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Investigating the Social Dimensions of Transport Disadvantage II: From Concepts to Methods through an Empirical Case Study

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ABSTRACT *This article is the second of two papers that review the field of spatially sensitive social scientific research into the links between social status and transport disadvantage. The first paper undertook a comprehensive review of the social scientific and transport planning literature to mark the level of development in the field and identify conceptual and methodological issues and constraints in this field of inquiry. The present article supports the advancement of socially and geographically sensitive transport research by opportunities for the development of more sophisticated spatial analytical methodologies. The approach we present is able to account for factors not previously addressed in either social or transport planning research, in particular the temporal dimensions of transport service accessibility. The article articulates the methodology through an empirical case study of socio-spatial transport disadvantage within the Gold Coast City. The article demonstrates that there are important theoretical and practical lessons to be gained for researchers and policy makers in addressing the social dimensions of transport and infrastructure provision. Further, the article argues that an attentiveness to new ways of combining and representing social and transport data-sets can promote policy relevant empirical social inquiry. The article also contributes in a productive way to the empirical knowledge of Australia's sixth-largest metropolitan area, which is often overlooked by urban scholars.*

KEY WORDS: Transport, urban, disadvantage, spatial, accessibility, methods

Introduction

Continuing socio-spatial restructuring in Australian cities is changing the dynamics between residential locations and the quality of access to employment and community services provided by transportation systems. Many Australian cities contain large tracts of residential areas where public transport services are either absent or inadequate (Mees, 2000). Such deficits in the provision of public transport mean that for many residents, access to employment and services is constrained or uncertain. In particular, those from vulnerable social groups reliant upon public transport can be subject to mobility

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disadvantage, resulting in diminished capacity to meet their own and their household's economic and social needs (Social Exclusion Unit, 2003; Johnson & Herath, 2004). Such households may be economically stressed by being forced to expend more on private transport, via the ownership and operation of a private motor vehicle, than they can reasonably afford. Levels of 'transport stress' may parallel housing stress in terms of impact on household financial capacity.

To date, however, urban social scientists both in Australia and overseas have been slow in responding to the research imperatives concerning social needs and inadequate transport provision, notwithstanding some recent specific forays (Pennycook *et al.*, 2001; Currie, 2004). Disciplinary boundaries and a lack of methodological sophistication have militated against scholarly progress on this topic. Transport accessibility assessment appears to have advanced with only limited attention to the multi-faceted social deficits this analysis might assist to reveal. The links between transport disadvantage and socio-spatial patterns have been particularly inadequately understood by social scientists and methodologies for comprehending the combined impact of social disadvantage and transport provision remain under-developed. This article aims to assist with the process of developing new methods for comprehending the connections between transport accessibility and social status, with specific reference to the Australian context.

This article is the second of two papers that focus on transport disadvantage and social status in urban Australia. The two papers should be read together as an attempt to contribute in a substantive way to the social scientific theorisation, conceptualisation and investigation of social disadvantage and transport problems in Australia. The first paper reviewed the scholarly and policy literature that is relevant to the consideration of the transport and social status nexus. This review demonstrated that while some attempts have been made to comprehend the transport and social status nexus, there remain important theoretical and conceptual limitations and many gaps in inquiry. In particular comprehending how transport provision impacts on various communities' access to services remains under-explored, particularly in the Australian urban context. The review also assessed the main methodological approaches that have been used to investigate transport and social disadvantage relationships. The majority of methods deployed in transport and social disadvantage research have emphasised one or the other of these dimensions. There are few studies which strongly combine both transport and disadvantage insights and which provide the opportunity for reflection on the socio-spatial methodologies used to achieve these insights.

This article builds from the foregoing review of frameworks for socio-spatial transport analyses by focusing on the ways in which new methodological approaches can:

- advance empirical inquiry and
- provide new tools for policy makers seeking to respond to urban social disadvantage mediated by transport policy.

The results from our investigations presented here do not represent an endpoint in the search for sophisticated techniques by which to comprehend urban social and transport interactions. However, the article marks a point in the development of such methods that we consider is significant both within the Australian context and internationally. This article serves a further purpose in directing social scientific attention to the empirical significance for urban enquiry of the Gold Coast City, which is one of Australia's fastest growing and sixth-largest urban region (ABS, 2005), but which has received very little

rigorous social scientific attention, notwithstanding the notable contributions of Cuthill (2002) and Taylor (2004).

By attending to the Gold Coast specifically we anticipate that our article will assist to further social scientific comprehension of the experience of Australian cities generally regarding transport disadvantage and household social status. While it lacks the concentrated central activity centre that characterises the largest five Australian cities, the Gold Coast is broadly representative of Australian suburban form and is comparable to areas of western Sydney, south-east Melbourne and outer areas of Brisbane and Perth. Such areas exhibit variegated patterns of social advantage and disadvantage combined with dispersed land uses and limited spatial coverage of public transport, although at generally higher residential densities than the suburban 'sprawl' typically found in US cities (Gleeson, 2006). In this regard therefore, the article contributes to the broader application of new developments in techniques for comprehending household social status and transport disadvantage, and reports these developments in a context that is immediately relevant to Australian policy makers.

Together our linked papers constitute an intervention in debates over social polarisation, urban change, and the equitable provision of urban infrastructure and services. Their collective aim is to contribute to improved understanding of the conceptual frames and methodological strategies that can be used to measure and explain the links between the geography of transport service provision and the spatial patterning of socio-economic needs in the contemporary Australian city. The guiding presumption is that access to transport is a spatially conditioned phenomenon that is a major determinant of social advantage and disadvantage. The issues illuminated by the article also highlight broader issues of public transport accessibility and car dependence for the general population, not just the socially vulnerable.

Constructing a New Methodology for Spatial Socio-economic and Transport Inquiry

The first paper demonstrated that there is a social scientific imperative to better theorise and understand empirically the links between the urban spatial distribution of socio-economic status and the access to employment and services via transport networks, particularly public transport. This review found that there is strong reported evidence of a link between the way housing and labour markets operate to allocate households within urban space and the potential mobility and accessibility disadvantage these households face as a result of transport infrastructure and service supply failures. Thus, for example, in the UK context, the inadequate provision of public transport has been identified as a factor in the incidence of social exclusion (Social Exclusion Unit, 2003). In the US context, the spatial mismatch between the residential location of inner-urban minorities relative to suburban employment opportunities has been compounded by inadequate transport linkages (Ihlanfeldt & Sjoquist, 1998). In Australia, some households face diminished access to employment and services through housing market processes which condition their 'choice' of housing locations on the urban fringe (Badcock, 1994; Maher, 1994).

Yet despite social scientific recognition of these social transport and mobility relationships, there have been few studies, internationally and in Australia, which have attempted to discern, at a broad urban rather than local scale, the distinct distributional impacts of the combined geographies of socio-economic status and transport services. Further, few investigations have taken into account divergent social geographies to

appreciate impacts across different categories of households. Nor have there been substantial analyses that have included both spatial and temporal factors in the distribution of public transport services. Also, public transport has typically been seen as a unitary entity, which in reality is subject to wide spatial and temporal variation both within and between cities (Mees, 2000). This article therefore contributes to the task of attempting to close this space within scholarly understanding by combining social and service information to produce a multi-scaled temporally sensitive analysis of the links between social status and transport service provision within one major urban context. The article deploys a novel spatial methodology based on geographical information system (GIS) analysis of social and transport information. A further contribution is to deploy these methods in the Australian context, which differs from both the UK and USA from which much of the literature on urban accessibility and transport social status is derived.

The first paper surveyed the alternative methodologies available to urban social scientists in the assessment of the interplay between social status and transport service provision. Conventional transport models, socio-spatial methods and qualitative assessment were all reviewed in terms of their capacity to illuminate relationships between social patterns and transport systems. To restate briefly, GIS methodologies were found to offer the strongest potential for the fruitful combination of social and transport data, at the scale of the metropolitan area sought in this context. While able to operate at the metropolitan scale, traffic modelling was assessed as being insufficiently differentially sensitive to multiple social categories to be sufficiently useful in the forms of explicit social analysis sought in this area. Further, traffic models are typically calibrated for automobile travel and focus on mobility, whereas the present study is concerned primarily with public transport systems and the specific access these provide to key household resources such as employment and services rather than to all potential destinations generally.

Qualitative analytical methods, such as the 'community mapping' technique used by Johnson & Herath (2004) were viewed as having substantial potential to identify the complex relationships between social status and access to employment and services by public transport. However, such methods are most suited to local scales rather than the metropolitan scale addressed by the present study and by most policy makers.

GIS analyses were assessed in the first paper as having the greatest potential for innovation within socio-spatial analysis of the relationship between household socio-economic status and the distribution and provision of transport infrastructure and services. Nevertheless, contemporary forms of such methods were found to—as yet—lack the capacity to incorporate multiple social categories with not only spatial but also the crucial temporal transport service characteristics. It is this limitation and the imperative to overcome such constraints that informs the present study. Hence this article explores ways to develop and apply GIS techniques that are able to accommodate multiple social categories and link these with the variable temporal characteristics of urban public transportation systems. This combination is critical if the complexity of urban social vulnerability is to be fully appreciated not only as an outcome of social processes that are constitutive of vulnerability, but which also interact in exclusive ways with spatial processes of infrastructure planning and provision. Analyses generated with such insights and methods can then assist to inform the critical debates over the social provision of urban infrastructure and services which these two papers seek to address. Importantly, the methods we offer will better identify those vulnerable groups who fall between

the transport gaps and thus identify for policy makers where improvements to service provision can have positive social impacts.

Integrating Analysis of Social and System Variables

Some transport research has deployed GIS methods in the assessment of spatial access to public transport systems. Murray *et al.*'s (1998) study for example used a 400 metre residential proximity to public transport routes (bus and train) within the Brisbane metropolitan area to assess the level of population access to public transport. This assessment however contained no evaluation of the quality of the services on the routes, such as frequency, periods and days of operation, nor of the differential impact of social geography on the access of different groups to public transport services.

Wu and Hine's (2003) Public Transport Accessibility Levels (PTAL) analysis used GIS to measure transport accessibility in Belfast. Like Murray *et al.*, the PTAL model included a 400 metre 'walking distance' as well as some temporal service quality patterns. However, while this model can be used to generate constructive information regarding the geographic differentiation of public transport services, the assessment did not include an explicit social dimension. The differential effects of socio-spatial patterns on groups who were at potential risk of transport-mediated social disadvantage were not assessed by Wu & Hine (2003).

The study reported in the remainder of this article aims to advance the understanding of the interaction of socio-economic patterns with public transport services. The methodology developed in this study combines social and transport service data via a GIS focused analysis to illuminate how differential social geographies interact with temporal patterns of public transport service to potentially exclude or include groups, or provide relatively better or poorer access to employment or services relative to the general population. In doing so the article seeks to take urban socio-spatial analysis beyond what has been achieved with previous studies to add the capacity of scholars to inform public policy making through the provision of spatial research that is sensitive to the different experiences of potentially vulnerable social groups.

The article also assists to refract the Australian experience of extensive suburbanisation through a transport accessibility and disadvantage assessment lens. Much of the scholarly reporting of methods for spatial transport accessibility assessment has come from the UK (Wu & Hine, 2003), in part as a response to the adoption of accessibility planning in that jurisdiction. US researchers have typically concentrated on automobile accessibility, which reflects the highly limited role of public transport in US cities. UK cities differ in form and structure from Australian cities having in most cases developed from an historic township with much higher densities, concentration of land uses and greater degrees of development regulation. By comparison, Australian cities contain extensive sub-regions comprised of car-dependent low-density suburbs often with dispersed land use activities. The application of the transport assessment methods we present therefore provides a novel engagement with these spatial methods in the Australian context.

Deploying the Methodology: The Gold Coast Case Study

The first paper founded the analysis in urban social geographic science, particularly, ongoing concepts of urban socio-spatial change. Transport disadvantage was theorised as

arising from the combined interaction of urban residential differentiation, labour market restructuring and irregular provision of infrastructure by urban governments. These processes have thrown up a challenge to urban social scientists to comprehend how socio-spatial processes combine with transport infrastructure and services provision to generate complex patterns of social disadvantage. Such processes and patterns have received only limited attention from social scientists.

This article draws on the theoretical standpoint developed in the first paper and above to examine an opportunity to advance the capacity of urban social science to comprehend spatial social and transport relationships. The specific purpose of this article is to test a new set of spatial analytical techniques to assess the extent to which socially vulnerable groups are differentially affected by patterns of transport services provision and the impact of provision patterns on their potential access to employment and social or community services.

The structure of the remainder of the article is as follows: the methods used for analysis are first discussed, after which the Gold Coast City is outlined as a case study area. The empirical findings are considered in four sections: (1) the spatial and temporal coverage of public transport routes, (2) spatial and temporal public transport coverage patterns relative to vulnerable social geographies, (3) comparative accessibility for different social categories and (4) access to areas of employment concentration via the public transport system. The article concludes with a discussion of the major empirical and methodological findings concerning the conceptual and methodological approach deployed across the two papers, the empirical importance of the findings for the Gold Coast context, and the broader issue of socially sensitive transport and infrastructure research.

To test the methodological techniques the article undertakes a case study of the Gold Coast City, Australia (Figure 1), during 2004–2005. The Gold Coast is Australia's sixth-largest and second-fastest growing metropolitan region, yet has received relatively little attention from urban scholars. Australian urban scholarship remains largely focused on the seven state capitals. The Gold Coast region is characterised by a dispersed urban form most of which has been developed since the 1960s. Unlike Australia's larger cities, the Gold Coast area lacks a concentrated central business district, and consists of loosely distributed urban activity centres, many of which are focused primarily on serving the city's dominant tourism areas (Gold Coast City Council, 1998). With little public transport infrastructure, the Gold Coast is highly dependent on automobile travel—only 3.8 per cent of work trips involved public transport modes in 2001 (Gold Coast City Council, 2003). The majority of public transport services are provided by buses. While a regional rail service connects the western suburbs of the Gold Coast to the state capital Brisbane, this link is poorly integrated with either the city's bus network or with urban land use activities. In addition to its urban structural characteristics, the Gold Coast City also displays a diverse urban geography, receiving high levels of inter-state immigration comprised of a wide and spatially variegated mix of socio-economic groups (Taylor, 2004). In general, the Gold Coast has a higher proportion of low-income households and a lower proportion of high-income households, relative to either the rest of Queensland or Australia generally. This income situation is reflected in labour force figures; the Gold Coast has lower labour force participation and higher unemployment than either Queensland or Australia (Gold Coast City Council, 2003).

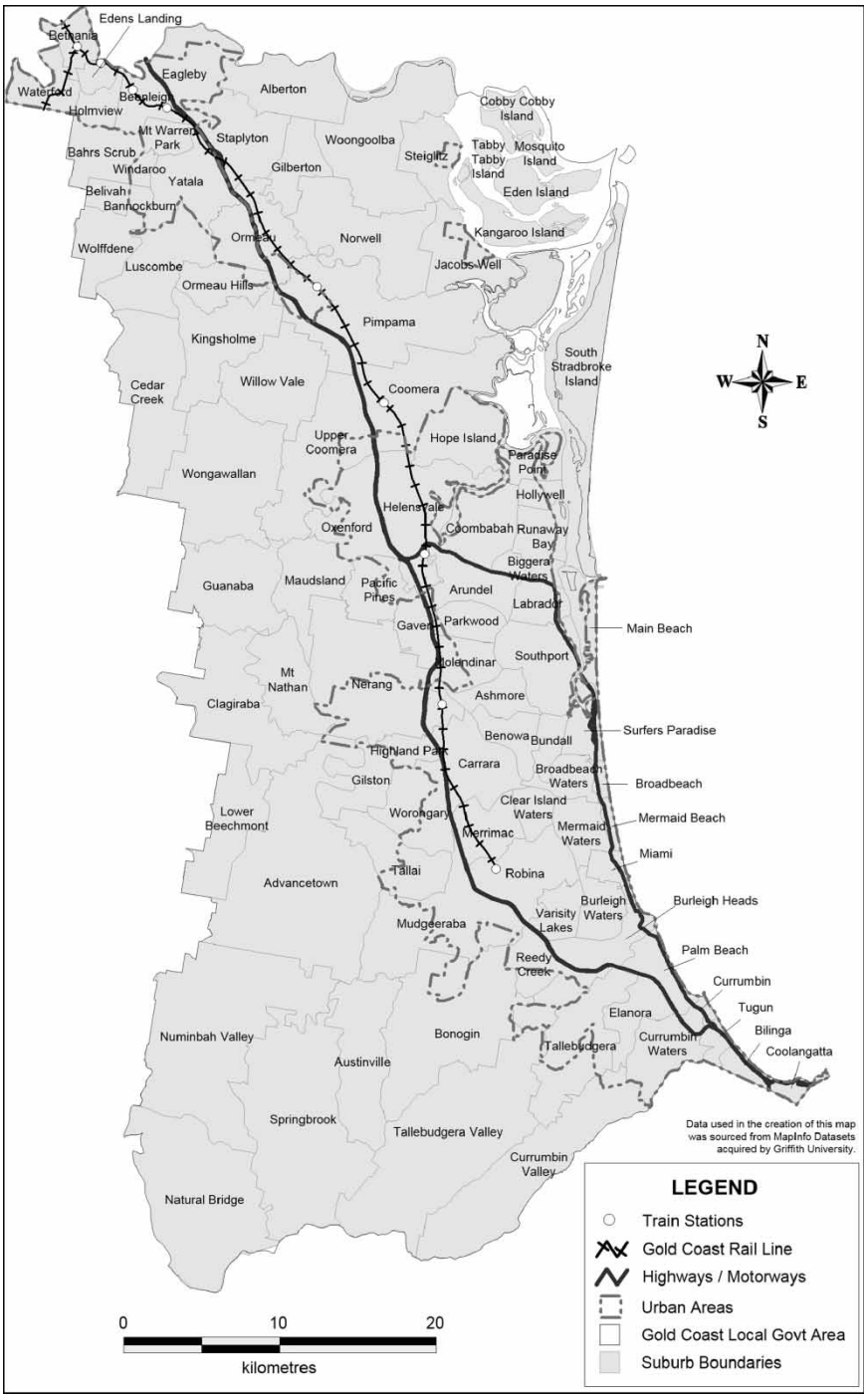

Figure 1. Map of Gold Coast City including suburbs, urban area and major transport infrastructure

GIS Methods for Transport Research

GIS is commonly used in research into public transport systems because it provides for an easy combination of spatial data-sets including public transport routes, land use activities and residential locations. One of the key capacities of GIS software is the capacity to easily generate a spatial 'buffer' around a geographic feature, such as a bus route, which can then be overlain on residential property boundaries and used to determine the number of properties within that given area that are within a specified distance from the public transport route. Hence it is relatively simple, using GIS, to determine the proportion of properties which fall within, for example, 400 metres of a bus route, and accordingly to make assessments of the degree of access to public transport that these properties experience. This is the method used by Murray *et al.* (1998) in their study of public transport access in Brisbane and by Wu & Hine (2003) in their PTAL study. Such methods measure access to public transport as a solely spatial quality.

However, to date GIS-based transport researchers have been poor at including temporal service factors in their assessments of access to public transport services. A further deficit is transport research that goes beyond simple access to public transport as a fundamental human service, to assessing the broader access that public transport services provide to other essential activities such as employment and community services. Finally, GIS has been rarely used to combine socio-spatial and transport data to assess how social geography impacts on the access to public transport experienced by different social groups, and similarly on the access such groups have to broader employment and services. The Gold Coast study tests a new approach which seeks to combine the imperative to account for temporal public transport service factors with sensitivity to the highly differentiated social geography of contemporary urban regions and the degree of broader access to employment and services provided by public transport networks.

Including the Temporal Dimension

The spatial distribution of public transport services provides a gross indication of the degree of 'access' provided to local populations by the system. The Queensland government's Translink agency, which plans the public transport network within the South East Queensland region, holds digitised information on the Gold Coast public transport system, including route and timetable information. Using GIS the route characteristics of the Gold Coast City public transport network can be easily mapped.

The basic route structure of the Gold Coast City public transport system relative to the urban area of the city is provided in Figure 2, with the 400 metre distance from each route indicated. Despite some large gaps in service coverage, Figure 2 suggests that the Gold Coast urban area is comprehensively covered by bus routes with some highly limited rail coverage. This gross assessment is supported by the social information provided in Figure 2 which depicts population levels as the scale of the Census Collectors District (CD).[1]

A methodological issue arises here with the combination of population and public transport service information within a GIS system. Census data provides the most complete and comprehensive basic population data-set available, particularly regarding social categories. However, as noted above, local level Census data is aggregated into CDs, for which the boundaries are largely arbitrary and only approximately related to

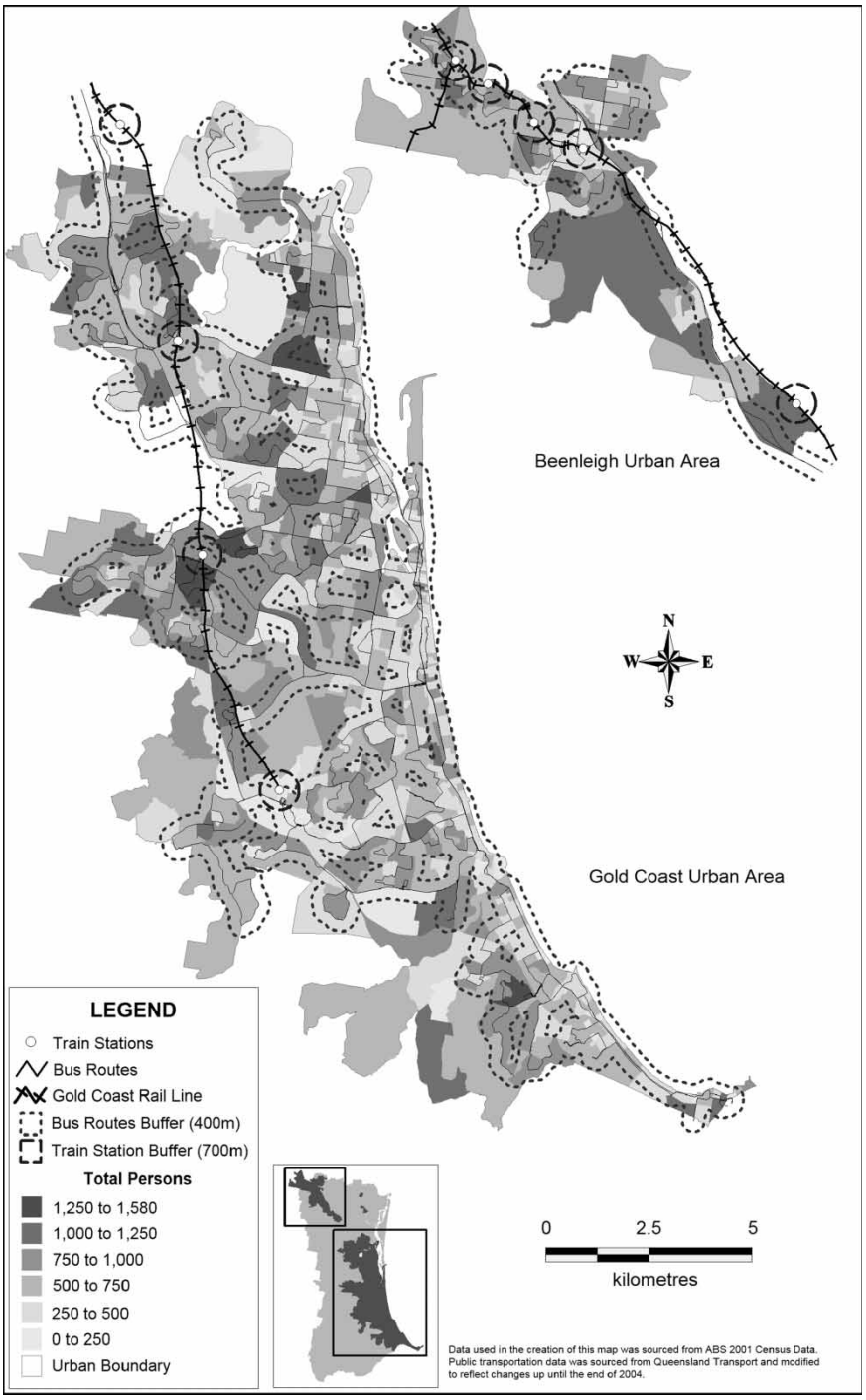

Figure 2. Gross spatial coverage of public transport services relative to population location within Gold Coast City

property boundaries, street network or suburban boundaries; CDs are almost universally larger than individual property boundaries. The calculation of the spatial coverage of the population by public transport routes at the local scale is complicated by the fact that route buffers often intersect but may not entirely cover CDs, especially in areas of lower population density where CDs tend to be larger.

To address this problem the study therefore imputed a 'centroid' for each CD, using GIS software, and used this point to calculate whether the population of a given CD was 'covered' by the 400 metre distance to public transport or not. Inevitably this method leads to some inaccuracy in the calculation of population coverage at the level of individual CDs as the actual resident population may be unevenly geographically distributed within any given CD. However, we assume that over the aggregate urban region differences of inclusion and exclusion of CDs from the 400 metre buffer largely even out. Other researchers who have used GIS modelling approaches have proposed means to overcome this problem. Somenahalli *et al.* (2004), for example, have used sophisticated GIS and statistical techniques to account for the technical problem of using spatial 'buffers' of public transport routes for social transport analysis at the Census CD scale. Their methodology sought to overcome the problem of a route buffer partially covering a CD leaving part of the unit, and conceivably some of the residents, without adequate transport access. Somenahalli *et al.*'s method accounted for this partial coverage problem by creating an algorithm to allow fractional distribution of CD population which could then be more closely matched to actual public transport route buffers. However, upon comparing these two buffer assessment methods they found that the differences in results obtained through their approach differed little from conventional buffering. These results appear to confirm that the partial, full or centroid buffer methods of assessing transport disadvantage using Census data are methodologically insignificant, a finding that supports the use of the 'centroid' method in the present analysis.

An alternative approach could be to combine CD-level population information with property-level information to assign population to individual residential land parcels and then use these individual parcels as the unit of coverage analysis—a method that we are continuing to develop. However, the problem of decomposing CD-level data to individual properties remains. Time and resource constraints mitigated against adoption of these extensive levels of spatial methodological precision for the present study. We consider the use of CD-level population data to be suitable for the purposes of our present analysis, particularly at the metropolitan scale of investigation.

The gross depiction of the service coverage could be assumed to indicate high levels of service provision within the city relative to population concentrations as Murray *et al.*'s (1998) study of Brisbane suggested for that city. However, the gross coverage is innocent of hourly and daily variations in service operation. Many bus routes operate at higher frequencies during peak morning and evening travel periods and often reduce or withdraw services during weekends. Such temporal variations can dramatically impact upon the access to employment and services experienced by populations. A more sensitive GIS analysis needs to account for such temporal variations in access to public transport services.

This study attempts to incorporate temporal factors into the spatial coverage analysis. We achieve this through the addition of bus and train timetable information to the GIS database. At the time of the study this process was undertaken manually through inspection of the published timetable for each bus and rail route, however, recent upgrades to the regional public transport data-sets mean this data is now available electronically.

To assist analysis, public transport timetable information was coded into temporal and qualitative categories via the GIS software. Hence each day was divided into four periods imputed from assumed patterns of travel demand. These travel periods are:

- start of service to 9:30 a.m. (morning peak);
- 9:30 a.m. until 3:00 p.m. (inter-peak);
- 3:00 p.m. until 7:00 p.m. (evening peak);
- 7:00 p.m. until the end of service (off-peak).

Service frequencies per travel period were calculated and categorised for each bus route. The categories assume that higher frequency equates to higher quality, as suggested by Mees (2000). The categories used in this study are, in descending order of quality:

- at least every 15 minutes (high frequency[2]);
- at least every 30 minutes (mid-frequency);
- service interval of more than 30 minutes (low frequency);
- no service.

The categories above were used to construct a four by four matrix of service frequency by period of the day for each day. However, as timetables were essentially unchanged between weekdays these were treated equally. Saturday was treated separately while Sunday services were discarded because service frequencies were found to be so low that the majority of routes fell into the 'no service' category.

The categorised and tabulated temporal and service categories for each bus route were then used to map service quality at the level of each CD within the Gold Coast City. The level of public transport service within 400 metres experienced by the population of each CD during the morning weekday peak travel period is depicted in Figure 3. The analysis presented in Figure 3 demonstrates that high frequency public transport services are concentrated within discrete corridors within the Gold Coast City during the weekday morning peak period, particularly along the Surfers Paradise coastal strip and extending into the northern hinterland. Further high frequency services operate within the separate urban area of Eagleby while some high frequencies are associated with the rail links at Nerang and Robina.

A wider group of areas receives service frequencies of at least every 30 minutes while a broad proportion of the Gold Coast City receives services during the morning peak of either less than every 30 minutes or no service at all. In particular, the expanding suburban areas around Nerang, Worongary and Mudgeeraba are very poorly served. The analysis also highlights the lack of west–east linkages, a matter of some policy concern given that the largest employment concentrations in the Gold Coast City are situated in the Southport/Surfers Paradise areas.

Further spatial coverage maps were prepared for other day and time combinations. Like Figure 3, these are comprehensive and presentation here is not feasible. To summarise briefly the spatial temporal coverage for inter-peak and evening off-peak public transport services on weekdays is reduced compared to that for the weekday morning peak period services depicted in Figure 3. High frequency services are restricted to the Southport–Surfers Paradise corridor. The situation for Saturdays and Sundays is comparably limited.

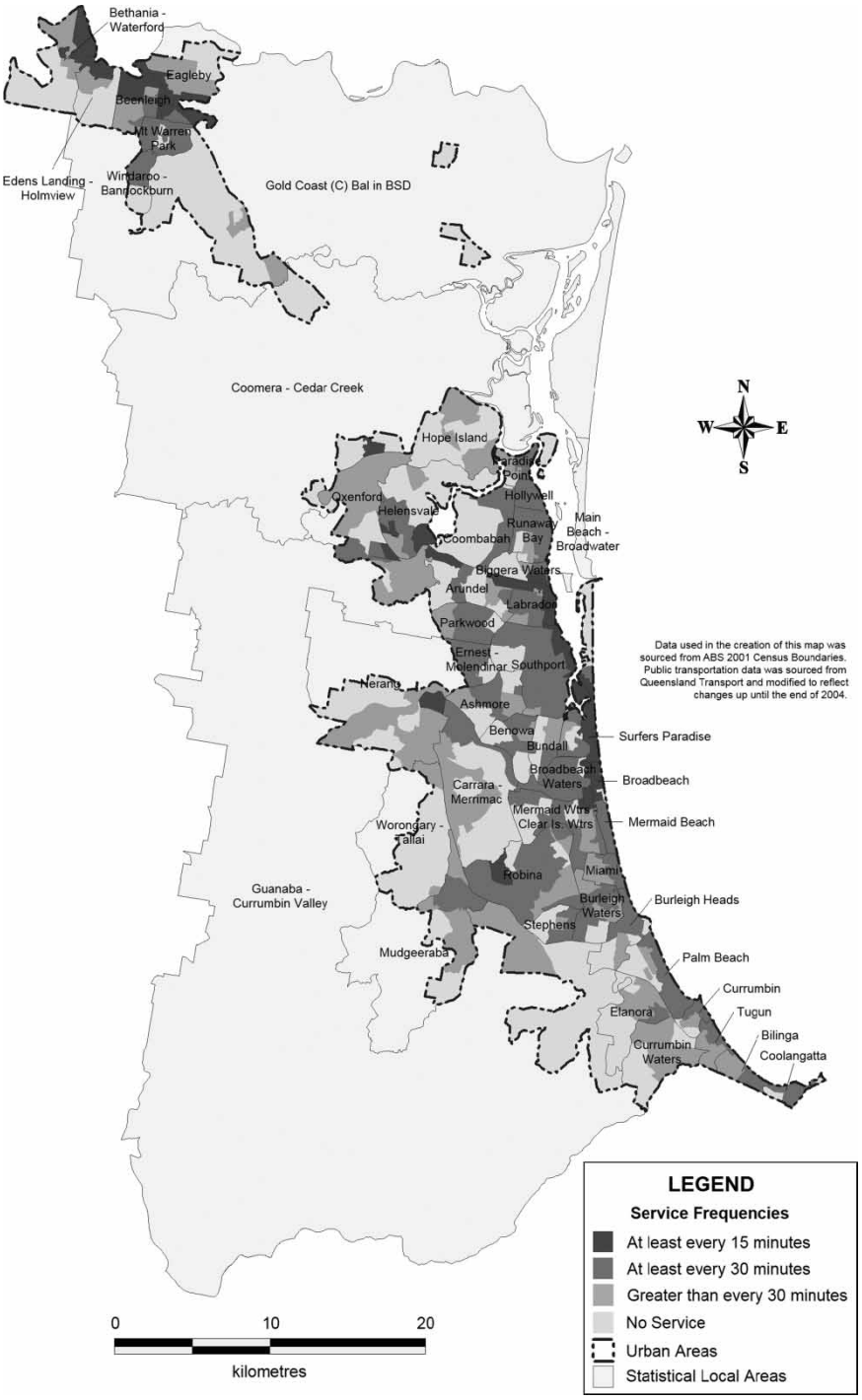

Figure 3. Service coverage and frequency for Gold Coast urban area during weekday morning peak

Incorporating Social Dimensions

The analysis provided above concentrates on the assessment of spatial temporal coverage of public transport services for the Gold Coast City generally. Like many urban areas, the Gold Coast City is highly socio-spatially differentiated (Gold Coast City Council, 2003; Taylor, 2004). Various social groups are more prevalent in some areas than others. For example, the unemployed are most concentrated in suburbs such as Labrador, Southport, Stephens, Coolangatta and Eagleby within the Gold Coast urban area, while those within the 5–14 years age group are dispersed mainly along the western urban fringe. The concentration of high quality public transport services within restricted spatial corridors is therefore likely to differentially impact on some social groups when compared to others, in terms of the access to employment and community services that public transport provides. Developing spatial methods to comprehend this differential distributional impact is the second major focus of the present study. The remainder of the article thus presents our second contribution to social scientific inquiry into the relationship between transport and social status in terms of the methodological advances we are seeking to achieve.

Simply stated our analysis seeks to connect socio-spatial Census information with our temporal mapping of public transport services. Spatial Census data is widely used in Australia for mapping purposes and we seek to extend the potential research questions with which this Census data can be interrogated. A wide range of social groups could be considered relevant to the analysis of transport disadvantage whether due to social factors or personal capacity. From the literature review undertaken in the first paper, we chose the following social categories for further investigation in this study:

- low SEIFA[3] households;
- the unemployed;
- low-income households;
- persons aged <14 years;
- persons aged >65 years;
- renter households paying $<\$150$ per week;
- mortgage holders paying $<\$600$ per week.

Space limitations prevent a comprehensive presentation of the impact of temporal public transport provision for all of these groups within the present article.[4] The results of analysis we present here are restricted to low SEIFA households, the elderly and young people. The final analytical section of this article considers the situation of the unemployed relative to the access to potential employment provided by the Gold Coast public transport system.

By combining the spatial and temporal coverage data layers constructed in the first part of this study with the ABS Census data, two main objectives can be achieved. First spatial service gaps which disadvantageously affect some groups relative to others can be identified. Next the use of GIS software permits the total and proportional quantification of the access to high quality transport services experienced by the groups in question. The results of this analysis for low SEIFA households are presented in Figure 4. For the purposes of this study 'low SEIFA' denotes those households in the bottom SEIFA quartile, that is, the most socio-economically disadvantaged 25 per cent of households.

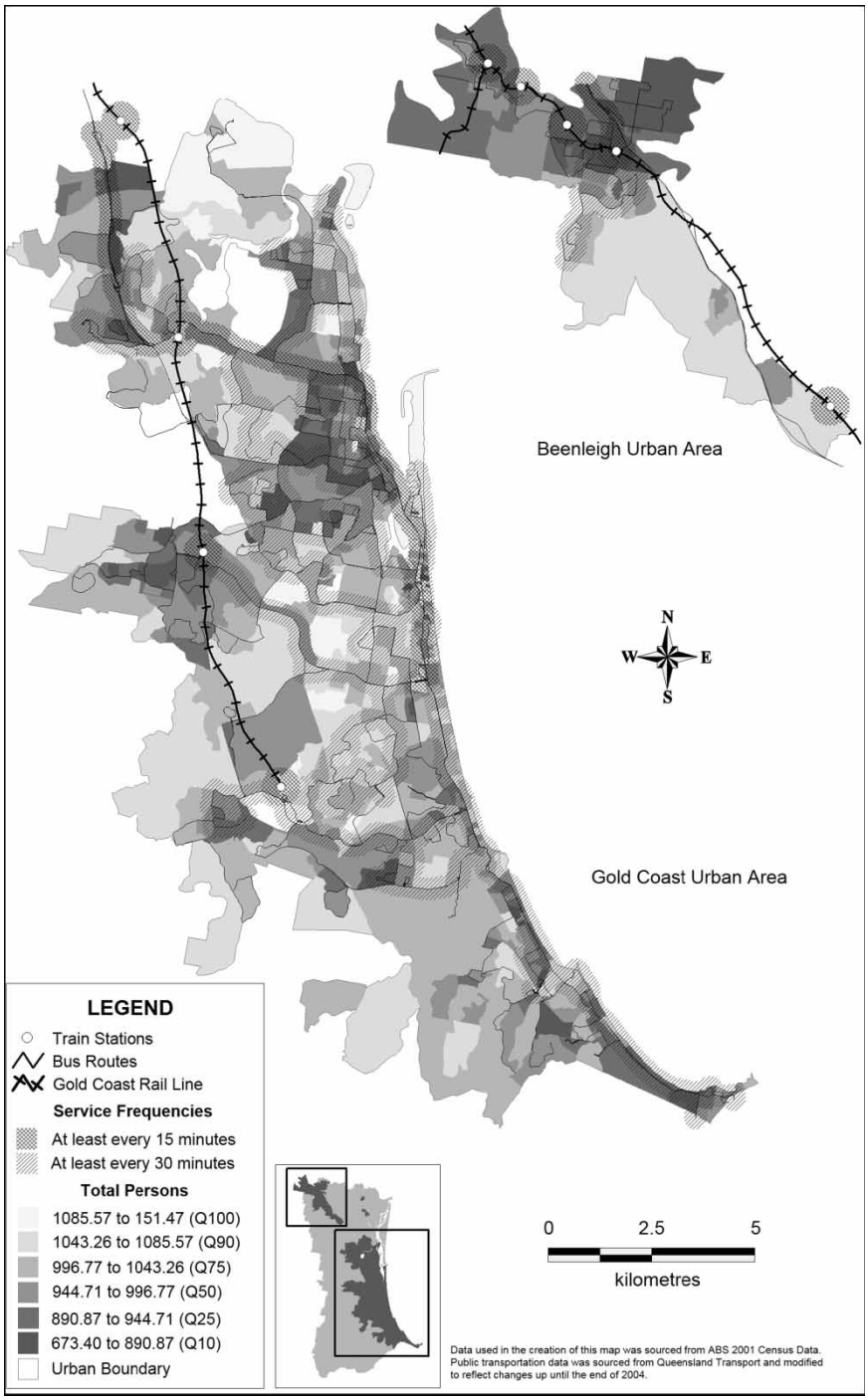

Figure 4. Public transport service coverage and frequencies for the morning peak relative to SEIFA categories within the Gold Coast urban area

Important differences in the relative levels of access to public transport services during the morning peak for households with low SEIFA status can be observed in Figure 4. First, some areas with high concentrations of low SEIFA households have good access to public transport services. In particular those households in the eastern parts of Southport and Labrador, to the west of the rail line in Upper Coomera and in some parts of Eagleby are relatively well situated near high frequency public transport compared to many high SEIFA areas. However, for low SEIFA households in western parts of Labrador and Southport, or in Coolangatta, Stephens, Worongary-Tallai, Nerang and many parts of Eagleby, the best peak hour public transport frequencies were greater than 15 minutes.

Similarly, many high SEIFA localities also had limited access to public transport services during the weekday peak hour. The comparatively affluent mid-central suburbs of the Gold Coast urban area between the rail line and the eastern coastal strip are noticeably poorly served by peak hour public transport. This article is focused on those at the lower end of the socio-economic scale, however, we note that there are many strong public policy reasons why moderately well-off households should also receive good public transport access. Service failures in the public transport system among the relatively affluent mid-central localities thus deserve attention in addition to the many service failures present in lower SEIFA localities.

The information informing Figure 4 was tabulated to allow more concise comparative consideration of the relative coverage of the low SEIFA areas by public transport services. Table 1 presents the service access for low SEIFA households for all periods. The table is spatially insensitive, however, it does permit some important observations.

First, while fewer than 87 per cent of low SEIFA households within the Gold Coast urban area received some public transport service, for the majority of these households the service frequencies were very low. At best, the table shows that 16.8 per cent of low SEIFA households received high frequency public transport during weekdays although many received services at frequencies greater than every 30 minutes. While such frequencies constitute poor services, only a minority of low SEIFA households, no more than 17 per cent received no service at all during all periods, with the exception of evening services, which were unavailable to at least 40 per cent of low SEIFA households during both weekdays and on weekends. The analysis demonstrates that there are clearly serious service deficits among those localities within the Gold Coast City where the most disadvantaged households reside.

The above discussion concentrates on those households categorised by the ABS as having low socio-economic status. This project also undertook mapping and analysis of the access experienced by other social categories. By way of comparison we present the results of the analysis for the distribution of the elderly population of the Gold Coast relative to the public transport system. While most of the social groups we considered in the broader study were potentially correlated with high levels of social disadvantage, such as the unemployed or those on low incomes, the elderly were considered a likely sub-category of potential disadvantage, but which displays a different locational geography compared to the low SEIFA households portrayed in Figure 4. The location of elderly persons (those aged over 65 years) within the Gold Coast City relative to the spatio-temporal public transport system is presented in Figure 5.

The geography of the elderly within the Gold Coast urban area differs somewhat from the spatial distribution of low SEIFA households. The main relative concentrations of the elderly are in a broad band between two and five kilometres inland along the eastern

Table 1. Proportion of low SEIFA households per public transport service quality category for Gold Coast City

	Weekdays				Saturday			
Frequency	Start–9:30 a.m.	9:30 a.m.–3:00 p.m.	3:00 p.m.–7:00 p.m.	7:00 p.m.–end	Start–9:30 a.m.	9:30 a.m.–3:00 p.m.	3:00 p.m.–7:00 p.m.	7:00 p.m.–end
At least every 15 minutes	16.8	9.1	13.3	0.0	0.7	9.1	9.1	0.0
At least every 30 minutes	40.9	38.7	39.3	17.3	29.5	22.3	22.3	13.3
Less than every 30 minutes	33.4	43.2	34.8	39.2	53.8	53.4	52.6	27.8
No service	9.0	9.0	12.6	43.5	16.0	15.3	16.0	58.9

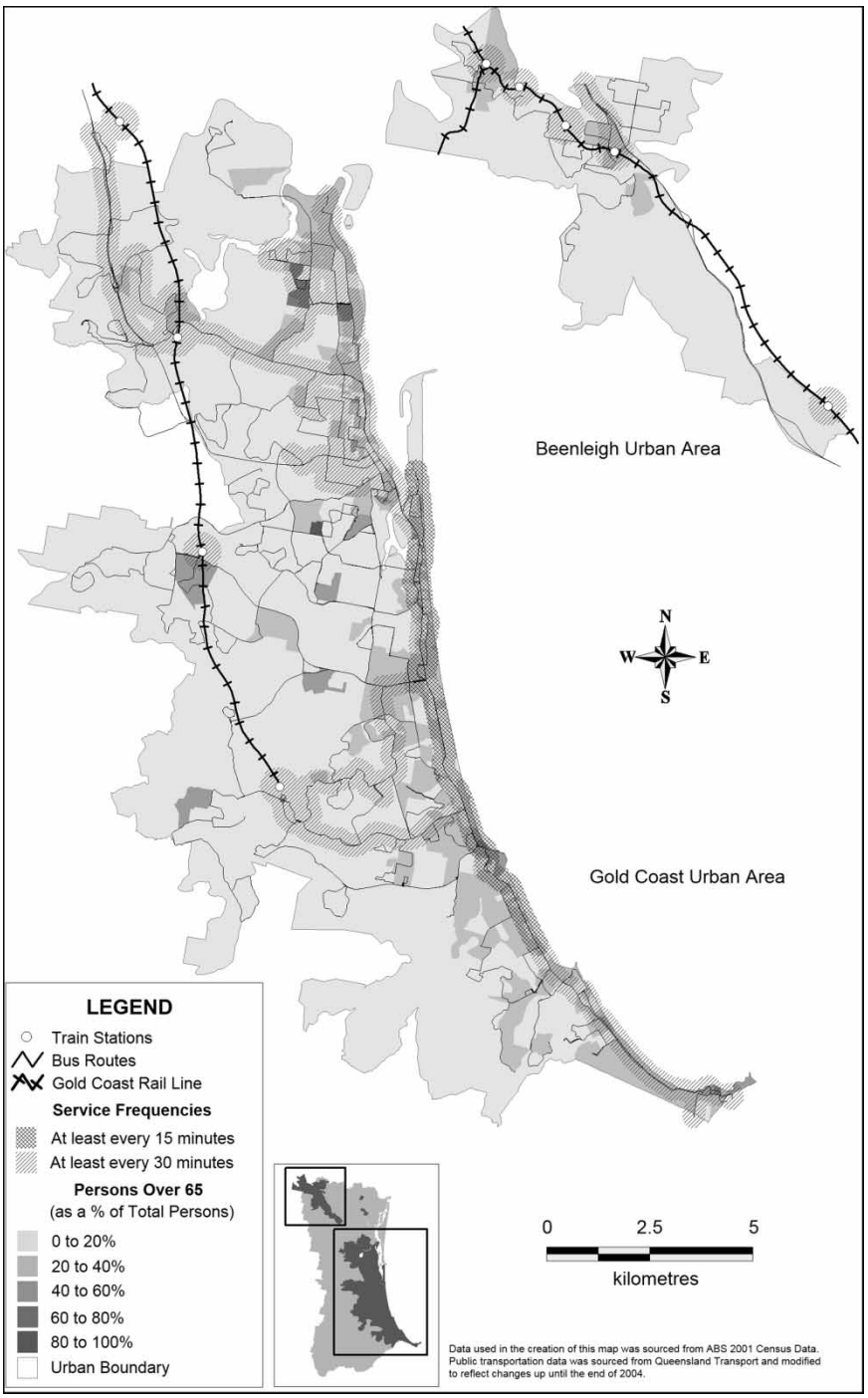

Figure 5. Public transport service coverage and frequencies for the weekday off-peak relative to elderly population concentrations within the Gold Coast urban area

coastal strip of the Gold Coast ranging from Broadbeach through to Coolangatta. High elderly concentrations also occur in specific locations such as Coombabah and Runaway Bay to the north of the marine strip, within Parkwood, Benowa and Nerang. In some of the CDs within these localities, such as in Ashmore, the elderly constitute above 60 per cent of the population, a level that is presumably associated with residential sub-markets such as retirement or aged care institutions (Figure 5).

On the assumption that the elderly are less likely to depend on peak hour services than other public transport users, we present the distribution of concentrations of the elderly population throughout the Gold Coast relative to public transport service distribution and frequency levels during the daytime inter-peak period of 9:30 a.m. to 3:00 p.m. As Figure 5 demonstrates, high frequency inter-peak services within the Gold Coast City are highly geographically focused with areas to which better than 15 minute frequencies are provided restricted to the narrow coastal strip along the Gold Coast highway between Surfers Paradise in the north and Currumbin to the south.

Of particular note is the lack of high frequency services in the Labrador and Southport localities immediately to the north-west of Surfers Paradise. Southport is the site of the major Gold Coast hospitals, services which are potentially highly patronised by those with greater healthcare demands, such as the elderly. While some inter-peak services operate through the middle and northern suburbs of the main urban area of the Gold Coast, our analysis demonstrates that many areas with high proportions of elderly residents have infrequent or no public transport services during this period. Like the public transport access gaps faced by low SEIFA households these provision gaps for the elderly are of serious public policy concern, as they potentially impact on the mobility and extent of social inclusion experienced by the aged population. However, from a methodological perspective, the combination of social and operational geographic data successfully enables the illumination of these problems, a task that would be difficult without the availability of GIS software.

Comparing Social Geographies of Transport Service Access

While the maps provided in Figures 4 and 5 demonstrate the differential impacts of divergent social geographies within a unitary public transport system operating to a set schedule, GIS analysis also permits the relative evaluation of quality of transport services provided to the various social groups under consideration. However, this analysis generates a great deal of numerical information which can impede easy interpretation and easy comparison between social groups. To assist with ready comparisons of the level of access to public transport experience by different social groups, we have tabulated the results of the GIS modelling in a symbolic form (Table 2). Hence in Table 2 positive ($\uparrow$) and negative ($\downarrow$) indicators are used to signify whether a given combination of service frequency and daytime period provides specific social groups with greater or poorer access to public transport services, when compared to the situation for the overall population.

As Table 2 demonstrates, low SEIFA households within the Gold Coast City have better access to public transport services during the morning weekday peak period than do members of the overall population while the access experienced by the overall population is in turn better than that received by the unemployed, in general, across the Gold Coast City. Further useful comparisons are possible. For example, those households without a car receive relatively better access to high and modest frequency public transport services

Table 2. Comparison of public spatial and temporal public transport access for selected social groups relative to the overall population within Gold Coast City

	Weekdays				Saturday			
Frequency	Start–9:30am	9:30am–3:00pm	3:00pm–7:00pm	7:00pm–End	Start–9:30am	9:30am–3:00pm	3:00pm–7:00pm	7:00pm–End
Low SEIFA								
	↑	↓	↓	–	↑	↓	↓	–
At least every 15 minutes	↑	↑	↑	↓	↑	↑	↑	↓
At least every 30 minutes	↑	↑	↑	↓	↑	↑	↑	↑
Less than every 30 No Service	↓	↓	↓	↓	↓	↓	↓	↓
Unemployed								
At least every 15 minutes	↓	↓	↓	–	↑	↓	↓	–
At least every 30 minutes	↑	↑	↑	↓	↑	↑	↑	↓
Less than every 30 minutes	↑	↑	↑	↑	↑	↑	↑	↓
No Service	↓	↓	↓	↓	↑	↓	↓	↓
Rental Households >$150 pw								
At least every 15 minutes	↑	↑	↑	–	↑	↑	↑	–
At least every 30 minutes	↑	↑	↑	↑	↑	↑	↑	↑
Less than every 30 minutes	↓	↓	↓	↑	↓	↓	↓	↑
No Service	↓	↓	↓	↓	↓	↓	↓	↓
Mortgage Household >$600 pm								
At least every 15 minutes	↓	↓	↓	–	↑	↓	↓	–
At least every 30 minutes	↓	↑	↓	↓	↓	↓	↓	↓
Less than every 30 minutes	↑	↑	↑	↑	↑	↑	↑	↓
No Service	↓	↓	↑	↑	↑	↑	↑	↑
Persons aged >15								
At least every 15 minutes	↓	↓	↓	–	–	↓	↓	–
At least every 30 minutes	↓	↓	↓	↓	↓	↓	↓	↓
Less than every 30 minutes	↑	↑	↑	↓	↑	↑	↑	↓
No Service	↑	↑	↑	↑	↑	↑	↑	↑
Persons aged >65								
At least every 15 minutes	↑	↑	↑	–	↓	↑	↑	–
At least every 30 minutes	↑	↑	↑	↑	↑	↑	↑	↑
Less than every 30 minutes	↓	↓	↓	↑	↓	↓	↓	↑

Table 2.. *Continued*

	Weekdays				Saturday			
Frequency	Start–9:30am	9:30am–3:00pm	3:00pm–7:00pm	7:00pm–End	Start–9:30am	9:30am–3:00pm	3:00pm–7:00pm	7:00pm–End
No Service	↓	↓	↓	↓	↓	↓	↓	↓
Households Without a Car								
At least every 15 minutes	↑	↑	↑	–	–	↑	↑	–
At least every 30minutes	↑	↑	↑	↑	↑	↑	↑	↑
Less than every 30 minutes	↓	↓	↓	↑	↓	↓	↓	↑
No Service	↓	↓	↓	↓	↓	↓	↓	↓

than the general Gold Coast City population, during all periods of the day, with the exception of the evening off-peak. Similarly, carless households are less likely than the overall population to have access to only poor frequency services during almost all of the periods assessed.

Clearly the analysis presented in Table 2 is a powerful means for comprehending the dynamics and relative differential impacts of uneven public transport service distribution on various social groups who are potentially more vulnerable to service deficits, or more dependent on those services that are present, than the population generally. The information presented in Table 2 suggests that overall, the potentially vulnerable groups selected for assessment in the present study are in general better served by public transport than is the overall population. However, this is a relative measure and substantial service inadequacies may nonetheless be present that result in all groups being poorly served from an absolute perspective. Importantly, and as we discuss in the final section of this article, the analysis undertaken above only assesses the spatial and temporal access to at least one public transport route. The analysis does not measure the degree of access this public transport route provides to multiple and diverse destinations including employment sites and concentrations of social and community services. The final section of this article reports on preliminary methodological developments that can assist with assessing this tertiary level of public transport accessibility.

Accessibility via the Public Transport System for Disadvantaged Groups

The final contribution this article makes to the advancement of GIS methods for assessing transport disadvantage is in the development of methods to evaluate the degree of accessibility or 'connectivity' that the public transport system provides. High connectivity public transport systems are those in which multiple routes provide for quick and efficient travel to a broad range of employment and service destinations with a minimum of waiting and interchanging between services (Mees, 2000). Connectivity modelling parallels the type of traffic flow models used by traffic analysts. However, while individual vehicles are dependent only on the presence of a continuous road network for their capacity to connect to various destinations, public transport systems operate temporally discrete services such that departures and arrivals occur at set times and likely involve waiting times before or between services.[5]

For urban public transport systems with modest connectivity, modelling the complexity that discrete services imply requires advanced spatial analytical techniques. The results we offer in this article are the result of ongoing refinement and development of modelling methods, and therefore represent intermediate rather than final findings. We are presently not aware of any reported scholarly research that has undertaken such a degree of analysis and inquiry. Our reporting is therefore undertaken in the interests of ensuring wide scholarly and policy appreciation of the capacities of GIS methods to advance social understandings within transport research, particularly in the context of increasing government attention to the important role of urban public transport systems in the management of contemporary metropolitan areas.

In the example presented, we model the connectivity between residential location and employment concentrations provided by the public transport system to low SEIFA persons[6] within the Gold Coast City. Our analysis focuses on the weekday morning peak hour period as a key period of high demand for employment access by public transport.

Necessarily, the assumption underlying this choice of variables is somewhat programmatic and made complex by conceptual and empirical concerns. We assume for the basis of analysis that irrespective of personal or labour market factors, for those low SEIFA households allocated by the housing market into locations distanced from employment opportunities, inadequate connectivity in the public transport system may impose a friction on their capacities to obtain or maintain employment.

To assess the connectivity of the public transport system we have used ABS Working Population Profile data to identify the sites of greatest employment concentration, focusing on retail, accommodation, café and restaurant employment. This focus is justified by the fact that the Gold Coast economy is disproportionately reliant on this employment sector (Gold Coast City Council, 2003). Such employment constitutes 26.9 per cent of Gold Coast City jobs and includes a high proportion of casual, part-time and low-skill work. Such employment is thus more likely to recruit from the pool of low-skill unemployed and with strong cyclical patterns is accordingly dependent on a flexible reserve labour pool.

Given that the Gold Coast City is a dispersed urban area, with wide scatterings of small employment centres, we have focused in our analysis on the three largest service sector employment concentrations as the destinations to which access by the public transport network is to be assessed. These areas are Surfers Paradise, Southport and Broadbeach Waters—as anticipated by our observations above, these employment centres are closely tied to the Gold Coast's dominant tourism sector.

The destination zones for our analysis were selected on the basis of a high concentration of unemployed persons. These areas include Nerang, Labrador and Stephens. Each displays particular characteristics. Labrador is an older declining area adjacent to the coastal strip, Nerang is an expanding outer-suburban activity centre, while Stephens contains one of the largest clusters of public housing estates within the Gold Coast City. Both Nerang and Stephens are situated at least five kilometres from either of the Surfers Paradise, Southport or Broadbeach Waters employment centres.

We recognise that the selection of destination and origin zones for this assessment is complicated by assumptions that might not be relevant to the actual experience of unemployed Gold Coast residents and to the patterns and strategies by which they seek employment. Indeed, substantial questions can be raised here such as the extent to which the unemployed seek work locally as compared to within regional labour markets. Similarly, the extent to which intra-metropolitan travel requirements influence work search strategies is not clearly understood in the Australian context (see Dodson, 2005). Notwithstanding these potential objections, we consider the analysis we present remains useful both from the perspective of illustrating the analytical power of GIS methods but also providing empirical insight into the way the Gold Coast public transport network is able to support regional labour markets.

A methodological problem was encountered in this component of the study in that the Working Population Profile data offered by the ABS is organised at the spatial scale of the Statistical Local Area (SLA). This means that unlike the social mapping presented in previous sections of this article the employment connectivity analysis cannot operate at the finer grain of the CD. Hence the detail and micro-scale accuracy of the spatial focus is reduced by decreasing resolution to the SLA level. Despite these constraints we consider that the analysis we provide is suitably spatially focused to enable fruitful methodological and empirical analysis and insight.

The results of our analysis of the connectivity between areas of high unemployment and employment concentration are presented in Figure 6. For the purposes of illumination we have also both the areas covered by bus routes (shaded) as well as the bus routes themselves to indicate precisely the direction of potential travel. Figure 6 demonstrates that of the high unemployment locations selected for analysis, only Labrador receives a high level of public transport service during the morning peak that connects to the employment centres along the coastal strip. While Nerang and Stephens both enjoy some connectivity, this is restricted largely to some sections of these SLAs and where present, such services operate at best less frequently than every 15 minutes. In Nerang in particular, large suburban tracts lack a high frequency cross-town bus service that would provide high quality access to the coastal suburban employment concentrations.

Given that the Gold Coast City housing market is structured in a way that positions relatively lower cost housing on the western urban fringe, such housing is thus potentially more likely to be occupied by lower income groups such as the unemployed, which means that the failure of the public transport system to provide good intra-urban connectivity to major employment concentrations is of some policy concern. This assessment, however, is made in recognition of ongoing debates within urban scholarly literature over the nature of the relationship between housing and employment links within suburban areas.

Residents of Nerang may not seek work within the coastal employment concentrations of Southport, Surfers Paradise and Broadbeach. However, in the absence of strong evidence to the contrary it is reasonable to assume that the poor public transport linkages observed through this study would constitute a friction on the access to employment opportunities faced by residents of unemployment concentrations such as Nerang and Stephens. We note also that methodological refinement and further development of the analytical techniques promoted in this article would assist substantially in addressing the conceptual concerns we outline above. Some improvements in the quality of data, such as the compilation of ABS Working Population Profile at CD rather than SLA scale, would improve accuracy in the modelling process.

Conclusions: Advancing Methods for Transport and Social Research

Socio-spatial changes driven by evolving economic and social forces in concert with policy shifts continue to transform Australia's cities, including non-capital urban areas, such as the Gold Coast. One important dynamic amongst these changes is the interplay of two shifting geographies: the distribution of socio-economic status and of urban infrastructure and services. The above analysis concludes the extensive conceptual, methodological and empirical advancements we have presented in this and a previous paper that has sought to improve comprehension of the connection between socio-spatial patterns and the access to employment and services provided by urban transportation systems.

Our hope is that these analyses, focused on the Gold Coast study, have advanced, if modestly, the Australian scholarly comprehension of urban transport disadvantage. Urban policy makers too require high quality information to inform decisions about the distribution of urban infrastructure and the planning of new land use activities and to make these decisions while appreciating the impacts of change on vulnerable groups.

This study has linked two broad sets of disciplinary capacities that have not historically been closely allied. The analysis of transportation systems has traditionally been the

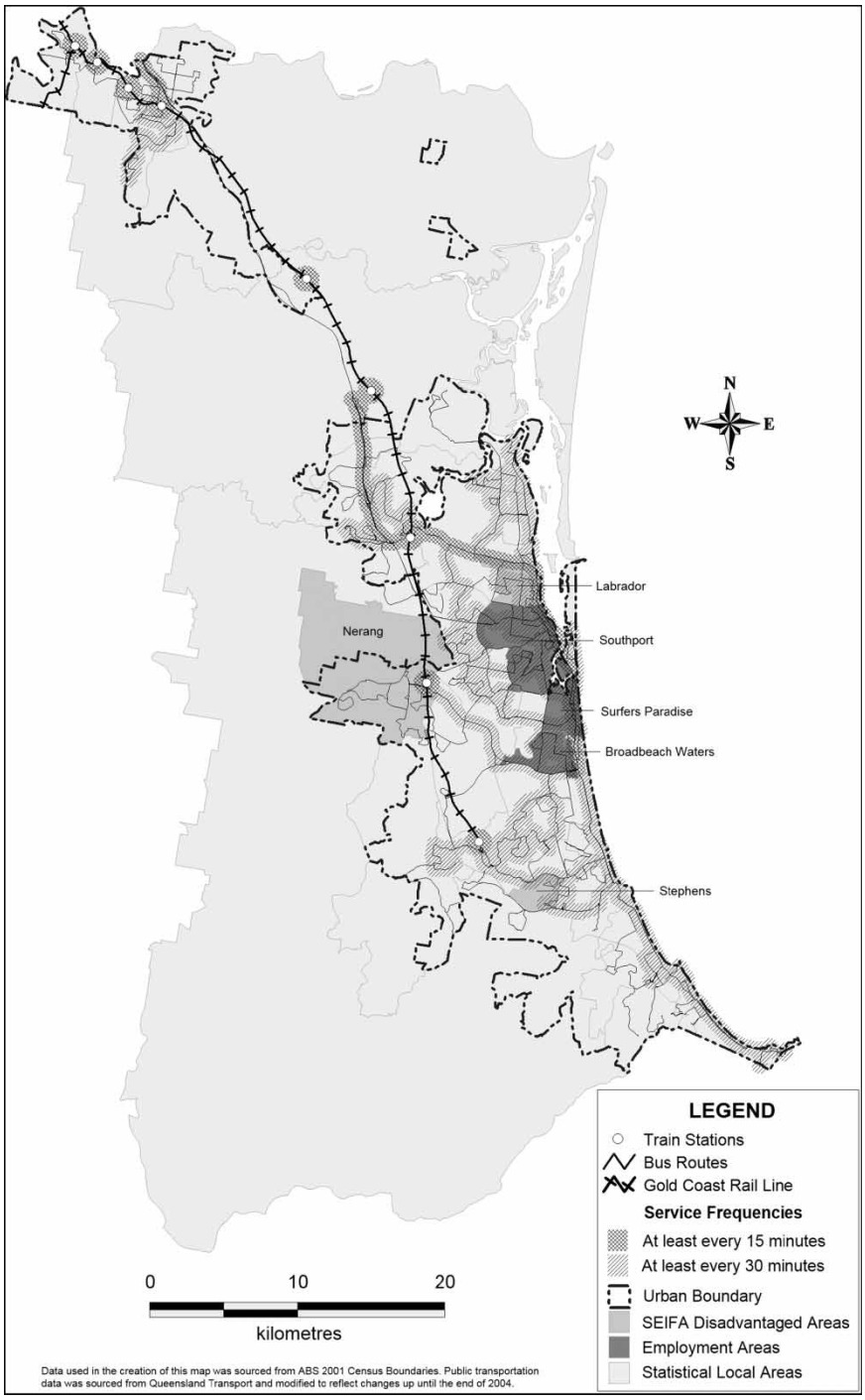

Figure 6. Connectivity of unemployment concentrations and employment opportunities by public transport within Gold Coast City

reserve of highly technical disciplines serving mobility objectives with little attention to the broader social and economic patterns, beyond those necessary for modelling of land uses and traffic flows, and which influence the character of mobility flows. Conversely, social analysts have been largely content to comprehend the distribution of social status and economic opportunity within urban areas to the exclusion of systemic and technical factors, particularly those relating to accessibility and mobility. Our investigation has been concerned to draw together the social and transport streams to develop a methodology that is sensitive both to social differentiation and to infrastructure distribution within urban areas. The method that we have presented will assist to illuminate the problem of socio-spatial transport disadvantage in the Australian city, a concern that has suffered from previous under-reporting. The conditions found in Australian suburban regions differentiate the research we have undertaken from previous scholarly reports on this methodological area which have typically focused on northern hemisphere urban contexts, particularly the UK experience.

When we compared various methodologies for combining social data with transport systems information, it was evident that GIS-based methods would provide more comprehensive and informative results than would transport modelling or conventional statistical analyses. The analyses we have presented have clearly highlighted major socio-spatial deficits in the provision of public transport services within the Gold Coast City. We have demonstrated that the combination of a variegated social geography with an uneven distribution of public transport leads to some vulnerable groups experiencing major relative inadequacies in access to public transport. Conversely, we have also demonstrated that some groups are better served than others, providing insights into relative social equities in transport provision. Such insights would have been unlikely to be obtained without the deployment of the methodology which we developed in this study.

This article has focused primarily on potential travel behaviour, imputing a standard distance of 400 metres as the limit that residents of the Gold Coast City are likely to travel to access public transport. These assumptions remain open to empirical testing through studies of revealed travel behaviour. Analysts in South East Queensland await the release of the data from the recently begun South East Queensland Travel Survey. Such data could potentially be incorporated into the methodology of the present study to improve the understanding of regional travel behaviour within the Gold Coast and to assist in refinement of the residence and employment accessibility linkages.

While the two papers have been concerned to account for social factors in transport research, we are cognisant of the critique that has been made of social analyses that are overly reliant on the use of ABS statistics, particularly Census categories (Gibson *et al.*, 1996). A view which adopts already constituted categories and telescopes down through centrally controlled quantitative data-sets can lead to generalisations that elide the subtleties and nuanced dynamics of local scale social change. The risk is that analysis reduces to dry technical exercises based on maps and statistics without any real appreciation of what is occurring on the ground and in the experiences of the persons represented in the models and plans. This risk has not been entirely overcome in the present study. We have traded off the rich local scale insights obtainable through methods such as 'community mapping' for a comprehensive metropolitan-scale analysis. Given the intention to identify the differentiation of localities through social and service geographies, this metropolitan view is appropriate. In this sense we have been able to demonstrate that our methodology is technically efficient at identifying gross service gaps

and inadequacies both spatially and temporally. From this study more detailed local scale studies could be undertaken to better tease out the barriers and frictions to public transport accessibility among the various groups we consider. Locally detailed and engaged studies such as those undertaken by Johnson & Herath (2004) provide a useful basis for such further investigation.

Clearly there is much room for further refinement of the methods we have deployed in pursuit of better connections between social and transport systems analysis. The collection of better travel data could assist in this regard, while there is substantial room for greater sophistication in the local scale units used for the mapping analysis. Some major advances in the combination of temporal accessibility in relation to multiple employment and services locations are possible. At the time of writing (August 2005) a research team within the Urban Research Program has been working on such a refinement of the accessibility modelling procedures. We look forward to the Australian and international scholarly community making further advances in the use of GIS and spatial methodologies in the investigation and examination of the important relationships between social status and transport systems.

The approach undertaken in the two papers has also highlighted the importance of comprehending the specifically Australian characteristics of transport disadvantage in relation to household social status. Much of the work on accessibility assessment has been undertaken in the UK and the methodological basis for this approach to planning practice has not been well reported to the social scientific community especially beyond the project report mode of presentation. Our study has thus served the dual purpose of reporting an advance in the socio-spatial assessment of transport disadvantage and social status that is of international relevance while simultaneously applying this method to the Australian urban experience.

Acknowledgements

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Notes

1. CD boundaries are determined by the Australian Bureau of Statistics and contain approximately 200 households. These are statistical boundaries and are constructed largely without reference to the urban layout.
2. We note that in many jurisdictions a service headway of at least every 15 minutes would be considered mediocre and not suitable to be described as ‘high frequency’. However, in the Australian urban transport context service frequencies of at least 15 minutes would generally be considered high frequency.
3. The ABS Socio-Economic Index for Areas (SEIFA) is a measure of socio-economic status derived from a composite of demographic, housing and socio-economic Census variables. Low SEIFA values indicate low socio-economic status. While SEIFA has been subject to some important methodological critiques it provides a sufficient illustration of the distribution of socio-economic status for the present analysis.
4. Readers seeking more extensive discussion are invited to peruse Dodson, Buchanan and Evans (2005).
5. The exception to this problem are the high frequency public transport systems described by Mees (2000) that operate such frequent services that waiting times are largely inconsequential, for example, Toronto or Zurich. As Mees demonstrates, such systems attract high patronage levels in part because they also offer high levels of interconnectivity across their metropolitan regions.

6. We selected low SEIFA households for this analysis over the unemployed in part to ensure consistency with the cases presented in the preceding sections, but also because low SEIFA concentrations necessarily include high concentrations of the unemployed but also include those with modest labour market status and those on low incomes, factors which are of substantial relevance when considering employment access needs.

References

ABS. (2005) *Regional Population Growth, Australia, 2004–2005* (Canberra: Australian Bureau of Statistics).

Badcock, B. (1994) 'Stressed-out' communities: 'out-of-sight, out-of-mind'?, *Urban Policy and Research*, 12(3), pp. 191–197.

Currie, G. (2004) Gap analysis of public transport needs: measuring spatial distribution of public transport needs and identifying gaps in the quality of public transport provision, *Transportation Research Record: Journal of the Transportation Research Board*, 1895, pp. 137–146.

Cuthill, M. (2002) Coolangatta: a profile of social and community wellbeing, *Urban Policy and Research*, 20(2), pp. 187–203.

Dodson, J. (2005) *Is there a spatial mismatch between housing affordability and employment opportunity in Melbourne?* (Melbourne: Australian Housing and Urban Research Institute).

Dodson, J., Buchanan, N. & Evans, R. (2005) *Transport Disadvantage and Social Status: A Gold Coast Pilot Project. Urban Research Program Research Monograph 8* (Brisbane: Griffith University).

Gibson, K., Huxley, M., Cameron, J., Costello, L., Fincher, R., Jacobs, J., Jamieson, N., Johnson, L. & Pulvirenti, M. (1996) *Restructuring Difference: Social Polarisation and the City* (Melbourne: Australian Housing and Urban Research Institute).

Gleeson, B. (2006) *Australian Heartlands: Making Space for Hope in the Suburbs* (Sydney: Allen & Unwin).

Gold Coast City Council (1998) *Gold Coast City Activity Centre Strategy* (Gold Coast City: Gold Coast City Council).

Gold Coast City Council (2003) *Our Community: A Social Profile of Gold Coast City* (Gold Coast City: Gold Coast City Council).

Ihlanfeldt, K. R. & Sjoquist, D. L. (1998) The spatial mismatch hypothesis: a review of recent studies and their implications for welfare reform, *Housing Policy Debate*, 9(4), pp. 849–892.

Johnson, L. & Herath, S. (2004) *Big Roads, No Transport: A Report of the Goodna and Gailes Community Mapping for Transport Improvements Study; Research Monograph 5* (Brisbane: Urban Policy Program, Griffith University).

Maher, C. (1994) Residential mobility, locational disadvantage and spatial inequality in Australian cities, *Urban Policy and Research*, 12(3), pp. 185–191.

Mees, P. (2000) *A Very Public Solution: Transport in the Dispersed City* (Melbourne: Melbourne University Press).

Murray, A. T., Davis, R., Stimson, R. & Ferreira, L. (1998) Public transportation access, *Transportation Research Part D*, 3(5), pp. 319–328.

Pennycook, F., Barrington-Craggs, R., Smith, D. & Bullock, S. (2001) *Environmental Justice: Mapping Transport and Social Exclusion in Bradford* (London: Friends of the Earth).

Social Exclusion Unit (2003) *Making the Connections: Final Report on Transport and Social Exclusion* (London: UK Government).

Somenahalli, S., Yue, W. L. & Taylor, A. P. (2004) A GIS approach to transit buffer analysis. 27th Australasian Transport Research Forum, Adelaide, 29 September–1 October.

Taylor, A. (2004) Changing patterns of disadvantage on the Gold Coast, State of Australian Cities Conference. Urban Frontiers Program, University of Western Sydney, Parramatta, NSW, 3–5 December 2003.

Wu, B. & Hine, J. (2003) A PTAL approach to measuring changes in bus service accessibility, *Transport Policy*, 10, pp. 301–320.