Bounding resource governance for collective action across multi-functional regions : A cross-scale 'Eco-Civic' approach

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Abstract

Despite a growing body of theory that emphasizes the importance of socio-spatial aspects in the representation of community interests, regionalisation for natural resource governance remains dominated by river catchments. At the same time, across many nations, local governments are being given increasing responsibilities for environmental and resource management, but work within boundaries that are largely historical artifacts. The confluence of these trends suggests it is timely to examine the requirements for spatial definition of resource governance regions. A considerable body of research on 'place' attachment, social networks, and participatory resource management combines to suggest that joining forces to take responsibility for collective action towards sustainability is more likely within particular social-ecological contexts and scales. We suggest three essential principles to guide the definition of boundaries of more efficient and effective regional contexts for collective engagement in natural resource planning, governance and actions. First, the nature and reach of environmental externalities of resource use should determine the size and nesting of resource management regions. Second, the boundaries of resource governance regions should enclose areas of greatest interest and importance to local residents. Third, the biophysical characteristics of a resource governance region should be as homogenous as possible. We applied these principles to the derivation of an 'eco-civic', resource governance regionalisation for the Australian state of New South Wales. This paper describes these concepts, the results and their potential policy application. An important finding was that many administrative and resource governance regions fall short on a regionalisation performance measure developed to gauge the fragmentation of representation of community interests. Such fragmentation of individuals' collective shared interests as communities reduces participation and effectiveness of planning, creates logger-heads and increased transaction costs. Potential institutional (re-) design is likely to be more effective given the spatially nested 'common grounds' provided by the 'eco-civic' regionalization technique.

Keywords: Landscape; Region; Catchment Management; Resource Governance; Civic engagement; Community boundaries; Nesting; Eco-Civic; Regionalisation.

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Introduction

Around the world, an increasing number of governments face rising social and environmental costs of resource use. There is increasing understanding amongst both scientists and policy makers, that many resource governance issues relate to the complex interdependencies of social and ecological systems operating at various scales. The emergent patterns and properties from social-ecological interactions across landscapes provide further evidence supporting the growing emphasis on efficient and effective community engagement and civic action at multiple scales of resource governance (Slocombe, 1993; Beckley, 1995; Brown and MacLeod, 1996; Berkes and Folke 1998; Brunckhorst 2000). Planning for resource management at multiple scales of biophysically similar landscapes or ecoregions is considered important because they reflect characteristics influencing land and other resource use (Omernik 1987,1995; Bailey 1996). Federated or nested administrative arrangements and spatial planning units have been employed by various governments in natural resource management (Waldo, 1984; Frey and Eichenberger, 1999; McGinnis, 1999). However, these arrangements have not always been effective in ensuring natural resources are used sustainably (Johnson et al., 1999; Barham, 2001; Carpenter and Gunderson, 2001; Blomquist and Schlager, 2005).

The placement of boundaries to define regions for integrated resource governance warrants more careful analysis than it has been accorded in the past. What actors with an interest in an area, what spatial civic representation and networks, and, what landscapes of ecological patterns, function and ecosystem services are included in a resource governance region? These considerations are vitally important to success or failure of strategies, plans and actions towards more resilient and sustainable social-ecological systems. We propose three basic principles that need to be considered in defining resource governance regions and, using the State of New South Wales in Australia, demonstrate an empirical method of deriving a nested hierarchy of such regions that are consistent with these principles.

A potted history of catchment based resource governance

Watersheds and catchments have become the dominant form of regionalisation for natural resource governance in many countries. Modern integrated catchment management has its roots in early 20th century progressivism in the United States (Waldo 1984; Muskingum Water Conservancy District 2002; Margerum 1995). In the 1960s, new social movements concerned with environmental and civil rights issues led to increased demands for direct citizen participation in public policy making. Together with other areas of public policy, integrated catchment management responded with a shift from technocratic planning to various forms of participative planning. This shift took place in the late 1980s and early 1990s, with little consideration either of the implications for the definition of resource governance regions, or of the considerable body of theory in the social sciences that is relevant to regionalisation, such as central place theory (Christaller 1933), gravity modelling (Carrothers, 1956), theories of place attachment (Kemmis 1990; Altman and Low 1992; Cuba and Hummon 1993) and hierarchy theory (Pattee 1973; McGinnis, 1999).

Research on public participation in natural resource governance grew through the 1990s (Buchy et al. 2000), as has the development, empirical testing and refinement of theories of place attachment (Feld and Basso 1996; Wilkinson 2000; Stedman 2003). There has also been increasing understanding of the role that place and community play in influencing natural resource politics and management (Beckley 1995; Shannon 1998; Field et al. 2003; Schusler et al. 2003; Cheng et al. 2003; Parisi et al. 2004; Carr 2004). While this conceptual and theoretical development was being assembled over the last decade, catchments have nevertheless remained the dominant administrative unit for regional natural resource governance in Australia and elsewhere (Reeve et al. 2002; Phelps 2003). Within the integrated catchment management literature, most authors accept unquestioningly that catchments should form the areal units within which natural resource governance takes place. Others make a case that river catchments can also form a natural unit encompassing cultural and social commonalities (McGinnis et al. 1999; Webler and Tuler 1999).

There is however, a growing weight of argument against the assumption that catchment-based regions automatically incorporate all resource governance issues and their communities of interest (Omernik and Bailey 1997; Getches 1998; Blomquist and Schlager 2005; O'Neill 2005). Brunckhorst (2000, 2002), Parisi et al. (2003, 2004) and Johnson et al. (1999) pointed out that regions of similar biophysical attributes and climate have little correlation to either watershed topography or areas of interest to land use communities. Barham (2001) argued that processes of democratic deliberation that have evolved over long periods of time prior to the emergence of modern environmentalism do not often fit with catchment boundaries. Other authors have argued that physical catchment boundaries rarely coincide with the boundaries of communities that usually form natural units within which resource governance issues are negotiated and resolved, (Ewing, 2003; Lane, et al., 2004; O'Neill, 2005). Syme et al. (1994) went so far as to suggest that organisation of community involvement on catchment boundaries would act against the achievement of the stated goals and purposes of integrated catchment management.

Describing Regions for Resource Governance

Although there have been mounting criticisms of catchments as natural resource governance regions, and the growing conceptual and theoretical development in socio-spatial aspects of natural resource governance, there has been surprisingly few attempts to propose and apply empirical techniques of regionalisation that might address some of these criticisms and build on this growing body of theory (see Omernik and Bailey 1997; Cheng et al. 2003; González and Healey 2005). One attempt described as an example here, was a major study by the Institute for Rural Futures to derive a nested hierarchy of resource governance regions for the non-metropolitan part of New South Wales in Australia. To underpin the spatial analysis however, it was necessary to distil from the growing literature on socio-spatial aspects of natural resource governance some principle characteristics that could inform methodological and analytical development. The three key principles chosen are described below.

Principle 1: Resource management regions should reflect the area of most interest to local resident communities.

People are quite capable of identifying the locality of their 'place attachment' or the area they regard as their community (Hillery 1955; Kemmis 1990; Altman and Low 1992; Cuba and Hummon 1993; Hobbs et al. 2002; Stedman 2003; Cheng et al. 2003). Place based territorial development for local to regional governance is considered important for a variety of purposes and processes (Brandenburg and Carroll 1995; Wilkinson 2000; Albrechts et al. 2003). Parisi et al. (2004) and Brunckhorst et al. (2006) have found that the "place geography" of residents of communities, corresponds with their area of local civic interest, their social networks and the area for which they want representation in decision making. A spatially representative social survey and initial methodological trials demonstrated that there is a high degree of spatial conformity between the areas regarded as the location of one's community, the areas regarded as acceptable for the residential location of one's elected representative in local government, the area of one's local social networks and interactions, and the areas within which one would wish to be consulted about resource governance decisions affecting those areas (Brunckhorst et al. 2006). Such an area is referred to here as a "community area". While people will have interests in distance places too, their local community area is the locus of substantial social and economic interaction with other residents, and of interaction with natural resource base.

A position in the landscape will lie within one or more community areas belonging to the people living in the vicinity of that point. A point in the landscape that lies within a large number of overlapping community areas is a point in which a correspondingly large number of people have an interest. Resource governance decisions affecting this point in the landscape will have to consider the interests of this large number of people. If the boundaries of natural resource governance regions cut through such an area, local community participation and engagement will be greatly compromised (Figure 1). Indeed, it is likely that many residents will feel dissatisfied with consultative processes and the representation of their interests (Knight and Landres 1998; Shannon 1998; Reeve, Marshall and Musgrave 2002; Parisi et al. 2002, 2003). Other points in the landscape will lie within relatively few community areas. It is preferable therefore, if the boundaries of natural resource governance regions pass through areas of minimum collective interest to local people. If the boundaries of natural resource governance regions pass through these parts of the landscape, then a minimum of people will be in a situation in which their community area is divided between one or more resource governance regions (Figure 1). For this reason, this first principle proposes that resource governance boundaries should pass through points that lie within relatively few areas of shared interest to local communities.

Principle 2: The administrative region within which natural resource management occurs should contain a relatively homogeneous set of landscapes – similar, climate, ecological and geophysical characteristics.

The biosphere can be divided into continents and oceans, and the former further subdivided into broad continental regions. These can be subdivided into ecoregions and landscapes, and landscapes into ecosystem components, and further subdivided into patches or structural units and so on (Wiken 1986; Omernik 1987, 1995; Bailey 1996; Brunckhorst 2000). Across broad continental regions, patterns are generally observable at various spatial scales where similar organisms or biophysical attributes occur together. These mosaics are composed of units within which internal homogeneity is relatively high. When similar recurring ecological communities are replaced by a different set of recurring natural units, landscape boundaries can be observed and their underlying causes inferred fairly accurately (Forman and Godron 1981, 1986; Hansen and di Castri 1992; Forman 1995). Efficiency and effectiveness in resource governance is likely to be considerably enhanced if planning, priority setting, and management actions and monitoring take account of these boundaries (Reid and Murphy 1995; Omernik and Bailey 1997; Johnson et al. 1999; McGinnis et al. 1999; Field et al. 2003). Resource management planning and actions are improved when dealing with similar contexts of soils, local climate, elevation and topography. Infrastructure capital expenditure and maintenance is also more efficient when understood in terms of simlar local to regional biophysical conditions (Slocombe 1993, Brunckhorst 2002).

Principle 3: The nature and reach of the environmental externalities of resource use determine the size and nesting of resource governance regions.

Collective decision making and collaboration in natural resource management is necessary because one person's use of natural resources impacts upon other parts of the landscape and people. The spatial extent of these environmental externalities can range from the local (e.g. noise pollution), to the regional (e.g. groundwater extraction from regional aquifers), to the national or global (e.g. carbon dioxide emissions). If those who create, and those who are affected by these externalities, are to be represented in shared decision making, then the resource governance region within which this takes place has to be of a similar scale as the reach of the externalities (Cole, 2002; Reeve, 2003).

Many environmental externalities operate simultaneously across a range of scales. For example, vegetation clearing for agriculture on a farm might result in outbreaks of salinized land on adjacent farms, and an increase in salinity of surface waters which has impacts on urban water users some distance away. For this reason, it is likely that in most areas resource governance regions will need to be nested, with smaller regions (dealing with local problems) nested within larger regions (dealing with environmental externalities with a longer reach). The institutional design principles by which nested resource governance regions might operate are beyond our focus herein, but should be carefully considered in application and development of governance arrangements (see McGinnis, 1999; Marshall, 2005).

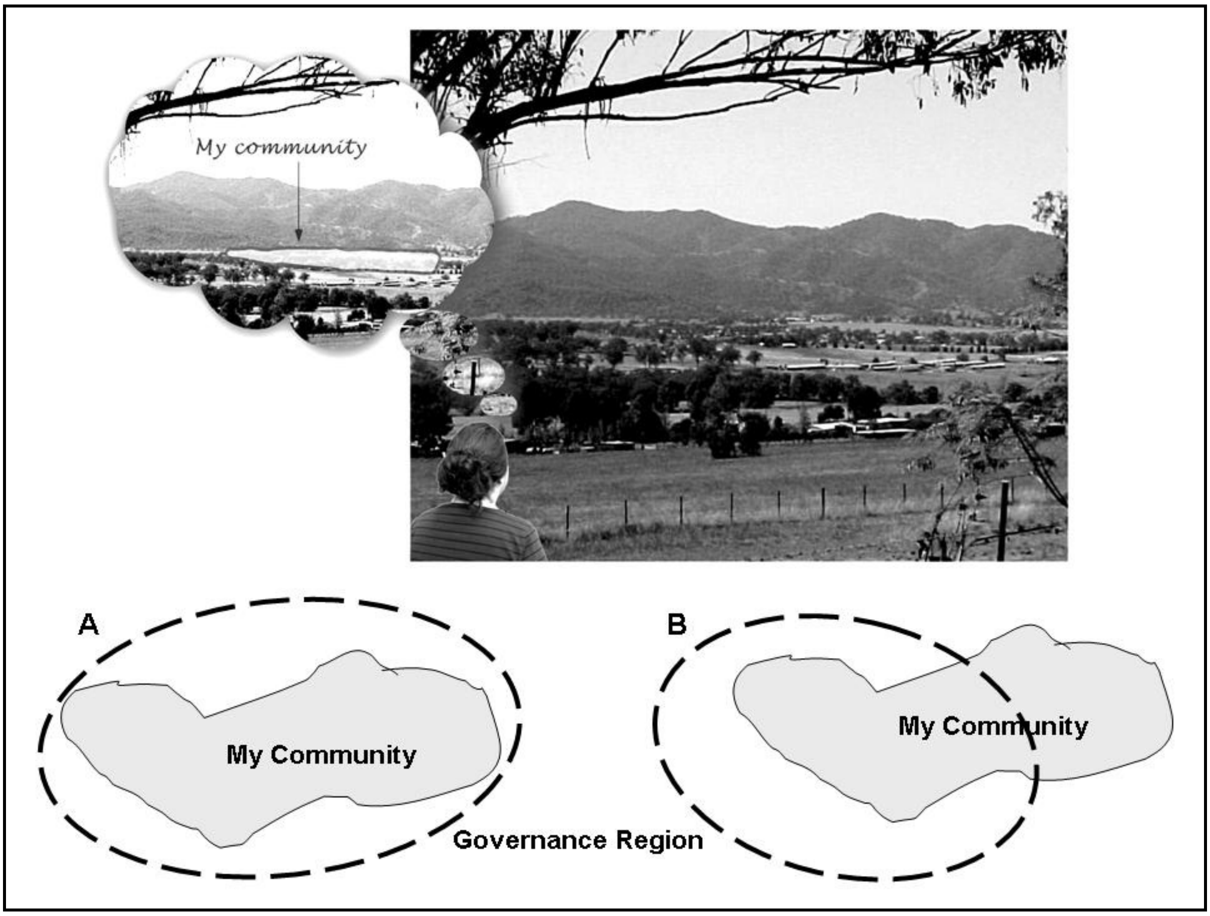

Figure 1. The "place geography" of community residents corresponds with their area of local civic interest, their social networks and the area for which they want representation in decision making. It is more desirable for residents to have their community of interest wholly within regional governance boundaries (A), than the boundary dividing their community of interest (B).

Application of Principles to Spatial Analysis.

The regionalisation approach consisted of three major components, and required the formulation of the concept of a "social surface", a topography of the areas of highest collective community identity and interest (described further below). The three steps were:

1. derivation of a social surface and a hierarchy of "civic" regions defined by the "valleys" in social surface (to satisfy Principles 1 and 3),
2. derivation of a hierarchy of biophysical regions (to satisfy Principles 2 and 3), and
3. optimisation of the boundaries of the two hierarchical regionalisations so that all three Principles are satisfied to the maximum degree possible.

The following sections describe the methods followed and results for each of these three components, with an emphasis on the social surface and civic regions.

Delineating Civic Regions from a Social Surface

The methods currently being used in Australia for the derivation of social catchments are highly dependent on the acquisition of primary data from surveys of residents and, for economic reasons, are infeasible to apply on a large scale (see review by Hugo et al. 2001).

A modelling approach was developed that could use mostly secondary data, and which utilised insights from theories of place and cognitive mapping (Hillery 1955; Tuan 1974; Altman and Low 1992; Cuba and Hummon 1993; Austin 1994; Kearney and Kaplan 1997; Hobbs et al. 2002; Cheng et al. 2003). This modelling approach was founded on the observation from the primary data from a study of northern New South Wales (see Brunckhorst et al. 2006) that the community areas that people drew on a map of their region approximated ellipses in outline, with sizes ranging from a few kilometres across the shortest dimension to over a hundred kilometres. For the majority of rural residents, the ellipse was defined by their place of residence (home point) at one end of the ellipse and a town at the other end. For residents in smaller towns or villages, the elliptical 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. Community areas tended to be larger in the more sparsely settled regions of northern New South Wales, and smaller in the more densely settled coastal regions. This suggested that it would be possible to model community areas by populating the State of New South Wales with simulated home points, and attaching an elliptical simulated community area to each home point, appropriately sized and orientated according to the location of towns of various sizes in the vicinity.

Simulating home points

A spatial resolution of 1km had been set for the study which led to a spacing of simulated home points at intervals of 500m or less. The Census Collection Districts (CCDs) for New South Wales were ranked by population density and the population fraction for simulation for the least dense CCD set to a value 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. The required population fraction for the least dense CCD was found to be 0.66. However, if this value were to be used in densely settled areas, this would result in far more simulated home points than needed to generate the social surface described below. 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 population dense metropolitan areas and large cities. The procedure described above resulted in 14,339 simulated home points spread across New South Wales.

Simulating community areas

Simulated elliptical community areas, sized and oriented according to the factors described above, were placed on each of these home points. New South Wales was divided into five regions, each region having a different mean community area size. These mean sizes were chosen to reflect the variation in community area size known from our previous study. 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 found in the earlier social survey of residents of north east NSW, with a mean community area size equal to that set for the region (Brunckhorst et al. 2006). The next transformation of the simulated 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.

The final step in the modelling procedure was to assign each simulated community area a height of one unit in a third dimension at right angles to the north-south and east-west dimensions of the map of New South Wales. Working in this three-dimensional space, the simulated community areas were summed to produce a "social surface". The social surface obtained by summing the elliptical community areas on each of the 14,339 simulated home points is shown in oblique view in Figure 2. High points on this surface corresponded to points that lay within the community areas of relatively large numbers of people (strictly, large numbers of simulated home points). Low points on the surface corresponded to points that lay within the community areas of relatively few people. As proposed in Principle 1, above, it is these low points in the social surface that are suitable areas through which resource governance region boundaries might pass.

Deriving a hierarchy of civic regions

A hierarchy of regions based on the simulated social surface can be produced by locating major and minor 'valleys' in the social topography of the surface. Boundaries based on the major 'valleys' will define larger level 1 regions, and boundaries following the 'valleys' within these regions will define the smaller level 2 sub-regions. At the next level, boundaries on minor 'valleys' within the level 2 sub-regions will define the yet smaller level 3 sub-regions.

Hierarchies and tributary levels of river watersheds and catchments are derived by the height and position of valleys in the landscapes topography. Likewise, a social surface can be treated as a topography where the hills and peaks represent spatially defined areas of high shared community interest and valleys at various lower levels indicate areas of less and lesser collective community of interest. The Hydrological Modelling Tool in ESRI ArcView 3.2 was used to produce such a 'drainage network' on the topography of the modelled social surface. '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. In some areas, the 'topography' of the social surface did not necessarily give a strong indication as to the placement of boundaries. This was a consequence of broad shallow 'valleys' in the surface, or the presence of several 'valleys' in close proximity that were equally good candidates for the location of a boundary. For this reason, a telephone survey of a number of community organisations with hierarchical structures of local, regional and State branches was undertaken. Use of 'key informants' is an efficient way of gathering surrogate data or for 'ground-truthing' as used here (Parisi et al. 2002; Cheng et al. 2003). A total of 403 interviews with office bearers in the Country Women's Association, the Hockey

Association, the Soccer Association and the Netball Association were completed. 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. Information from the telephone survey of community organisations and the spatial arrangement of ‘valleys’ in the social topography was combined to produce a three-level hierarchical regionalisation of the modelled social-civic surface, shown in Figure 3.

Validation of the hierarchy of civic regions

Our earlier study provided an empirically measured social surface and associated set of civic regions for north eastern New South Wales, against which the modelled civic regions could be compared. In that study, a classification matrix was used to record, for each civic region, the proportion of home points that were assigned to the same civic region when the modelled surface is used to derive the boundaries between the regions. The accuracy of placement or 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 (Kappa=0.982, p<0.0005).

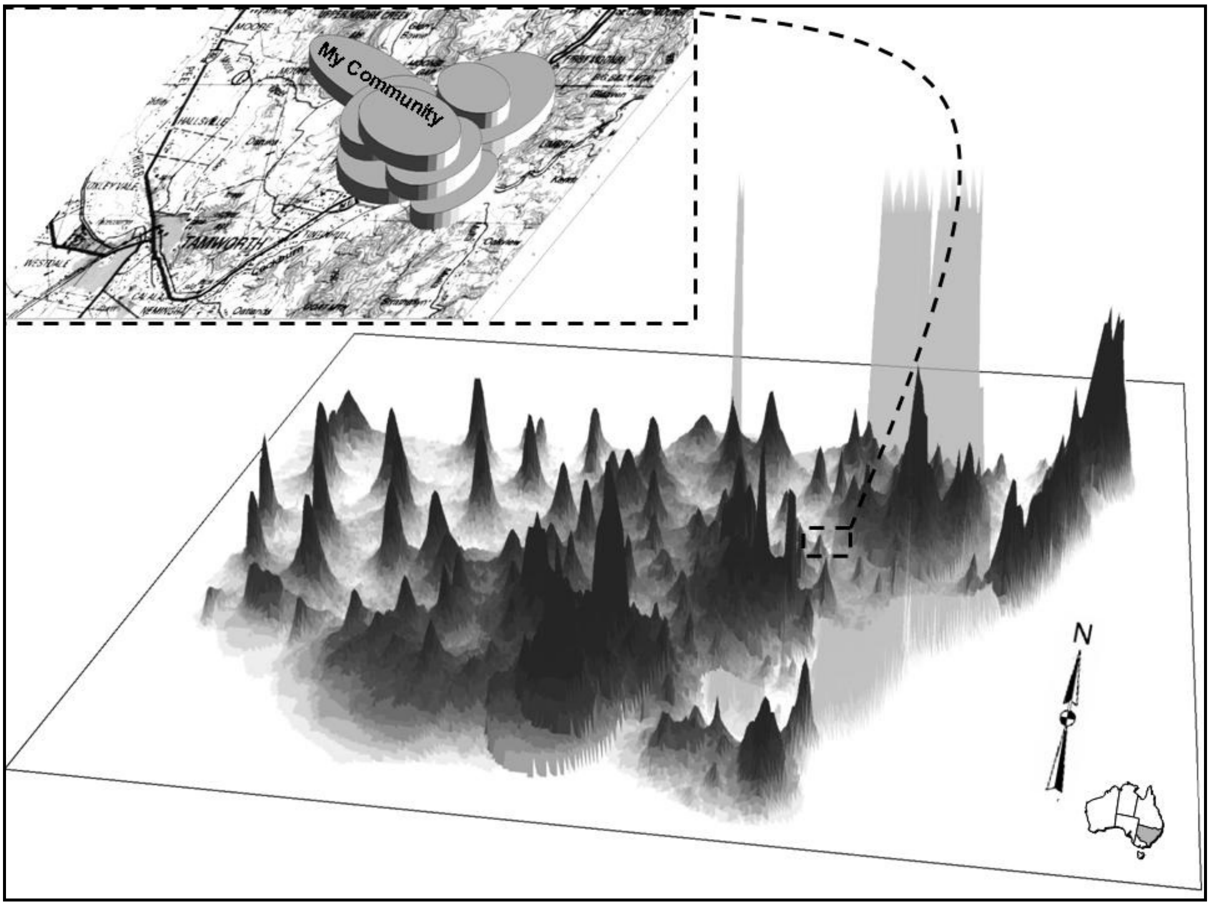

Figure 2. Areas of shared interest to local communities overlap and stack on each other creating a social-civic topography. This figure shows the simulated social surface for non-metropolitan New South Wales. The peaks representing Sydney and Canberra have been truncated and rendered semi-transparent to avoid obscuring the parts of the surface behind. With the exception of the Sydney and Canberra regions, darker areas indicate higher elevations of the surface.

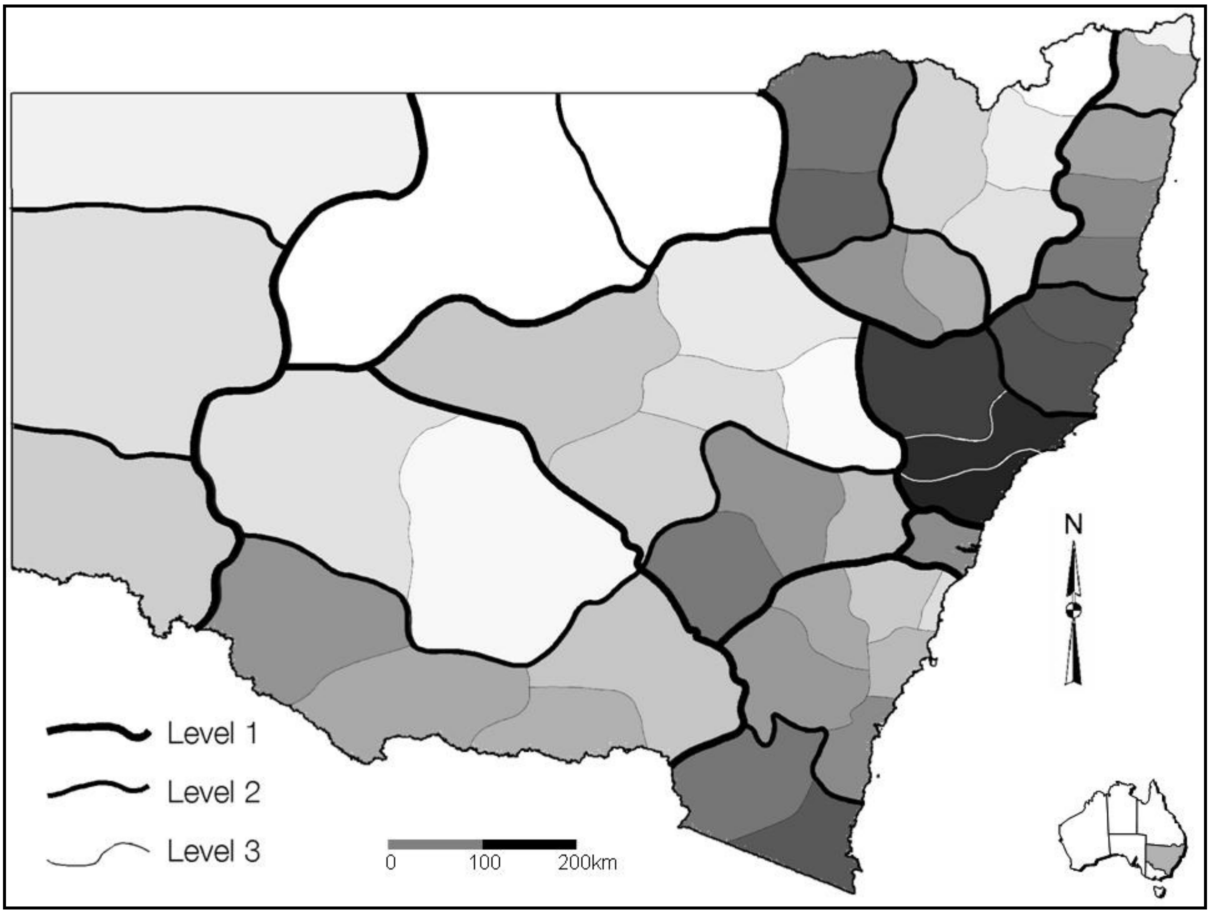

Figure 3. Hierarchy of civic regions derived from the simulated social surface.

Deriving Ecoregions

The biophysical regionalisation was based on elevation, soil moisture, soils, and climate data at scales of 1km or finer, using the ERDAS Imagine 8.5 classification routine (for details, see Brunckhorst et al. 2006). Vegetation data, as a surrogate for environmental attributes, were also classified separately for comparative purposes and to confirm nesting of ecoregions. The result was a hierarchical biophysical regionalisation comprising eight major regions (level 1), each of which was divided into sub-regions (level 2). The level 2 sub-regions were further subdivided into level 3 sub-regions. While a fourth level might have been derived for some areas, the scale of mapping and spatial accuracy might be compromised without finer scale social survey data. The hierarchical ecoregional boundaries of the biophysical regionalisation are shown in Figure 4.

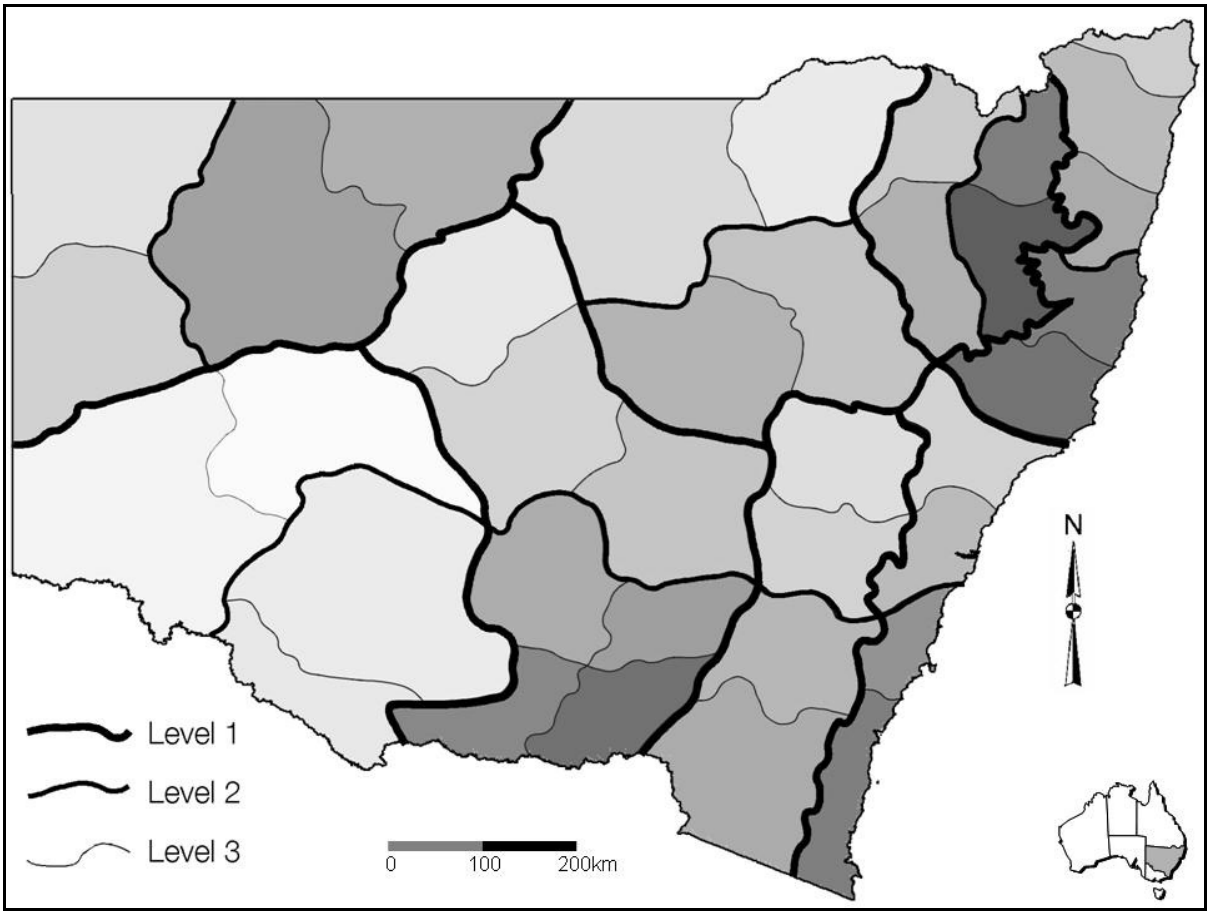

Figure 4. Nested ecoregions – the hierarchical biophysical regionalisation of the State of New South Wales.

Integrating ecoregions and civic regions through boundary optimisation

The boundaries that define the civic regions (Figure 3) do not necessarily coincide with the boundaries of the ecoregions derived from the multi-attribute biophysical regionalisation (Figure 4). There is coincidence along the eastern escarpment of the northern and southern tablelands, because a sparsely settled area coincides with a major climatic, floral and faunal discontinuity in the landscape.

At the three different scales of the hierarchy across the regions, it is necessary to adjust the boundaries of the civic regions to bring them into closer coincidence with the boundaries of the biophysical regionalisation. This is 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' (level 1) 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, (Levels 1 and 2), the optimisation routine can give more weight to the biophysical boundaries. However, at finer scales (Level 3) it is necessary to ensure that the optimisation routine does not shift boundaries into relatively high areas on the social surface. Following this routine for boundary placement boundaries when integrating biophysical and civic regions is termed 'eco-civic optimisation'. The resulting set of regions is termed an 'eco-civic regionalisation'. The eco-civic regionalisation for New South Wales is shown in Figure 5.

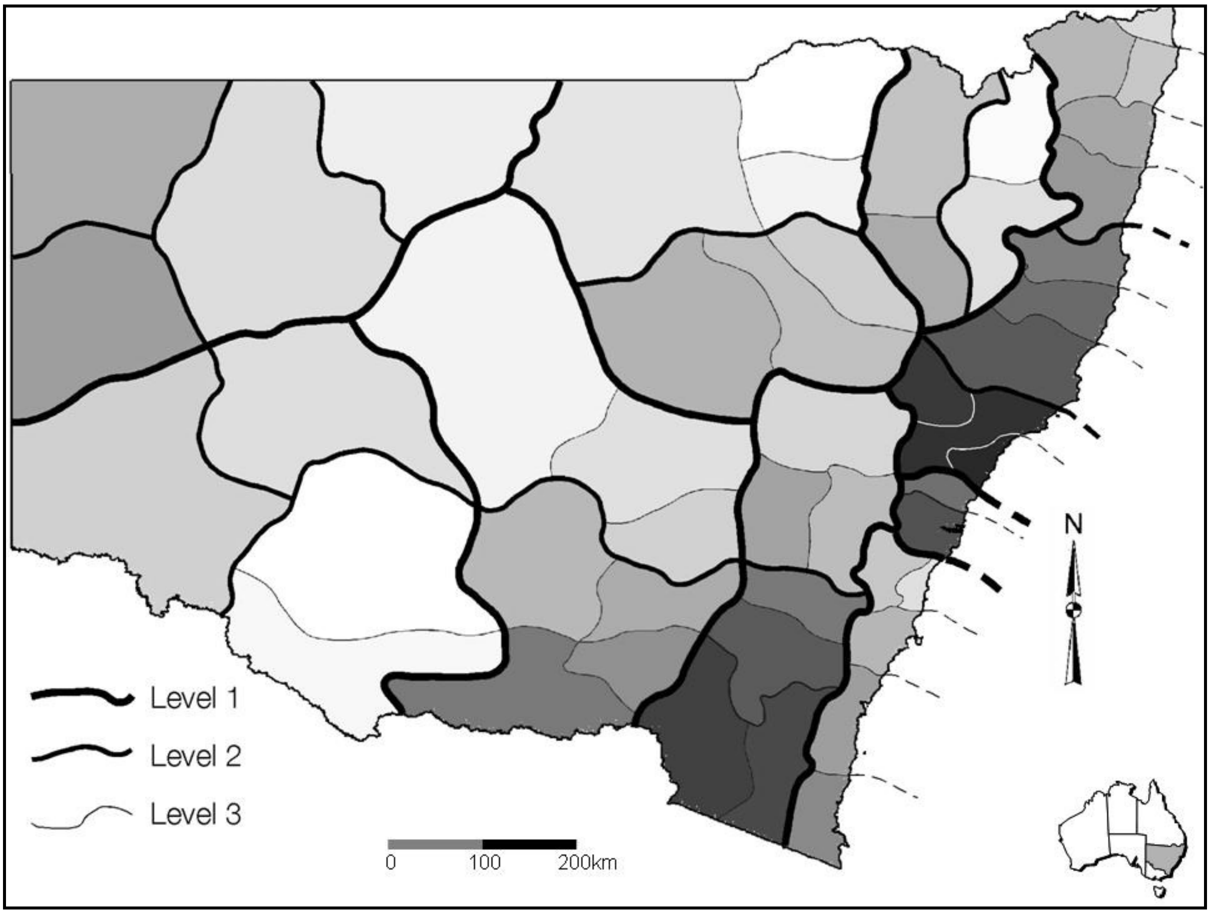

Figure 5. Eco-Civic regionalisation of New South Wales, following optimisation of boundaries through integration of biophysical and civic regionalisations.

Comparing the Performance of Regions

If the catchment boundaries of existing Catchment Management Authorities (CMAs) are overlaid on the boundaries of the level 2 eco-civic regions (Figure 6), it can be seen that these catchment-based boundaries are a poor fit with both the areas of community interest and with ecoregions. The eco-civic regions appear to be more representative of homogeneous social and ecological characteristics.

Before Eco-Civic regions were to be implemented as planning and administrative areas for resource governance however, policy makers may wish to know how well existing administrative regions perform in comparison. 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 resource governance region in terms of its ability to include the areas that are of most civic interest to residents. This index is termed the "Community Capture Index" (CCI). The CCI provides a means of comparing the performance of different regions in terms of the extent to which people's community areas are intersected by region boundaries. In conformity with Principle 1, above, a regionalisation with boundaries that intersect fewer community areas (higher value of the CCI), is preferable to a regionalisation that intersects a greater number of community areas (lower value of CCI; see Figure 1).

Figure 7 shows the plot of CCIs for the three levels of the eco-civic regionalisation, and for a range of current administrative regions in New South Wales, including Local Government Areas (LGAs) and, Catchment Management Authority (CMA) regions (Figure 6) which are based on catchment boundaries. The figure demonstrates that the current administrative boundaries including CMAs are in sub-optimal locations because they intersect or divide up areas of shared collective concern and interest to local residents and communities. The Eco-Civic regions minimise the number of people for which a regional governance boundary might intersect an area of interest to them. Of note is the very poor performance of existing Local Government Areas (LGAs) in their representation of communities of shared interest and identity (Figure 7). Indeed previous work has shown that the most populous LGAs, represent only around 10% of the area of social and civic interest to resident communities, performing worse in there representation of communities of interest than would a random allocation of areas (Brunckhorst et al. 2006).

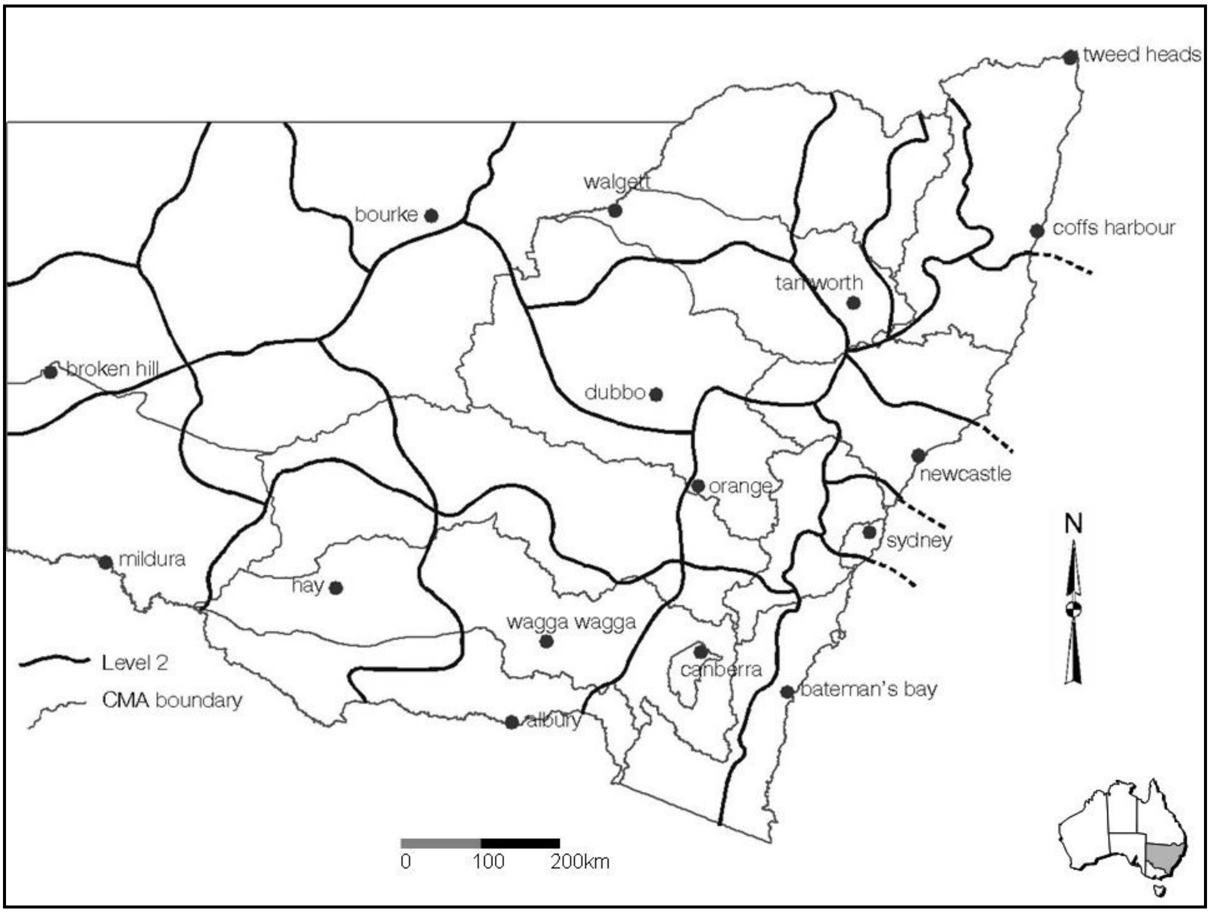

Figure 6. Boundaries of Catchment Management Authorities (CMAs) and the level 2 eco-civic regionalisation.

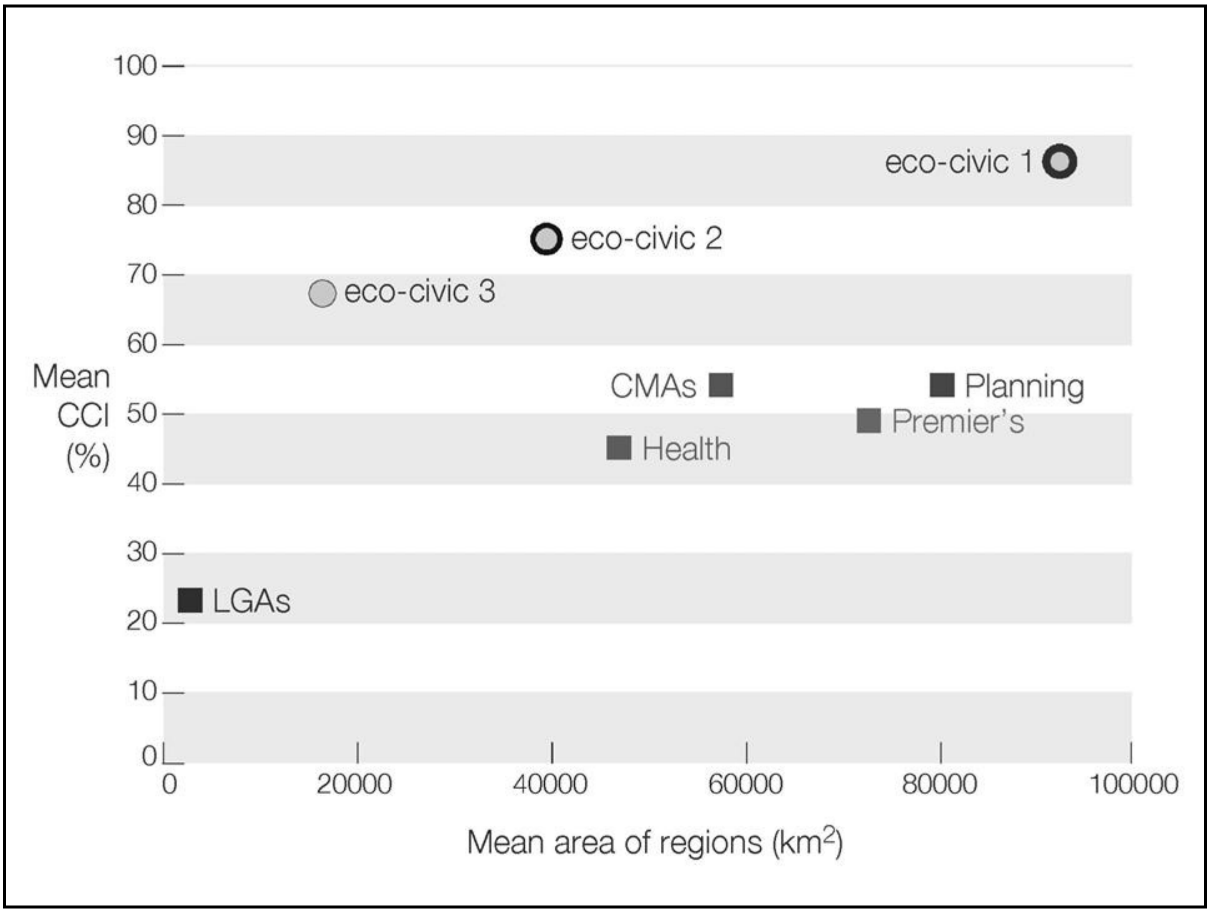

Figure 7. Mean Community Capture Index (CCI) plotted against mean area of regions for a range of administrative regions. LGAs = Local Government Areas; CMAs = Catchment Management Areas; Health, Planning and Premier's refer to Government Departments for administration and service delivery.

Conclusions: Past, Present and Future Resource Governance

The past three decades has seen the emergence of catchments and watersheds as the dominant spatial framework for resource governance, planning and natural resource management. The assumption has been that soils, vegetation, other biodiversity, land use, and ground water, along with community engagement and collective action occur within catchment boundaries. In practice, catchment management has a history of in-efficiency, inappropriate monitoring and high transaction costs (Stokols and Shumaker 1981; Syme et al. 1994; Minami and Tanaka 1995; Omernik and Bailey 1997; Getches 1998; Brunckhorst 2000; Barham 2001; Lane et al. 2004; O'Neill 2005). Catchments however, generally do not represent the 'place attachment', 'communities of interest' or local networks of trust and co-operation through which civic engagement will be maximised. Nor do catchments usually represent other multiple attributes of the ecological resource base very well.

This paper has described three principles which can underpin the development of regionalisations for government administration of, and community participation in, natural resource governance. The principles relate to the spatio-social context representing communities of interest, optimised for homogeneity of the ecological landscape, and spatially bounded in a nested hierarchy to facilitate scaling of institutional arrangements for management of externalities. While some small catchments and watersheds might reflect these characteristics, most do not. The approach illustrated involves identifying where boundaries between resource governance regions should pass so as to minimise the fragmentation of the areas of the landscape with which local people identify and in which they have an interest. Boundary placement is further optimised to ensure that natural resource issues and ecosystem functions are as homogenous as possible within the regions defined by the boundaries. The Community Capture Index provides a numerical measure of the extent to which boundaries cut through areas of the landscape with which resident communities identify and have an interest.

Utilisation of Eco-Civic regions is more likely to increase and maintain civic interest and engagement in local governance issues, including the planning and monitoring of natural resource management, while reducing transaction costs and externality effects. Application of the eco-civic methodology to the design of local to regional institutions for resource governance would be valuable in Australia and other Nations, for reassessing federalism and regionalism governance issues, including the restructuring of local government areas to regional government, while integrating appropriate scales of regional environmental and development planning, and other government surface delivery. Nesting at broader scales would also enhance collaboration and cross-jurisdictional management as dictated by externalities and efficiently integrate sustainability policy and actions across multiple scales of social-ecological systems interactions.

Future Directions

There are challenges in forging systems-based, integrative solutions for cross-scale resource management. Changing trajectories in policy and planning for integrated resource management is not likely to be easy, as entrenched practices have been institutionalised beyond their capacity to deliver sustainable resource management. The science-policy dialogue must become increasingly responsive, each to the other. Understanding and identifying windows of opportunity to change direction in policy, planning and governance need to be strategic priorities of science-policy and community interactions (Brunckhorst 2005). The concepts and applications of the advances described in this paper provide a plausible new direction in strategic spatial governance along with a practical application through policy and planning for future resource governance.

Future applications of the eco-civic approach to establishing nested regional governance at international levels include contributing solutions and options to address the challenges faced by the European Union with regionalism issues (see for example, Albrechts et al. 2003) and social-ecological systems contexts which sometimes transgress nation State boundaries. Plans for use of the eco-civic methodology are being developed towards understanding scales of social-ecological interactions across Idaho and Montana for conservation and sustainable land use, cross-boundary programs. At other scales of application in strategic spatial governance of resources, future applications include finer scales of local policy communities, and nested institutions for water sharing, trade and management.

Acknowledgements
This project was funded by the NSW Government and Land and Water Australia grants to DB. We thank technical team (Phillip Morley, Justin Graham, Phil Coop, Karl Bock, Michael Coleman) and other colleagues' (Margaret Shannon, Judith McNeill, Graham Marshall and anonymous reviewers) for their various contributions.

References

Albrechts, L., Healey, P. and Kunzmann, K.R. (2003) Strategic spatial planning and regional governance in Europe. *Journal of the American Planning Association* 69(2): 113-129.

Altman, I. and Low, S. M. (eds). (1992) *Place attachment,* Plenum Press, New York, NY.

Austin, D. E. (1994) Incorporating cognitive theory into environmental policymaking, *Environmental Professional*, 16: 262-274.

Bailey, R.G. (1996) Multi-scale Ecosystem Analysis. *Environmental Monitoring and Assessmen,t* 39: 21-24.

Barham, E. (2001) Ecological Boundaries as Community Boundaries: The Politics of Watersheds. *Society & Natural Resources*, 14: 181-191.

Beckley, T.M. (1995) Community stability and the relationship between economic and social well-being in forest-dependent communities. *Society & Natural Resources*, 8(3): 261-266.

Berkes, F. and Folke, C. (eds). (1998) *Linking Social and Ecological Systems: Management practices and Social Mechanisms for Building Resilience,* Cambridge University Press, Cambridge, UK.

Blomquist, W. and Schlager, E. (2005) Political pitfalls of integrated watershed management, *Society & Natural Resources*, 18: 101-117.

Brandenburg, A. M. and Carroll, M. S. (1995) Your place, or mine: The effect of place creation on environmental values and landscape meanings, *Society & Natural Resources*, 8: 381-398.

Brown, J. and MacLeod, N. (1996) Integrating Ecology into Natural Resource Management Policy, *Environmental Management,* 20(3): 289-296.

Brunckhorst, D. J. (2005). Integration research for shaping sustainable regional landscapes. *Journal of Research Practice*, 1(2), Article M7. available at http://jrp.icaap.org/content/v1.2/brunckhorst.html (accessed January 2008).

Brunckhorst, D.J. (2002) Institutions to sustain ecological and social systems, *Ecological Management and Restoration* 3(2): 109-117.

Brunckhorst, D.J. (2000) *Bioregional Planning: Resource Management Beyond the New Millennium.* Taylor and Francis, Amsterdam.

Brunckhorst, D., Reeve, I. and Coop, P. (2006) Eco-civic optimisation: a nested framework for planning and managing landscapes. *Landscape and Urban Planning,* 75(3-4): 265-281.

Buchy, M., Ross H., and Proctor, W. (2000) Enhancing the information base on participatory approaches in Australian natural resource management, in Land and Water Australia (ed.) *Natural Resources Management: People and Policy*, (Chapt. ANU21), Land and Water Australia, Canberra.

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

Carpenter, S.R., and Gunderson, L.H. (2001) Coping with collapse: ecological and social dynamics in ecosystem management, *Bioscience*, 51(6): 451-457.

Carr, A.J. (2004) Why do we all need community science? *Society & Natural Resources*, 17(9): 841-849.

Carrothers, G. (1956) A Historical Review of the Gravity and Potential Concepts of Human Interaction, *Journal of American Institute of Planners,* 22: 94-102.

Cheng, A.S., Kruger, L.E. and Daniels, S.E. (2003) “Place” as an integrating concept in natural resource politics: Propositions for a social science research agenda. *Society & Natural Resources*, 16(2): 87-104.

Christaller, W. (1933) *Central Places in Southern Germany* (Translated by C.W.Baskin, 1966), Prentice-Hall, Englewood Cliffs, NJ.

Cole, D.H. (2002) Pollution and Property. Comparing Ownership Institutions for Environmental Protection, Cambridge University Press, Cambridge, U.K.

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

Cuba, L., and Hummon, D. M. (1993) A place to call home: Identification with dwelling, community, and region, Sociology Quarterly, 34: 111-131.

Ewing, S. (2003) Catchment management arrangements, in Dovers, S. and Wildriver, S. (eds.) *Managing Australia's Environment*, (pp.393–412), Federation Press, Sydney.

Feld, S., and Basso, K. H. (1996). *Senses of Place.* School of American Research Press: Santa Fe.

Field, D.R., Voss, P.R., Kuczenski, T.K., Hammer, R.B. and Radeloff, V.C. (2003) Reaffirming Social Landscape Analysis in Landscape Ecology: A conceptual framework. *Society & Natural Resources,* 16(4): 349-362.

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

Forman, R.T. and Godron, M. (1986) *Landscape Ecology*, J. Wiley and Sons, New York, NY.

Forman, R.T. and Godron, M. (1981) Patches and structural components for landscape ecology, *BioScience,* 31: 733-740.

Frey, B.S. and Eichenberger, R. (1999) *The new democratic federalism for Europe*, Edward Elgar, Cheltenham, UK.

Getches, D. 1998. Some irreverent questions about watershed-based efforts. *Chronicles of Community*, 2:28-34.

González, S. and Healey, P. (2005) A sociological institutionalist approach to the study of innovation in governance capacity. *Urban Studies*, 42(11): 2055-2069.

Hansen A.J. and di Castri, F. (eds) (1992) *Landscape Boundaries: Consequences for Biotic Diversity and Ecological Flows,* Springer-Verlag, New York.

Hillery, G.A. (1955) Definitions of Community: Areas of Agreement. *Rural Sociology* 20: 111-124.

Hobbs, B.F., Ludsin, S.A. Knight, R.L. Ryan, P.A. Biberhofer, J.and Ciborowski, J.J. (2002) Fuzzy cognitive mapping as a tool to define management objectives for complex ecosystems. *Ecological Applications*, 12: 1548-1565.

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

Johnson, K., Swanson, F. Herring, M. and Greene, S. (1999) *Bioregional Assessments: Science at the Crossroads of Management and Policy*. Island Press, Washington D.C.

Kearney, A. R., and Kaplan, S. (1997) Toward a methodology for the measurement of knowledge structures of ordinary people: The Conceptual Content Cognitive Map (3CM). *Environmental Behavior*, 29:579-617.

Kemmis, D. (1990) *Community and the politics of place,* University of Oklahoma Press, Norman.

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

Lane, M.B., McDonald, G.T. and Morrison, T.H. (2004) Decentralisation and environmental management in Australia: a comment on the prescriptions of the Wentworth Group. *Australian Geographical Studies*, 42(1):103–115.

Margerum, R.D. (1995) *Examining the Practice of Integrated Environmental Management: Towards a Conceptual Model*. Unpublished PhD Dissertation. University of Wisconsin-Madison.

Marshall, G.R., (2005) *Economics for Collaborative Environmental Management: Renegotiating the Commons*, London, Earthscan.

McGinnis, M.D. (ed.) (1999) *Polycentric Governance and Development,* University of Michigan Press, Ann Arbor.

McGinnis ,V.M., Wooley, W. and Gamman, J. (1999) Bioregional Conflict Resolution: Rebuilding Community in Watershed Planning and Organizing, *Environmental Management,* 24(1): 1-12.

Minami, H., and Tanaka, K. (1995) Social and environmental psychology: Transaction between physical space and group-dynamic processes. *Environmental Behavior,* 27: 43-55.

Muskingum Water Conservancy District (2002) Frequently Asked Questions about the Muskingum Water Conservancy District. Retrieved April 16, 2007, from http://www.mwcdlakes.com/about.htm

Omernik, J.M. (1995) Ecoregions: A spatial framework for environmental management, in Davis, W. and Simon, T. (eds.), *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making*, (pp. 49-62), Lewis Publishing, Boca Raton, Florida.

Omernik, J.M. (1987) Ecoregions of the conterminous United States (Level II), *Annals of the Association of American Geographers,* 77(1): 118-125.

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

O'Neill, K.M. (2005) Can watershed management unite town and country? *Society & Natural Resources*, 18: 241-253.

Pattee, H.H. (1973) *Hierarchy Theory: The Challenge of Complex Systems*, Braziller, New York, NY.

Parisi, D., Taquino, M., Grice, S.M. and Gill, D.A. (2004) Civic Responsibility and the Environment: Linking Local Conditions to Community Environmental Activeness, *Society & Natural Resources*, 17(2): 97-112.

Parisi, D., Taquino, M., Grice, S.M. and Gill, D.A. (2003) Promoting environmental democracy using GIS as a means to integrate community into the EPA-BASINS approach, *Society & Natural Resources*, 16(3): 205-220.

Parisi, D., Grice, S.M., Taquino, M. and Gill, D.A. (2002) Building capacity for community efficacy for economic development in Mississippi, Journal of Community Development and Society, 33(2): 19-38.

Phelps, A. (2003) *Total Catchment Management in New South Wales: Governance Rhetoric and Reality,* unpublished thesis, University of New South Wales, Sydney.

Reeve, I. (2003) *Principles for the nested governance of water resources* (Occasional Paper 2003/1), Institute for Rural Futures, University of New England, Armidale. Retrieved August 15, 2007, from http://www.ruralfutures.une.edu.au/publications/occpapers/occpapers.htm

Reeve, I., Frost, L., Musgrave, W. and Stayner, R. (2002) *Agriculture and Natural Resource Management in the Murray-Darling Basin: A Policy History and Analysis*, Published Report to the Murray-Darling Basin Commission. Institute for Rural Futures, University of New England, Armidale, and Murray-Darling Basin Commission, Canberra.

Reeve, I., Marshall, G. and Musgrave, W. (2002) *Resource Governance and ICM,* Published Report to the Murray-Darling Basin Commission. Institute for Rural Futures, University of New England, Armidale, and Murray-Darling Basin Commission, Canberra.

Reid T.S. and Murphy, D.D. (1995). Providing a Regional Context for Local Conservation Action: A natural community conservation plan for the southern California coastal sage scrub, *BioScience Supplement,* 1995: 84-90.

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* (pp. 529-551), Springer Verlag, New York, NY.

Slocombe D.S. (1993) Implementing Ecosystem-based Management: Development of theory, practice and research for planning and managing a region, *BioScience,* 43(9): 612-622.

Stedman, R. C. (2003) Is it really just a social construction? The contribution of the physical environment to sense of place, *Society & Natural Resources*, 16(8): 671-686.

Stokols, D. and Shumaker, S.A. (1981) People in places: A transactional view of settings, in Harvey, J.H. (ed.) *Cognition, social behaviour, and the environment* (pp. 441-488), Lawrence Erlbaum Associates, Hillsdale, NJ.

Syme, G. J., Butterworth, J. E. and Nancarrow, B.E. (1994) *National Whole Catchment Management: a Review and Analysis of Processes* (Occasional Paper 01/94), Land and Water Resources Research and Development Corporation, Land and Water Australia, Canberra.

Waldo, D., (1984) *The Administrative State: A Study of the Political Theory of American Public Administration,* Holmes and Meier, New York.

Webler, T. and Tuler, S. (1999) Integrating Technical Analysis With Deliberation in Regional Watershed Management Planning: Applying the National Research Council Approach, *Policy Studies*, 27(3): 530-543.

Wiken, E. (1986) *Terrestrial ecozones of Canada* (Ecological land classification series No. 19), Environment Canada, Ottawa, Ontario, Canada.

Wilkinson, K.P. (2000) *The Rural Community in America*. Social Ecology Press, Middleton, WI.