professor Brunckhorst and his research team with staff of the Department's Land and Property Information Division; in particular Peter Goddard and Alan Garside. Not only are the outcomes significant, useful and timely, the task has represented exceptional professional application and commitment within a tight project timeframe.

Warwick Watkins
Director General, &
Surveyor General
Department of Lands

9 February 2004

executive summary

> Most students (of community) are in basic agreement that community consists of persons in social interaction within a geographic area and having one or more additional ties.
>
> Hillery 1955: 111

The concept of "community of interest" might seem vague, if not difficult to define, yet most scholars over the past 50 years would still be in agreement with Hillery's summary. While globalisation has expanded the scales of various forms of communities, local sense of place, area of interest, social activity that builds local ties and community cohesion has not suffered.

Governments around the globe also have a renewed interest in spatially defining local to regional scales of communities of interest. Provision of government services, planning, management and administration of social, fiscal and natural resources might be better delivered along the lines of a civic geography. With governments striving also for better community participation in decision-making on many such interrelated issues, it is recognised that greater civic engagement is likely when the area in question is consistent with community residents' area of interest.

Natural resources underpin community well-being in many respects. This can include local government planning for development and provision of clean water, waste and other services, as well as agriculture land-use and related economies around which communities have developed. Areas of civic interest might therefore be very useful to integrate and coordinate government service delivery. Where there is a more or less coincident development of land-uses reflecting the natural resource base, a common social-ecological region ('eco-civic') might also be delineated for integrated natural resource management (NRM), local governance, local planning and other government service delivery.

The digital map products (on CD ROM) accompanying this report are the result of a project undertaken by the Institute for Rural Futures at the University of New England for the NSW Department of Lands. The Institute has used its recently developed nrm civimetric techniques to provide spatial resources for this analysis.

These techniques make it possible to identify a nested hierarchy of regional and local administrative boundaries. The objective of this work was to build on a methodology and existing primary data of the Institute to spatially delineate three nested, local to regional, levels of civic interest to communities of NSW; and in taking into account the biophysical attributes of the natural resource base of NSW, to similarly delineate three nested levels of eco-civic regions.

The project was highly resource, data and analysis intensive. It was a tremendous challenge to the Institute's senior staff and their respective teams — earning due acknowledgment here for their fine professional work and dedication to a complex task undertaken within very tight timelines. We are pleased to have been able to meet this timetable and to contribute the digital spatial data and recommendations. This work will be a substantial input into current government decision-making and reviews on NRM and local government and in planning future service delivery.

The Land and Property information (LPI) division of the Department of Lands has collaborated in this work through provision of spatial data and support. Our sincere thanks go to LPI staff, Des Mooney, Peter Goddard, Alan Garside for their guidance and various inputs. We appreciate the vision of Warwick Watkins in setting such high standards in his spatial and data agenda for NSW, coupled with his clear understanding of its importance and use in good governance, policy making and service delivery.

The results of this study and the digital data provided to the LPI, together with the recommendations contained in this report are based on the analysis of the Institute for Rural Futures' nrm civimetrics research and policy analysis team. Therefore they do not necessarily represent the views of either the Department or the government. We trust however, this work will be of value to the government and to the communities of NSW.

1 introduction

With its Environmental Planning and Assessment Act of 1979 and Total Catchment Management Act of 1989, New South Wales has been a leader in the move in Australia towards greater community involvement in resource management and development decisions.

As part of its on-going commitment to efficient and effective local government and resource management, the New South Wales Government is currently examining and implementing further reforms in this area. The Premier's Department is also interested in mechanisms for better inter-departmental coordination and integrated service delivery.

The location of administrative boundaries, such as between local governments or Catchment Management Authorities, is an important issue to be considered in these reforms. In addition, the efficiency and effectiveness of the delivery of government services is also dependent on the boundaries used in the administration of these services.

To inform the analysis of boundary issues in the current reforms, the New South Wales Government engaged the Institute for Rural Futures at the University of New England to use its recently developed nrm civimetric techniques to provide spatial resources for this analysis.

These techniques make it possible to identify a nested hierarchy of regional and local administrative boundaries that ensure that:

- as few people as possible have the areas that they regard as their community intersected by the boundaries, and
- as many people as possible with a shared interest in their local area are located within the boundaries.

This means that the representation of people's interests in community consultative processes is not fragmented across different administrative units.

Nrm civimetric techniques also allow for the optimisation of boundaries to achieve as greater natural resource homogeneity as possible within the regional units defined by the boundaries.

2 nrm civimetrics

2.1 background

Nrm civimetrics has its origins in the PhD research of Phillip Coop at the Institute for Rural Futures, supervised by David Brunckhorst and Ian Reeve, and funded by Land and Water Australia. This research was undertaken between 2000 and 2003 and included extensive international and Australian literature search and review in ecology, sociology, social geography and GIS technology (see report by Brunckhorst, Coop and Reeve, 2002 in appendix 3). This work revealed that there was no technique in use to:

- acquire spatial information on the areas within which residents wish to have representation in local government and resource management decisions,
- aggregate this information into a summary surface showing areas of high and low community interest,
- assess the performance of defined regions in terms of the degree to which the areas of interest to residents in those regions are captured by the region boundaries,
- define nested regions to maximise this performance, and
- optimise region boundaries to take account of ecological landscape types.

Techniques for these tasks were then developed and were first presented at an international conference attended by landscape ecologists, natural resource managers and social scientists in December 2001 (Reeve, Coop and Brunckhorst, 2002). Since that time the techniques have been presented in a number of fora and have received favourable peer review.

2.2 concepts

Nrm civimetrics is based on three simple concepts:

- people can identify their community spatially,
- the areas people identify can be aggregated into a three-dimensional surface, and
- boundaries which do not intersect the areas people regard as their community are preferable to boundaries which cut through these areas.

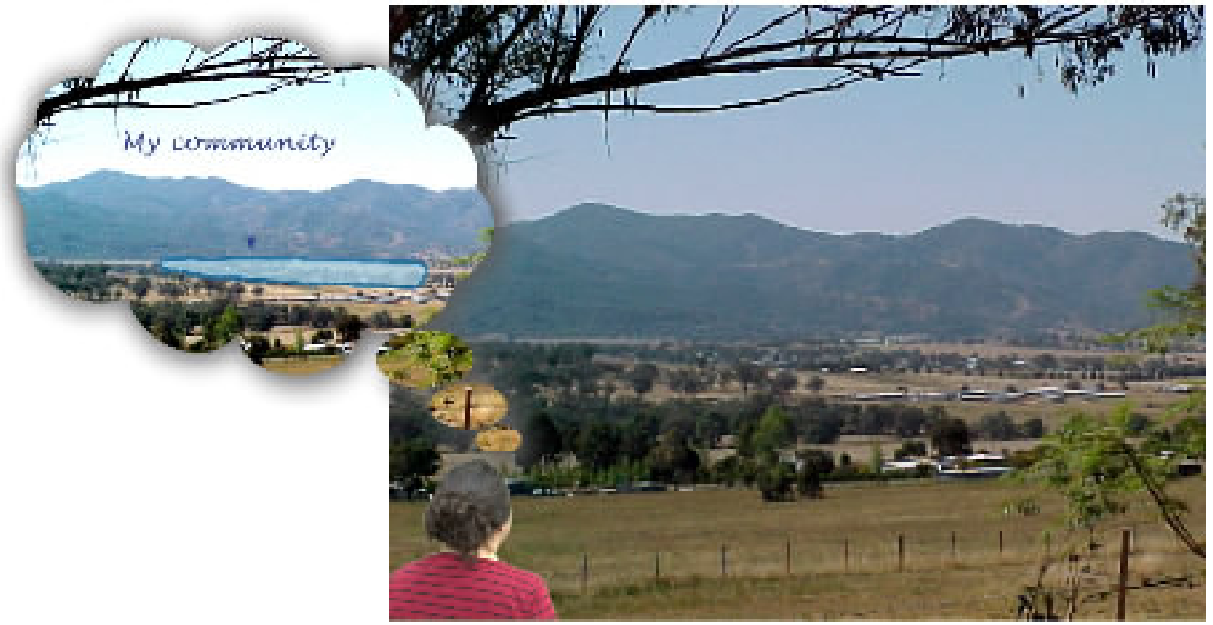


figure 2.1

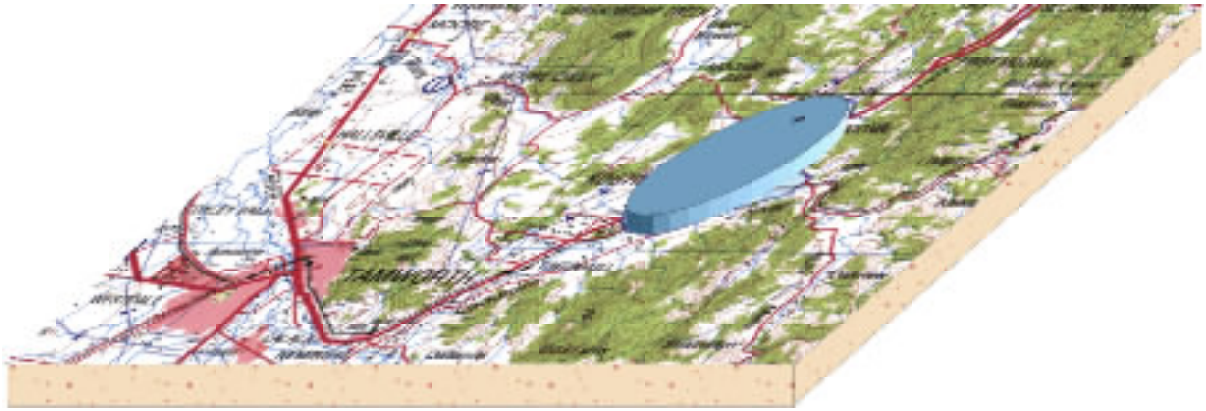
People can identify spatially the area that they regard as their community.

The area that people identify as their community tends to be the area they encounter and traverse in their daily lives. It is likely to contain one or more towns or villages that are places of residence or are frequently visited. People prefer that the local government councillors that represent them are resident within this area, and that they should have a say in any decisions about development or use of resources within the same area (Shannon, 1998; Hugo et al., 2001; Brunckhorst, 2002). The study by Coop (2003), which asked people to draw their community and home point on a map such as that in figure 2.2, below, showed that these community areas are approximately elliptical in shape, with the person's home point at one end of the ellipse and one or more towns or villages at the other end.

figure 2.2

The area that a person regards as their community can be plotted on a map, together with their 'home point', i.e. their place of usual residence.

figure 2.3



In three dimensional space, the area that a person regards as their community can be represented as a disc with a height of one unit (upper figure). This disc can be approximated by a suitably oriented elliptical disc of similar dimensions (lower figure).

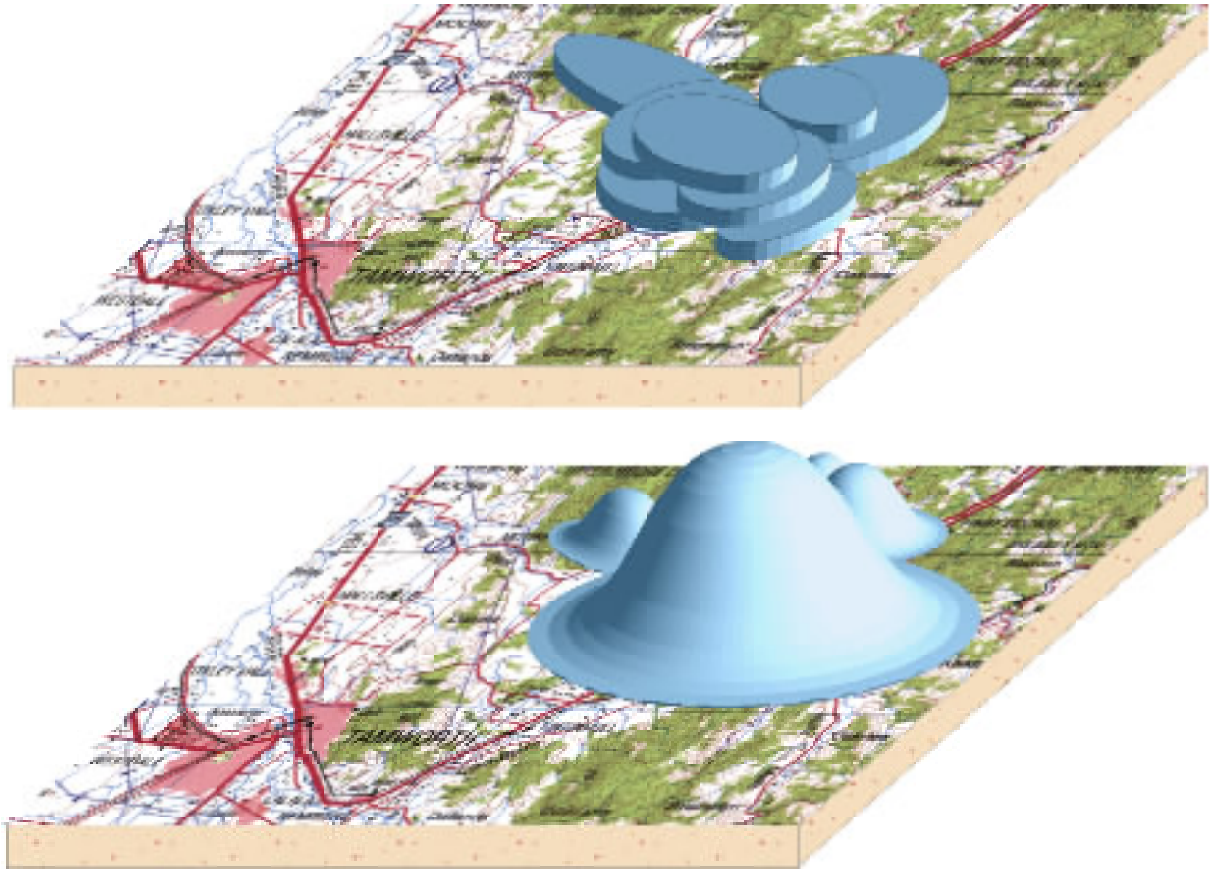


figure 2.4

If the community areas for all the people in a district are approximated by ellipses, the result is a pile of elliptical discs, each being one unit high (upper figure). These discs can be summed to produce a surface which, if the number of people involved is fairly large, will be a smoothly curved surface (lower figure).

figure 2.5

A regional boundary that cuts through very few community areas (purple line) is preferable to a boundary that cuts through many such areas (red line).

If the boundaries of regional administrative regions, such as local government areas or Catchment Management Authorities, cut through areas that large numbers of people regard as their community (figure 2.5, above), then it is likely that many will feel dissatisfied with their representation in local government, and with consultative processes associated with natural resource management (Knight and Landres, 1998; Reeve, Marshall and Musgrave, 2002; Shannon, 1998). As depicted in figure 2.4, above, the social surface formed by aggregating community areas, is relatively high in those places in which there is strong community interest. In places that only a few or no people regard as being part of their community, the social surface is relatively low.

It is these lower parts of the social surface that are best suited to the placement of boundaries between administrative regions. Boundaries that follow the 'valleys' in the social surface minimise the fragmentation of the areas that people regard as their community, and thereby minimise dissatisfaction with representation and consultation caused by this fragmentation. This is likely to improve civic engagement in decision-making and related community activities.

For any given administrative region, some community areas will be wholly within the region boundary, while others will be intersected by the region boundary. The proportion of people's community areas that are wholly

within a region boundary, compared to the total number of people living within that boundary, provides an index of the performance of the particular administrative region in terms of its ability to include the areas that are of interest to residents. This index is termed the Community Capture Index (CCI).

box 2.2 — key terms

Community area:	The area that people regard as 'their community'. It usually includes where they live and the parts of the landscape they encounter in their daily lives, including towns or villages where they work or access services (figures 2.1 - 2.3).
Home point	The point within an individual community area at which a person resides. For people living in rural areas, the home point is often at one end of an elliptical community area, For people living in larger towns, the home point is more often located near the centre of an elliptical or circular community area (figure 2.2 and 2.3)
Social surface	The social surface is obtained by giving each community area a height of one unit and summing all the community areas at each point on the map on which the community areas are plotted (figure 2.4).
Community Capture Index (CCI)	The proportion of people's community areas wholly within an administrative region, compared to the total number of people living in the administrative region.
Ecological landscape	Area with similar, shared, biophysical characteristics and processes (often reflected in similar vegetation and landuse) — Forman(1995).

Additional detail on the concepts and techniques of nrm civimetrics is provided in Appendix 3.

3 methodological overview

The methodological approach used to prepare an eco-civic regionalisation for New South Wales is depicted in figure 3.1, below. The approach can be divided into three main tasks: the preparation of a modelled social surface (chapter 4, below), landscape classification (chapter 5) and eco-civic optimisation to yield an eco-civic regionalisation (chapter 6).

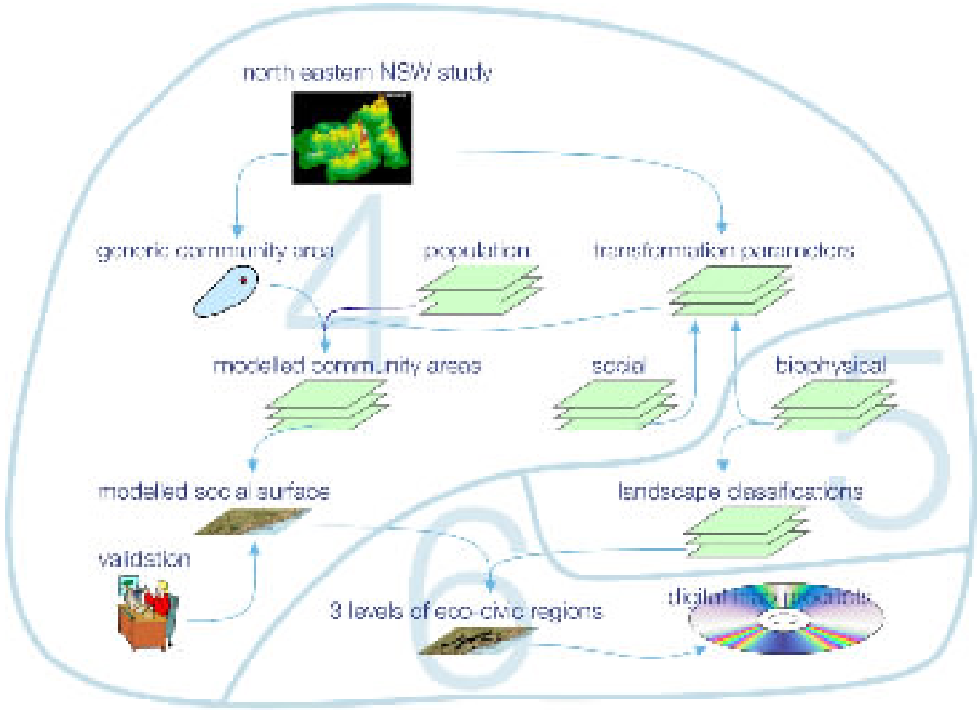


figure 3.1

Methodological overview (the large numbers refer to the ensuing chapters).

3.1 modelled social surface

The preparation of the modelled social surface involved the following sub-tasks:

- analysis of the data from the Coop (2003) study for north eastern New South Wales to determine the shape of a generic community area to be used in modelling,
- additional analysis of this data to determine the size distribution of community areas and the factors that influence their size and orientation (termed 'transformation parameters'),
- setting transformation parameters for New South Wales (for example, community areas in western New South Wales will tend to be larger because of the larger distances between towns),
- the generation of home points on which the modelled community areas were to be based,
- the modelling of community areas for these home points,
- the aggregation of these community areas into a social surface,
- compilation and mapping of secondary data on the spatial extent of social interaction among community groups and sporting organisations, and
- a validatory telephone survey of key informants to provide additional information about the disposition of the social surface in areas where the modelled surface did not provide clear guidance for the location of boundaries.

3.2 biophysical classification

The development of the biophysical classification for New South Wales involved the following sub-tasks:

- acquisition and processing of elevation, soil moisture, soils, vegetation and climate data,
- data reduction to produce a parsimonious data sub-set for further analysis, and
- iterative classifications to produce three level hierarchy of biophysical regions.

3.3 eco-civic regionalisation

The preparation of the eco-civic regionalisation required:

- level 1 boundaries from the social surface and the biophysical classification spatially optimised for best fit, giving greater weight to biophysical boundaries, and
- level 2 and 3 boundaries from the social surface and the biophysical classification spatially optimised for best fit, giving greater weight to the social surface.

3.4 digital data products

The social surface and regionalisation, the biophysical classification and the eco-civic regionalisation are provided on the CDROM accompanying this report. The surface and regionalisations are provided as coverages and shape files in GDA94 geographic coordinates.

The files are organised on the CDROM in the directory structure shown in figure 3.2.

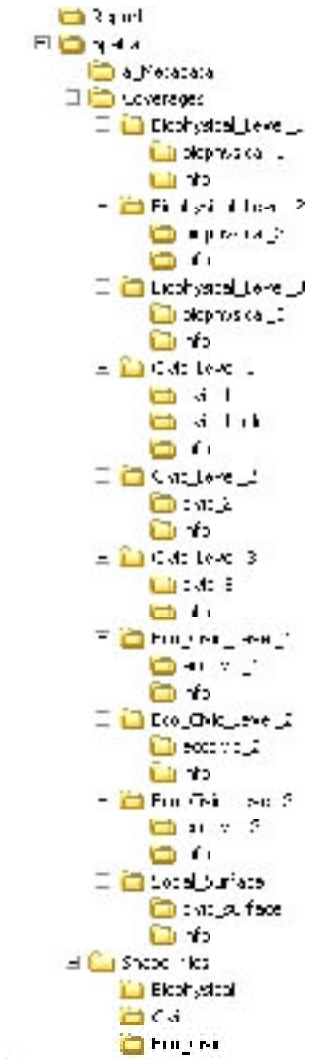


figure 3.2

Organisation of data files on the CDROM with this report.

4 social surface

4.1 introduction

As described in chapter 2, the social surface is a spatial representation of the degree of community interest across rural and regional New South Wales. At a point where the surface is high, there is likely to be relatively more people who regard that point as part of their community area. At a point where the surface is low, relatively few people regard that point as part of their community area. If the boundaries of local and regional administrative units are located in the low parts of the surface, then the number of people whose community area is split across several units is minimised, and the number of people whose community area is wholly within a single unit is maximised.

4.2 generic community area

The community areas drawn by the 1973 respondents to the Coop (2003) survey in north eastern New South Wales were examined to establish the most appropriate shape to use for modelling these areas. It was found that the majority of community areas were elliptical in outline, with sizes ranging from less than a kilometre across the shortest dimension to over a hundred kilometres. The size distribution of the community areas is shown in figure 4.1.

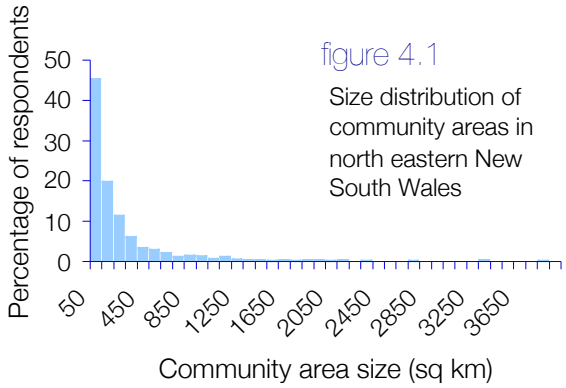


figure 4.1
Size distribution of community areas in north eastern New South Wales

Analysis of the relationship between community area orientation and the relative location of home points and towns showed that the majority of community areas for rural residents were oriented such that the home point and one or more towns or villages were included in the

community area. For non-urban respondents, the community area was often elliptical in shape with the home point at one end of the ellipse and a town at the other end. For residents in smaller towns or villages, the community area generally included the nearest larger town, while for residents in larger towns, the community area included one or more smaller towns in the region, usually along major highways.

In a small number of instances, land use patterns influenced the orientation of the community area, with more distant towns in regions of similar land use to that at the home point being favoured over closer towns in regions of different land use.

Analysis of the sizes of community areas showed that there was a tendency for them to be larger in the more sparsely settled regions of north eastern New South Wales.

4.3 transformation parameters

The modelling procedure involved the modification of elliptical community areas according to a number of parameters derived from the analysis described above. Firstly, New South Wales was divided into five regions, with different mean community area size in each region. These mean sizes were chosen to reflect the variation in community area size with population density described above, and to optimise the interpretability of the final social surface.

As community areas were generated by the model in each region, they were randomly varied in size to give a size distribution similar in shape to that in figure 4.1, above, with a mean community area size equal to that set for the region.

The second transformation of the generated community areas was to orientate them such that they included one or more towns in the vicinity of the home point. To avoid boundary effects in regions close to the New South Wales border, towns in Queensland, South Australia and Victoria were included among the towns influencing the orientation of generated community areas.

4.4 generation of home points

To produce a modelled social surface for New South Wales, each ellipse generated by the model needs to be located at a point that represents the simulated home point of a hypothetical resident. While it is feasible to populate all the ABS Census Collector Districts (CCDs) in New South Wales with the CCD population uniformly distributed across the geographical extent of the CCD,

this results in far more simulated home points than is needed to generate the simulated social surface. For this reason, each CCD in New South Wales was populated uniformly with a fraction of the population of the CCD. In CCDs with very low population densities, which is where the boundaries of the eco-civic regionalisation are likely to be located, the fraction of the CCD population used needs to be sufficiently large to provide the desired level of resolution in the positioning of boundaries. The terms of reference for the project specified a spatial resolution of 1km, which requires simulated home points at intervals of 500m or less.

The CCDs for New South Wales were ranked by population density and the population fraction for the least dense CCD set to a value (0.66) that would provide for distances of 500m between simulated home points when that fraction of the population of the CCD was uniformly distributed across the geographical extent of the CCD. However, if the value of the CCD population fraction of 0.66 were to be used in densely settled areas, this would again result in far more simulated home points than is needed to generate the social surface. Accordingly, a continuously variable population fraction was used, where the fraction was an inverse function of population density. This resulted in one simulated home point per CCD in metropolitan areas and large cities. The procedure described above resulted in 14,339 simulated home points spread across New South Wales. .

4.5 modelled social surface

The transformation parameters and simulated home points described above were used to generate a modelled community area for each of the 14,339 home points. These were then summed to produce the modelled social surface. The print version of the social surface is shown in figures 4.3 and 4.4, below.

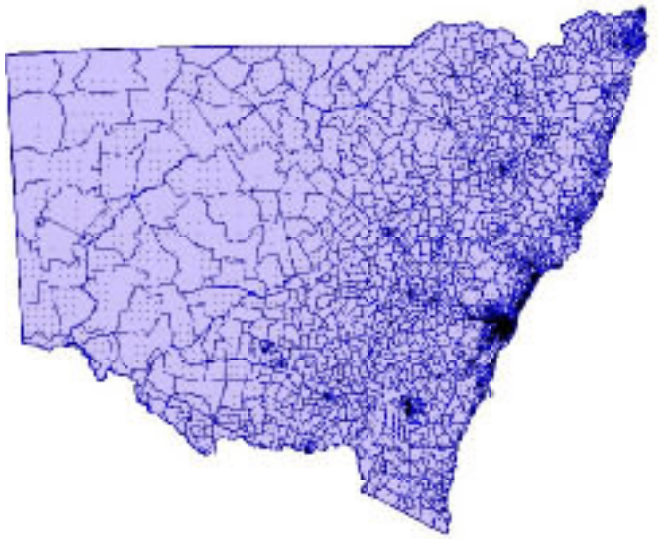


figure 4.2

CCD boundaries and simulated home points. A total of 14,339 homepoints were used to generate modelled community areas.

4.6 validation of modelled surface

4.6.1 comparison with north eastern nsw

The study by Coop (2003) provides an empirically measured social surface for north eastern New South Wales, against which the modelled social surface can be compared.

There are two approaches to making this comparison. Firstly it is possible to compare the shape of the two social surfaces using a statistical measure such as a correlation coefficient. Alternatively, the boundaries and regions derived from the two surfaces can be compared. One way of doing this is to determine how many home points lie in the correct region when the modelled surface is used to derive the boundaries between the regions. The Kappa statistic is widely used in this type of situation (Congalton, 1991; Carletta, 1996).

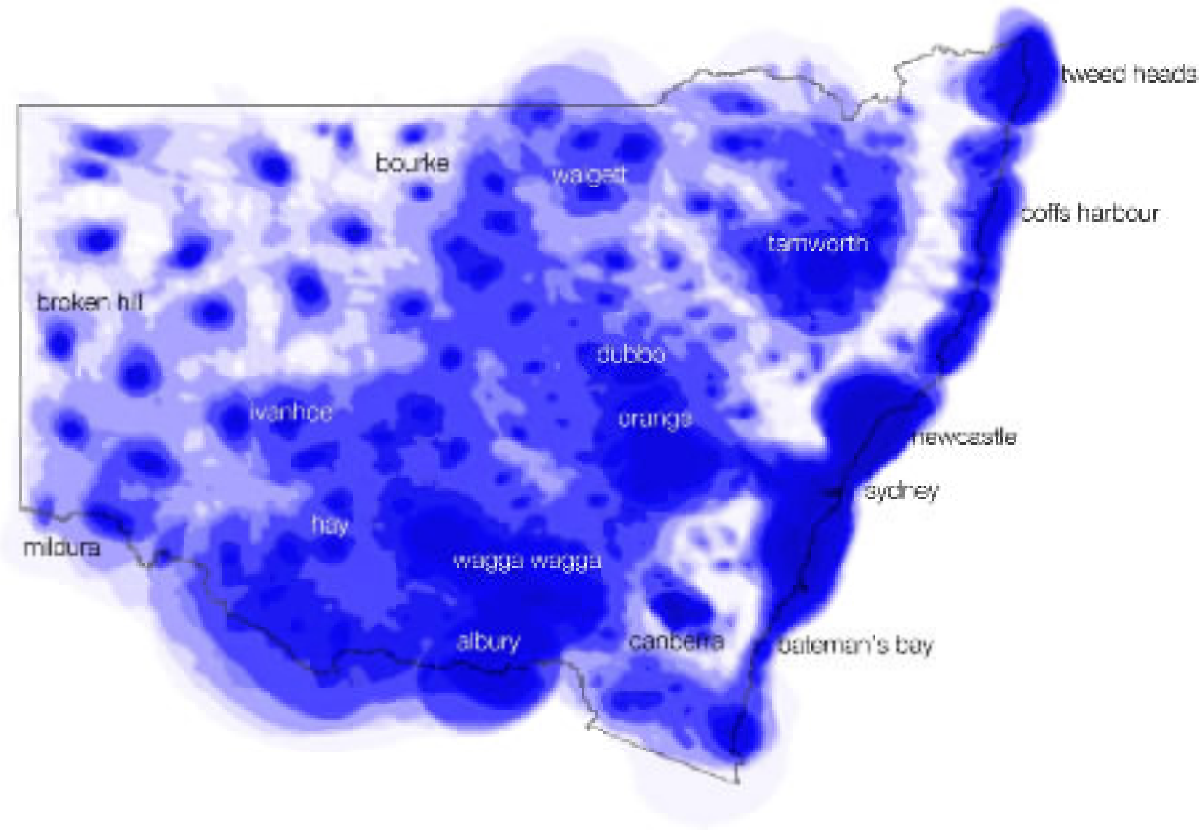
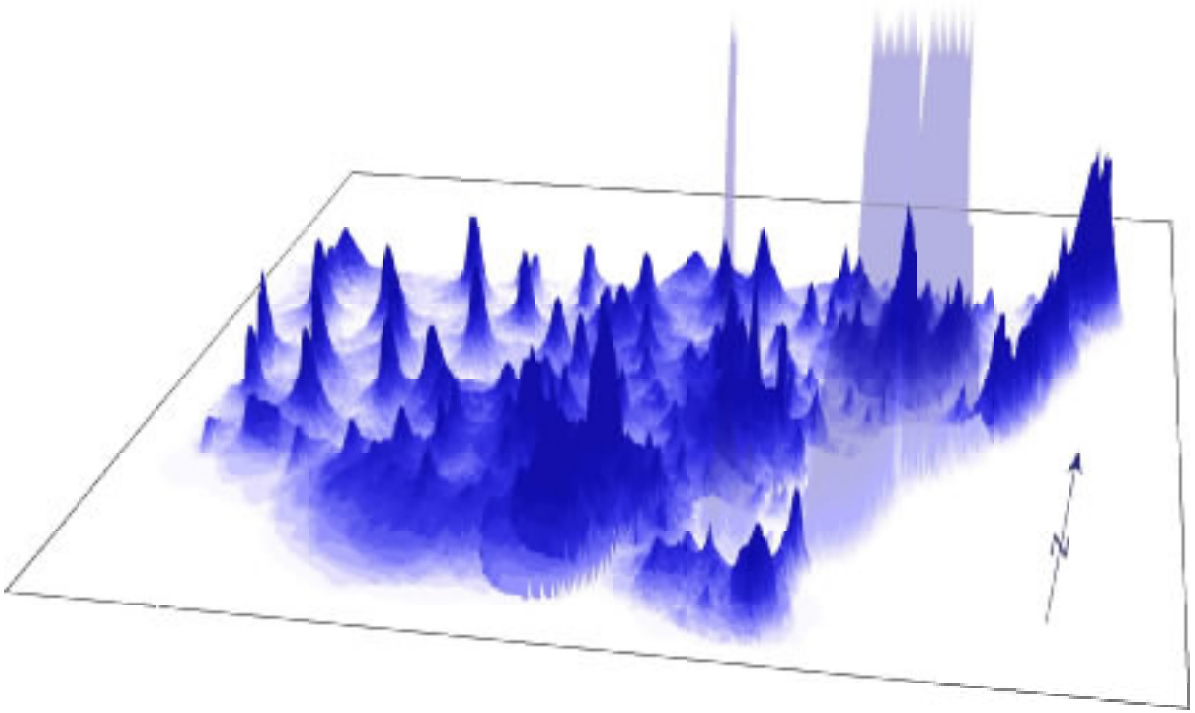


figure 4.3

Print version of the modelled social surface. Darker areas indicate higher elevations of the surface.

While correlation coefficients as high as 0.7 could be obtained between the measured and modelled surfaces, depending on the model parameters used, it was found that the correlation coefficient was a poor indicator of the match between the boundaries and regions derived from the surface. This was because the

figure 4.4



Oblique three dimensional view of the modelled social surface. With the exception of the Sydney and Canberra regions, darker areas indicate higher elevations of the surface. The peaks in the surface representing Sydney and Canberra have been truncated and rendered semi-transparent to avoid obscuring the parts of the surface behind these peaks.

correlation coefficient was influenced by mismatches in all parts of the surface, whereas the boundaries derived from the surface depend only upon the lower parts ('valleys') of the surface. For this reason, the Kappa statistic is preferred as the indicator of the accuracy of fit of the modelled boundaries to the measured boundaries in north eastern New South Wales.

As shown in box 4.1, below, the level of agreement between the modelled boundaries and the measured

boundaries in north eastern New South Wales was extremely good, with correct classifications of more than 98.6 per cent of the 1,973 home points in the region for which measured data was available.

box 4.1 —Kappa statistics

Level of regionalisation	Proportion of home points correctly classified (%)	Kappa	Significance
Level 1	99.9	0.999	$p < 0.0005$
Level 2	99.5	0.994	$p < 0.0005$
Level 3	98.6	0.982	$p < 0.0005$

4.7 regionalisation of social surface

4.7.1 defining regions

To produce a hierarchy of regions based on the modelled social surface it is necessary to locate major and minor 'valleys' in the surface. Boundaries based on the major 'valleys' will define level 1 regions, and boundaries following the 'valleys' within these regions will define the level 2 sub-regions. Once again, boundaries on minor 'valleys' within the level 2 sub-regions will define the level 3 sub-regions. The Hydrological Modelling Tool in ESRI ArcView 3.2 was used to produce a 'drainage network' on the modelled social surface (figure 4.5). 'Valleys' at the lower 'altitudes' of the modelled social surface, indicate possible locations for level 1 boundaries, those in the middle 'altitudes' — level 2 boundaries and those at the upper 'altitudes' — level 3 boundaries.

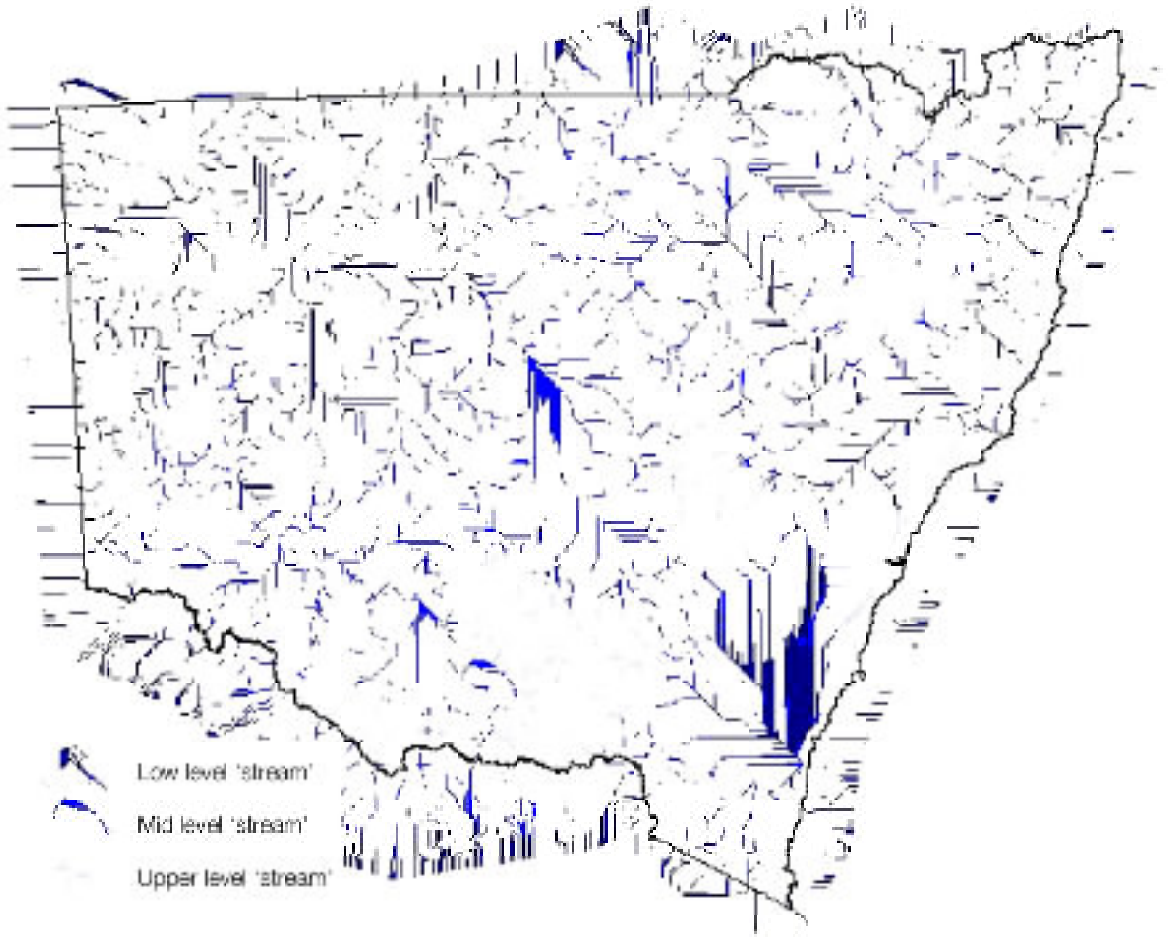


figure 4.5

'Drainage network' on the modelled social surface. The centre lines of the 'valleys' in the surface are represented by 'streams', which are coloured according to the 'altitude' of the social surface at which they occur.

4.7.2ground-truthing

In some areas, the 'topography' of the social surface does not necessarily give a strong indication as to the placement of boundaries. This can be the result of broad shallow 'valleys' in the surface, or the presence of several 'valleys' in close proximity that are equally good candidates for the location of a boundary. In these circumstances, ground-truthing can assist in boundary placement decisions.

Only limited ground-truthing was possible within the timeframe for the project. Ground-truthing data was compiled from two main data sources, then integrated and mapped to provide a resource to support the positioning of the boundaries of the eco-civic regionalisation.

The first source of data was the World Wide Web pages of regional sporting and community organisations in New South Wales. This provided information on the localities that participated in regional sports competitions. This data source was also used to compile a sampling frame of key informants who could provide additional information about the spatial aspects of social interactions among local organisations.

A telephone survey of these key informants provided the second source of data used in ground-truthing. Interviewees were asked about the localities in their region where their organisation interacted with similar organisations as part of social activities and/or sporting competitions.

A summary of the survey details are provided in box 4.2, below. A full list of organisations and regions is provided in appendix 1.

box 4.2 —ground-truthing survey summary

Type of local organisation	Number of local organisations	Number of completed interviews
Country Women's Association	438	293
Hockey Association	35	30
Soccer Association	35	30
Netball Association	75	50

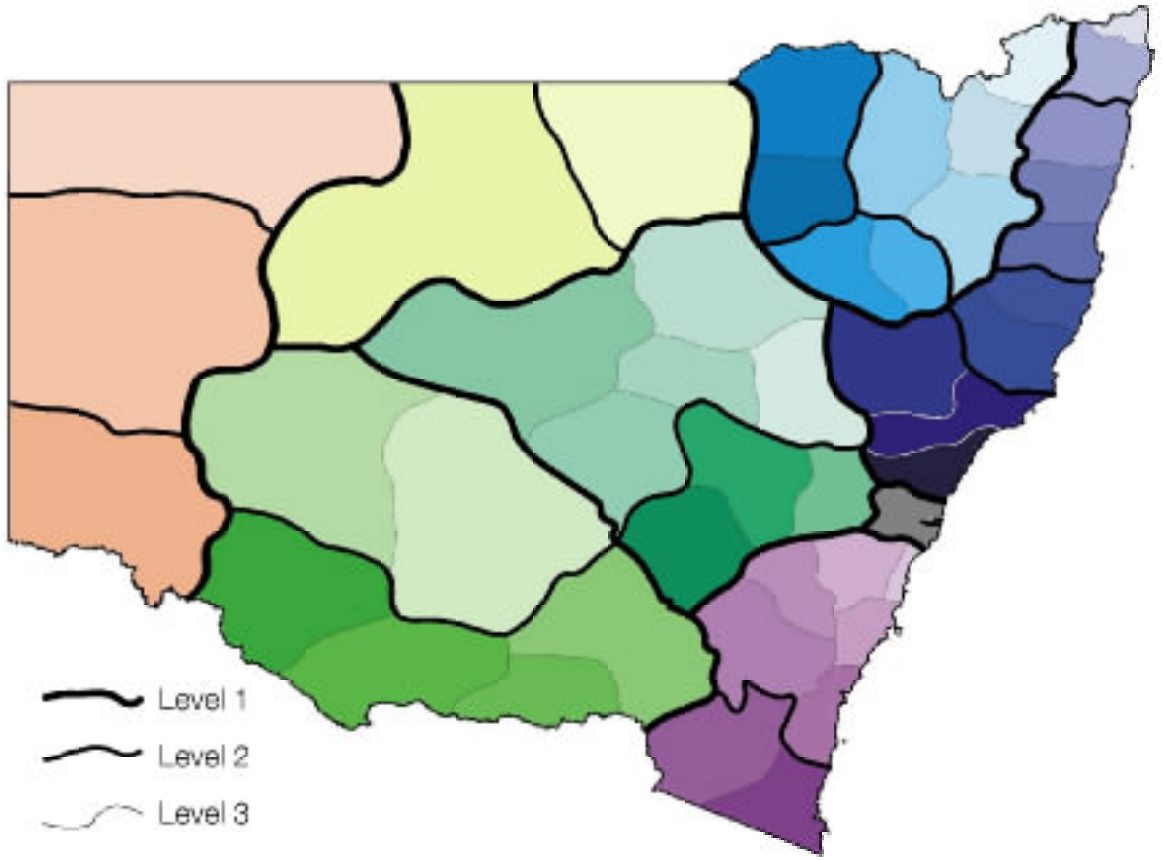


figure 4.6

Print version of the hierarchy of civic regions derived from the modelled social surface.

Information from the ground-truthing survey and the 'drainage network' was used to produce a three-level hierarchical regionalisation of the modelled social surface, shown in figure 4.6.

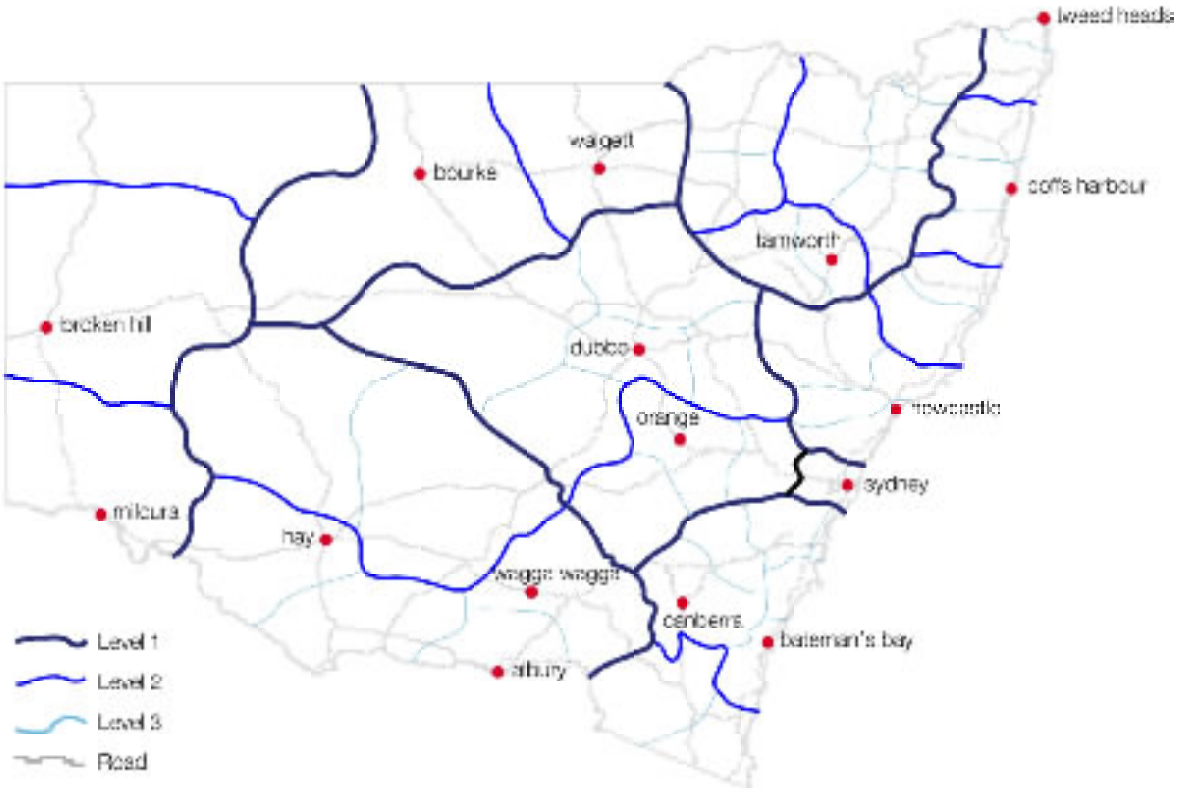


figure 4.7

Print version of the hierarchy of civic regions derived from the modelled social surface, showing towns and main highways.

The boundaries of the hierarchical regionalisation of the modelled social surface, are shown relative to the larger urban centres and the main highways in figure 4.7, above. level 1, level 2 and level 3 regionalisations are shown separately in supplementary figures s1 to s3 at the end of this report, and in appendix 2.

5 biophysical classification

Regional landscapes display patterns of ecosystems and agri-ecological landuses, which reflect underlying functions and interactions of some key biophysical variables (Forman, 1995; Brunckhorst, 2000). The most influential of these are soils, available water, temperature and elevation (Bailey, 1996). Biophysical data sets for these variables were used to develop a hierarchical biophysical classification comprising eight main regions. (level 1), each of which was divided into two sub-regions (level 2). The level 2 sub-regions were further subdivided into two or more level 3 sub-regions. The hierarchical biophysical classification is shown in figure 5.1. The classification boundaries are shown superimposed on a Landsat 7 picture mosaic in figure 5.2. level 1, level 2 and level 3 classification boundaries are shown separately in supplementary figures s4 to s6 at the end of this report, and in appendix 2.

technical details

For the NSW 'EcoCivic' project, ecological landscapes were described hierarchically (levels 1-3) using GIS classification or regionalisation of multi-attribute data including:

- Digital Elevation Model (Geodata 9 second D.E.M.),
- BRS/NLWRA soil moisture surface,
- soils – 7 functional groups derived from 18 soil classes (based on DIPNR NSW soils map and BRS/NLWRA soils atlas), and
- climate surface – 3 surfaces based on Principal Component Analysis of 60 band climate surface (ANUCLIM 5.1, McMahon et al. 2001; Hutchinson, 1998), which include evaporation, maximum and minimum temperatures, rain and, rain days for each month of the year.

The scale of data available was at 1km or finer. The recent NSW NPWS hierarchical vegetation classification is mapped at 10 km, but was not used within the classification routines. Vegetation is considered by ecologists to be a reasonably good approximation / 'surrogate' for interacting biophysical structure and function, therefore it was used here as a rough 'ground-truthing' guide and check on the classifications. Some latitudinal and longitudinal weighting was also used in the classification routine to assist clumping of more homogeneous groups.

The biophysical regionalisation was developed using the ERDAS Imagine 8.5 classification routine running an ISODATA classification (a spatial auto-correlation method using general linear models).

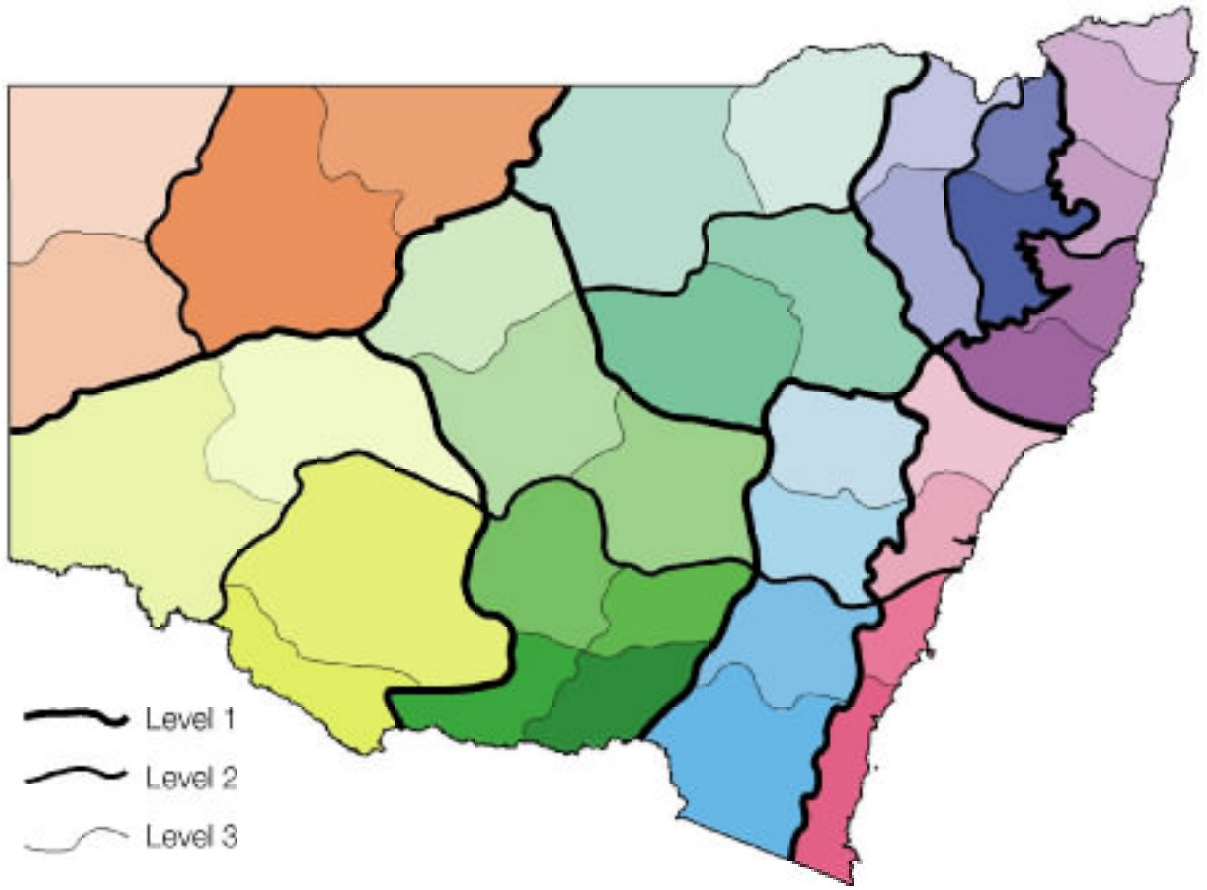


figure 5.1

Print version of the biophysical classification, showing the hierarchy of biophysical regions.

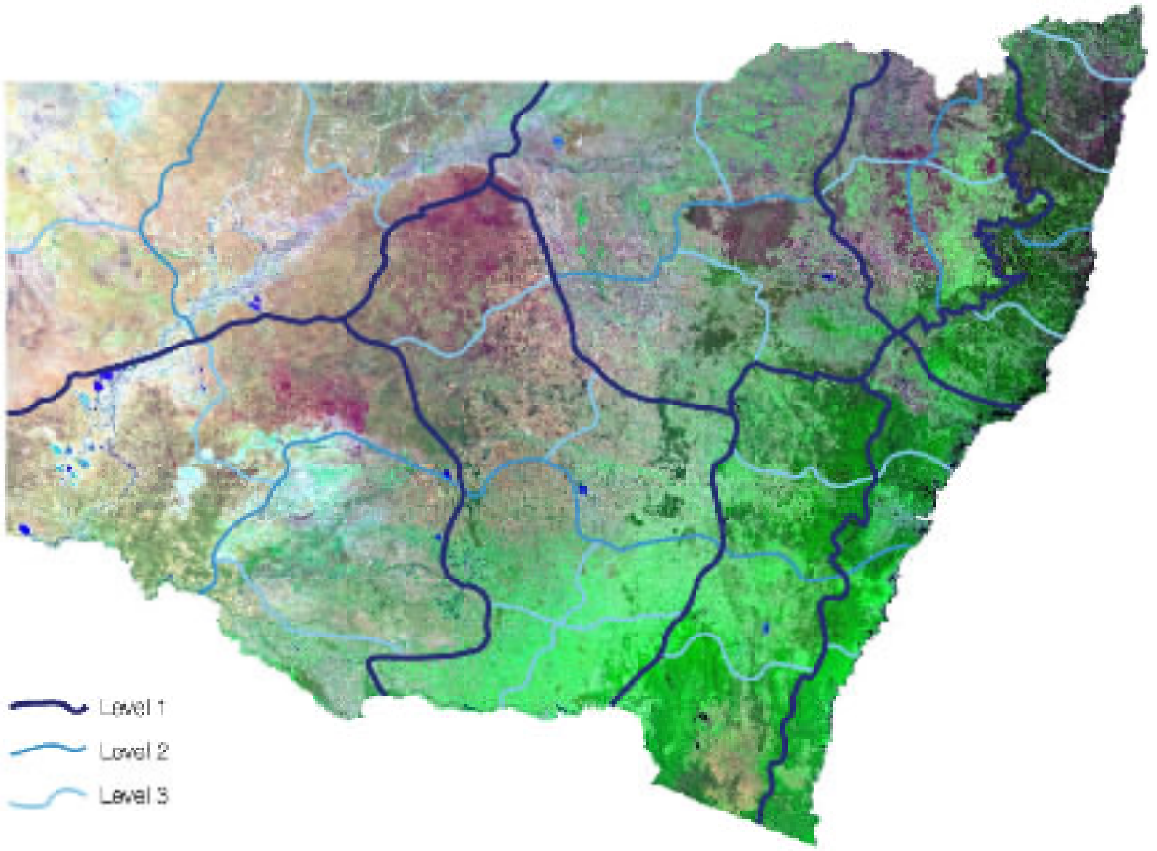


figure 5.2

Print version of the biophysical classification, super-imposed on the Landsat 7 Picture Mosaic of Australia.

6 eco-civic regionalisation

6.1 ecocivic optimisation

For effective natural resource management, it is important that the administrative region within which management occurs contain a relatively homogeneous set of landscapes, resources and ecological processes. However, as described in chapter 2, it is also important that administrative regions have boundaries that minimise the fragmentation of the areas that people regard as their community. These are the boundaries (presented in chapter 4) that are obtained by following the 'valleys' in the social surface — the social regionalisation.

The boundaries that define the biophysical regionalisation (presented in chapter 5) do not necessarily coincide with the boundaries of the social regionalisation, although the coincidence is fairly good along the eastern escarpment of the northern tablelands. This is because a sparsely settled area coincides with a major climatic, floral and faunal discontinuity in the landscape.

In many areas, however, it is necessary to adjust the boundaries of the social regionalisation to bring them into closer coincidence with the boundaries of the biophysical regionalisation. This is made possible by the fact that the 'valleys' in the social surface can be quite broad. This is particularly so for the 'valleys' at lower 'altitudes' in the social surface. This means that the boundary can be moved reasonable distances within the valley, without causing a significant increase in the number of community areas that are intersected by the boundary.

At broader scales therefore, (i.e. level 1), the optimisation routine can give more weight to the biophysical boundaries. However, at finer scales (i.e. level 3) it is necessary to ensure that the optimisation routine does not shift boundaries into relatively high areas on the social surface.

Residents of coastal communities have an interest in both the management of both the terrestrial coastal zone and inshore waters (Brunckhorst, 2000; Coop, 2003). Consequently, boundaries coastal regions need to be extended beyond the coastline into inshore waters.

The process of optimising boundaries to take account of the above considerations is termed 'eco-civic optimisation', and the resulting set of regions is termed an 'eco-civic regionalisation'. The eco-civic regionalisation for New South Wales is shown in figure 6.1. Figure 6.2 shows the boundaries of the regions relative to the main highways and major towns. level 1, level 2 and level 3 regionalisations are shown separately in supplemantary figures s7 to s9 at the end of this report, and in appendix 2.

6.2 nesting

Nesting is the process of forming sets of sub-regions that are more similar to each other than they are to other sub-regions. For example, the cereal growing sub-regions of north and central western New South Wales are more similar to each other than to, say, either the grazing sub-regions of the northern tablelands or the sub-tropical north coast. All the regionalisations provided in this report — social, biophysical and eco-civic are nested hierarchies of regions.

A nested eco-civic regionalisation provides the means to scale up and down government service delivery, natural resource management and local governance. For example, to assist appropriate levels of decision making and civic engagement in natural resource management, community residents in a level 3 eco-civic region can exercise a high degree of autonomy in deciding on local actions to maintain quality and availability of resources. However, if decisions affect other communities of resource users, the decision needs to be made collectively at the next higher eco-civic level (level 2).

Similarly, level 3 eco-civic regions might be appropriate local government areas, but if environmental planning has impacts beyond individual level 3 eco-civic regions, then this planning will need to be conducted by a group of level 3 regions, i.e. a level 2 region.

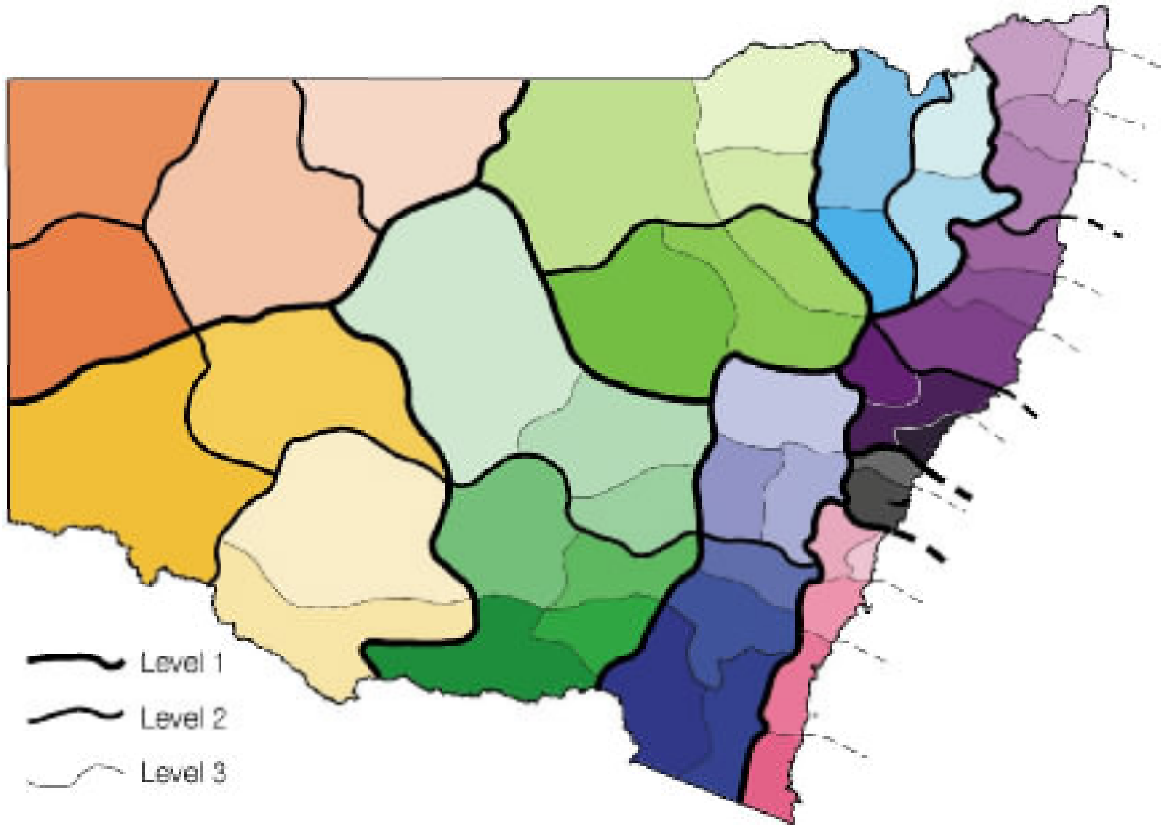


figure 6.1

Print version of the eco-civic regionalisation, showing the hierarchy of eco-civic regions.

figure 6.2

Print version of the eco-civic regionalisation, super-imposed on the Landsat 7 Picture Mosaic of Australia and the road network.

7 outcomes and recommendations

7.1 outcomes

The research and analysis undertaken in this project has extended the original eco-civic methodology to new levels of application. It demonstrates that with a foundation of primary empirical data and targeted ground truthing it is possible to extrapolate to a much larger area, in this case the State of NSW, to delineate eco-civic regions at several scales. The study examines the spatial relationships of non-metropolitan communities and the ecological landscapes in which they live and work.

The eco-civic regionalisation of NSW is the major product of the current work. It is provided at three hierarchically nested levels. Two other products, each at three nested levels are the social-civic regionalisation and the biophysical regionalisation. The CDROM accompanying this report contains all the spatial data outputs and coverages (ESRI GIS format) in GDA94 geographic coordinates.

This data will be available through the Department of Lands spatial infrastructure for a diverse range of uses. The eco-civic regionalisation of NSW will be a valuable resource that can inform decision making when administrative frameworks, including their spatial context and institutional arrangements, are being reviewed. It will be an indispensable tool in the review and development of policies, planning, governance and representation issues, service delivery, co-ordination programs and natural resource management (NRM). It will be of value to individuals, the private sector, government agencies and non-profit organisations throughout NSW and Australia.

The specific outputs from the project are:

1. 3D modelled social surface of communities of interest for NSW.
2. Level 1 modelled civic regions for NSW (broadest/highest level in hierarchy of regional communities of interest).
3. Level 2 modelled civic regions for NSW (mid-level in nesting of hierarchy of regional communities of interest).

4 Level 3 modelled civic regions for NSW (smallest level in nesting of hierarchy of regional communities of interest).

5 Biophysical classification of ecological landscapes (at scale of level 3 modelled civic regions for nesting up-scale). This is combined with level 1-3 civic regions from above and the boundaries optimised for best-fit to provide the final three products.

6 Level 1 eco-civic regions for NSW. This will provide broad scale integration across large catchment or resource management regions and their land-user communities.

7 Level 2 eco-civic regions for NSW. This is the level likely to be appropriate for Resource Management Authority regions, Regional Planning and other administrative delivery of government services.

8 Level 3 eco-civic regions for NSW. This is the level likely to be appropriate for boundaries for State Government service delivery and future local government areas (LGAs).

9 A comparison of the performance of eco-civic regions (levels 1 – 3) with some current administrative areas (LGAs, Planning, Catchment Management Authority (CMA), Planning, Premier's Department and Health regions).

10 A list of recommendations to government.

7.2 discussion

The eco-civic regionalisation presented in section 6 is a resource that can inform decision processes when adjustments to administrative regions are being considered. To make decisions about the merits of options for the location of administrative boundaries, it is necessary to have criteria that provide measures of the performance of the administrative regions in relation to administrative functions and, appropriate civic engagement and resource management.

As noted in section 2.2 (page 7), if the boundaries of an administrative area or natural resource management region splits areas that most people regard as an area of interest to them, and in the case of NRM splits areas having similar soils, vegetation and land use, there is likely to be dissatisfaction with the government and consultation processes. In addition, communities with shared interactions, similar land uses and issues might be split and have to compete inappropriately with each other or otherwise be asked to make collective decisions with communities with which they have much less of a common interest (Shannon, 1998;

Brunckhorst, Coop and Reeve, 2002). For example, the effectiveness of Catchment Committees of the early 1990s was hampered because different land use communities ended up at loggerheads, which in turn created more fragmentation in planning and decision-making.

One of the difficulties currently faced in catchment management (ICM and TCM) are unfounded assumptions that whole catchments fully represent people, place and natural resources. Rarely is this the case. Communities of interest, their land use, soils, vegetation, ground water and climate variables do not follow catchment lines (O'Neill, Hunsaker, Jones, et al.,1997; Omernik and Bailey, 1997; Reeve, 1998; Brunckhorst 2000, Phelps 2003, Stedman, 2003).

The run-off, silt and nutrients transported by catchments to the sea has a considerable influence on coastal waters and their resource productivity, often as far as the continental shelf edge (Ray and Hayden 1992). Coastal communities have an area of interest inclusive of the use and management of the coastal-marine interface, particularly inshore waters adjacent to their communities (Brunckhorst and Bridgewater 1995; Coop 2003). This is also apparent in the current work. For resident fishing communities or communities whose livelihoods depend on marine based tourism, the coast and inshore waters are analogous to the resource base of land use communities west of the divide. The boundaries of regional local government areas and NRM regions of the future could extend seawards to the limit of State waters.

Effective local governance, including natural resource governance and management, requires appropriate institutional arrangements and processes. These need to allow decision making and action to occur at the lowest appropriate level, but also should have the capacity to scale up when required to the next appropriate level for decisions, or issues with external impacts that effect others (Knight and Landres, 1998; Reeve, Marshall and Musgrave, 2002). A hierarchically nested framework allows scaling up spatially and institutionally for planning or decisions which might affect other people, areas, or resources outside the immediate area for which planning or decisions are being made (Norton and Ulanowicz, 1992; Meidinger 1997,1998; Reeve, Coop and Brunckhorst, 2002).

In the eco-civic framework presented here, level 3 eco-civic regions might be appropriate local government areas, but if environmental planning has impacts beyond individual level 3 eco-civic regions, then this planning will need to be conducted by a group of level 3 regions, i.e. a level 2 eco-civic region.

The eco-civic framework assists integration for planning, decision making and policy across departments. For example to co-ordinate planning under the EP&A Act, it is important that LEPs at the Local Government level are consistent in their representation of communities, land use, resource needs and local government services and that similar adjacent LGAs and their respective LEPs can be grouped at a higher level and be included with regional planning and management activities for natural resources.

The spatial disposition of local government areas (LGAs) has its roots in the patterns of settlement in the late 19th century. Modern transport, communications, services and changes in the nature of social and economic interactions have resulted in communities of interest and place attachment that bear little similarity to the original patterns of settlement (Stedman 2003; Coop 2003). These communities of interest can be identified at several hierarchical scales and mapped (see section 4). On average, there are about three current LGAs per level 3 eco-civic region, although in all cases entirely new local government boundaries would be required to reform local government administration to the more representative level 3 eco-civic regions.

7.3 performance comparisons

With governments striving for greater efficiencies as well as improved co-ordinated service delivery and, better community participation in decision-making on many such interrelated issues, it is recognised that greater civic engagement is likely when the area in question is consistent with community residents' area of interest. The spatial attributes of the underlying ecological resource base (section 5) are also important in meeting community needs for ecosystem services, well-being and, urban development and resource use. The eco-civic regionalisation (section 6) provides the best combination of area of shared community interest with similarity in the ecological resource base. This is achieved within the smallest area possible while minimising cutting off or dissecting residents' area of interest (or 'disc'; see figure 2.5).

In the research undertaken previously (Brunckhorst, 2002; Brunckhorst, Coop and Reeve, 2001, see Appendix 3; Reeve, Coop and Brunckhorst 2002; Coop, 2003), it was clearly demonstrated that while both the boundaries and size of an administrative region are important, it is the location of the boundaries which is of fundamental importance in minimising the dissection of areas of common concern or interest for civic engagement by community residents.

In any administrative region, some community areas will be wholly contained within the region boundary, while others will be intersected by the boundary. The proportion of people's community areas that are wholly within a region boundary, compared to the total number of people living within that boundary, provides an index of the performance of the particular administrative region in terms of its ability to include the areas that are of interest to residents. This index is termed the Community Capture Index (CCI).

Figure 7.1 summarises the CCIs for the three eco-civic regions and current administrative regions for Local Government, Health, Planning, the Premier's Department and the proposed Catchment Management Authority (CMA) Regions. It demonstrates that the current administrative boundaries and those proposed for CMAs are not in the best locations. The three levels of eco-civic regions perform much better.

Figure 7.2 provides a map overlay and CCI for current LGAs and level 3 eco-civic regions. Non-metropolitan LGAs on average represent less than 25% of the area interest to local communities. Level 3 eco-civic regions are, on average, two to three times the size of current LGAs, and increase the representation to almost 70% of communities areas of interest. Level 3 eco-civic regions would be appropriate to consider for single local government areas. This would reduce the non-metropolitan LGAs to 49.

Figure 7.3 provides a map overlay and CCI for the proposed CMA regions with eco-civic 2 regions. Even though they are huge areas of multiple catchments the CMA regions perform poorly in terms of the CCI (notably, the former CMB regions do not perform any better — Coop, 2003). Only one large part of the (upper) Namoi performs almost as well as the level 2 eco-civic region in that location. Figure 7.3 also provides a map overlay of the proposed CMA regions with the level 2 biophysical regions. This highlights the fact that catchments do not represent the ecological resource base well either. Soils, vegetation and ground cover, available soil moisture associated with climate variables, elevation, and human land uses do not generally follow catchment lines. Nor do the communities of land and resource users. Catchment frameworks need to be re-evaluated in their role in integrated resource management.

figure 7.1

Mean Community Capture Index (CCI) plotted against mean area of regions for a range of administrative regions. The Community Capture Index is the percentage of people whose community area lies wholly within the particular type of region.

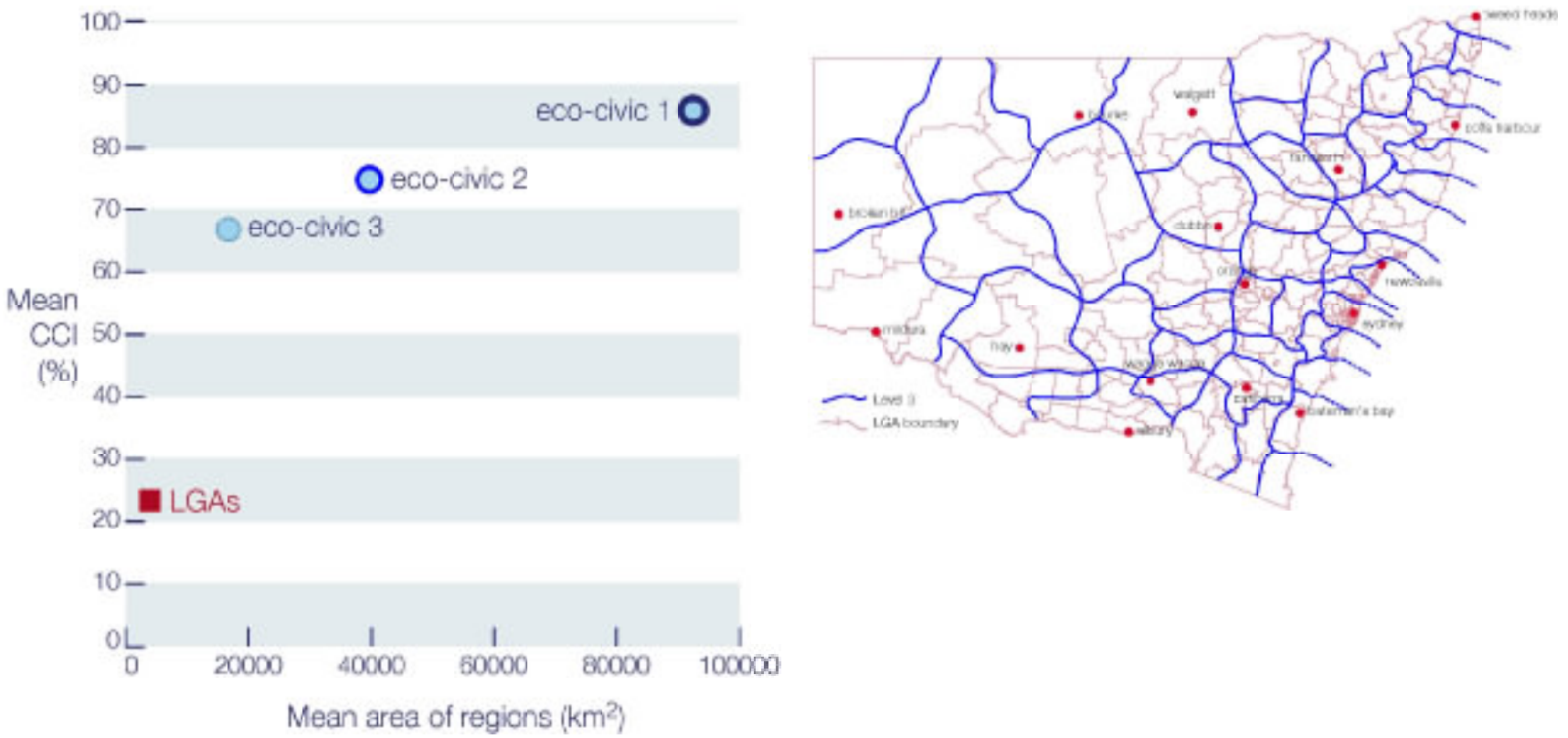


figure 7.2

Comparison of level 3 eco-civic regions and LGAs. The Community Capture Index (CCI) is the percentage of people whose community area lies wholly within the particular type of region.

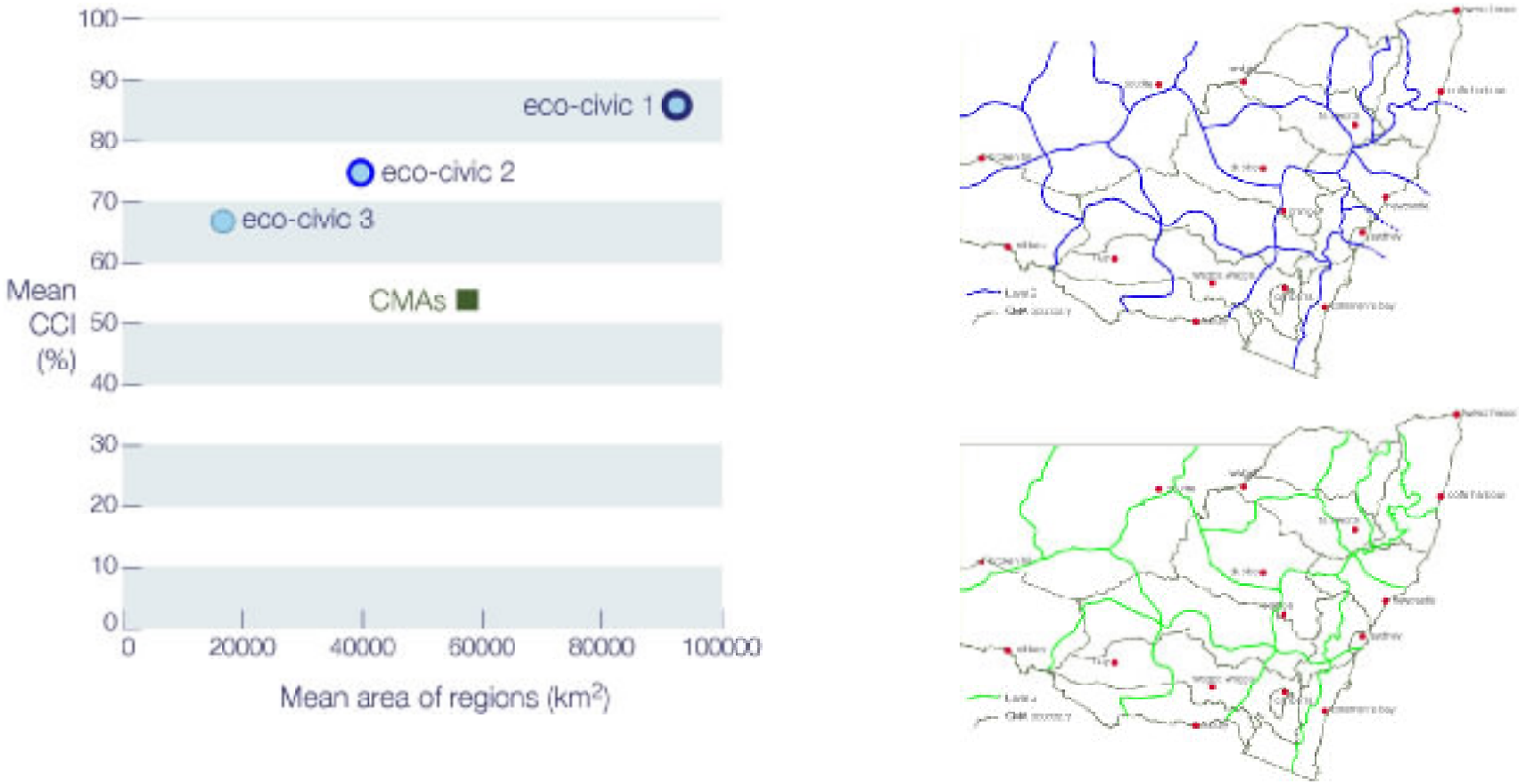


figure 7.3

Comparison of level 2 eco-civic regions (map, upper right), level 2 biophysical regions (map, lower right) and CMAs. The Community Capture Index (CCI) is the percentage of people whose community area lies wholly within the particular type of region.

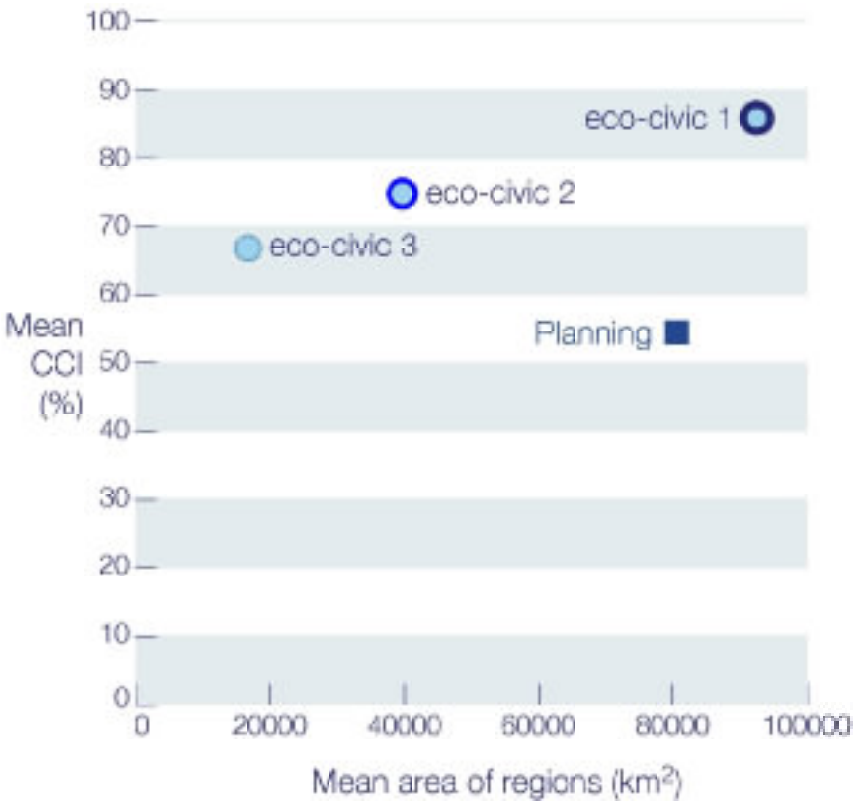


figure 7.4

Comparison of level 1 eco-civic regions and Planning regions. The Community Capture Index (CCI) is the percentage of people whose community area lies wholly within the particular type of region.

Figure 7.4 (previous page) provides a map overlay and CCI for the current Planning regions with level 2 eco-civic regions. While the Planning regions are very large, their performance as reflected in the CCI is poor. Level 2 eco-civic regions would be more appropriate regional frameworks for planning – especially if level 3 eco-civic were LGAs nesting up to the eco-civic level 2 Planning and Resource Management (CMA) regions.

As previously noted, the map products provided in this work will be of use to the government in many different and diverse applications. The work is of immediate value and application in the government's timely reform agenda in local government and resource management.

The new spatial understanding and synthesis provided by the eco-civic regionalisation and comparative analysis of administrative boundaries has identified some mal-alignment of LGA and catchment management boundaries. The government's reform agenda, however, provides the opportunity to concurrently adjust boundaries and administrative arrangements for both LGA and CMA regions so that new regional LGAs (eco-civic level 3) nest up into resource management regions (eco-civic level 2). This would provide a wide range of benefits, as well as efficiencies to the Government and local communities, while maintaining and building civic interest and support. It would also raise planning and natural resource management to a whole new level of integration that would make NSW a world leader in bioregional planning and management.

7.4 recommendations

7.4.1 short term

1. Local Government and Planning: The NSW Government consider adopting the 49 level 3 eco-civic regions as new regional local government areas; and, that the 20 level 2 eco-civic regions encompassing these be used as Planning Regions and Premiers Department coordination regions.

2. Natural Resource Management: The government further consider adjustment of the number and boundaries of proposed CMAs (possibly as Resource Management Authorities) by using the 20 level 2 eco-civic regions. Consistent with recommendation 1 above, the new regional LGAs would nest up into the resource management regions.

3. Coastal and Marine Integration: With reference to recommendation 1, the government consider extending the eco-civic level 3 local government regions in coastal areas into adjacent inshore waters as far as the State

waters jurisdiction. Establish matching administrative arrangements for relevant authorities such as fisheries, coastal zone management and, boating and water ways management administrative groups.

4. Monitoring and Reporting: After implementing 1 and 2 above, reconfigure regional State of the Environment reporting, coupled with a State of Society (regional socio-economic status) so that data is collated and reported at these 2 levels (i.e., eco-civic level 3 LGAs synthesised to eco-civic 2 NRM region, then State level). These reports should include spatial data that contribute to the Governments Spatial Infrastructure in the Department of Lands.

7.4.2 Medium Term

5. Community Representation: The NSW Government adopt the eco-civic regionalisation as an input in planning and policy development in relation to community representation issues at various scales, administrative boundaries and service delivery, and location of Branch offices.

6. Co-ordination and Integration: The Premier's Department consider the use of the eco-civic regionalisation in reviews to assess and improve inter-departmental co-ordination, regional coordination and integration for service delivery needs.

7. Administrative review: With the adoption of recommendations 1 and 2, the Government undertake further examination of administrative and service delivery arrangements which might benefit from integration and coordination at larger or smaller scales of the eco-civic framework. For example, Health and Community services and delivery might need to be contracted to eco-civic level 3 regions in some places while level 1 eco-civic regions might be appropriate for larger scale requirements such as Roads and Traffic Authority for highways and main roads, but with branch offices associated within level 3 regions.

8. Spatial Data Infrastructure: The Government strongly support the continued development of spatial data of relevance and important to government, business and communities of NSW. Spatial data, its integration, quality control and management access is a critically important resource to the State and the nation.

9. Leadership in spatial integration and applications: Through the implementation of these recommendations, NSW will be a world leader in the use and application of spatial data for well integrated service delivery representing the complex landscape

patterns of communities and their interaction with natural resources. The Government is urged, through its Department of Lands, to encourage the Federal Government and other State Governments through ANZLIC, the Australian Bureau of Statistics and other relevant agencies to develop similarly integrated spatial information, and to tailor the collection of community, socio-economic and environmental resource data in formats enabling spatial integration.

8 references

Bailey, R.G. 1996. Multi-scale Ecosystem Analysis. Environmental Monitoring and Assessment 39: 21-24.

Brunckhorst, D.J., 2000. Bioregional Planning: Resource Management Beyond the New Millennium. Gordon and Breach Harwood Academic, Amsterdam.

Brunckhorst D.J, 2002. Institutions to Sustain Ecological and Social Systems. Journal of Ecological Management and Restoration 3(2): 107-119

Brunckhorst, D.J. and P.B. Bridgewater. 1995. Coastal Zone Conservation - Sustaining Nature and Society. Pp 87-94 in, O. Bellwood, H. Choat and N. Saxena, eds, Recent Advances in Marine Science and Technology '94. PACON International and James Cook University

Brunckhorst D., Coop, P. and Reeve, I. 2002. Designing 'Eco-Civic' Regions for NRM. Final report to Land & Water Australia on UNE 35: The social and ecological functions of landscapes. Institute for Rural Futures, University of New England.

Carletta, J. 1996. Assessing agreement on classification tasks: the kappa statistic. Computational Linguistics, 122, 249-254.

Congalton, R. 1991. A review of assessing the accuracy of classifications of remotely sensed data. Remote Sensing of the Environment, 37:35-46.

Coop, P. 2003 (unpub.). Eco-Civic Landscapes: Capturing Civic Interest in Multi-Scale Natural Resource Management Frameworks. PhD thesis. University of New England, Armidale.

Forman, R.T.T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, Cambridge.

Hillery, G.A., 1955. Definitions of Community: Areas of agreement. Rural Sociology 20: 111-124.

Hugo, G., P. Smailes, C. Macgregor, M. Fenton and D. Brunckhorst, 2001. Defining Social Catchments in Non-metropolitan Australia. Bureau of Rural Sciences, Australia.

Hutchinson M.F. 1998. ANUDEM Version 4.6 User Guide. Centre for Resource and Environmental Studies, The Australian National University, Canberra.

Knight R.L. and Landres, P.B. (eds) 1998. Stewardship Across Boundaries Island Press, Washington D.C.

McMahon, J.P., Hutchinson, M.F., Nix, H.A. and Houlder, D.J. 2001. ANUCLIM 5.1 User Guide. Centre for Resource and Environmental Studies, The Australian National University, Canberra.

Meidinger E.E. 1997. Organizational and Legal Challenges for Ecosystem Management in K.A. Kohm and J.F. Franklin (eds) Creating a Forestry for the 21st Century:

The Science of Ecosystem Management. Washington, D.C.: Island Press.

Meidinger E.E. 1998. Laws and Institutions in Cross-Boundary Stewardship. Pp. 87-110, in R.L. Knight and P. B. Landres (eds) Stewardship Across Boundaries, Washington D.C.: Island Press.

Norton B.G. and R.E. Ulanowicz 1992. Scale and Biodiversity Policy: A Hierarchical Approach. Ambio 21(3): 244-249.

O'Neill, R.V., C.T. Hunsaker, K.B. Jones, K.H. Riitters [and others], 1997. Monitoring Environmental Quality at the Landscape Scale: Using landscape indicators to assess biotic diversity, watershed integrity and landscape stability. BioScience 47 (8): 513-519

Omernik, J.M. and R.G. Bailey, 1997. Distinguishing between Watersheds and Ecoregions. Journal of the American Water Resources Association 33 (5): 1-15.

Phelps, A. 2003 (unpub). Total Catchment Management in New South Wales: Governance Rhetoric and Reality. Honours Thesis, School of Social Science and Policy, University of New South Wales).

Ray G.C. and B.P. Hayden 1992. Coastal Zone Ecotones. Pp.403-420 in A.J. Hansen and F. di Castri (Eds), Landscape Boundaries, Springer-Verlag, Berlin.

Reeve, I.J. 1998. Commons and Coordination: Towards a Theory of Resource Governance. Pp 54-65, in R. Epps (ed), Sustaining Rural Systems in the Context of Global Change. Proceedings of the Conference of the Joint IGU Commission for the Sustainability of Rural Systems and the Land Use - Cover Change Study Group, University of New England, Armidale, July, 1997. University of New England, Armidale.

Reeve, I., Coop, P. and Brunckhorst, D. 2002. Community surfaces and 'ecocivic' optimisation: an approach to forming nested resource management regions. In: Graham, J., Reeve, I. and Brunckhorst, D. (eds). Proceedings of the 2nd International Symposium on Landscape Futures, 4-6 December, 2001, Armidale.

Reeve, I., Marshall, G. and Musgrave, W. 2002. Issues Paper No 2: Resource Governance and Integrated Catchment Management. Report to Murray-Darling Basin Commission. Institute for Rural Futures, University of New England, Armidale.

Shannon, M.A., 1998. Understanding Social organizations and Institutions. In: Naiman, R.J. and Bilby, R.E. (eds), River Ecology and Management: Lessons from the Pacific Coastal Ecoregion. New York: Springer Verlag. 529-551

Stedman, R.C. 2003. Is It Really Just a Social Construction? The Contribution of the Physical Environment to Sense of Place. Society and Natural Resources 16(8): 671-686.

supplementary figures

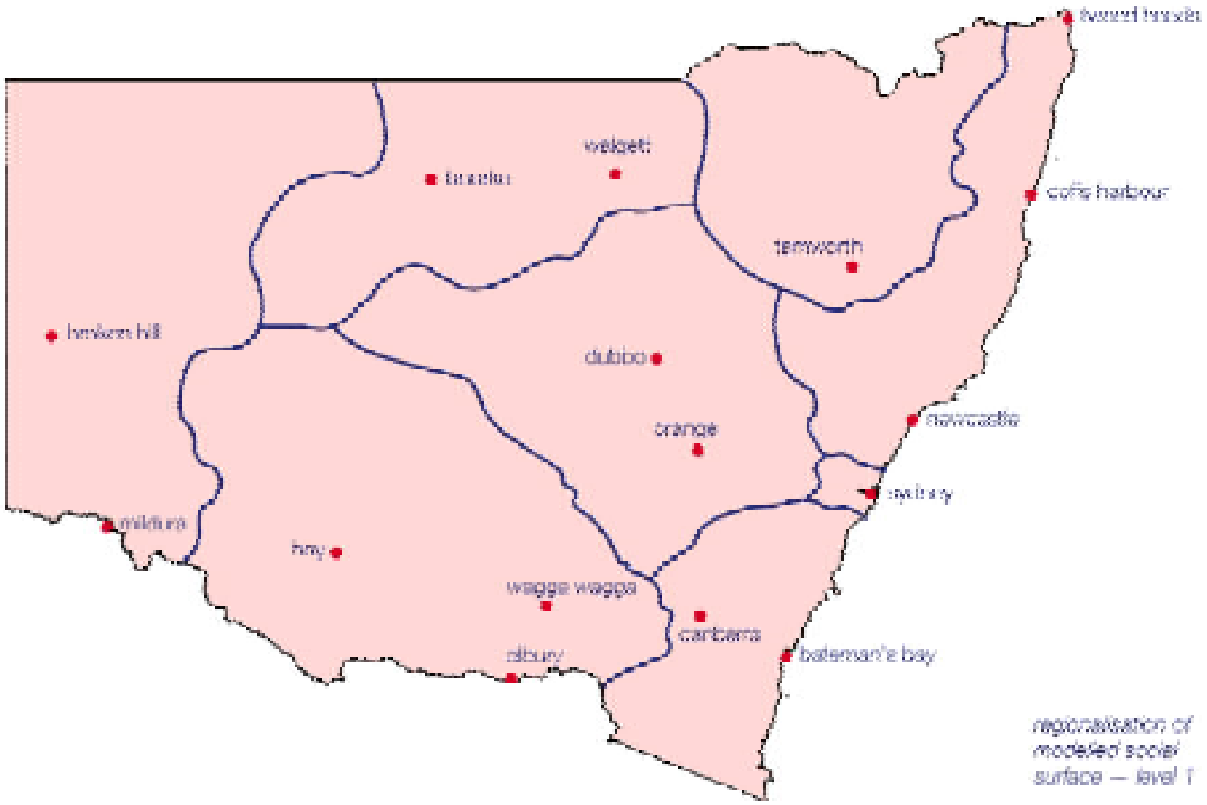


figure s1


velget
broken hill
dubbo
orange
wagga wagga
canberra
albury
batemans bay
regionalisation of
modified soiler
surface — level 2

figure s2

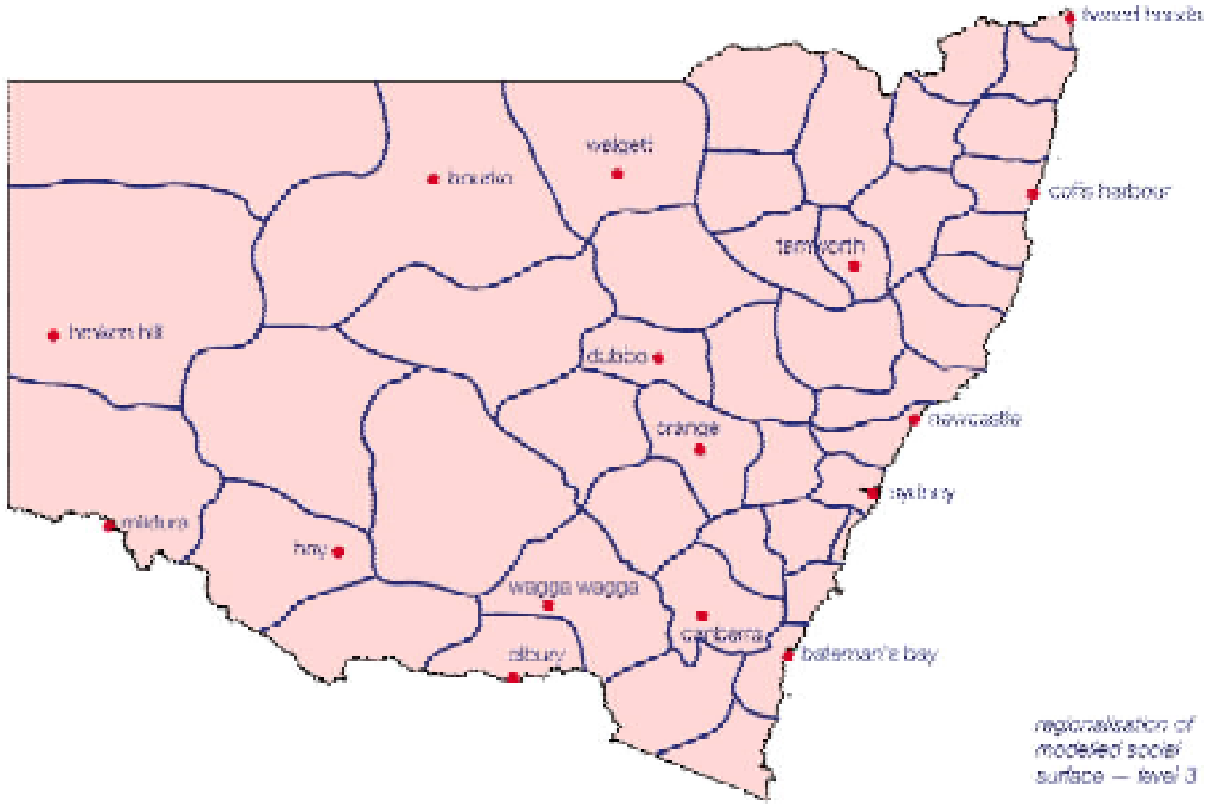

tweed heads
coffs harbour
tamworth
broken hill
dubbo
orange
newcastle
sydney
mildura
hay
wagga wagga
albury
batemans bay
regionalisation of
modelled social
surface — level 3

figure s3


bourke
walgett
coffs harbour
tamworth
dubbo
orange
wagga wagga
canberra
bateman's bay
biophysical
regionalisation
– level 1

figure s4


broken hill
dubbo
orange
wagga wagga
canberra
bateman's bay
coffs harbour
tamworth
biophysical
regionalisation
– level 2

figure s5


bourke
walgett
broken hill
dubbo
tamworth
coffs harbour
orange
griffith
mildura
hay
wagga wagga
albury
bateman's bay
biophysical
regionalisation
– level 3

figure s6


bourke
walgett
coffs harbour
tamworth
dubbo
orange
wagga wagga
canberra
bateman's bay
albury
hay
mildura
eco-civic
reconnaissance
– level 1

figure s7


bourke
walgett
coffs harbour
dubbo
orange
wagga wagga
canberra
bateman's bay
albury
hay
eco-civic
regionalisation
– level 2

figure s8


bourke
walgett
coffs harbour
dubbo
orange
griffith
bateman's bay
albury
eco-civic
regionalisation
– level 3

figure s9

INSTITUTE FOR **Rural Futures**

Institute for Rural Futures
University of New England
Armidale NSW 2351
02 6773 2220
irf@pobox.une.edu.au
www.ruralfutures.une.edu.au

CBRM

UNE
THE UNIVERSITY OF NEW ENGLAND

Department of Lands
Reliable from the ground up