Defining Social Catchments in Non-metropolitan Australia

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Executive Summary

Social Catchments: a definition…	Social catchments are the territory occupied by a group of households and individuals who are in some form of regular interaction and which the inhabitants identify as 'their' community or region.
Social catchments are an ideal geography for social and community planning and policy development	Social catchments represent 'communities of interest'. It is generally acknowledged that they represent the most important local geographic unit for social and community planning and management. The community networks within them also have the possibility of mobilising group involvement and action. They therefore have important administrative, policy and planning implications.
Methods of defining social catchments should consider the existing ABS ASGC structure	The Australian Bureau of Statistics (ABS) uses the Australian Standard Geographical Classification (ASGC) in the collection, processing and dissemination of census statistical data. Census data forms the basis of much social research. However, most of the spatial elements within the ASGC structure do not coincide with social catchments, particularly in non-metropolitan areas. Nevertheless, in developing methods of defining social catchments some compatibility with the existing ASGC structure is important for data accessibility and transfer.
Central Place Theory **demonstrates the nested nature of social catchments**	Larger towns have larger social catchments than smaller towns by virtue of the broader *range* of goods and services offered. The larger social catchment comes about because people are prepared to travel further to access a more diverse range of goods and services than may be available closer to where they live. Central Place Theory explains that social catchments are nested because small social catchments sit within larger social catchments. The relative ranking or order of towns within a region can be determined by examining the goods and services the towns provide. In simple terms social catchments take the form of hexagons but these can only be considered the crudest spatial representation.
Journey to work data can be used to define social catchments	Journey to Work (JTW) data has been used in the United States to define social catchments. JTW data has also been collected by previous Australian censuses but to date the data has only been processed for the large metropolitan centres.
Different approaches to defining social catchments in Australia include 'bioregional planning' and 'town resource cluster' analysis – both rely on collecting primary data	Questionnaires can be used to directly ask communities about their perceptions of 'community'. Questionnaires can extract information about the normal place of purchase for selected goods and services. People can also be asked to define 'their community' by drawing on a map. Such maps can be used to develop *bioregions* in the natural resource management context to overcome identity problems associated with catchment management. Town Resource Cluster analysis uses business and household expenditure data to help determine dependency on natural resource industries and therefore communities of interest.

Gravity modelling has potential to portray relatively accurate social catchments	Gravity Modelling has traditionally used population and/or service provision data as a 'weighting' to determine the *Break Point* (BP) lying between two centres. In simple terms, the BP lies closer to small towns than their neighbouring larger towns, which in effect means that larger towns have larger social catchments. However, unlike the hexagonal social catchments generated by Central Place Theory, those defined by Gravity Modelling are determined by the spatial distribution of towns. A nested hierarchical approach to gravity modelling can also take place where the social catchments of small towns of similar size can be overlaid with the catchments of the larger towns of similar size.
GIS is the ideal spatial tool for defining social catchments	Geographical Information Systems (GIS) are sophisticated computer-based systems for the capture, storage, manipulation, analysis, retrieval and graphic representation of spatially referenced information. Information is stored and displayed in 'layers' and these layers represent a wide variety of themes eg population, services, transport networks, topographic features etc. GIS can also generate social catchments from stored data. For example, the location of towns, details of their populations and services, and the provision of roads, could be used to generate catchments.
Social catchments should be considered during local government decision-making and policy development	In terms of planning and managing communities, it is clearly more useful to use geographic units that are recognised by communities of interest – ones in which communities can have a direct association with. Most social spatial analysis in Australia is currently undertaken within the existing ASGC structure simply because that is currently how the census data is collected and made available. This structure is important mainly because one of the primary spatial units within it are closely aligned with administrative local government areas. However, these areas often have little in common with social catchments. The methods detailed in this discussion paper appear to have potential for determining more socially relevant spatial units thus allowing more effective government policy development and decision-making.

Introduction

Recent years have seen an increased focus of attention on levels of wellbeing and the adequacy of service provision to the 37.3 percent of Australians living outside cities with more than 100,000 inhabitants. In planning for these people it is important to use spatial units which are meaningful both in terms of the people being planned for and the particular area of planning under consideration. Traditionally we have employed administrative units as the basic spatial units of planning in non-metropolitan Australia. This in many ways is appropriate given that local and regional governments are important providers of services for communities in the Australian context. However, there has long been a questioning of the meaningfulness of administrative boundaries for many areas of social, economic and environmental planning in non-metropolitan areas and the possibility raised that there may be spatial units which are more relevant, and which facilitate the planning process. Much of this discussion has centred around the idea of 'social catchments'. These can be defined as follows:

> *The territory occupied by a group of households and individuals who are in some form of regular interaction and which the inhabitants identify as 'their' community or region.*

The present paper seeks to review the current state of thinking and knowledge about social catchments in non-metropolitan Australia. It begins with a discussion of what social catchments actually are. It is also important to briefly review the existing situation in Australia with respect to the spatial units which are employed in non-metropolitan planning. This involves us considering the Australian Standard Geographical Classification (ASGC) which is the geographical classification used by the Australian Bureau of Statistics (ABS) and many other organisations (especially in government) for the collection, processing and analysis of statistical data. Crucial questions which must be addressed here are firstly whether it is necessary for any system of social catchment areas to be developed for use in planning in non-metropolitan areas. Secondly, it must be decided if such units can utilise existing units within the current ASGC. As should become apparent, social catchments as described later in the paper can be compatible with the ASGC and have a life of their own outside the ASGC.

The paper then briefly discusses Central Place Theory which in many ways provides a theoretical underpinning for an examination of social catchments. Then a range of approaches which have been adopted in the defining of social catchments are outlined. These broadly fall into two classes although there is a diversity of approaches within each category. The first set of approaches adopt intensive primary data collection methods to define catchments while the second employ secondary data and statistical methods to define these areas.

In the conclusion of the paper it is argued that there is a need in Australia to develop a nested hierarchy of social catchments for social, economic and community planning in non-metropolitan areas. It is suggested that an amalgamation of methods will be needed to do this. It is realised that this recommendation will be opposed by some because it does not fit into the existing ASGC structure. The strength of this counterargument is acknowledged but it is suggested that there is both a need for, and the real possibility of injecting flexibility into, the ASGC because there is now the technology available for efficient and very rapid storage, retrieval and analysis of vast quantities of individual and small area data. This was not the case, however, when the ASGC was first introduced. Indeed, Geographical Information Systems (GIS) make it possible to have user-defined areal units for the dissemination of data rather than

relying only on a restricted structure of units. It is argued that the ASGC must be working toward more diversity and flexibility in the types of spatial units it recognises. It does not mean that current elements in the ASGC should not be retained. Indeed, they are extremely important. The point is that we should be working toward much more flexible systems of spatial units which make it possible to utilise the spatial units which are most meaningful and relevant to a particular situation.

It must be acknowledged that social catchments are only one of many sometimes conflicting geographies which some would argue should be part of the ASGC. However the ASGC, and indeed any single classification, cannot provide for all desired geographies and it could be argued that incorporating social catchments into the existing ASGC structure, would simply introduce another specialised view of the world. Resources would likely be better spent on providing flexible base units from which various special interest groups can develop their own specific but compatible classifications.

At the outset it needs to be acknowledged that there are at least three groups of researchers working in Australia in developing a methodology to identify social catchments. All are referred to in this paper. They differ in their approach and in the States within which they are predominantly working. It is suggested here that there is a great deal of overlap in the approaches that they employ and if it is decided that it is desirable to develop a national system of social catchments the work of each of these groups can make a contribution to that effort. The three groups are:

- The most substantial and longstanding work both in terms of conceptualising the meaning of, and developing the methodology to delimit social catchments has been the work of Peter Smailes at the Adelaide University. His work in this area goes back more than three decades and is of great relevance to this paper.
- Mark Fenton and his colleagues at the James Cook University have developed the Town Resource Cluster technique of identifying clusters of communities linked by a common resource exploitation linkage and a number of other social and economic interactions.
- David Brunckhorst and his colleagues at the University of New England are working on the development of a nested hierarchy of bio-regions which are defined on both social and ecological bases.

The present paper seeks to summarise the current 'state of the art' with respect to social catchments in Australia and draws heavily on the work of the three groups.

Conceptualising Social Catchments

As indicated in the definition presented earlier, social catchments are representative of meaningful communities in non-metropolitan areas and have three basic dimensions as has been articulated by Smailes (2000: 128):

- Territoriality (a habitat/place dimension);
- Communion (a shared feeling of belonging);
- Interaction (the local social system).

A key element of social catchments is that they are centred on a particular urban area or central place. This is the *focus* of much of the social and economic interaction

which occurs in the catchment and is the location of many of the facilities that people living in the area need and use. There is a longstanding literature linking central places with the areas and populations surrounding them and functionally linked to them. These have variously been referred to 'city-regions', 'hinterlands', umlands, urban functional areas, urban fields, service areas, trade areas and labour markets. A second key characteristic of social catchments is that most (but not all) of the people living within them feel a sense of belonging to the community and the social group living within them. While social catchments can be delimited with sharp boundaries, it is likely that in reality their boundaries are somewhat diffuse. An important characteristic of social catchments, however, is that the people living within them share a common interest and purpose.

One of the most important issues relating to social catchments relates to scale. In fact they can occur at several geographical scales. One can feel attached to, and interact within, one's local area, within a wider region, a state and the nation. Of course one may feel the attachment to one or other of those levels with varying degrees of strength. Smailes (2000, 160), for example, has argued that the primary social allegiance and place identification of most households is highly local in nature. Hence he places considerable emphasis on the significance of localism in social allegiance. Nevertheless, it is important to recognise that individuals can belong to a number of social catchments at different scales and the degrees of attachment people feel to various scales of social catchments is an area of needed research in non-metropolitan Australia.

One area of argument relates to the extent to which social catchments overlap with hinterlands of centres based on economic activity such as commuting patterns, shopping patterns and business linkages. Some interesting work has been done in non-metropolitan South Australia along these lines by Smailes (2000). He argues that whereas in the past the geographies of social identification on the one hand, and of commercial and business activity on the other, were once closely linked they are now 'separating and slowly drifting apart' (Smailes 2000, 158). He bases this argument on surveys of 2,000 households living outside of country towns with more than 200 people in non-metropolitan South Australia in 1968-69, 1982-83 and 1992-93. In these studies he collected information on where people purchased 20 goods and services as well as on the location of social activity, sense of community identification and a series of questions on attitudes towards the local community identified by each respondent as socially most important to him or her. He found that over time there was a growing disparity between interactions of commercial and business activity which were conducted over an increasingly wider area and social areas which remained essentially locally based. The expansion of the area over which economic interactions take place has been a function of increased levels of personal mobility and different patterns of retailing. He argues that people are identifying socially with one area and interacting economically over a wider area. He suggests that there is greater inertia in people's social space over time compared with their economic space. This provocative argument needs further investigation in the Australian context.

Why are Social Catchments Important?

It is important to ask why social catchments may be of significance or relevance to considerations of non-metropolitan Australia. At the outset it needs to be pointed out that elements such as location, regional identify and feelings of common purpose and community can be potent forces in people's consciousness in non-metropolitan areas (Smailes 2000). In fact, social catchment areas represent 'communities of interest' which open up the possibility of mobilising group action and group involvement in

activities. There has been a growing recognition that social capital is one of the most important assets of non-metropolitan communities (Putnam 1995) and the concept of social catchments must be strongly linked to discussion of social capital in regional contexts.

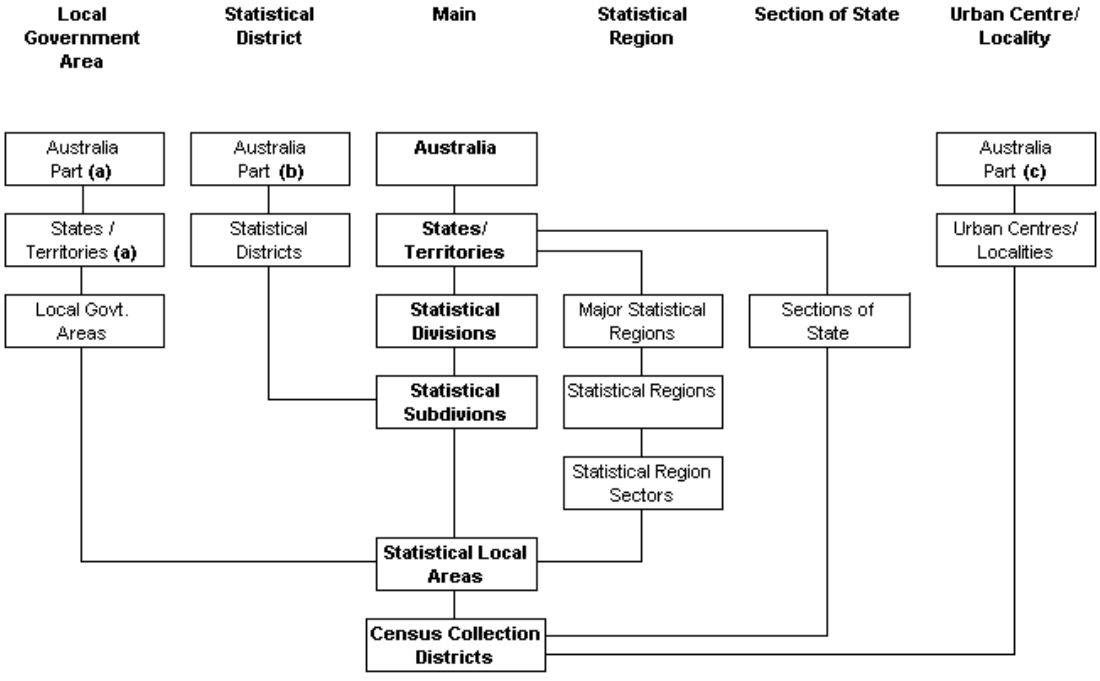
From the perspective of government or private sector planners, there are also efficiencies to be gained from locating outlets for providing goods and services in the central places associated with social catchments. This derives from the fact that people living within the social catchments will travel regularly to the central place of that catchment. Hence services wishing to serve the entire catchment can be located in the central place and effectively serve the whole area.

One important issue relates to the fact that social catchments may often be a more meaningful unit for social and economic planning than conventional administrative divisions. If planning involves community mobilisation it will be possible to do this more readily within an existing cohesive community.

The Australian Standard Geographical Classification (ASGC)

The ASGC is the geographical classification designed by the Australian Bureau of Statistics (ABS) to be the national standard for the spatial units to be used in the collection, processing and dissemination of statistical data. It is used not only by the ABS but also by a number of other organisations. The ASGC is a hierarchical classification which currently comprises six parallel structures. The 2001 edition of the ASGC contains a seventh new structure which concerns areas classified according to their degree of remoteness/accessibility. The structure of the current ASGC is shown in Figure 1.

Figure 1: ASGC Structural Chart
Source: ABS 1999



An important aspect of the ASGC structure is that the basic building block in the system is the census Collection District (CD). All other units in the system are made of aggregations of CDs. A CD is an area which was originally developed as a data collection tool – it constituted the area which a single census collector could cover. It has an average of around 220 households in urban areas and less in rural areas. In the past the design of CDs was such that it facilitated a collector getting around the district. This did not always fit with relevant social or environmental boundaries. In recent years, however, efforts have been made to make the boundaries of CDs more closely aligned with social, economic and environmental regions. At present the CDs which create the most problems to analysts are those which are located in non-metropolitan areas, especially those of low population density in more remote locations (Hugo *et al.,* 1997). This is because in those areas the CDs are largest in area and often contain considerable variations in population density. Often the population in the CD tends to be clustered in one or more areas within the CD. This makes it difficult to split the CD population when the boundary of areas being employed in an analysis cuts across CD boundaries.

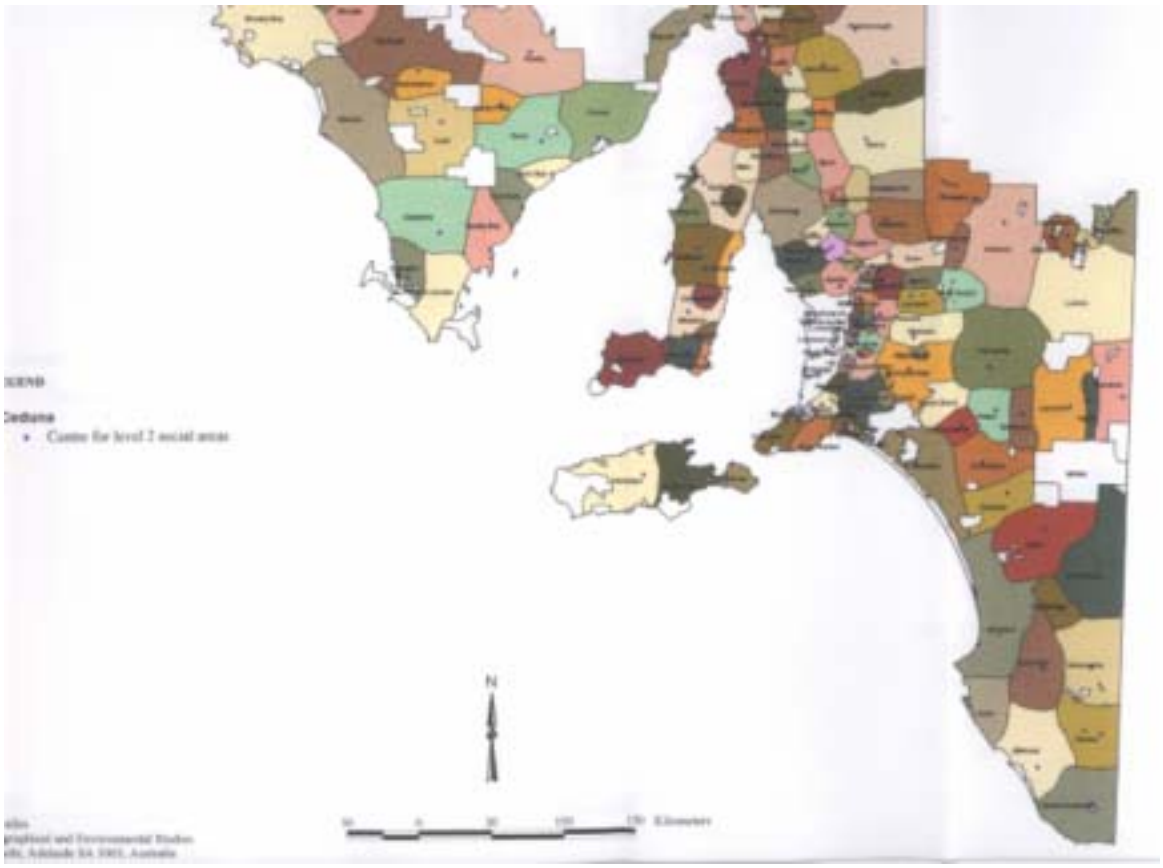
In rural areas the use of roads as CD boundaries can lead to difficulties in defining small communities. If a community of less than 40 non-farm dwellings sits astride a road or around the intersection of two major roads then it is quite possible that the community will be split across two or more CDs and its population will be indistinguishable from that of the rest of the CD. While this is undesirable it may be unavoidable either due to lack of alternative physical features to adopt as boundaries or lack of information about the existence of such small communities at the time of CD design.

An important feature of the ASGC is the fact that one of the units most used in dissemination of statistics (the SLA or Statistical Local Area) is derived predominantly from administrative areas – Local Government Areas (LGAs). Although this correspondence is getting less and less as there is amalgamation of LGAs, it could be argued that while it is important to retain such administrative-based areas in the ASGC, those areas often do not constitute meaningful social, economic or environmental regions and hence may not be appropriate for social analysis purposes. As Fenton, Coakes and Marshall (2000, 6) have pointed out:

> *'Definitions of community should be meaningful in relation to prevailing social structures, levels of community organisation and interdependence and not to be defined purely on the basis of convenient administrative boundaries or data availability'.*

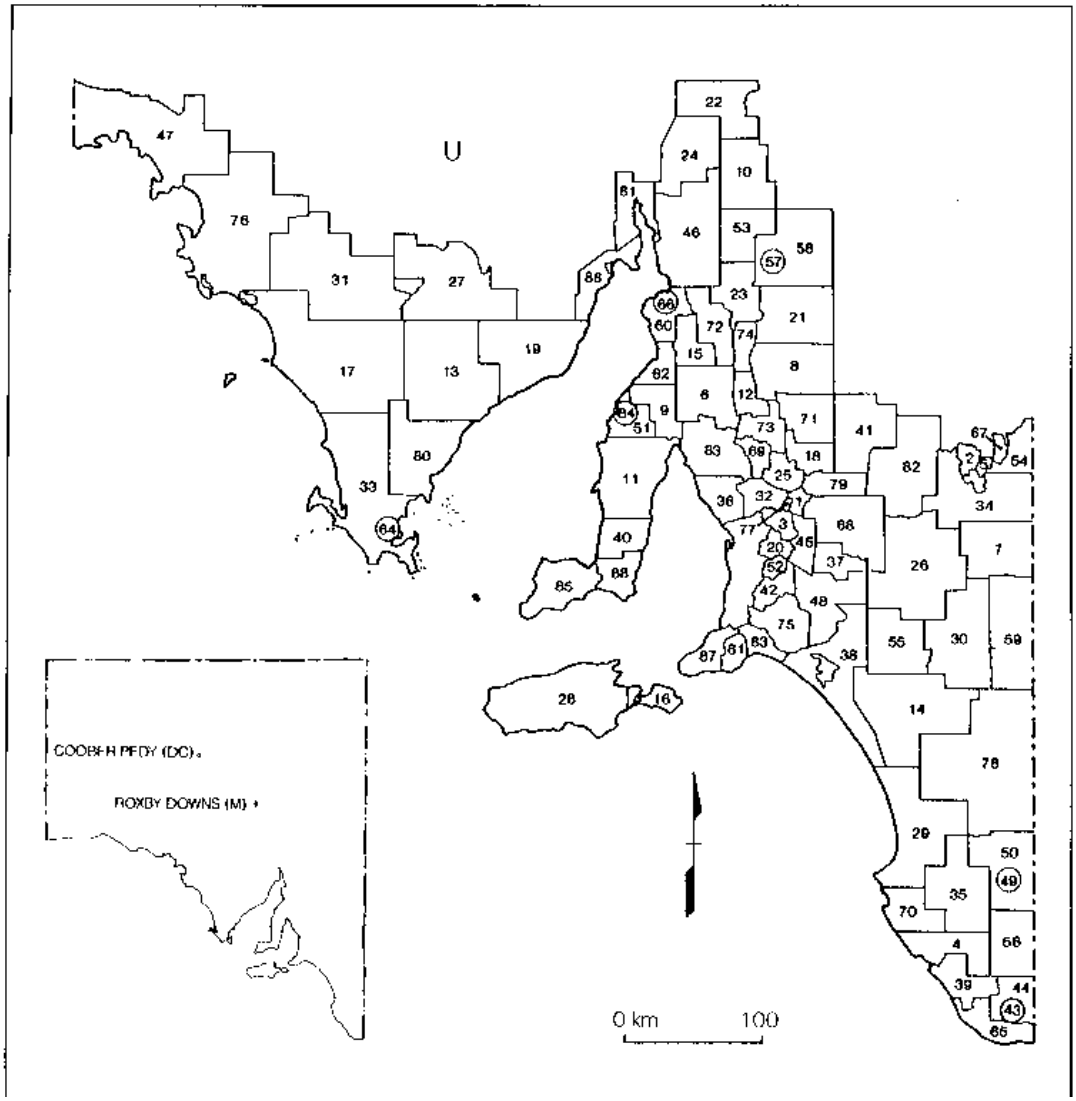
In this context it is interesting to compare some non-metropolitan social catchments derived by intensive interviews of respondents with official SLA boundaries. Below we make such a comparison for non-metropolitan South Australia. Figure 2 depicts a level of social areas derived by Smailes (1999) using intensive interviewing of respondents living outside urban centres and localities with 200 inhabitants or more. The sample of respondents was drawn from the electoral roll of the State. It is apparent when comparing these maps to the current boundaries of LGAs in non-metropolitan South Australia (Figure 3) that the fit is by no means perfect. However, since social catchment boundaries are, by their very nature 'fuzzy' and temporal, there does seem some remarkable correspondence in some cases.

Figure 2: Level 2 Social Areas: South Australia
Source: Smailes 1999



Urban centres and localities are groups of CDs which represent population clusters. Urban centres of greater than 20,000 people are contiguous clusters of CDs with population density greater than 200 persons per square kilometre. For smaller urban centres of 1,000 to 19,999 persons more subjective criteria are used to bind the urban area. Localities are population clusters of 40 or more non-farm dwellings and a minimum population of 200 persons. There are 1,662 urban centres and localities defined in the ASGC 1996 edition. Urban centres and localities are only defined in the census year.

Figure 3: South Australia – Local Government Areas Outside Adelaide, 1996



Large urban centres will encompass a number of social catchments and discreet communities. In rural areas the ABS locality will most certainly form the focal point of a social and economic catchment but the ABS does not attempt to define the extent of that catchment as such.

It should be noted that rural localities are bounded at the time of CD design using a very comprehensive national GIS. Even given the substantial advances in digital map data in recent years, it is still quite difficult to reliably detect and bound small rural localities. For example, there is no comprehensive nationally available mapping of dwellings in Australia. The ABS makes use of digital cadastral databases showing land parcels, but these are at best a poor indicator of the existence of dwellings. If a locality is missed at the time of CD design, there is no way to detect after the census that the population of a CD is in fact concentrated in one part of the CD and could, therefore, qualify as a locality.

Geographical Names Boards in most States have gazetted, or are currently gazetting, locality names and boundaries. These gazetted localities are designed to cover the whole State or Territory without gaps or overlaps. Part of the gazettal process involves

public consultation so these gazetted boundaries should represent at least a public perception of community. ABS urban centres and localities will usually have the same name as a gazetted suburb or locality but are, by definition, quite different. In urban areas the urban centre will encompass many gazetted localities (suburbs). In rural areas the ABS locality will be the population cluster within the broader boundary of the gazetted locality. There will be many rural gazetted localities which do not have a corresponding ABS urban centre/locality.

With some exceptions, only data from the Census of Population and Housing is available for CDs. Other data collected by the ABS (eg. the Agricultural Census) and data generated by other organisations such as the Australian Institute of Health and Welfare are more commonly available for SLAs, the next level up from CD in the main structure of the ASGC. Of particular importance to the social catchments debate is Estimated Resident Population (ERP). These population estimates are only published in non-census years at the SLA level.

SLAs are directly related to LGAs and by default are identical to a whole LGA. Exceptions are the NT, ACT and parts of Queensland where LGAs are either exceptionally large or do not exist. The ABS has deliberately maintained this link to LGAs because of the increasing importance of this third tier of government and because the LGA, as an administrative area, is recognised by, and of interest to, a wide range of data users. The disadvantage of LGAs as a geographical unit is that they are subject to some degree of change over time although they do tend to be more stable than some of the alternatives such as postcodes and suburbs.

LGAs, as a spatial unit, do not define communities but they are a longstanding administrative unit. Some have existed with their boundaries virtually unchanged for many years while others have evolved over time to reflect relationships between new and emerging centres of commerce and social interaction. Such interactions may be natural or may in fact be forced by the imposition of administrative boundaries but either way LGAs should not be overlooked as an input to defining social catchments.

Where an LGA has been divided into two or more SLAs, the ABS draws upon local knowledge to define their boundaries and SLAs will therefore be, in terms of community of interest, at least as homogeneous as the parent LGA from which they are created.

Statistical District (S Dist), as currently defined, may be of interest for larger communities. The ABS will, in the 2001 edition of the ASGC, define a S Dist for every urban centre of population 25,000 or more. The S Dist consists of whole SLAs aggregated to form an area which will contain the growth of the urban centre over the next twenty to thirty years. While this criteria is somewhat subjective, it has resulted in 35 S Dists which, in practical terms, represent the larger urban centres plus their satellite towns and the rural area surrounding them.

Where a S Dist is dominated by one major town it provides a very good indicator of the catchment of that centre. The situation is less clear where a single S Dist is defined around two or more large centres, which interact with each other and with the surrounding rural areas. Depending on the definition of social catchments, examples such as Sunshine Coast (Queensland) would require considerable additional analysis to divide the S Dist into more discreet catchments.

Statistical Division (SD) is the largest spatial unit in the ASGC Main Structure immediately below State/Territory. There are 66 SDs to cover all of Australia and as

such they are large areas which encompass many communities. They are defined, however, as an area of shared community of interest under the dominance of one or more major towns. SD boundaries have proved reasonably representative of social catchments. This indicates that while SDs do not define individual communities, they do represent an overlying boundary, or an aggregation of communities, which any methodology for defining social catchments would do well to consider.

Postcode is not a unit of the ASGC and while the ABS and Australia Post would both like to share some commonality in their respective geographies, it is unlikely that postcode will ever be a suitable unit for inclusion in a national standard geographical classification. In census years, the ABS does define a derived unit called Postal Area which consist of whole CDs which approximate the postcodes where people live.

Both Australia Post postcodes and ABS Postal Areas could cause considerable difficulties if used as an input to the definition of social catchments. In particular there is a tendency for outlying population to use the postcode of a nearby population centre rather than the correct postcode for their location. This situation has been exacerbated with the emergence of Geographical Names Boards' gazetted localities. There is substantial misalignment between the gazetted localities and current postcodes leading to misdirection of mail. Australia Post has advised that a substantial redesign of postcodes will need to be undertaken in rural areas to overcome this problem. Nevertheless, the postcode is included in most administrative data sets of a service or user of a service.

The availability of data for various spatial units is a function of:

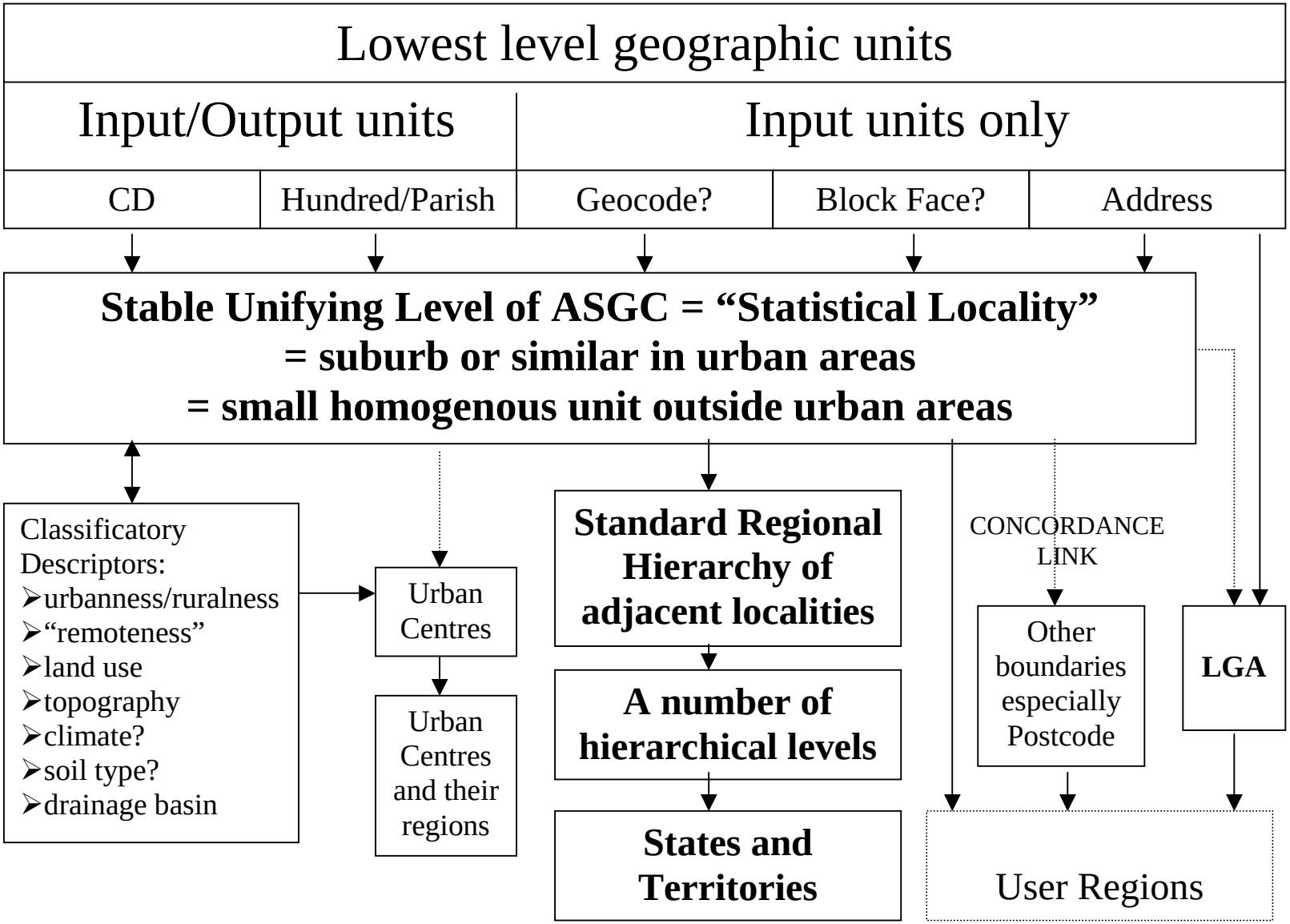
- whether the data are collected by census or sample survey; and
- the ability to code statistical units to a geographical area.

Sample surveys are generally not a suitable source of data for small areas. In the Census of Population and Housing, dwellings are coded to a CD by virtue of the collection methodology. In other censuses, like the Agriculture Census, the ABS must rely on the location address of the farm to code the agricultural activity to a geographical area. Until now, there has been no reliable and cost-effective means to code addresses to CDs. In the case of agricultural activity it is even difficult to code correctly to a SLA. The same restrictions also apply to the wealth of administrative data collected by various State and Commonwealth agencies.

The ABS is currently working with the Public Sector Mapping Agencies (PSMA), Australia Post, Telstra and AEC to develop a national geocoding infrastructure which will allow addresses to be pinpointed on a digital map. This infrastructure, when available, will have a profound impact on the ability to code dwellings or businesses to small geographical areas such as CDs or aggregates of CDs such as localities. It will also provide a very powerful 'map' of the distribution of dwellings within CDs and allow a much more flexible approach to the design of statistical output units. Geocoding infrastructure has an obvious relevance to the definition of social catchments.

Some years ago the ABS conducted a review of the ASGC (ABS 1996 and 1997). While few of the recommendations of that review were taken up immediately, some have been subsequently introduced. Figure 4 presents a suggested conceptual framework for a revised ASGC which was developed during the review. An interesting aspect of this was the 'statistical locality' element in the classification.

Figure 4: **Overview of Possible Conceptual Framework for a Revised ASGC**
Source: ABS 1997



This was a unit largely intended to replaced the SLA although it was maintained that the LGA should remain in the system since local government is obviously an important element of governance and planning. The new statistical locality in non-metropolitan areas was to be defined so as to include 'homogeneous' units – presumably including entire communities. A concordance was to be developed to allow intercensal comparisons using SLAs to be made. There has been a move toward this concept in the ABS with the increasing use of suburbs in metropolitan areas but the recommendation for statistical localities in non-metropolitan areas was rejected. The proposed statistical locality was also supposed to remain stable over time whereas social catchments, however they may be defined, are temporal units subject to change over time.

A key issue to be addressed in the present report is, to what extent can social catchments be derived using units within the ASGC and to what extent should we recommend that social catchments could constitute a new structure within an expanded ASGC? This is an issue pursued later in the report but at present we need to note that in many non-metropolitan areas neither CDs or SLAs – the two main 'building block' type units for which ABS Census, economic and social data are available – should have the capacity to nest into social areas, especially in lower density areas.

Cental Place Theory

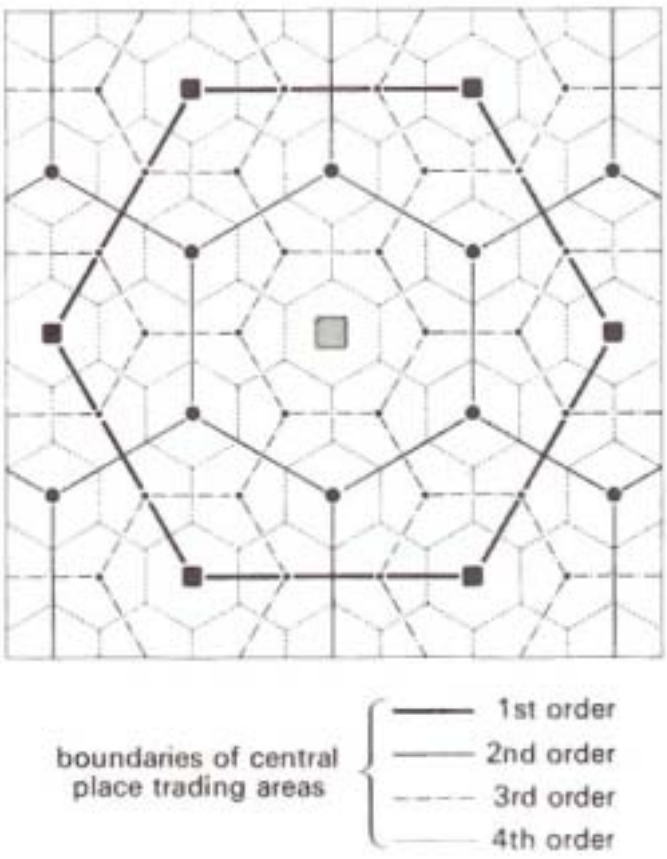
Although, as was indicated earlier, some argue that people's social areas and those areas in which they carry out commercial activity can be different, we can turn to the latter to provide a useful theoretical basis for considering social catchments. This comes via Central Place Theory, which was originally developed by Walter Christaller (1933). This theory argues that there is a particular pattern of ordering in the location, size, nature and spacing of central places. Of particular significance is the fact that Central Place Theory maintains that the central places in an area when ranked according to their size do not form a continuum but there is a *hierarchy*. It is possible to recognise a number of levels of the hierarchy and the central places in a particular level of the hierarchy share a common set of goods and services. Each order of the hierarchy is characterised by a particular suite of goods and services, a similar amount of functional complexity and a relatively similar population size. Centres in higher orders of the hierarchy contain the functions of lesser order centres together with those which characterise their order.

Two concepts are of particular importance in Central Place Theory – Range and Threshold:

- Range indicates the distance people are willing to travel to obtain a particular good or service. Some goods needed on a very frequent basis will have a short range. Those needed infrequently will have a long range.
- Threshold is the minimum number of people needed to support a particular function.

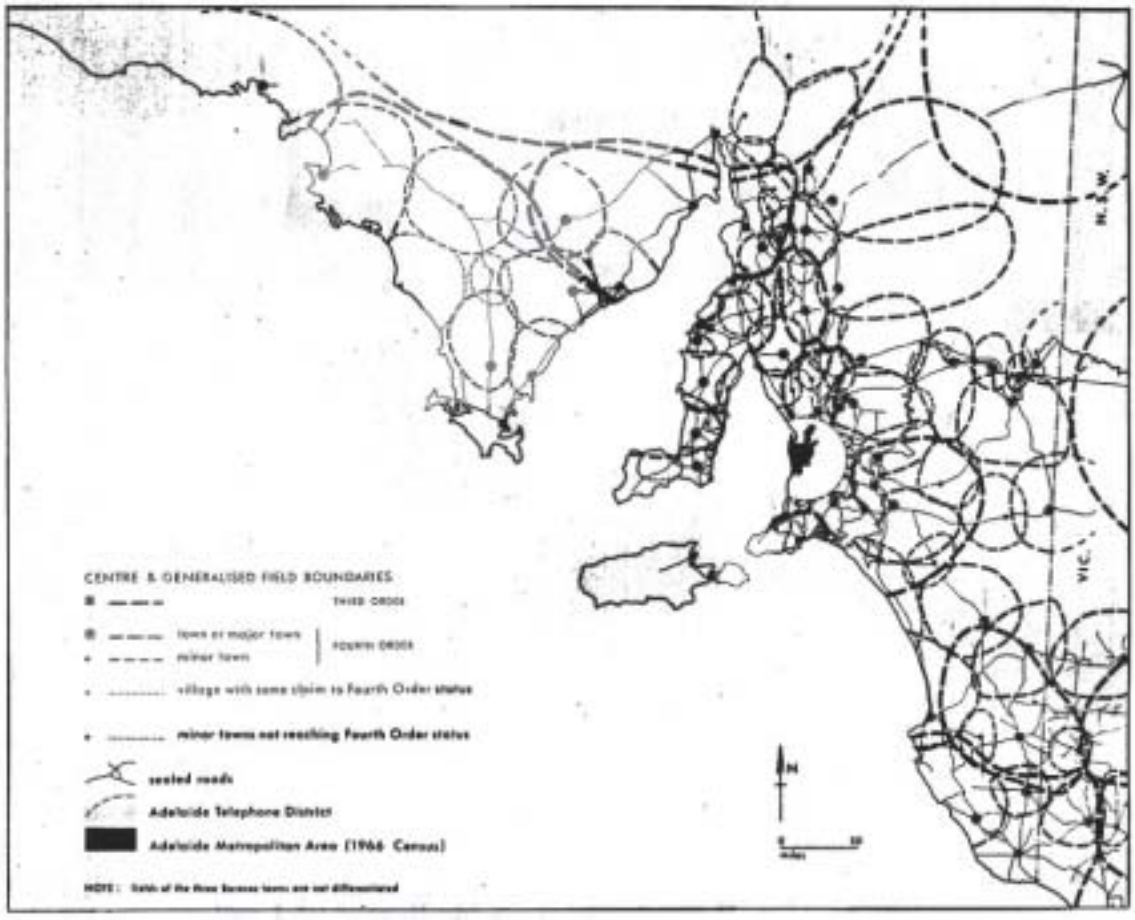
A centre will provide a good or service if there is more than a threshold population living within the range of that good. Central Place Theory argues that the central place system sorts itself out so that lower orders of places will nest within the areas serviced by higher orders.

Figure 5: A Network of Four Orders of Central Places
Source: Fairbairn and May 1971



Of particular importance for our consideration of social catchments is that Central Place Theory argues that there is not only a hierarchy of central places but there is also a hierarchy of the 'trade areas' they serve. Moreover, the trade areas of lower order centres nest within the trade areas of higher order centres. The theoretical ideal would be for these trade areas to be hexagonal in shape so that they completely cover an area. Figure 5 presents such a pattern. In reality, of course, the pattern is not so simple. Figure 6 presents the results of an intensive study determining the trade areas in South Australia.

Figure 6: The Generalised Urban Field Boundaries of South Australian Country Towns
Source: Smailes 1969



From the perspective of social catchments, we need to stress a few points. The first is that central places (and their hinterlands) are organised in a number of orders of a hierarchy. Studies in several States in Australia have demonstrated this. An early study in Tasmania, for example, (Scott 1964) produced the hierarchy shown in Figure 7 and Table 1 presents some of the characteristics of central places in each of the levels of the hierarchy. It will be noticed with each higher level of the hierarchy the distance between settlements increases (because of the larger range and higher threshold proportion of goods in the larger centres), the number of central places decreases, and the number of functions increases.

Figure 7: The Relationship Between Number of Functions and Occurrence of Functional Units in Central Places in Tasmania
Source: Scott 1964

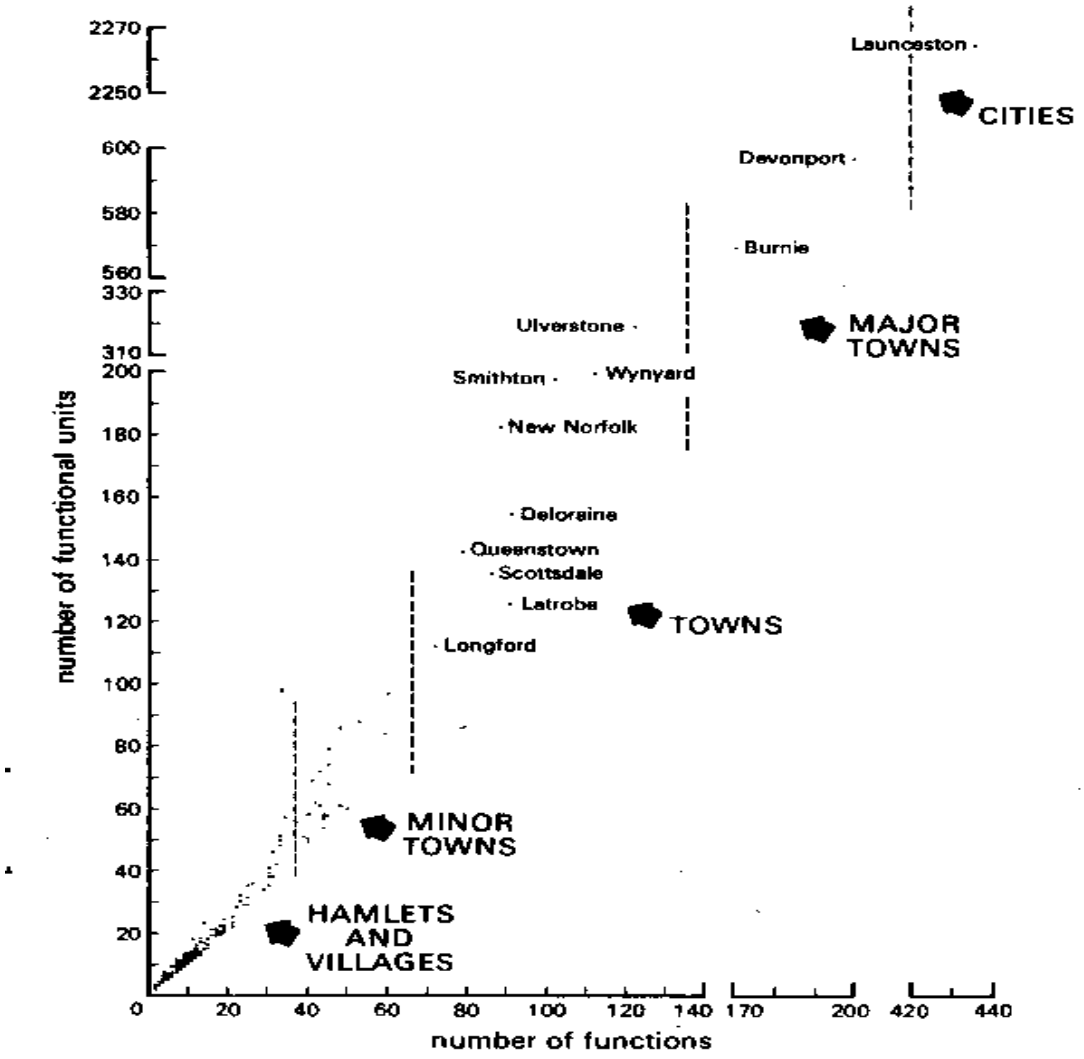


Table 1: Characteristics of Central Places
Source: Scott 1964

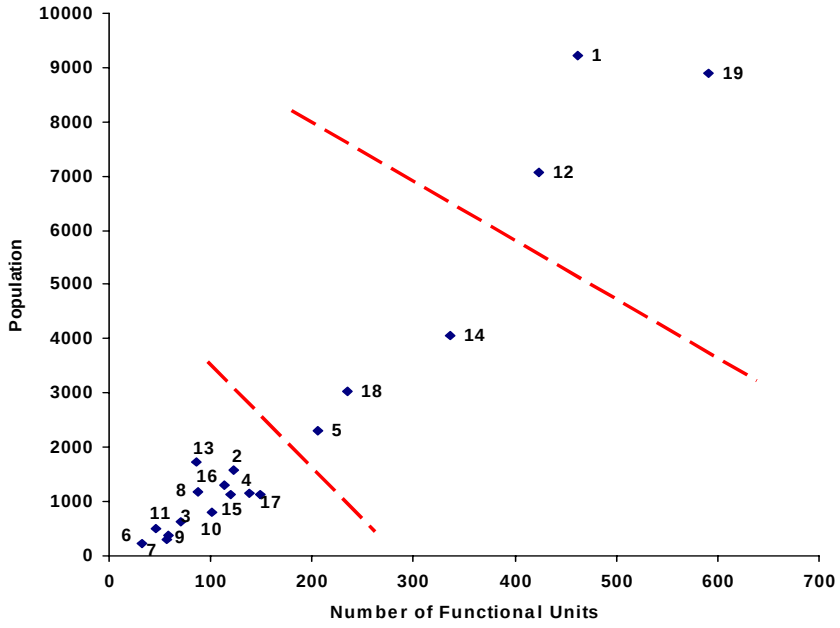
Class of Settlement	Average Distance Apart (Miles)	Number of Settlements	Number of Functions	Some Typical Identifying Functions
Hamlets	3½	191	Up to 6	Post office, hall, church, primary school
Villages	5½	171	7 to 34	Telephone exchange, service station, carrier
Minor Towns	16	20	Up to 60	Doctor, trading bank, judicial functions
Towns	27	9	72 to 122	Dentist, solicitor, plumber, furniture store, jeweller, court of petty sessions
Major Towns	56	2	170 to 199	Secondary school, variety store, laundry, dental mechanic
Cities	98	2	Over 400	Department store, taxation consultant, antique dealer

It will also be seen that each level has a characteristic suite of goods and services. Figure 8 shows a more recent hierarchy developed for northern Australia by Macgregor (1996). An important point is that the central place hierarchy has been changing in non-metropolitan Australia due to increased mobility in the population enabling them to travel further than they have in the past and shop in larger centres with more comparative shopping, cheaper prices etc. In addition, retailing and service provision has become more centralised (Smailes 2000). Hence the number of levels in the central place hierarchy may be being reduced.

A second important point of Central Place Theory for our analysis of social catchments is the notion of nested hierarchies of trade areas of central places. This clearly relates to the earlier point made that people can identify at the same time with areas at different scales – the locality, the region, the state etc.

It is not just from a theoretical perspective that Central Place Theory has much to offer social catchment work. The methodologies developed and employed to derive and study non-metropolitan central place systems clearly have some utility in the important question of how can we demarcate social catchments.

Figure 8: **Distribution of Selected Towns from Northern Australia**
Source: Macgregor 1996



The issue, then, becomes what data are required in order to carry out an analysis of the central place system and there is a considerable literature on this including a significant body of work that has been done in Australia. The data required to carry out a central place analysis are as follows:

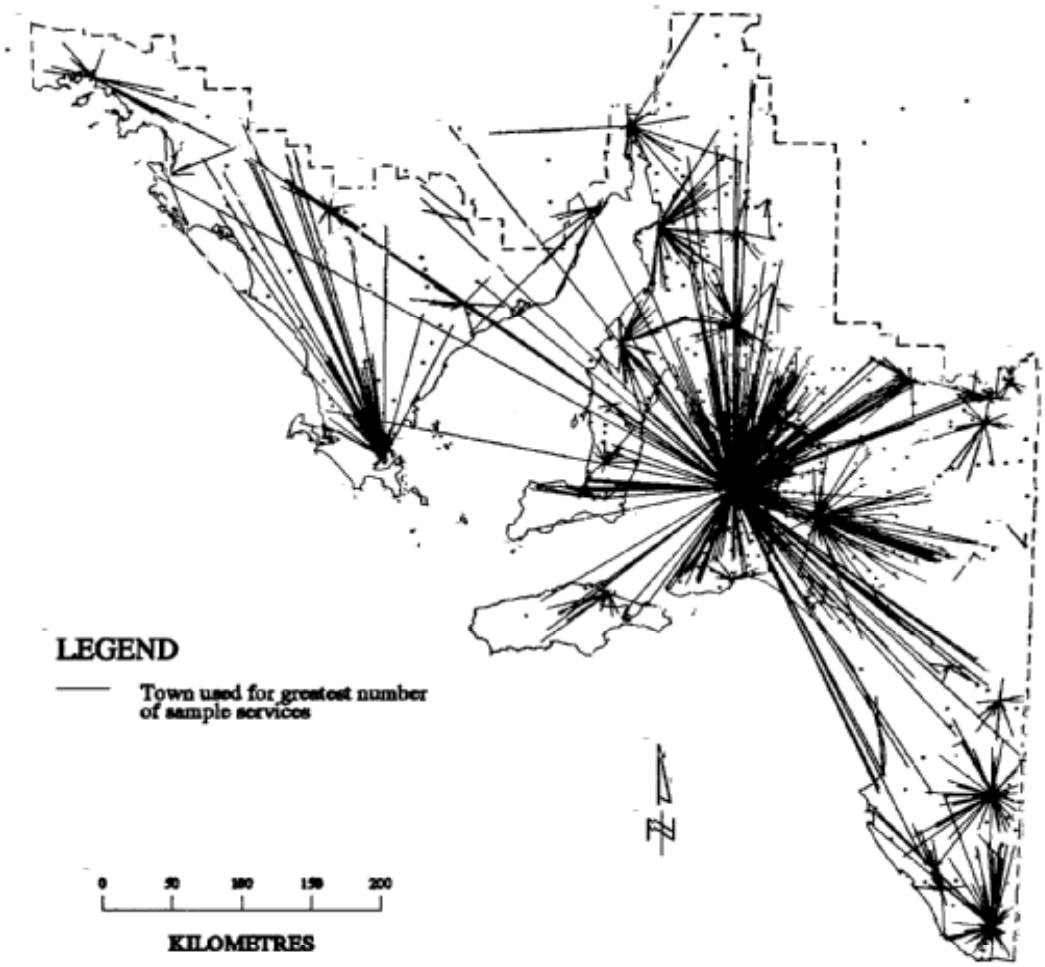
- Information is required on the number and type of services and functions in central places.

- Information is also required on the distribution of the population. This means not only the population of central places but the distribution of the population in their hinterland.
- Information is needed on the shopping patterns of people living outside of central places so we can draw in the boundaries of the trade areas of central places.

While data aspects are considered in more detail below, it is worth mentioning some of the limitations of existing sources of information relating to these three areas. Firstly, with respect to data relating to services, it needs to be reported that there is no single source which provides comprehensive information about the number and type of functions in central places. There are a number of partial lists such as the ABS list of businesses, Yellow Pages documents etc. However, there is a pressing need to develop a consolidated geographically referenced system providing comprehensive lists of services in central places. This set of information is required in order to be able to establish an urban hierarchy in Australian regional areas.

Figure 9: The Links Between Rural South Australians' Homes and the Town Supplying Each Survey Respondent With the Greatest Number of 20 Selected Goods and Services

Source: Smailes 2000, 168

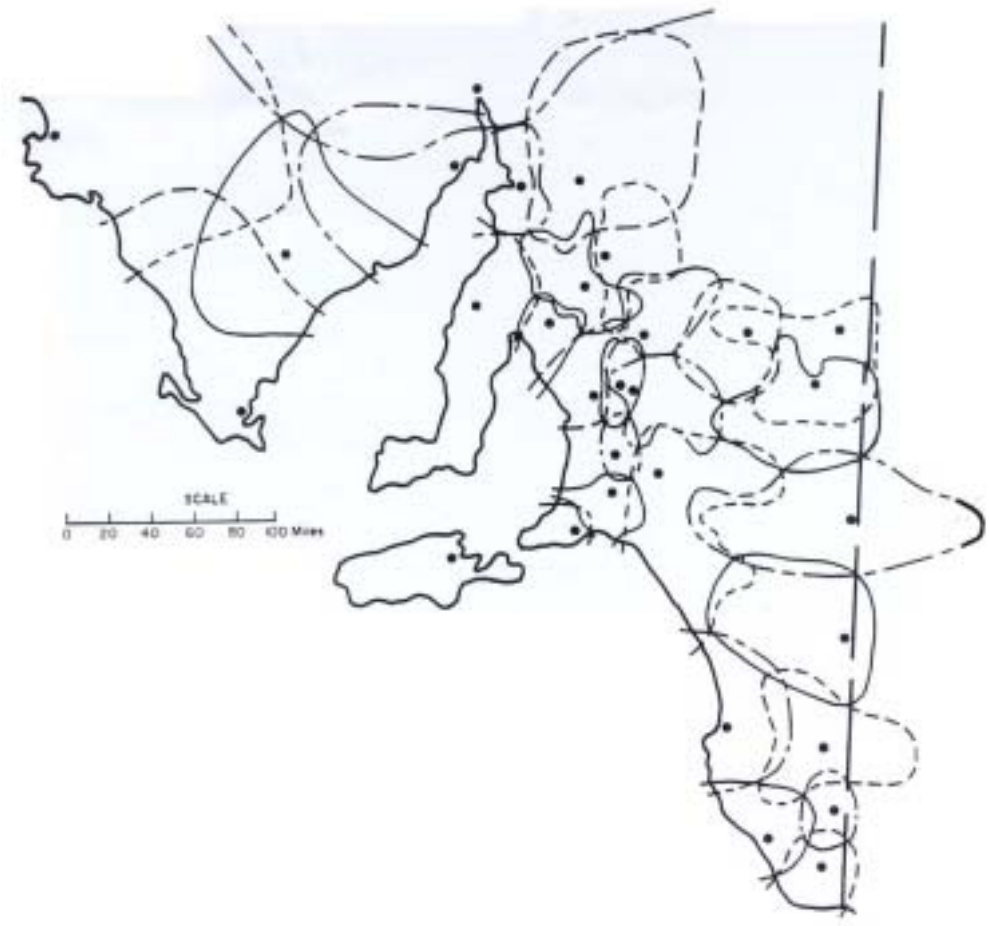


The second set of information relates to population distribution. As indicated previously this can be achieved through CD level data from the population census. The problem lies in the fact that CDs do not necessarily nest within the service areas of central places so that estimating the populations of service areas is rendered difficult. The third set of information is required to be able to demarcate the boundaries of the service areas of central places. In Central Place Theory the information for drawing the boundaries of trade areas is usually though collection of shopping behaviour information. This can be collected from shoppers interviewed in a central place with their home places being identified and the trade area of the centre thus delimited. An alternative approach is to interview a sample of residents living outside of central places to establish where they shop for selected items representing a range of different threshold populations. An example of the latter is shown using data from the sample of South Australians living in non-metropolitan areas with less than 200 residents referred to earlier. Figure 9 depicts linkages between the sampled homes and places where 20 selected goods and services were purchased.

Other Methods of Delimiting Trade Areas

It is clear from the last point that determining the patterns of shopping behaviour can be an intensive process of primary data collection. There have been a number of other methodologies utilised to establish the areas of influence of central places. One method is to utilise the circulation figures of local and regional newspapers. Hugo (1971) has done this for South Australia and one of the maps he derived from this is presented in Figure 10.

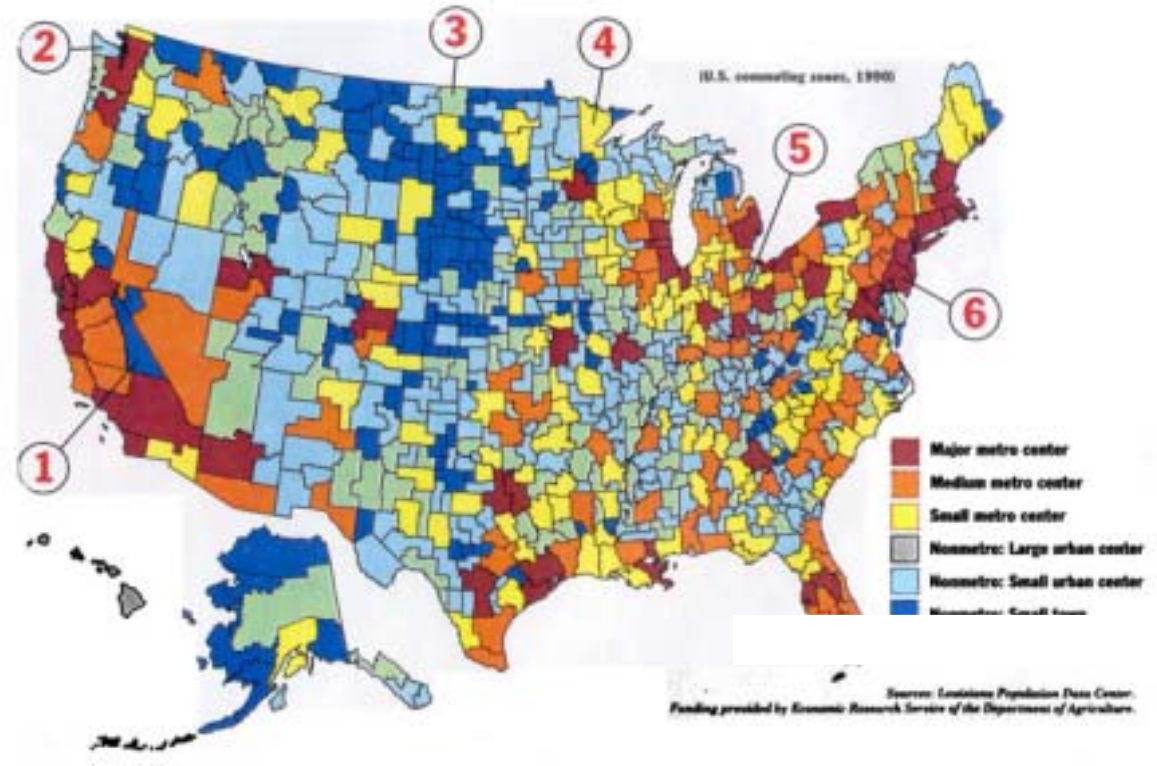
Figure 10: South Australia: Approximate Service Areas of Non-Metropolitan Newspapers, July 1971
Source: Hugo 1971, 58



Another promising methodology involves the utilisation of details of telephone traffic. Since telephone calls will reflect the economic and social linkages of households, they can be used to delimit the areas of influence of central places. Unfortunately, the privatisation of telecommunications in Australia has meant that telephone traffic data are now regarded as being commercial information which has meant that researchers now have not been able to gain access to them although researchers were able to utilise them in the pre-privatisation era (Smailes 2000). In the United States the areas served by regional television stations have been utilised to establish community of interest areas (Berry 1995).

One of the most useful types of analysis has involved the demarcation of *labour market areas* around central places using the journey to work (JTW) data collected at the census. This involves analysing the areas from which a central place draws its workforce from outside the central place (and, in the case of activities like town farming, the areas where the central place sends its workforce to work daily). Censuses in most OECD nations include a question on, not only what work people do, but also the location of their place of work. A cross-tabulation of place of work against place of residence allows the JTW to be established. Figure 11, for example, depicts the labour market areas identified in the 1990 US population census using JTW information.

Figure 11: US Commuting Zones, 1990
Source: Edmondson, 1995



These maps have proved extremely useful in planning community-based labour market programs and employment generation programs etc. (Tolbert and Sizer 1996). However, the above commuting zones are based on US counties which have populations much larger than Australian LGAs. In the Australian context the JTW

question has been included in all population censuses since 1971 (Paice 1990). However, the 1996 data have only been processed for large metropolitan centres and adjoining areas, although the areas included in this processing were considerably expanded between the 1991 and 1996 Censuses. This expansion involved not only an extension of the area round the State capitals for which the JTW data were processed but also an inclusion of some major provincial cities and their immediate hinterlands. Nevertheless, inspection of Table 2 will show that it is only the largest centres in each State and Territory for which commuting data were collected.

Table 2: Urban Centres for Which There is Some Coverage of Journey to Work Data Available for the 1996 Census

NSW/ACT
- Sydney
- Newcastle
- Wollongong
- Canberra Queanbeyan
- Gold Coast - Tweed Heads
- Central Coast
- Maitland

VICTORIA
- Melbourne
- Geelong
- Ballarat
- Bendigo
- Latrobe Valley

NORTHERN TERRITORY
- Darwin
- Alice Springs

QUEENSLAND
- Brisbane
- Toowoomba
- Gold Coast - Tweed Heads
- Townsville
- Cairns

SOUTH AUSTRALIA
- Adelaide

WESTERN AUSTRALIA
- Perth

TASMANIA
- Hobart
- Launceston
- Davenport
- Burnie – Somerset

Moreover, the coverage in some of the provincial urban centres is unlikely to include the total area from which those centres are likely to draw commuters. Table 3 shows that in 1991 there were almost 200 urban centres with more than 5,000 inhabitants so it is clear that the existing JTW data availability is extremely limited in terms of its ability to delineate the hinterlands around central places in non-metropolitan Australia.

Table 3: Numbers of Urban Centres in Particular Size Category by State and Territory in 1991

Source: ABS 1991 Census of Population and Housing

State	250,000+	100,000 to 249,999	20,000 to 99,999	10,000 to 19,999	5,000 to 9,999	Total
New South Wales	2	2	16	17	29	66
Victoria	1	1	7	13	21	43
Queensland	1	2	11	9	23	46
South Australia	1	-	2	6	3	12
Western Australia	1	-	5	4	7	17
Tasmania	-	1	3	1	4	9
Northern Territory	-	-	2	-	2	4
ACT	1	-	-	-	-	1
Total	7	6	46	50	89	198

The restrictions of the coverage of the JTW data processing are clearly evident in Table 4 which shows that some JTW data in 1996 are available for each of the 7 centres with more than 250,000 residents in 1996 and for the 6 with 100,000 to 249,999. For centres with between 50,000 and 99,999 residents JTW data are available for 6 of the 8 centres. They are available for only 4 of the 38 centres with from 20,000 to 49,999, one of those between 10,000 and 19,999 and none of those for centres between 5,000 and 9,999.

Table 4: Urban Centres with more than 30,000 Residents in 1991 According to Whether Journey to Work Data are Available for 1996

Centre	1991 Population	Availability	Centre	1991 Population	Availability
Sydney	3,097,666	Yes	Darwin	67,939	Yes
Melbourne	2,762,085	Yes	Launceston	66,691	Yes
Brisbane	1,145,557	Yes	Ballarat	65,002	Yes
Perth	1,018,868	Yes	Albury-Wodonga	63,581	No
Adelaide	957,444	Yes	Bendigo	57,441	Yes
Canberra-Queanbeyan	299,922	Yes	Rockhampton	58,722	No
Newcastle	262,385	Yes	Maitland	45,265	Yes
Gold Coast-Tweed Heads	256,313	Yes	Wagga-Wagga	40,839	No
Wollongong	211,459	Yes	Mackay	40,245	No
Central Coast (NSW)	197,100	Yes	Bundaberg	38,040	No
Hobart	127,122	Yes	Rockingham	36,647	No
Geelong	126,311	Yes	Tamworth	31,098	No
Townsville-Thuringowa	101,367	Yes	Shepparton-Mooroopna	30,491	No
Toowoomba	75,973	Yes			

Footnote: Centres with less than 30,000 inhabitants for which JTW data are available - Latrobe Valley (17,972), Alice Springs (20,418), Davenport (22,663) and Burnie-Somerset (20,510).

While JTW data are not available for centres with populations of less than 5,000, it is difficult to be conclusive about the usefulness of such data to reliably predict social catchments, particularly in regions that contain a number of small towns such as eastern NSW and Victoria. This is because residents may live in one town but work in another, obtain services from another and visit friends etc in other towns.

Comparable nations to Australia have been fully processing and utilising their JTW data for several years. Tolbert and Sizer (1996), for example, have used JTW data derived from the 1990 US Census to divide the entire nation into commuting zones and these are aggregated into a number of labour market zones each with at least 100,000 people. While these are very large zones compared to what would be found here in Australia, Tolbert and Sizer's (1996) work nevertheless demonstrates the capacity of census-based data, not only for labour market analysis and design and targeting of labour market programs, but also for a wide range of other social, economic and health-based analyses (Tolbert and Sizer 1996, 3-5). A sample of some of the uses made of the regions defined using 1980 JTW data is presented in Table 5.

Table 5: Sample of Uses Made of Division of USA into Journey to Work Zones on the Basis of the 1980 Census by Researchers and Program and Policy Makers

Source: Tolbert and Sizer 1996, 4-5

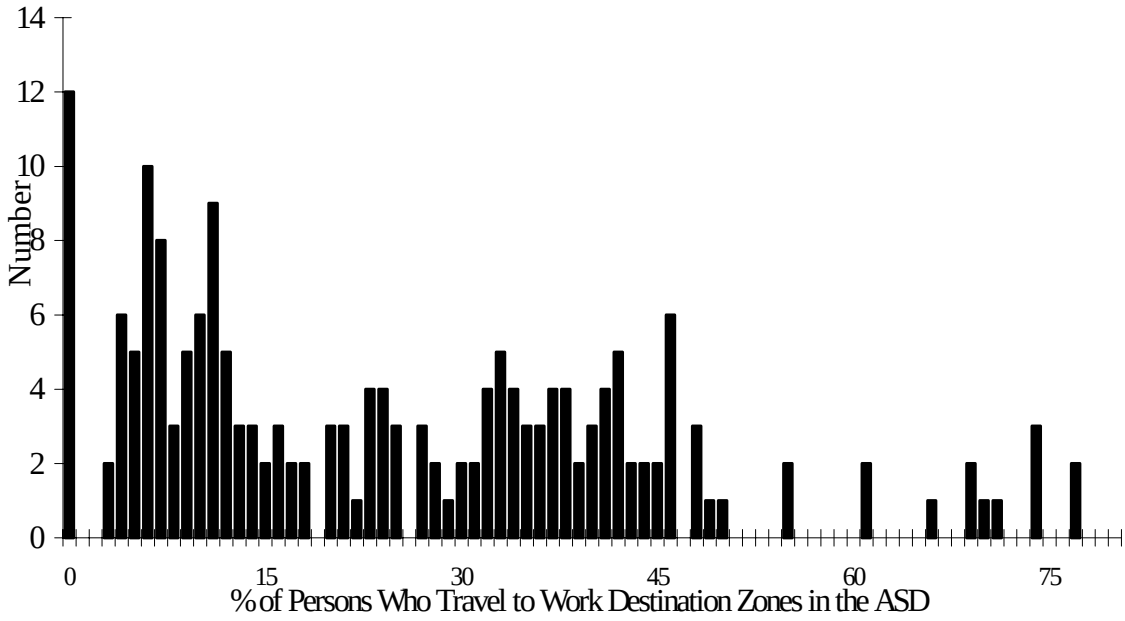
Researchers	Topics
Tickamyer and Bokemeier, 1988	Sex Differences in Labor Market Experiences
Lyson, 1989	Growing Divergence of Southern Urban and Rural Areas
Tolbert, 1989	Comparison of Various 1980 Census County Group Schema
Tigges and Tootle, 1990	Men's Underemployment
Colclough and Tolbert, 1990, 1992, 1993	High-Tech Labor Force
Lichter *et al.*, 1991	Marriage Markets and Black and White Women
Lichter *et al.*, 1992	Racial Differences in Marriage Patterns
Deseran *et al.*, 1993	Household Structure and Labor Force Participation
Kodras and Padavic, 1993	Economic Restructuring and Women's Sectoral Employment
McLaughlin *et al.*, 1993	Transitions to First Marriage
Pfeffer, 1993	Black Migration and the Legacy of Plantation Agriculture
Talley and Cotton, 1993	Minority Concentration and Black-White Inequality
Tickamyer and Latimer, 1993	Sources of Income of Poor and Near Poor
Tootle and Tigges, 1993	Black Concentration and Underemployment
Bloomquist, 1990	Sociodemographic Group Differences in Occupational Concentration
Killian and Hady, 1987	Local Economic Performance
Reynolds and Maki, 1990	Small Business Development
Padavic, 1993	Spatial Dynamics of Women's Employment
Siegel *et al.*, 1993	Socioeconomic Correlates of Stroke Mortality
Singelmann *et al.*, 1993	Economic Performance of Labor Market Areas
Whitener and Parker, 1993	Off-Farm Employment of Farmers
Steahr, 1990	Local Labor Markets in New England
Makuc *et al.*, 1991	Health Service Areas for the United States
Frey and Speare, 1992	Proposal for Census 2000 Geography

The plan for the 2001 Australian Census of Population and Housing is that the JTW data *will* be analysed for all of non-metropolitan Australia. The spatial unit to be adopted for this purpose is the SLA. An important decision will have to be made about what threshold proportion of the workers in an SLA need to be working in a centre outside of the SLA for that SLA to be part of the labour market of the centre. This is important because as mentioned above, for smaller centres, the picture will be very mixed with people from the same area commuting in different directions to different centres.

In the United States the criterion for inclusion in a metropolitan region is that 15 percent of resident workers in a county should work in the urban area. There needs to be some experimentation with the Australian 2001 Census data to determine what should be the threshold for Australia. However, in their detailed case study of the Sydney ex-urban region, Burnley and Murphy (1995a and b) suggest that this level should be 10 percent of workers. As an experiment we have calculated the

percentage of workers in each CD in the Outer Adelaide Statistical Division (ASD) who worked within the ASD and the distribution of the proportions is shown in Figure 12. In Figure 13 these percentages are mapped.

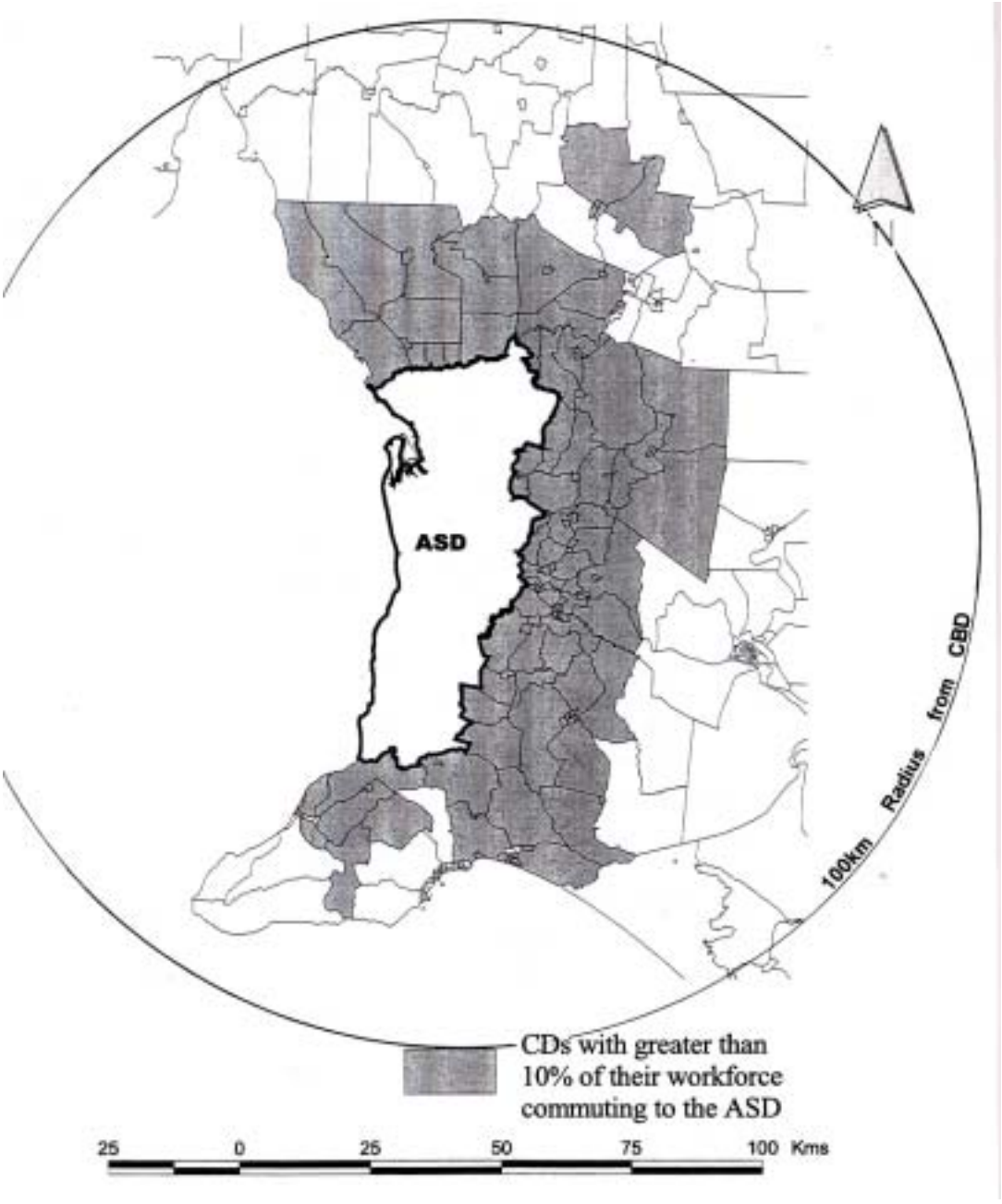
Figure 12: Proportion of Outer ASD Persons Who Travel to Work in the ASD



The distribution presented would seem to suggest that there is a significant break around the 10 percent level identified by Burnley and Murphy (1995b) as a meaningful outer limit for delimiting the Sydney ex-urban zone. This will need more analysis with other cities and towns but it would appear that the 10 percent threshold may be a meaningful one to use to identify the labour markets around Australian cities and possibly smaller towns.

Figure 13: Journey to Work Patterns: Collection Districts in the Outer Adelaide Statistical Division to the Adelaide Statistical Division

Source: Calculated from 1991 Census Journey to Work data supplied by ABS, SA Office



Delimiting Social Catchments: the Smailes' Methodology

The question which one must return to is the extent to which the methods reviewed in the last two sections allow us to demarcate social catchments which are useful for the purposes of social, economic and environmental planning. Labour intensive methodologies usually concentrate on collecting the following types of information:

- Data relating to patterns of interaction – social visiting, shopping, economic linkages, telephone traffic, commuting etc.
- Data relating to identification of an area or region as being the 'community' of the respondent.

The two types of information can be exemplified by the work of Smailes (1999). Figure 14 shows the results of two types of data collection in the Fleurieu Peninsula area south of Adelaide. The top map is the result of respondents drawing on a map the area they identify as 'their community or neighbourhood'. The second diagram shows the same respondents' ideas on where they go to shop for a selected basket of items. Figure 16 shows the experience of using local intensive household surveys to define social catchment areas. The work of Smailes has been referred to on several occasions in this report. He has developed a methodology for determining social catchments which combines the methodology adopted in the intensive community study reported in Figure 14 with an ability to cover the entire dispersed non-metropolitan populations of States and Territories (Smailes 1999). Some explanation of the methodology is warranted.

The first step in the Smailes' (1999) approach is to draw up a sample of households living outside urban centres and localities (ie. in areas with less than 200 residents). The sampling frame for this is the electoral rolls. A questionnaire and covering letter is then sent to all in the sample. Among the questions asked, the following are especially important:

- Community identification (a map is provided for this purpose).
- Householder attitudes toward the community with which they identify.
- The normal place of purchase for 20 selected goods and services.

Figure 14: Spatial Pattern of Rural Neighbourhoods and Rural Communities in the Fleurieu Peninsula, SA

Source: Smailes 1999

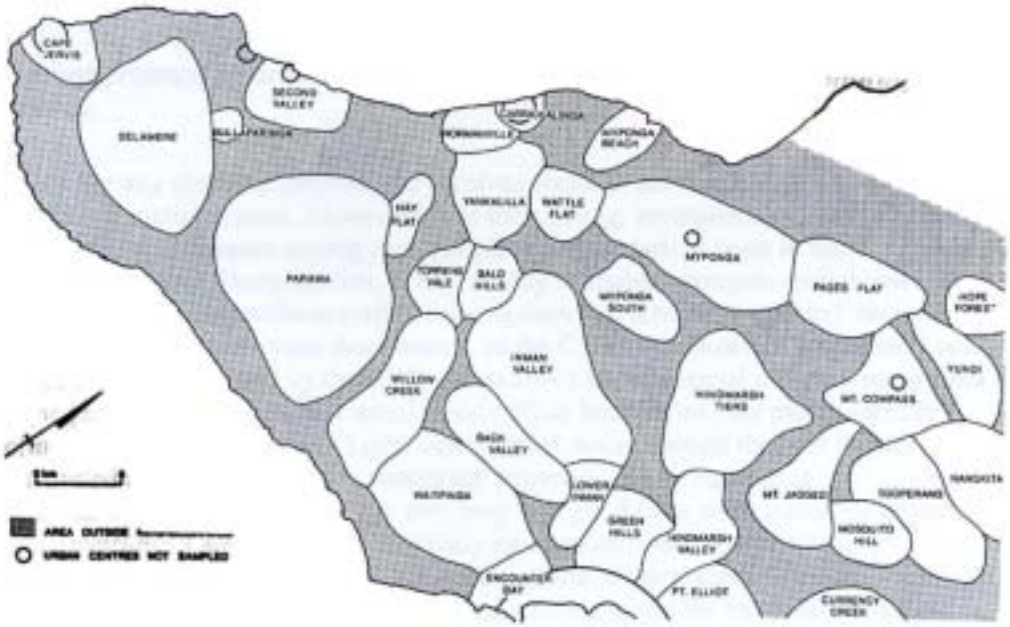


Fig.3A Spatial pattern of rural neighbourhoods in the Fleurieu Peninsula, S.A

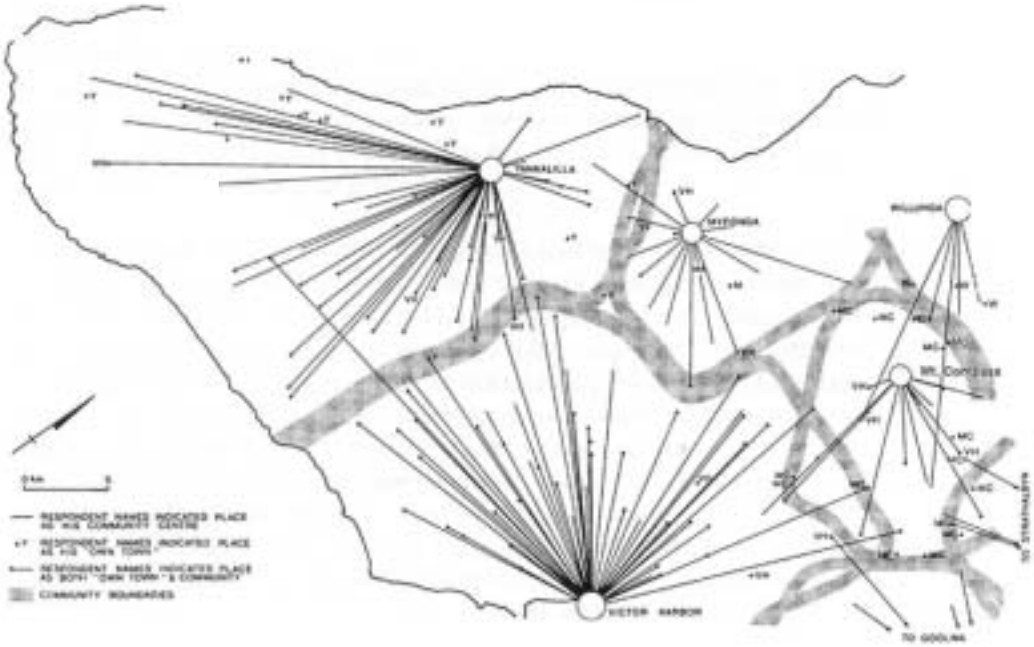
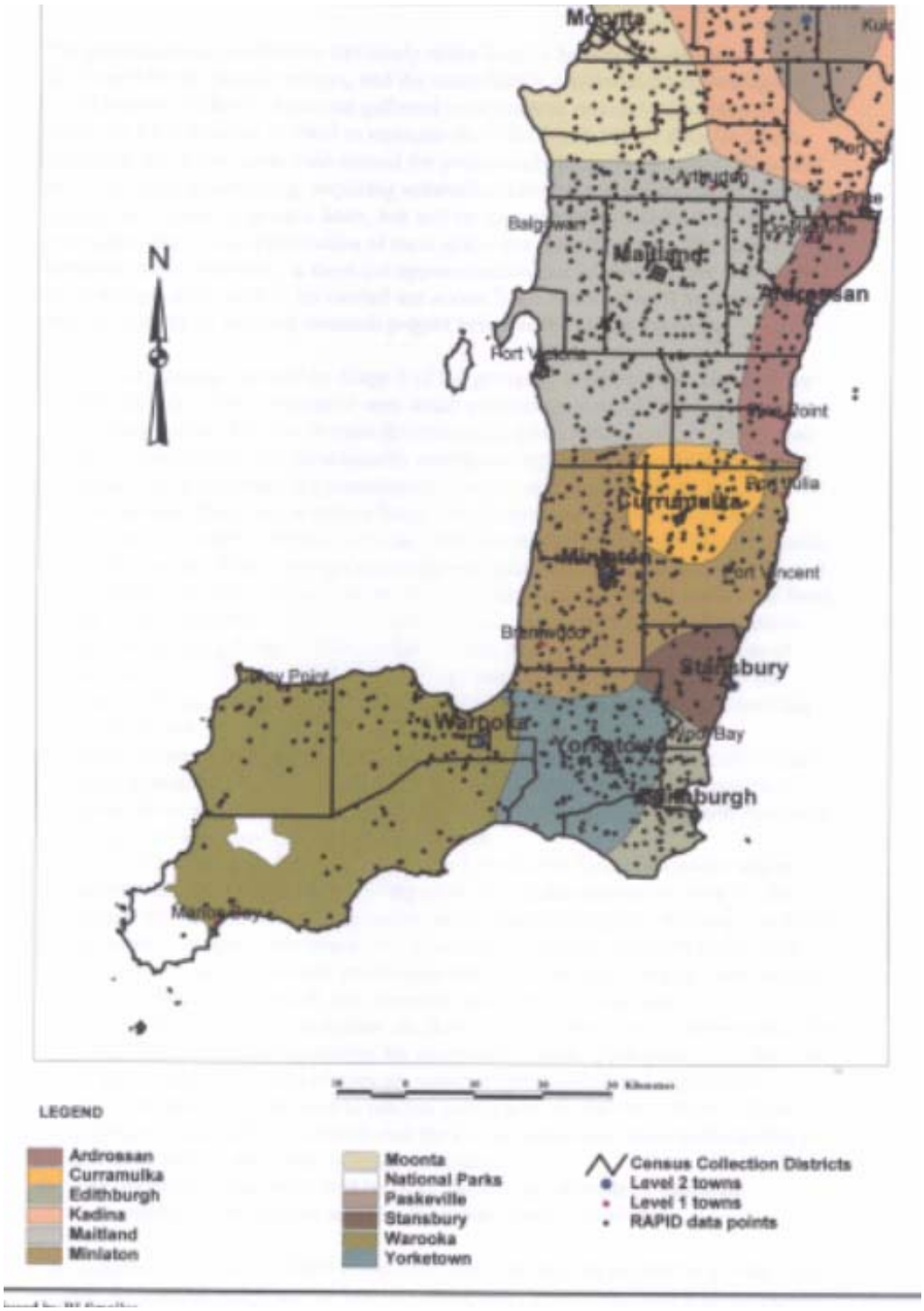


Fig.3B Spatial pattern of rural communities in Fleurieu Peninsula, South Australia.
Source (both Figures): Smailes, P.J. and O'Dowd, A.D. (1981)

The postal survey is followed up with a telephone call if a response is not received within a time limit. At this scale the method is not expensive of time or money and utilises available data. Moreover, the experience has been that interest among respondents in the survey is high with the result that the response rate also is high. Of course, should such a study be undertaken at a national scale then it would imply a significant capital investment. Nevertheless, as Smailes has demonstrated, the survey has been done on several occasions to detect change over time and there is consistency in the results.

Figure 15: Example of the Use of RAPID Database to Apportion Census CDs to Social Areas, Southern Yorke Peninsula, SA

Source: Smailes 1999



A crucial part of social catchment methodology is the determination of the population living within catchment boundaries. The nature of the problem is well illustrated in Smailes' work. Figure 15 shows the results of the household survey for Yorke Peninsula in South Australia. The boundaries of social catchments have little in common with the boundaries of the CDs for Yorke Peninsula which are also depicted in Figure 17. However, it must be acknowledged that the areas depicted in Smailes' study are for very small populations, some of which do not appear to contain a central place.

The question that emerges from the Smailes' study is, how can the CD population be divided between the social catchments they include? A number of possibilities suggest themselves but basically there is a need to identify the distribution of households within CDs and then allocate the census data *pro rata* according to the proportion of CD households falling in each social catchment. Smailes' approach has involved utilising the *RAPID* data base maintained in South Australia to supply Emergency Services with details of where occupied dwellings are specifically located so that they can be quickly located in case of an emergency. Accordingly, there has been a program of Geocoding[1] all dispersed dwellings in non-metropolitan areas. This then allows the population of CDs to be distributed between various social catchments included within a particular CD. There are similar programs in several other States.

The 'Splitting' CD Population Problem

While the Smailes' methodology of splitting CD populations appears to offer some promise, it is worth considering the issue further since it is of fundamental importance to social catchment work or indeed to any other attempt to use spatial units not currently in the ASGC for planning or analysis purposes. Before considering this it is important to point out that some other countries' statistical agencies have recognised the need to create building block spatial units at below the CD size level. The Canadian Hierarchy of Standard Geographical Areas is presented in Figures 16 and 17.

[1] Geocoding involves the fixing of the exact location on the earth's surface of a household (or other feature) via its latitude and longitude. It can be derived using a GPS (Global Positioning System) or through map-based geocoding or digitising.

Figure 16: Canada: Hierarchy of Standard Geographic Areas
Source: Statistics Canada 1991

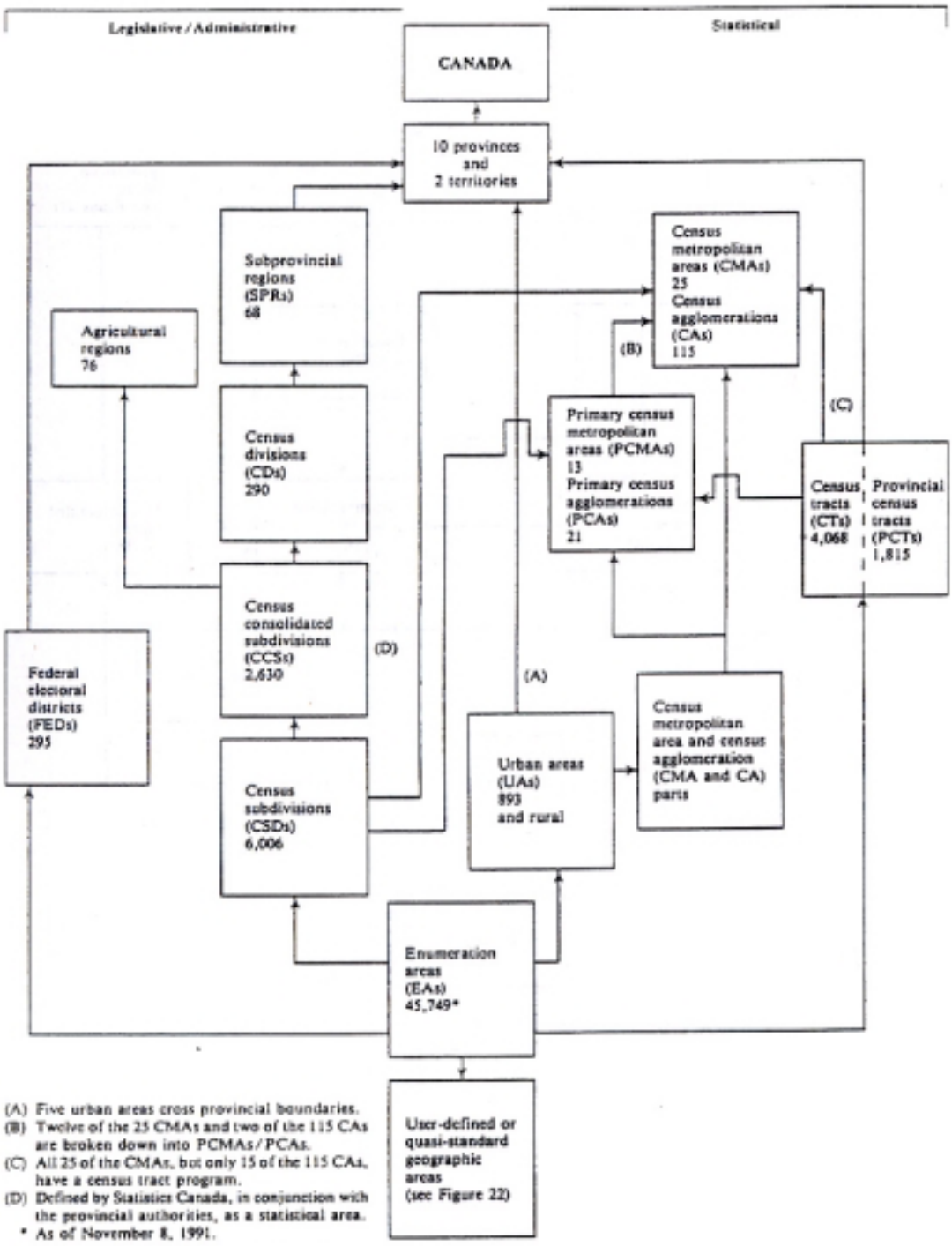
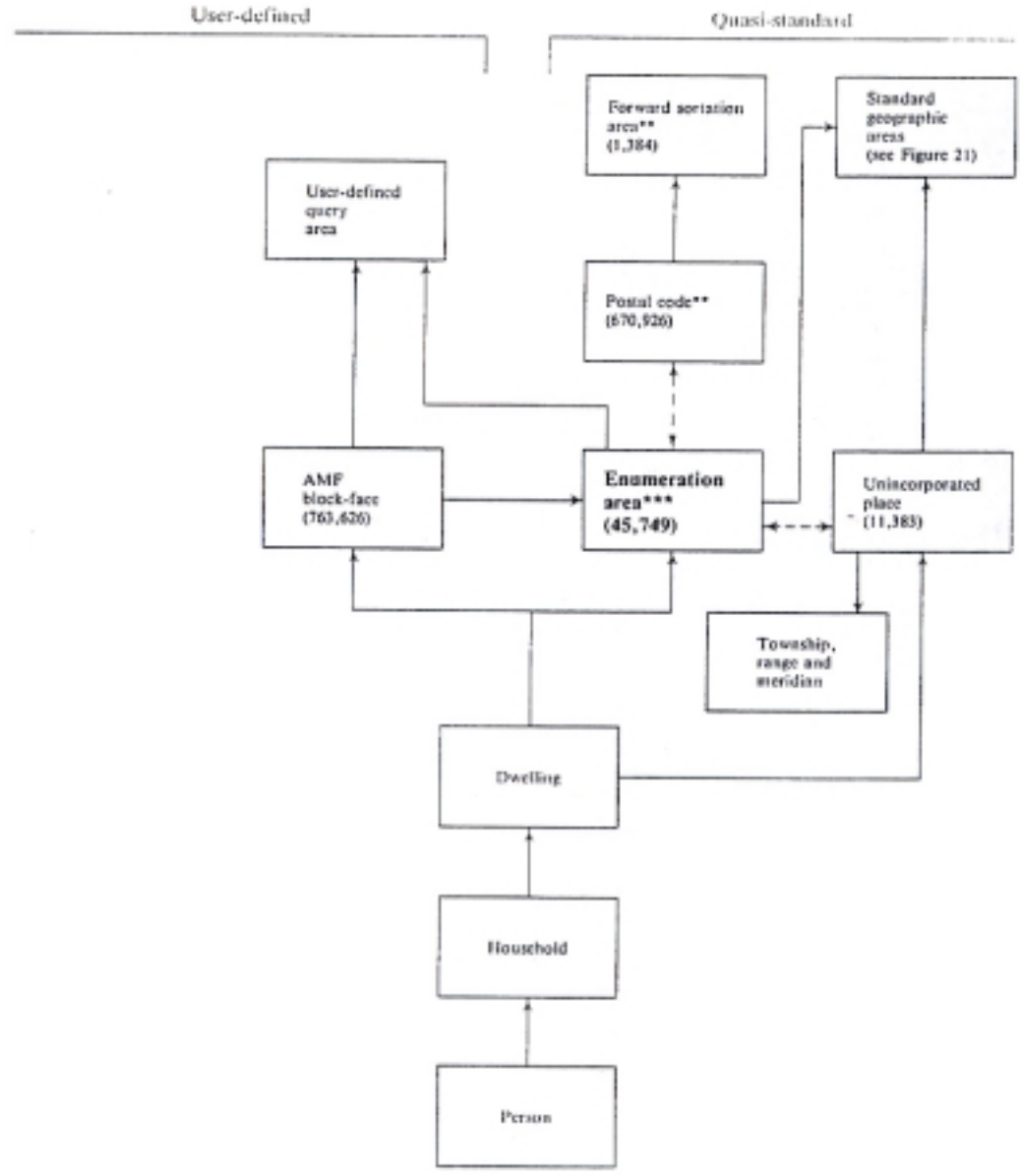


Figure 17: Canada: Hierarchy of Quasi-Standard and User-Defined Geographic Areas*, 1991 Census

Source: Statistics Canada 1991



* All counts are preliminary.
** See the definition of postal code for further details.
*** Enumeration areas are a standard geographic area (see Figure 21).
<--> These are "many to many" relationships.

The key point is that Statistics Canada produces census data not only for their standard spatial units but also for areas other than standard geographical areas by:

- Aggregation of standard areas.
- Custom query areas created by aggregating small building block geographical units - blockfaces in urban areas and enumeration areas elsewhere. A geocoded centroid is assigned to each area so that census data for user-defined areas can be retrieved by aggregating the centroids. The geographical infrastructure and hierarchy supporting data retrieved for user-defined geographical areas are shown in Figure 17.

In New Zealand, too, they have produced data for spatial units below the CD level for so-called *meshblock* areas. These allow the provision of census data for user-defined spatial units. The development of some kind of blockface or meshblock system is currently being contemplated within the Australian Bureau of Statistics.

Also, within the ABS there has been considerable discussion about geocoding its data collection activities, including the Census of Population and Housing. This would not obviate the need for having an ASGC. Clearly, the ABS would never be in a position of being able to release individual information because it would breach confidentiality. However, geocoding would allow data to be aggregated into any spatial units users required. Hence the ASGC would remain for standard data dissemination. The meshblock/blockface would represent a compromise which would allow the population of non-standard areas such as social catchments, watersheds etc. to be built up from aggregating the meshblock/blockface units.

The greatest need for the smaller units, in fact, is in the areas of lower population density. With metropolitan areas, the higher density of population means that CDs are often already quite homogenous in their internal population distribution and population characteristics.

In the absence of geocoding or sub-CD units it will be necessary to derive a method of splitting the CD population. A number of possibilities suggest themselves, including that used by Smailes (1999) and described above. The alternative approaches involve allocation of households to different parts of the CD so they can be apportioned to the various social catchments included in the CD. Possible ways of doing this could include:

- Allocating the households using areal photographs,
- Allocating the households using the geocoded telephone numbers maintained by Telstra,
- Allocating the households using telephone directories,
- Using key information.

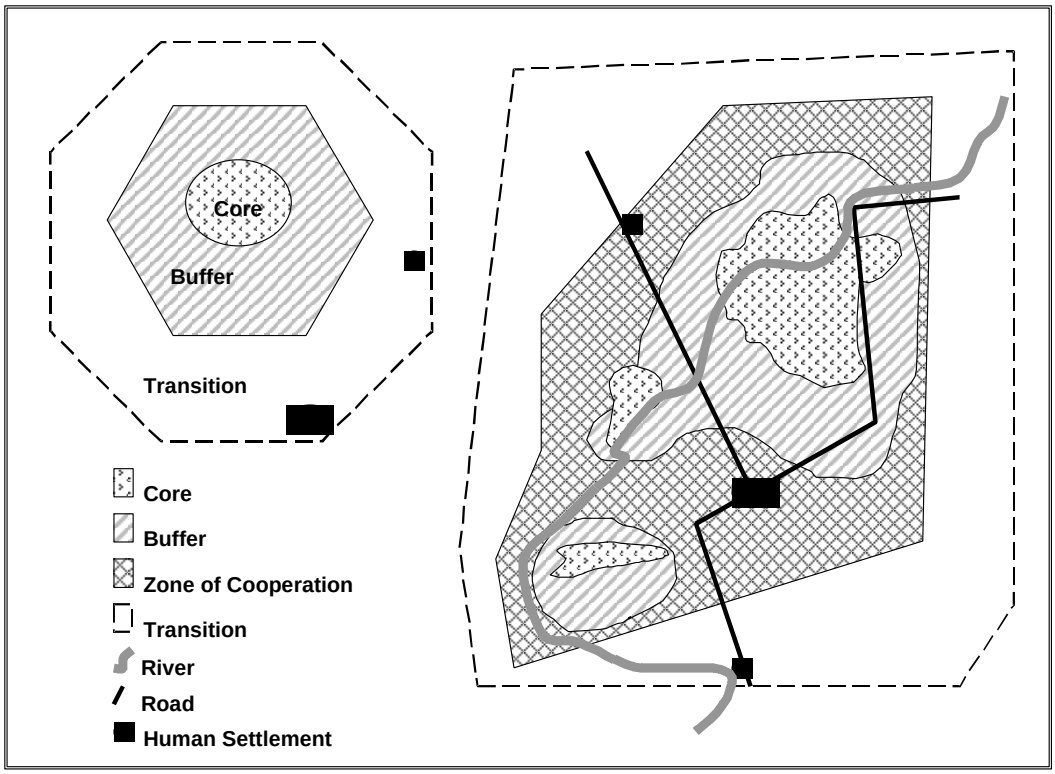
Brunckhorst's Bio-regions

The Central Place Theory idea of developing a nested hierarchy of trade areas has been applied to a number of areas. A land management example would include the Biosphere Reserve Model (BRM) depicted in Figure 18 which was originally proposed by the Man and the Biosphere (MAB) Council in 1971 to be later endorsed by UNESCO in 1984.

Some ecologists have adopted a similar approach. An examination of sustainability issues and indicators in the agricultural context by Smith and McDonald (1998) revealed at least four nested hierarchies. At the largest scale are those that can be associated with field or paddock; then there are those associated with the farm; then those associated with the watershed or catchment; and lastly, there are those associated with the region or even nation. The indicators of concern to natural resource management vary according to the scale one is concerned with.

Similarly, Brunckhorst (1998; 2000a; 2000b) also supports hierarchy theory in the management of ecosystems. He points out that 'the objective of a nested hierarchy is the development of a systematic framework for classifying and mapping areas based on the associations of ecological units at various geographic scales ... [and these hierarchies are] useful in human planning' (Brunckhorst 2000b, 21). He also points out that culturally constructed functional ecological areas (he referred to these as 'bio-regions') should be built on social concepts such as 'sense of place' as well as ecological concepts and that these are likely to cross or encompass political jurisdictional boundaries. He notes that identifying such 'communities of common concern' will make innovation for development and the pursuit of social and ecological sustainability more attainable (Brunckhorst 1998).

Figure 18: Theoretical, Concentric Circles of Biosphere Reserve Model (left) and Application of Model in Practice (right)
Source: Brunckhorst 2000a



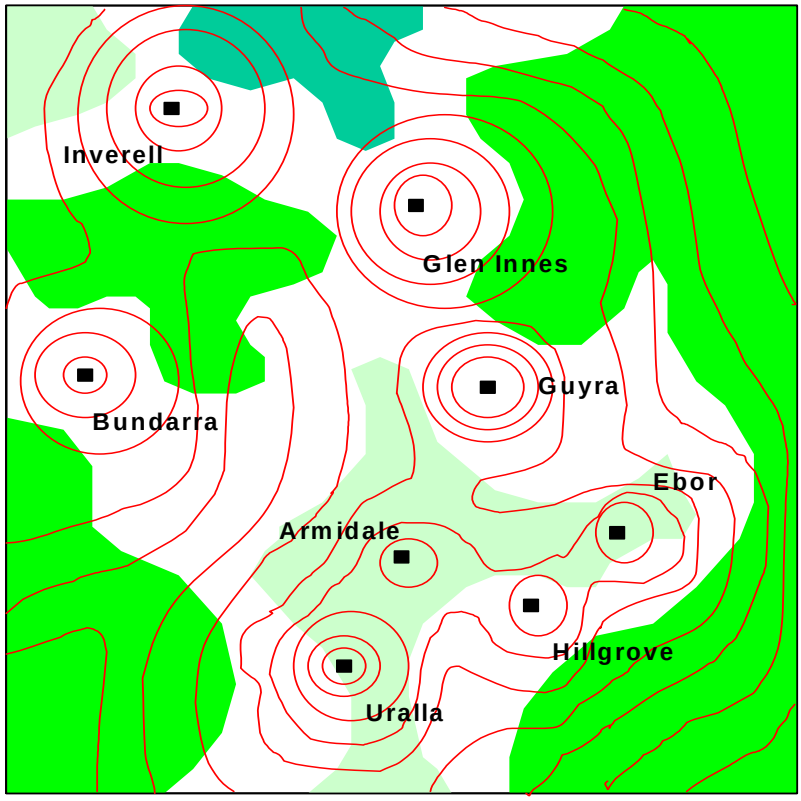
Brunckhorst's work has important implications for traditional approaches to natural resource management such as those offered by catchment management. Traditionally, catchment management has been approached from a watershed perspective whereby the natural geomorphic processes (in particular, the flow of surface water across the landscape) provides the basis for planning and management. However, Brunckhorst (2000b) notes problems with such an approach. First, the

responsible agencies and programs often remain compartmentalised, which inhibits any strategic or integrative approach. Secondly, watershed streams may not always be evident in the landscape – this is particularly true in Australia, which has a highly eroded, flat landscape with a dry and unreliable rainfall distribution. And thirdly, even in landscapes with flowing rivers, the various human communities within a particular catchment often have little in common with one another. As a result they pay little regard to the potential downstream effects of particular land management practices. Coordinated planning and management is therefore difficult and rarely achieved. However, Brunckhorst (2000b) is not completely dismissive of the catchment approach. He sees it as one part of inter-related scales in resource management for communication, information sharing and debate, but warns if the scale of the catchment is large, then developing a common strategic vision is rarely successful.

Brunckhorst's (1998, 2000c) preferred approach to natural resource management can perhaps be summarised by considering the *Spatial Analysis of Both Social and Ecological Functions* project based at the Institute for Rural Futures at the University of New England (Armidale, NSW), which demonstrates the bio-regional approach. It covers a large study area across the New England – northwest and the escarpment to the coast of northern NSW. Pilot studies for this project involved mapping communities of common concern, identity and function across the northern tablelands of NSW as shown in Figure 21 (Brunckhorst and Coop 2001).

The shaded areas in Figure 19 represent ecological surfaces reflecting similar landscapes (based on climate, vegetation, soils and geology coupled with land use data). The contours represent the significance of different areas to the population derived from survey information. The 'hills', depicted by the contours, represent areas that are of significance to more people than the 'valleys'.

Figure 19: Communities of Shared Interests and Functional Relationships on the Northern Tablelands
Source: Brunckhorst and Coop 2001



Areas may be thought of as significant because they define the community people feel they belong to, or have a common interest in, the area where they believe they should have a say in resource management. The deeper 'valley' in the surface between Guyra and Glen Innes compared with that between Guyra and Armidale shows that Guyra people are more likely to regard Armidale as part of their community than Glen Innes. However, the lack of any deep 'valleys' between the towns of Guyra, Armidale, Ebor, Hillgrove and Uralla, together with the ecological similarity of the landscape, suggests that the area around these towns would be an appropriate regional unit for resource management – community of common concern (Brunckhorst 2000c).

The Town Resource Cluster (TRC) Approach

The Brunckhorst method discussed above attempts to combine both social and ecological elements in delineating a nested hierarchy of regions. Another approach which seeks such an integration is that developed by Fenton, Coakes and Marshall (2000) entitled Town Resource Cluster (TRC) analysis. The aim of TRC is to define meaningful social units on which to ground later examination of social impact and assessment processes. TRC defines communities in terms of a collection of interdependent towns and their hinterlands within a region. However, the cluster of towns has an identified relationship to areas of natural resources. Hence the towns are linked by their relationship with fisheries, forestries, water resources, agriculture or mining. TRC analysis seeks to combine social and resource systems in defining regions.

Table 6: An Example of Inter-Town Dependency Measures
Source: Fenton, Coakes and Marshall, 2000

Town	Business Location	Business Expenditure	Employee Locations	Household Expenditure	Service Use	Average Dependency
Lucinda	66.6	10.3	40.0	3.2	31.6	30.3
Halifax	13.9	0.0	20.0	3.6	14.6	10.4
Ingham	13.9	44.3	40.0	85.4	34.1	43.5
Dungeness	5.6	3.2	0.0	0.0	0.0	1.8
Townsville	0.0	24.2	0.0	2.5	7.3	6.8
Cairns	0.0	7.6	0.0	0.0	4.9	2.5
Bundaberg	0.0	7.4	0.0	0.0	2.5	2.0
Brisbane	0.0	1.5	0.0	0.0	2.5	0.8
Innisfail	0.0	1.5	0.0	5.3	2.5	1.9
	100.0	100.0	100.0	100.0	100.0	100.0

Figure 20: **Twenty-five Queensland Fisheries TRCs**
Source: Fenton 2001

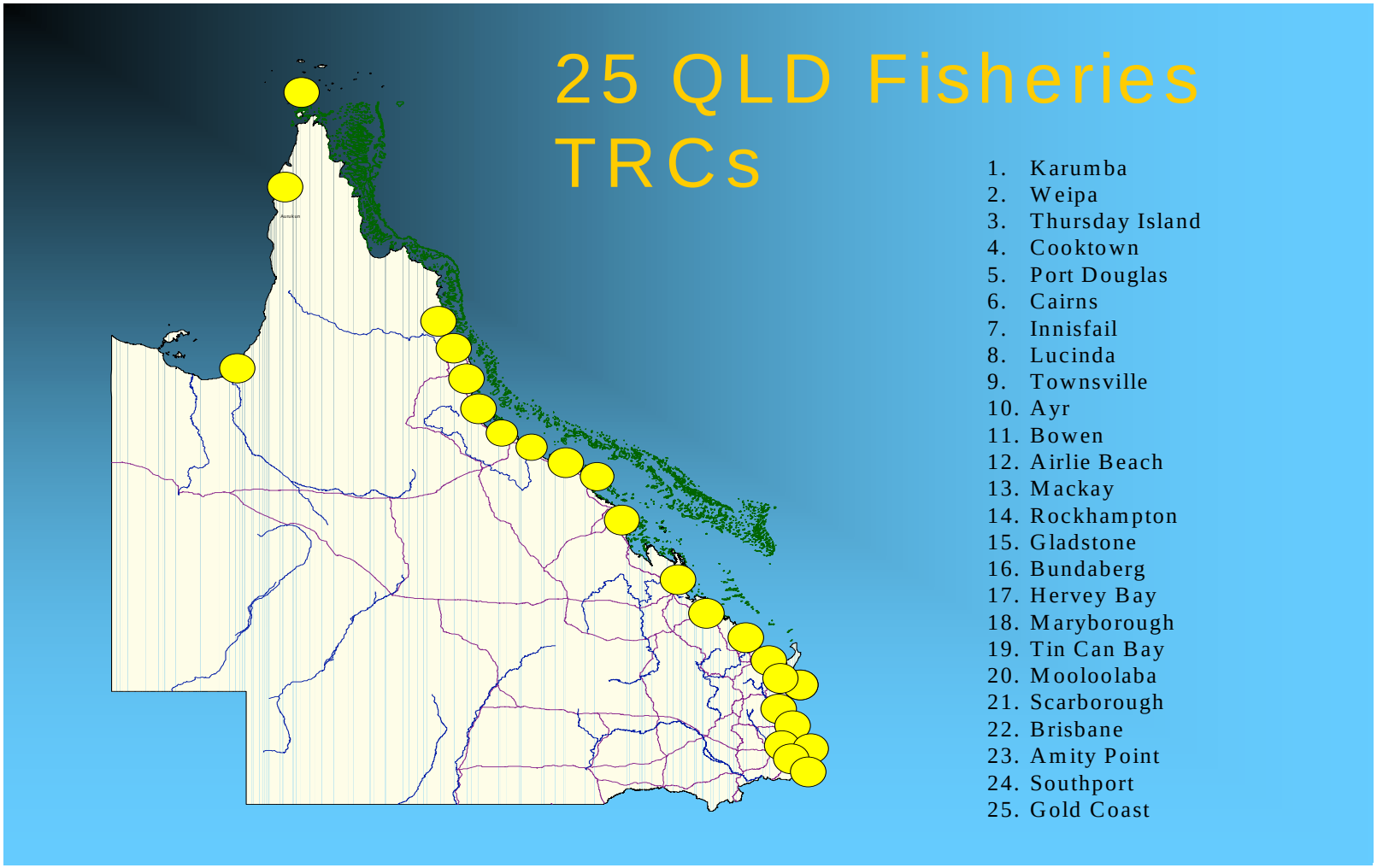


Figure 21: **Cooktown, Lucinda, Gladstone and Port Douglas TRCs: Resource Catchments**
Source: Fenton 2001

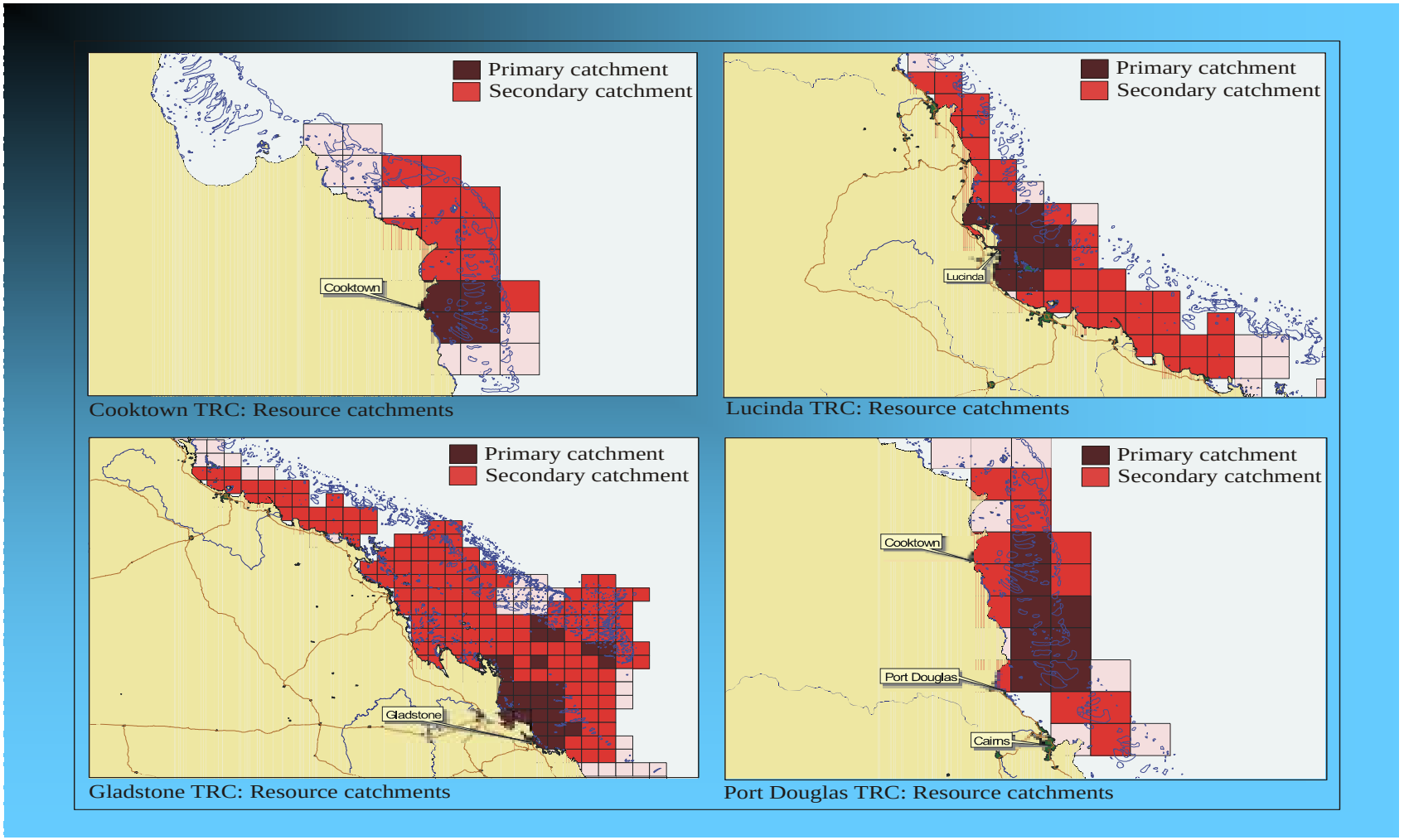


Figure 22: **Gippsland RFA: Location of Native Timber Resource Use**
Source: Fenton 2001

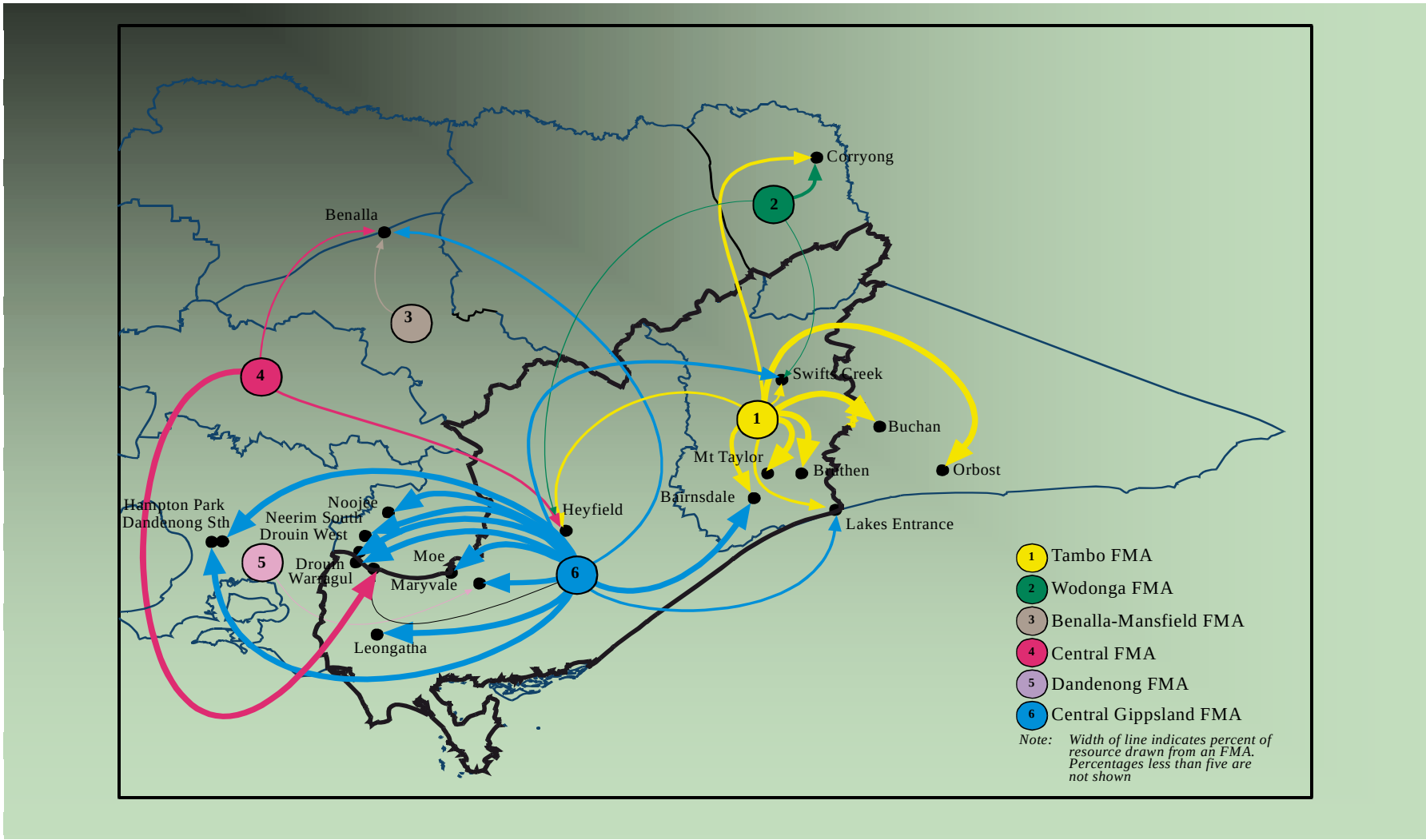
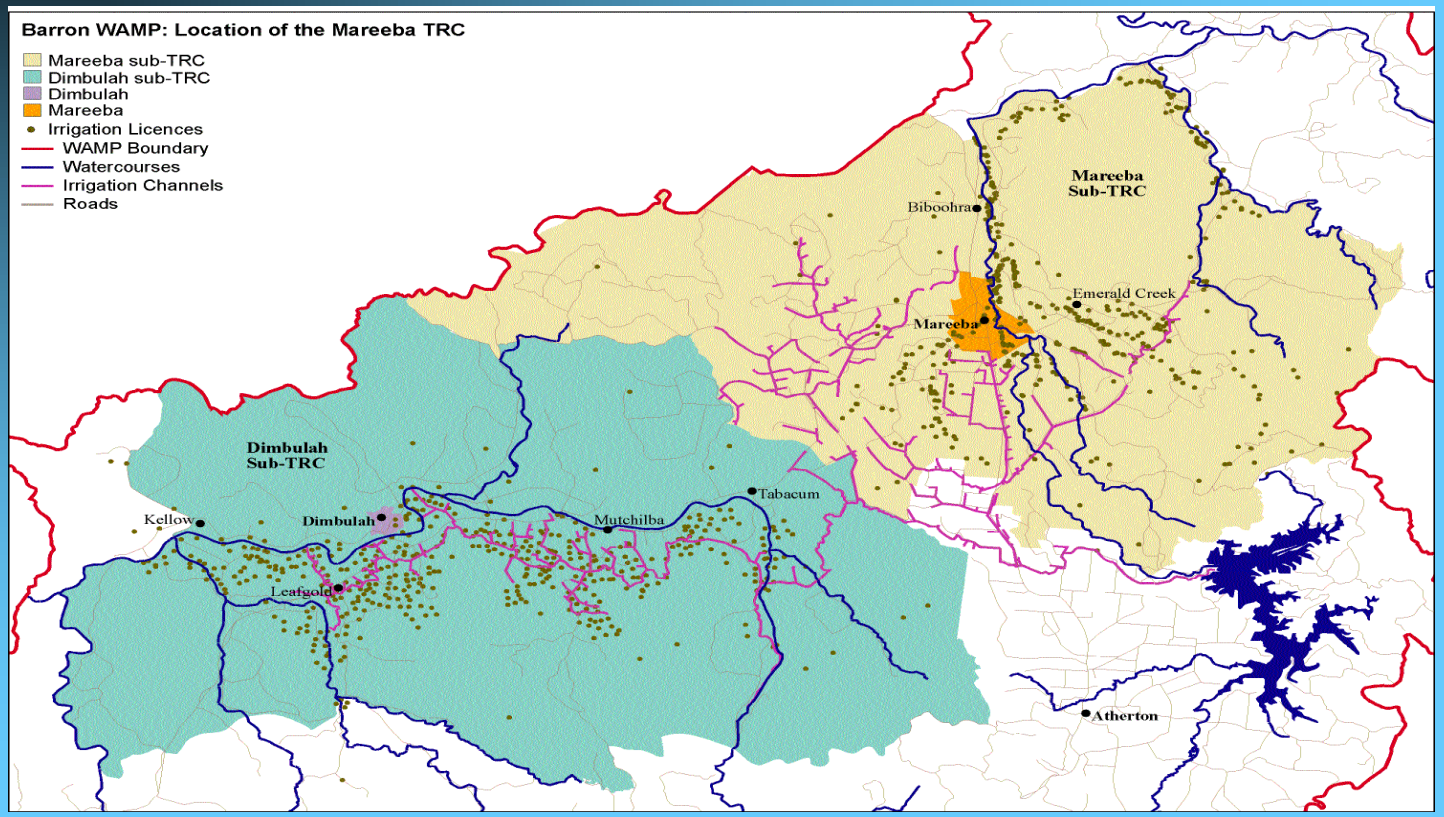


Figure 23: **TRC-Analysis and Water Resources: Barron Water Allocation and Management Plan (WAMP)**
Source: Fenton 2001

TRC-Analysis and Water Resources:

Barron Water Allocation and Management Plan (WAMP)



Patterns and degrees of inter-town dependency were established through a range of primary and secondary data collection activities concerning:

- business expenditure,
- employee expenditure,
- employee residential locations
- social infrastructure services and facilities
- social networks.

This information was collected from structured interviews, survey research of business owners and employees directly involved in resource production (eg. fishermen, timber mills, logging contractors, irrigation farmers etc.). These data are put together to derive a set of measures of inter-dependency between towns. Table 6 presents an example of a set of measures derived in a study of a fisheries-based TRC in the Lucinda area of Queensland. Fenton has identified 25 Queensland fisheries TRCs along the coast of Queensland as depicted in Figure 20. For each of the TRCs there is a secondary and a primary catchment identified and four of these are depicted in Figure 21. Another example of application of the TRC methodology to native timber resource use is shown in Figure 22. This shows the linkages established between towns in the Gippsland area according to links in forestry-based activities. Similarly, the approach has been used to delineate TRCs on the basis of use of water resources. Figure 23 shows the TRCs defined in the Barron region.

Gravity Models

As is the case with the Smailes-type approach to defining social areas in non-metropolitan areas, the TRC analysis considered so far is quite intensive in terms of primary data collection. However, Fenton and his colleagues have recognised this and have investigated ways in which TRC analysis could be undertaken using more readily available information. This raises an important general issue relating to the delineation of social catchments in Australia. This can be summarised as follows:

> *Is it possible to use secondary information and computer-based modelling techniques to derive social catchments as an alternative to intensive primary data collection techniques?*

A key point here is:

> *Having derived such a secondary data-based methodology, this needs to be 'ground-truthed' against the results of more intensive definition methods through undertaking a number of case studies to test the results of the secondary data modelling against those of intensive methods.*

Fenton and his colleagues have suggested that gravity models be utilised to generate social catchments. Working at approximately the same time as Christaller (see previous discussion on *Central Place Theory*) was another geographer, William J. Reilly (1899-1970) who was also interested in the concept of hinterlands. He drew upon the earlier work of Henry Carey (1858) who, like Christaller, had recognised that a large city is more likely to attract an individual than a smaller town. Carey believed that the attraction of central places could be determined by a simple formula developed from Newton's *Law of Universal Gravitation*. This came to be known as the *Gravity Concept* where the expected interaction *(I)* between two places, *a* and *b*, can

be calculated by using population size *(P)* as a surrogate as a measure of mass, so that:

$$Iab = \frac{PaPb}{Dab^2}$$

Using the population and distance inputs of the gravity model, Reilly (cited in Carrothers 1956) concluded that the breaking point or boundary marking the outer edge of either of the central places' hinterlands could be located by the expression:

$$BP = \frac{Dab}{1 + \sqrt{\frac{P_b}{P_a}}}$$

where: *BP* = distance from central place *a* to the breaking point (or boundary)
Dab = distance between central place *a* and central place *b*
Pa = population of central place *a*
Pb = population of central place *b*

The use of gravity models in social catchment analysis fundamentally involves the determination of the breakpoint between two adjoining catchments. In the case of urban fields it would involve drawing the boundary between the catchments of adjoining urban areas at the same level of the urban hierarchy.

Fenton and his colleagues have carried out a comparative analysis using primary survey data from farmers and secondary data using gravity models to derive TRC water resources regions in southern Queensland as depicted in Figure 24.

As indicated earlier, in the theoretical central place system the nested hierarchy is one of hexagons. However, as Brunckhorst (2000b, 2000c) and Brunckhorst and Coop (2001) demonstrate there are some obvious limitations in describing hinterlands as neat hexagons. Christaller's (1933) model assumes a topographically uniform plain with a uniform population density. He also assumed that central places of the same order will have hinterlands of the same area and configuration. Clearly such assumptions are problematic if we wish to take account of natural variability in the landscape and go someway to reflect reality. One method of overcoming the hexagon problem is with the use of *voronoi* diagrams. Voronoi diagrams have had numerous applications in many disciplines including astronomy, physics and social science. A notable social science application is in modelling retail trade areas (Boots and South 1997 and 1999) and possible applications also exist for defining social catchments. In its simplest form, the 'ordinary' voronoi diagram can be derived geometrically by drawing a line between two urban centres on a map, dividing the distance along the line by two and then drawing a perpendicular line. This line then becomes the Breaking Point (BP)or boundary edge between the two urban centre's hinterlands. All the corresponding hinterland boundaries for all the urban centres in question can be constructed in this manner (Figure 25).

Figure 24: **TRC-Analysis and Water Resources: Burnett Water Allocation and Management Plan (WAMP)**
Source: Fenton 2001

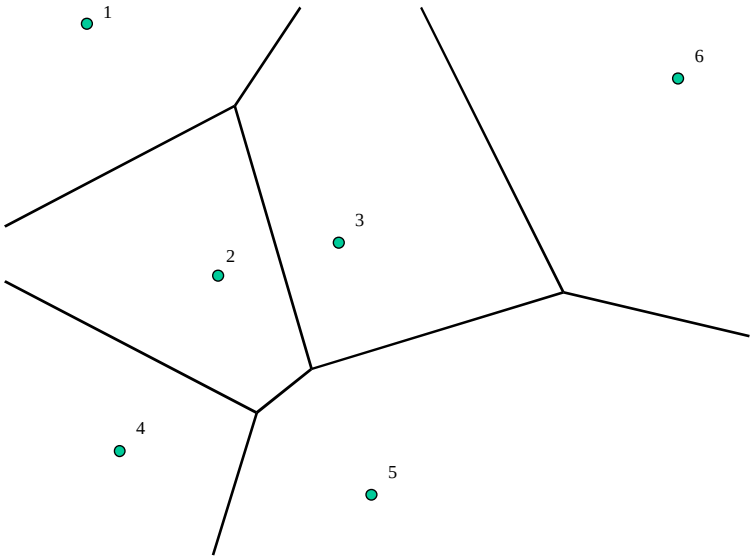
TRC-Analysis and Water Resources:

Burnett Water Allocation and Management Plan (WAMP)

Confirmation of TRCs through:

- Gravity models (secondary data)
- Survey data from farmers (primary data)

Figure 25: Hypothetical Ordinary Voronoi Diagram Depicting Hinterlands

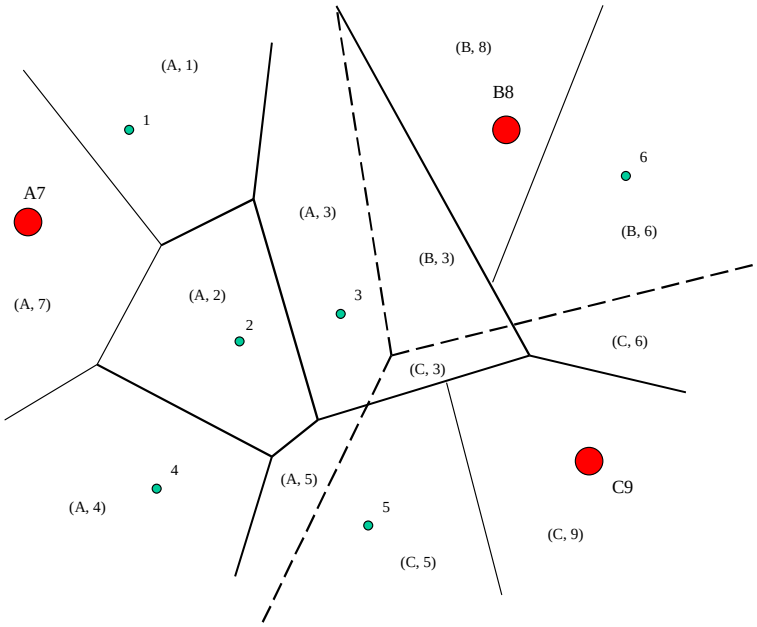


While the ordinary voronoi approach overcomes the hexogen problem, there remain at least two other problems. First, the developed hinterlands do not take account of the hierarchical order of towns. Second, the hinterlands do not reflect the range of the goods and services that the towns provide. In other words, the constructed hinterlands will inevitably be either under or over-estimated so long as the distance for placing hinterland boundaries is determined by simply dividing the distance between towns by two. This problem may be overcome by introducing *gravity modelling* into the voronoi construction.

In a study of small towns in northern Australia, Macgregor (1996) incorporated the gravity formula to modify the ordinary voronoi diagram approach. The net effect was to move the *BP* closer to the smaller of the two central places in question. However, population is not the only data option. For example, in a study of West Australian wheatbelt towns, Jones (1983) used functions and functional units to determine the hierarchical order of the towns and then used the functional units in a gravity model equation to determine hinterlands. While this approach requires acquisition of reliable service provision data, the merit of the method lies in the fact that it draws attention to the 'attractiveness' of the centres because it is more likely that services attract than population, which really acts more as a proxy.

The above approach clearly portrays the hinterlands of larger towns better but, as mentioned previously, the approach still does not take sufficient account of the hierarchical nature of the towns. A preferable approach would be to also integrate the hierarchical orders of the towns into hinterland construction. One approach to this involves constructing 'higher-order' voronoi diagrams for each of the hierarchical orders revealed by the hierarchical order graph (Boots and South 1999). If, for example, there are two hierarchical orders then the corresponding hinterlands can be represented by over-laying two voronoi diagrams (Figure 26).

Figure 26: 1st and 2nd Order Towns with Corresponding Hinterlands



In the hypothetical example above there are six first-order towns (numbered 1 to 6) and three second-order towns (numbered A7, B8 and C9). The first-order towns have hinterlands depicted by the solid lines eg areas (A, 2), (A, 6), (C, 5) etc. However, second-order centres have hinterlands depicted by the dashed boundaries so that town A7 has a first-order influence over area (A, 7) and a second-order influence over areas (A, 1), (A, 2), (A, 4) and parts of first-order hinterlands of towns 3 and 5 defined here as (A, 3) and (A, 5).

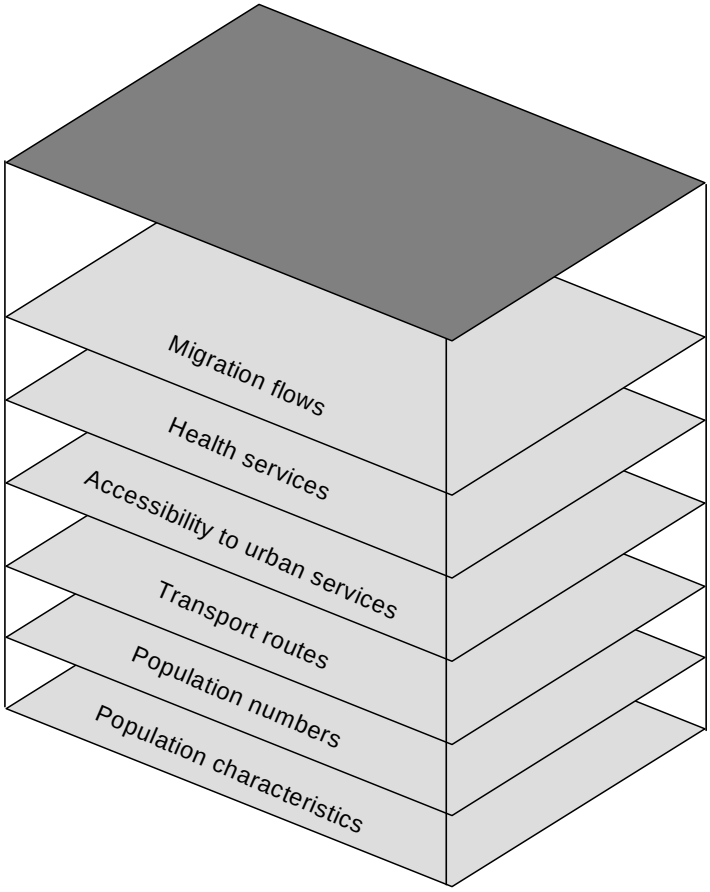
Theoretically, there is no limit to the number of hierarchical orders one could accommodate by the higher-order voronoi method. However, Okabe and Sadahiro (1996) advise that little can be gained by considering a configuration beyond seven (similar to Christaller's hierarchy of the administrative principle). But in practical terms, there seems little benefit in depicting more than three or four orders, particularly where the interest is at regional scales, and given the practicalities of government administrative processes and service delivery.

It is important to acknowledge that there are limitations in developing survey methodologies based on the theories of Christaller and Reilly. As mentioned above, 'real' world hinterland boundaries never follow the exact mathematical lines derived by any of the above calculations. Hierarchies and the hinterland boundaries are 'fuzzy' and are determined, not only by the quantity of services, population and the distance between central places, but also other factors such as topography, the direction and condition of roads, the types and variety of goods and services, and even the personal preferences and values of individuals. As Brunckhorst (2000c, 39) points out 'any kind of regionalisation [regardless of scale] is a human construct no-matter how it is built…its [ultimate] value lies in its acceptance and usefulness rather than how accurately its boundary line is placed'.

The Use of Geographical Information Systems (GIS)

It is certain that if a national system of deriving social catchments is developed it should be put within a Geographical Information System (GIS). This would enable the derivation of catchments to be done more effectively and quickly than use of any other method. GIS are sophisticated computer-based systems for the capture, storage, manipulation, analysis, retrieval and graphic presentation of spatially referenced information. Spatially referenced information is information whose specific location on the earth's surface is known, ie its precise latitude and longitude are known.

Figure 27: A Simplified Model of a Geographical Information System



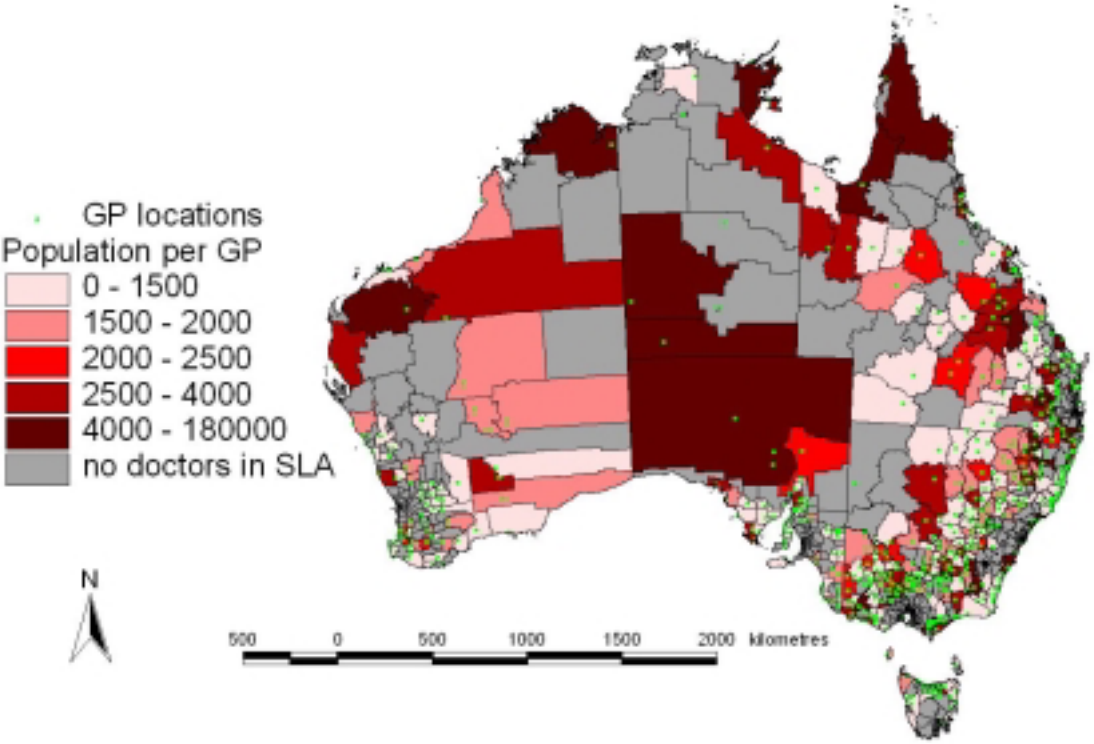
Spatial referencing gives added value to such information since it allows not only consideration of the information itself (things such as characteristics of places or people) but allows it to be related to other characteristics of the point and the area in which it is located and for its relationship to other points on the earth's surface via measures of accessibility, connectedness etc. GIS can be depicted as a series of layers of spatially referenced information as depicted in Figure 27. GIS allows us to cut vertically through the layers of information and considers all the information from each layer at a particular point on the earth's surface. Hence it facilitates traditional geographical analysis which involves spatial analysis. However, GIS can greatly facilitate this due to:

- The fact it can handle huge amounts of information with rapidly developing computer-based technology and methodology.

- The information in the various layers can be of different types – point, area or flow information – eg population numbers, soil types, transport routes etc.
- The layers need not use the same spatial units for presentation of information.
- Traditional spatial modelling can be done on a scale and with a speed not previously considered possible.

Clearly GIS has a great deal to offer in the delineation of catchments. An example of how GIS can be used in this way is given below and relates to the areas served by general practitioners across non-metropolitan Australia. If traditional spatial units are utilised to examine the distribution of General Practitioners (GPs) in Australia the pattern shown in Figure 28 results. This shows a pattern of under-provision of doctors in the more remote areas. However, the use of SLAs as the units of analysis in the diagram can produce misleading results. Figure 29 shows how a situation can arise where, because GPs are concentrated in one SLA, people from adjoining SLAs can use the GPs although their doctors are not located within the boundaries of their SLA. Hence in Figure 29 the SLA of Coolgardie with two doctors for 6,000 residents, shows up as underprovided while neighbouring Kalgoorlie, with 28 doctors for 29,000 people, has high levels of provision. However, in practice many Coolgardie residents travel to Kalgoorlie to use the doctor. A GIS approach can derive more appropriate spatial units to assess the adequacy of GP provision.

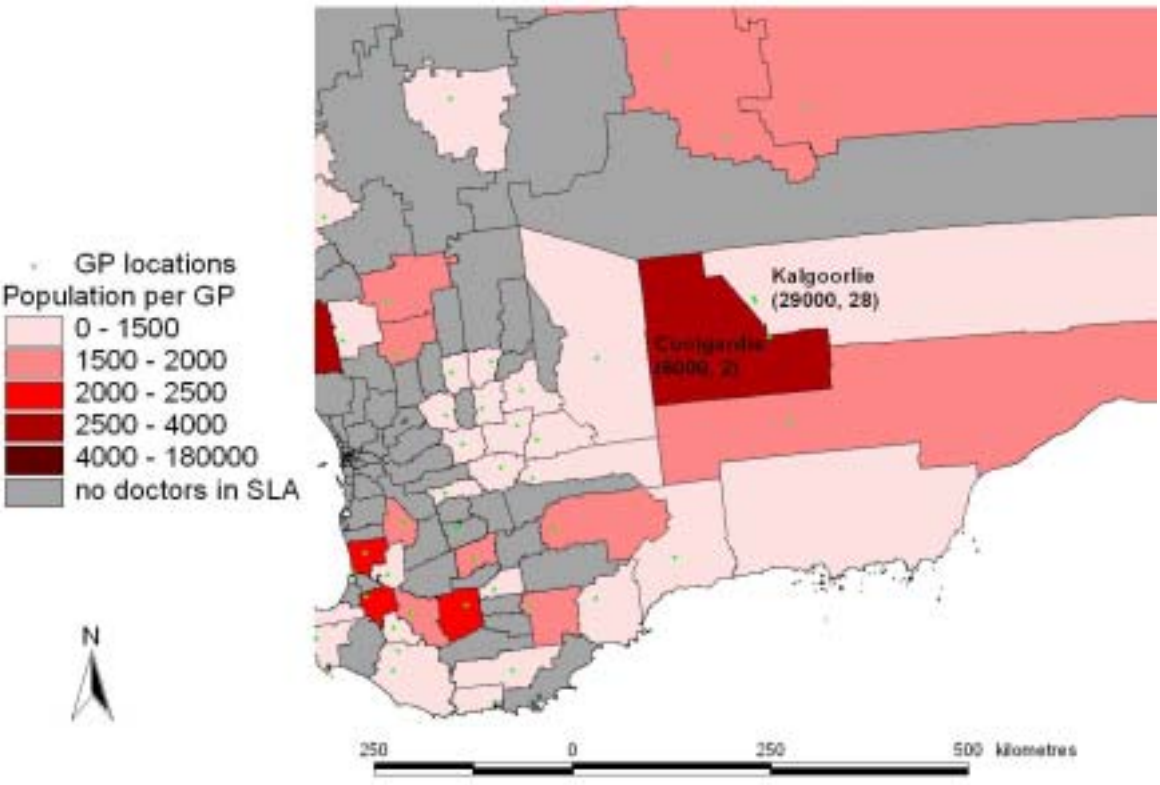
Figure 28: Population per GP for SLAs
Source: Bamford and Hugo 2000



A GIS approach involved the following steps:

- The location of all GPs in non-metropolitan areas was fixed.
- All 11,338 populated localities in non-metropolitan Australia were allocated to their nearest GP by road. This was done by including all roads in the GIS and the GIS calculated the nearest road distance.
- This allowed the following map of 'natural catchments' for GPs to be defined and the level of provision in each catchment to be calculated (Figure 30).

Figure 29: Population per GP in WA
Source: Bamford and Hugo 2000



It is clear that a more realistic picture of patterns of provision is provided by using these 'natural' GP catchments than is the case with SLAs. Figure 31 overlays the natural catchments with SLAs and the differences are readily apparent.

An alternative approach to deriving the GP catchments from using the nearest GP is to use information on actual usage of GPs. This can be derived from the Medicare data maintained by the Health Insurance Commission or it can be obtained directly by interviewing GPs and asking from where they draw their patients. The latter approach has been utilised in Queensland where all non-metropolitan GPs were surveyed and asked:

- The proportion of their patients derived from within the central place in which they are located.
- The other places from where they derive patients.

Figure 30: **Natural Catchment Boundaries for GPs**
Source: Bamford and Hugo 2000

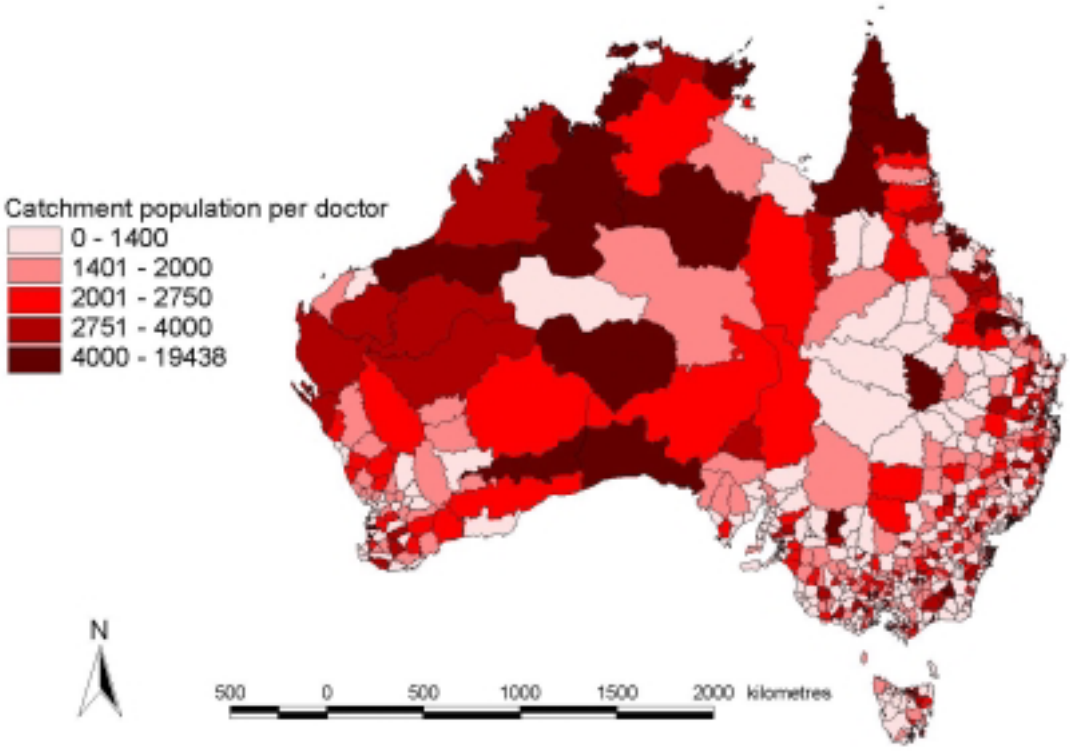


Figure 31: **Natural Catchment Boundaries for GPs and SLAs**
Source: Bamford and Hugo 2000

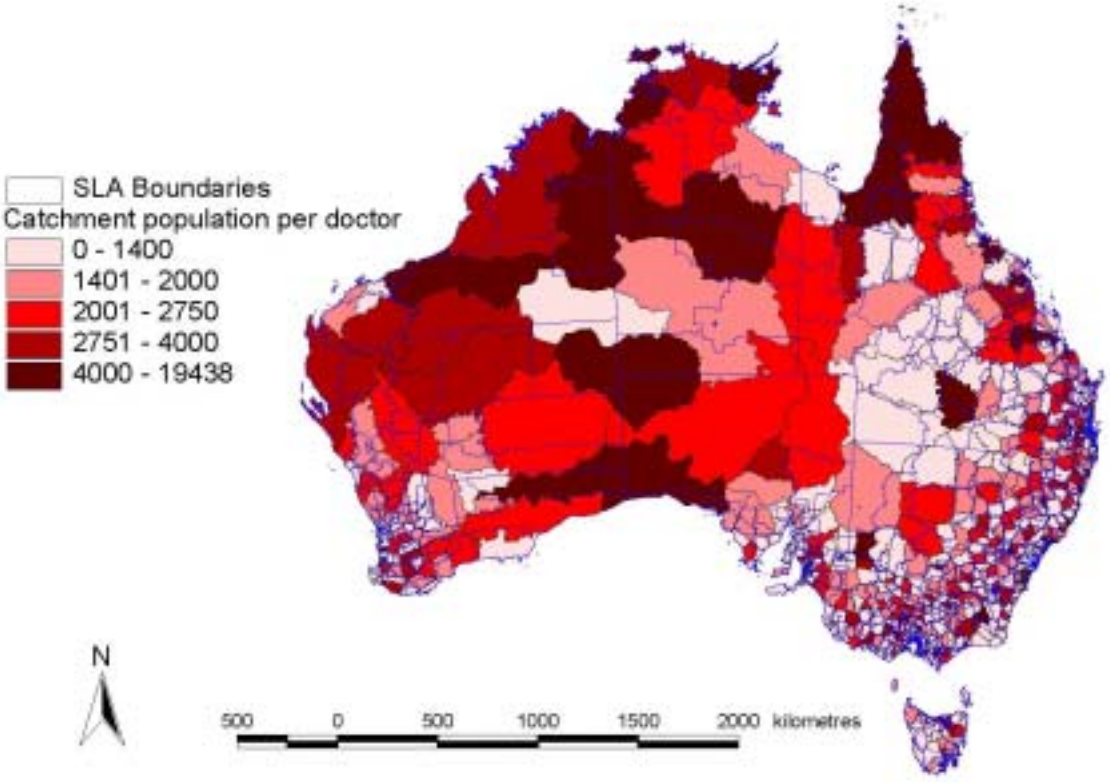
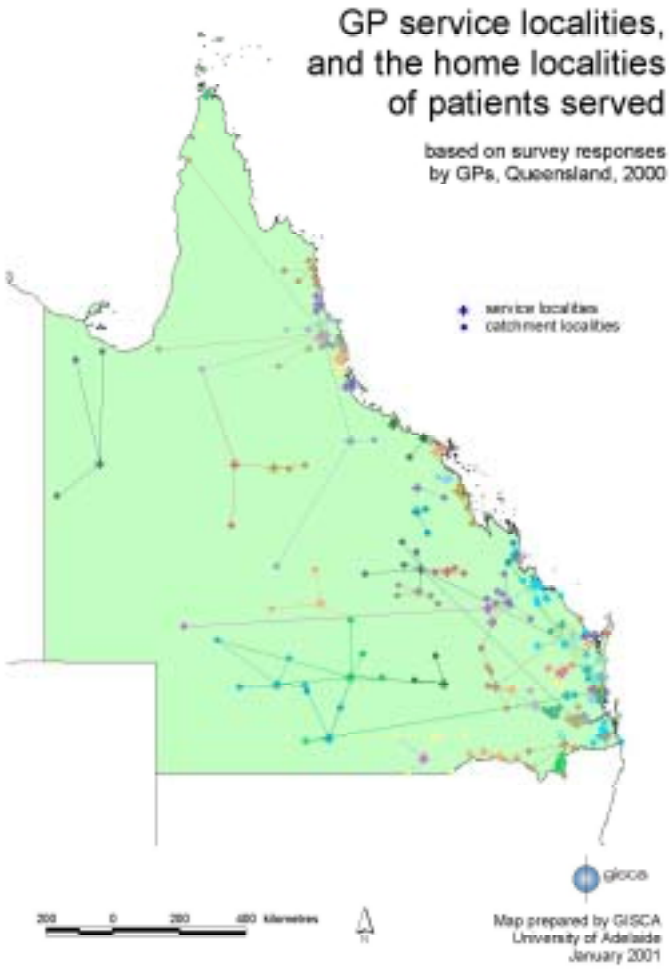


Figure 32: GP Service Localities, and the Home Localities of Patients Served
Source: GISCA, Adelaide University



This allowed the use of GIS to draw in the catchments of GPs. Figure 32 depicts the overall pattern obtained in Queensland while Figure 33 illustrates how it is possible to 'zoom in' on local areas in a GIS.

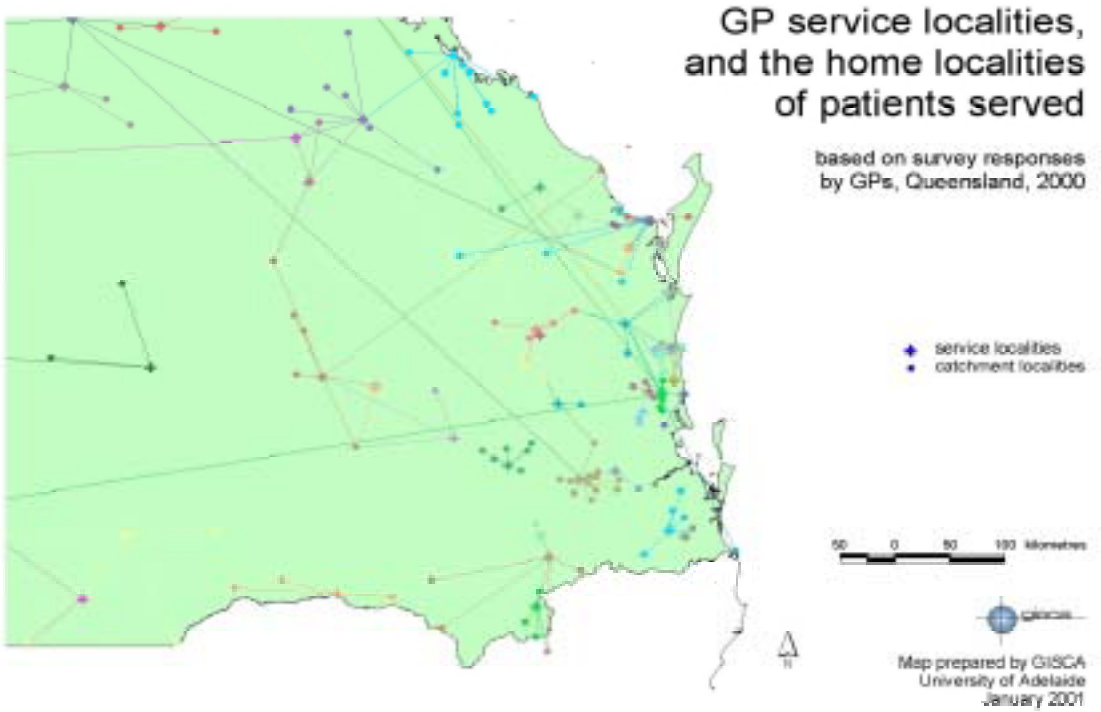
What is the relevance of this for social catchment analysis? It is apparent that a GIS can be created to allow the development of 'natural catchments' for central places in a similar way that natural catchments were calculated for GPs in the example presented above. It would seem that the following spatially referenced data set is required to be included in a GIS to develop social catchments:

- location of all central places,
- details on all functions in each of these central places,
- all roads,
- the distribution of the total non-metropolitan population including some sub-CD information.

This would allow 'natural catchments' to be defined for each function or service in the same way as has been done for GPs.

Figure 33: GP Service Localities, and the Home Localities of Patients Served, Southeastern Queensland

Source: GISCA, Adelaide University



In defining a hierarchy of more generic social catchments, the following would be required:

- An initial step would be to allocate all central places to a national hierarchy of central places. This would require information on the number and types of functions in each central place and these would be used to plot all centres on a graph with number of functions on the X-axis and number of functional units (or total population) on the Y-axis. Natural breaks in the distribution can then be used to establish the number of levels in the national central place hierarchy. Such an exercise would not only be the basis for producing a national system of social catchments but also be highly useful in many other areas of social and economic planning in non-metropolitan areas of Australia.
- Having allocated each central place in Australia to one of the levels of the national central place system, GIS can then be used to establish the breakpoints or boundaries of the catchments between adjoining central places of the same order of the hierarchy. This can be done in either of two ways:

  (a) Firstly, it can be assumed that all central places in a particular level of the national central place hierarchy are of the same size. Then each 11,338 non-metropolitan populated places in Australia can be allocated, using GIS, to its nearest central place in each level of the hierarchy. The breakpoints or boundaries between the social catchments of adjoining central places in the same level of the hierarchy can then be used by GIS to calculate voronoi diagrams to approximate the social catchments of each central place.

(b) An alternative approach to calculating the social catchments is to utilise the data on functions to differentiate the sizes of central places *within* each order of the hierarchy. A gravity model can use data on the number of functions or the population of central places to do this. Hence the breakpoint between two adjoining central places at the same level of the urban hierarchy will not be decided by allocating the dispersed population to its nearest central place but to assume that larger centres will attract people over a wider area than smaller places in the same level of the hierarchy.

- GIS can be utilised to smooth the boundaries of social catchments so a nested hierarchy of catchments is obtained.

This approach allows social catchments to be defined without using detailed primary data collection. Nevertheless, it will be necessary to exhaustively 'ground truth' the results of the GIS-based analysis by adopting a number of case study areas across Australia and undertaking detailed analysis of the Smailes and/or Fenton type. The results of the intensive analysis can then be carefully compared with those of the secondary data analysis. The results can then be used to modify or fine tune the secondary data approach.

Summary

There are a range of new pressures being exerted on rural and regional Australia from policies and institutional reforms that are associated with globalisation (eg the National Competition Policy) on the one hand and sustainability on the other. These have added to the already substantial list of challenges already being faced by non-metropolitan communities. There has been an emerging appreciation of the importance of social capital in the development of non-metropolitan communities. This has brought the issue of social catchments to the forefront. Social catchments can be defined as "the territory occupied by a group of households and individuals who are in some form of regular interaction and which the inhabitants identify as their community or region". Social catchment areas represent 'communities of interest' which can be potent forces shaping people's consciousness and open up the possibility of mobilising group action and group involvement in activities. It is argued that social catchments have the potential for providing a meaningful spatial unit for social, economic and environmental planning in non-metropolitan Australia.

There is a range of approaches to defining social catchments, several of which have been applied to parts of Australia. The discipline of geography was one of the first disciplines to consider the question of social catchments and the work of the well-known urban geographer, Walter Christaller is pivotal in that he was able to provide a theory that both offered a hierarchical system for nesting social catchments but also determining the geographic area of influence. The work of William Reilly is also notable because his gravity model approach partially took account of the spatial distribution and size of the central places of concern.

Both the central place and gravity approaches have tended to be used when the research questions are generic in nature. However, where there may be a more specific research question or context the central issues can influence the methods of definition. The Town Resource Cluster analysis developed by Fenton and his colleagues is an economic natural resource dependency example that clearly has useful applications in the forestry and fishing industry sectors. Brunckhorst et al's approach is one that is more concerned with an ecological context – pulling together

both ecological and social data to define areas that may be regarded as being more meaningful to land managers concerned about natural resource management.

Recent technological developments in the form of Geographic Information Systems (GIS) now mean that we have the opportunity to access powerful spatial data handling and analysis techniques, which make it possible to bring together a wide variety of geographical data sets such as demographic, social, service provision, economic, ecological etc into one data management system. And, while such data may only be available in a variety of different spatial units, the GIS has the capacity to concord such data allowing mapping to more meaningful geographies, such as social catchments, as well as at more useful scales.

Many commonwealth research and planning and/or management agencies could benefit from a national social catchment structure for all urban localities in Australia (central places with 200 or more residents). The range of methods for determining social catchments presented in this discussion paper testify to the diversity of approaches. However, in reviewing the methods it is apparent that hierarchies for planning and management do exist but unfortunately they do not usually conform to convenient jurisdictional and/or administrative boundaries such as those offered by local government or ABS recognised spatial units. There certainly appears to be a case for developing more meaningful social catchments particularly at the local and regional scales and a nested-hierarchical approach is evidently the way forward. Clearly, compatibility with the existing Australian Standard Geographical Classification (ASGC) structure is also important for data accessibility and transfer.

A possible way forward would be to utilise a GIS to capture urban locality secondary data to include sociodemographic/economic attributes the number and type of service functions in each place. This would make it possible to determine the hierarchical nature of the central places and, in itself, would make an invaluable resource tool for planning for, and management of, rural communities. Where available, other relevant data, such as the type and condition of roads can also be incorporated into the GIS to contribute to social catchment definitions. Analysis methods for determining social catchments can utilise methods presented here but the definitions would also need to be tested and refined with case studies.

The plight of rural communities is increasingly of concern to commonwealth, state and local governments. Given the trends to regionalise approaches to planning and management, there is a need for the production of a nationally available data set of non-metropolitan social catchments.

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