# Public Transportation Access

Alan T. Murray[a], *, Rex Davis[b], Robert J. Stimson[c] and Luis Ferreira[d]

a Australian Housing and Urban Research Institute, Department of Geographical Sciences and Planning, University of Queensland, Brisbane, Queensland, Australia
b Australian Housing and Urban Research Institute, University of Queensland, Brisbane, Queensland, Australia
c Australian Housing and Urban Research Institute, University of Queensland, Brisbane, Queensland, Australia
d School of Civil Engineering, Queensland University of Technology, Brisbane, Queensland, Australia

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**Abstract**
The form of a city has a major impact on the lifestyles of its residents. As urban centers grow, careful strategies are required to ensure that the regional quality of life is not adversely affected by this growth. An important strategic consideration is transportation planning. Questions regarding the sustainability of dispersed car dependent urban forms have led to a renewed interest in public transportation. This paper examines access to public transportation and discusses approaches for improving such access. Examples from the South East Queensland region of Australia will be used for illustration.

Author Keywords: public transit; access; Australia.

## 1. Introduction

The well being of growing and expanding urban metropolitan regions is intimately connected to the provision of adequate and appropriate transportation services. An expanding urban population requires access to business activities, education, employment and recreational opportunities. The location of these services and the provision of adequate transportation infrastructure, such as freeways, mass transit, and parking accommodation, is the essence of urban planning. The transportation system has a great influence and impact on regional patterns of development, economic viability, environmental impacts, and on maintaining socially acceptable levels of quality of life. It is not surprising to find that considerable resources continue to be expended by government agencies in the planning and development of more effective transportation services. While the path from policy specification to system implementation is not necessarily clear or deliberate, it is important that processes be established and utilized by which performance and achievement of goals may be monitored and measured.

The South East Queensland region of Australia, which includes Brisbane, the Sunshine Coast and the Gold Coast, has experienced rapid population growth over the

past two decades and now exceeds 2 million people. This population growth is forecast to continue well into the next millenium and will place considerable stress on existing infrastructure. Transportation service provision is an important element of the social, economical and environmental sustainability in the South East Queensland region in terms of planning for anticipated future growth and development. Specifically, ensuring that goods and services distribution is viable as well as social activities and networking are plausible in this growing and expanding region are significant considerations. Population growth and urban form combine to provide formidable challenges for the transportation system. Moreover, transportation planners need to establish means by which the transportation system may be evaluated and monitored so as to ensure that short and long term objectives are capable of being sustained or achieved.

The complexity and number of components involved in the transportation planning process is quite significant. This ranges from the planning of major infrastructure projects such as interstates, freeways, busways and light and heavy rail systems to the regulation of pollutant emissions. An important element of the transportation planning process is to ensure that certain modes of public transport are available for use. The importance of public transport services in a successful transportation system is widely recognized (Nash, 1982 and May and Roberts, 1995). There are several reasons for this, with the most significant being an assurance of long term sustainability in terms of resource consumption and the environment (Banister et al., 1997). Also important is providing a transportation option for those without access to a motor vehicle, as well as providing a travel alternative to commuters in order to decrease stress on current infrastructure. In all, this provides strong motivation for public transport services.

Interrelated issues to be addressed in providing public transportation are access and accessibility to this mode of travel. Access is the opportunity for system use based upon proximity to the service and its cost. If the distances or barriers to access a service are too great at either the trip origin or destination, then it is unlikely to be utilized as a mode of travel. Similarly, if the cost is either too expensive (i.e. cheaper modes exist) or unaffordable then utilization of the service is also unlikely. Accessibility is the suitability of the public transport network to get individuals from their system entry point to their system exit location in a reasonable amount of time. Thus, accessibility encompasses the operational functioning of a system for regional travel. Access greatly impacts the public transportation system and complements service accessibility. This relationship is illustrated in Fig. 1. Given these definitions, there is a clear distinction between access to public transportation and the accessibility of the public transport system. Further, access and accessibility are dependent upon each other if the public transport system is to be successful and well utilized. While both are important, only access will be dealt with presently.

Fig. 1.

This paper discusses issues and policy implications associated with access to public transportation based on proximity. The topics detailed in this paper will be supplemented by aspects of current public transport provision in the greater Brisbane region. The next section begins by placing access within the more general concerns of transportation planning. Access and how it may be evaluated is then considered. From this, questions related to improving access to public transport are addressed. Finally, a discussion and conclusions are given.

## 2. Public Transportation

Transportation planning is a critical element in the evolution and growth of metropolitan regions. Such planning must take into account trip purpose, temporal and spatial distributions of trips, modal splits of travel, and costs (Meyer and Miller, 1984). These considerations will impact current and future infrastructure as well as the environment. A big picture perspective suggests influences on mobility which fits into a more general interpretation of sustainability that includes social, economic and environmental factors. Transportation systems form the basis by which economic development can occur and the means by which society interacts. An ineffective transport system and associated urban forms will limit economic and social opportunities. More importantly, the greatest transportation implications for the sustainability of a region stem from the energy and environmental consequences of excessive single vehicle automobile travel. Newman and Kenworthy (1989) observed the relationship between high fuel use and low urban density in Northern American and Australian cities as compared to higher density, more energy efficient European cities. The implications for urban forms designed for motor vehicle transport are an inefficient use of nonrenewable resources, congestion and noise and air pollution externalities. Transportation planning is a vital aspect of regional growth and prosperity that is intimately connected to policy formulation and implementation.

It is essential that approaches exist for monitoring, evaluating and modeling system performance in order to better inform and understand policies and regulations associated with transport services. For example, in the United States the Clean Air Act and subsequent amendments to this act are policy based regulations aimed at reducing the environmental impacts of emissions (Hanson, 1995). Associated with this has been the continued development and application of analysis approaches and models for identifying and assessing alternatives for achieving mandated reductions. Another example is the urban transportation modeling system which consists of interrelated models for helping to predict travel demand (see Meyer and Miller, 1984). This is essential for evaluating impacts on facilities and various modes of travel resulting from regional growth and change. A final example is the interaction between land use and transportation, which has also been the subject of modeling efforts (Paulley and Webster, 1991). A key component in the emerging methods and techniques for better understanding transportation processes is geographical information systems (GIS). Whether it is the assessment of broad scale regional policies or link specific capacity, GIS are proving to be valuable transportation management and modeling platforms (Nyerges, 1995). Thus, significant investment has been made to establish transport planning approaches and relevant data for assisting the monitoring, evaluation and modeling processes.

Since the 1960s, increased transportation demands associated with the rapid expansion of metropolitan areas in Australia have been addressed through a program

of continued road building. In South East Queensland the Wilbur Smith and Associates, 1965 report led to the partial construction of a regional highway system. The removal of the Brisbane tram system in favor of a more cost effective bus system was also an outgrowth of this report (Wilbur Smith and Associates, 1965). However, in recent years Government agencies have placed a renewed focus on public transport planning and provision. Reasons for this include a community desire to provide a transport option to those lacking a private vehicle and an increased awareness of the problems associated with automobile dependency. Sustainable regional development must therefore include public transport service provision as some component of the transportation planning process. This often takes the form of operating some interconnected combination of bus, rail or ferry services subsidized by local, state and/or federal governments. In fact, the Clean Air Act discussed above has placed increased emphasis on public transport provision (Pas, 1995). There are numerous details to be sorted out in providing or overseeing this form of public assistance such as the best placement of stops and routes, the frequency of operation, and the connectivity of the transport network for regional service delivery. The Integrated Regional Transport Plan for South East Queensland attempts to identify a transportation system future that will meet anticipated needs without sacrificing desirable aspects of quality of life (Queensland Government, 1997). The South East Queensland plan is similar to the plan developed for the Sydney region (New South Wales Department of Transport, 1995) and the planning approaches for Perth (Transport Western Australia, 1995). Each of these plans accept the fact that private vehicle travel is an established and necessary part of existing transportation systems. However, increasing the percentage of private vehicle trips undertaken is not a desirable outcome in growing and expanding metropolitan regions.

While public transport is only one component of a transportation system, increasing the patronage of this mode of travel is likely to benefit urban regions substantially, both in terms of mobility and sustainability. Gauging or measuring the effectiveness of public transportation performance is critical in assessing policy goals as well as planning for future improvements. How this should be done is an important consideration.

## 3. Evaluating Access

Access to public transportation is the opportunity to use the service. This may be interpreted in terms of proximity to and the cost of using transport services. The latter has been approached from an economic perspective (see Jansson 1993) and is not the focus of this paper. Rather, the interest here is proximity based access to public transport. Specifically, how does the location of public transport facilities such as bus, train or ferry stops serve the needs of the population? Motivating this interest further is the Integrated Regional Transportation Plan for South East Queensland. This plan specifies a policy goal for public transport in the region of at least 90% total population coverage within 400 meters of a bus, rail or ferry stop (Queensland Government, 1997). The focus is thus on origin based access. Such a service goal is one of many criteria designed to improve public transport operation as well as its attractiveness, through enhanced service quality. Ensuring suitable service coverage is a worthwhile objective as the time taken to reach a public transport stop has a major impact on total travel time, which influences potential patronage. The interpretation of the 400 m coverage distance or threshold is that it represents a comfortable walk for most people under normal conditions. The distance criterion could be dynamic to suit

specific circumstances or terrain. Unfortunately, many long term strategies, goals and policies, such as providing suitable coverage, are often more representative of political desires rather than thorough and detailed analysis. What is important, however, is that such goals and policies be properly assessed and monitored in a rigorous and replicable fashion.

Technical issues associated with evaluating a policy goal like suitable access coverage are ever present. One issue is that information on the exact residence or location of individuals is not available. The most precise geographic information which exists is census data reported at some aggregate scale. For the Brisbane region, census data at the collection district level is the most disaggregate form of spatial information. Thus, this information is an aggregate representation of the actual location of individuals in the region. Given that the ultimate intent is to evaluate public transportation access, the use of such data obviously introduces the potential for erroneous estimates. This problem is one of scale and aggregation as discussed in Murray and Gottsegen (1997). Often little can be done to deal with this issue, as the form in which the data is obtained is beyond the control of an analyst or planner. Nevertheless, this is an important concern which should at least be recognized.

Evaluating access to public transport is of particular interest in policy making as well as the locational siting of specific dwelling types. As an example, high occupancy buildings or perhaps public housing would benefit from placement providing good access to public transport. How can access be estimated? If access is defined to be a specified distance (or travel time) to a public transport stop, then it is possible to identify all of the areas within the threshold distance of all stops. Knowing these areas, the total number of individuals in a region having suitable access may be determined. This does create the need for some sort of areal interpolation process, as partial coverage of spatial units is very likely. An alternative would be to compare the distance from a spatial reporting unit, say a collection district, to its nearest stop. If this distance is within the threshold, coverage is achieved. Both approaches do have potential for error. However, they are contrasting perspectives and used together provide a means for ensuring that estimates of access are reliable or stable. For the analysis discussed in this paper, both approaches were applied and provided similar findings. Thus, no distinction will be made in the results which follow. It is worth noting that based upon the above discussion, there may be implications for the scale and aggregation issue, but further empirical analysis would be necessary.

The policy goal of providing 90% of the total population access within 400 m of a bus, rail or ferry stop in the South East Queensland region is actually a common transportation planning objective in Australia. A similar mandate has been included in the regional transportation plan for Sydney (New South Wales Department of Transport, 1995) . Given this explicit goal for the Brisbane region, examining the degree to which such a policy objective is being met is of interest. Using a commercial GIS, the public transport access coverage in the greater Brisbane region was assessed using bus, rail and ferry stop locations supplied by Queensland Transport. Population data from 1991 and 1996 at the collection district level (the most disaggregate form available) was utilized. Examining the 400 m coverage criterion using the 1996 census data shows that only 55.25% of the population in the region (or approximately 954,000 people) was found to have suitable access to public

transport as shown in Fig. 2. This is far from the stated objective of 90% total population coverage.

Fig. 2.

An interesting question may be raised regarding the sensitivity of the threshold distance in evaluating access coverage. What if the distance was 350 m or 450 m, how would this alter coverage? Fig. 3 depicts the coverage tradeoff for threshold distances ranging from 50 m to 7.5 K. Within this range, the public transport system has not achieved the regional goal of providing 90% of the population with suitable coverage. In fact the 90% goal is not achieved until a distance of 8.8 K is reached, which is far beyond the stated distance of 400 m. Alternative suitable access distances, such as the 800 m standard used by Smith and Taylor (1994) in examining rail service in the Brisbane region, would obviously fail to achieve the 90% population coverage goal as well. The logarithmic relationship between population coverage and suitable access to a public transport stop means that the population is so dispersed in certain areas that substantial distances are necessary to access a public transport stop. In fact, extending the acceptable threshold distance often has little net impact. For example, at three kilometers approximately 83% of the population is considered suitably covered. Relaxing the threshold distance to 7.5 K only provides an additional regional population coverage of 6%. The ability to realistically achieve the 400 m service objective for the entire region is questionable at best.

Fig. 3.

Given the results shown in Fig. 3, there would not appear to be any sensitivity associated with the threshold distance utilized, in terms of meeting the stated objective of 90% total coverage in the region. However, Fig. 2 shows that there is a spatial relationship to public transport access in this region. Outlined in Fig. 2 are the four regions of council (ROC) for South East Queensland consisting of Brisbane, NORSROC (north), WESROC (west), and SROC (south). They are primarily administrative sub-regions with little political power, but the regional delineation does reflect the urban structure of the city. The Brisbane city sub-region in 1996 contained 37.8% of the total population of the region. Based on this, the Brisbane sub-region has the potential to greatly influence regional transport coverage. It is not entirely surprising that most of the total population provided service in this region is in or around the city as shown in Fig. 2. Evaluating service coverage based upon the threshold distance measure for each sub-region, Fig. 4 supports the spatial effects shown in Fig. 2. Specifically, Fig. 4 shows that the city nearly meets the 90% service criterion with 86% total coverage using the 400 m standard. However, the three other ROC sub-regions are far from meeting this standard. The reason for this is that these areas are more rural and providing public transport coverage is more difficult because of their dispersed population.

Fig. 4.

Of particular interest to policy makers in Queensland may be the poor performance of the NORSROC region. The Sunshine Coast is the fastest growing center in this rapidly expanding sub-region. It also represents an area where many people are deciding to spend their retirement, indicating a high proportion of people with a potential need for public transport services. At the sub-regional level, more attention should be devoted to such issues in the planning and provision of these services.

The intent of processes such as the Integrated Regional Transport Plan for South East Queensland are to establish a path for meeting future regional transportation needs, both short and long term. The performance of the public transport system, and the planning for the region, is even more disappointing when results using the 1991 census are compared to the 1996 census. Fig. 3 shows the coverage tradeoff curves for 1991 and 1996. As can be seen, public transport access has declined over this five year period. At the 400 m access threshold for 1991, 58% of the population had public transport access (as opposed to 55.25% in 1996). Thus, little attempt or gain to improve public transport access appears to have been made in this time period. Without a concerted and deliberate effort to improve access opportunity over periods of time, it would not seem realistic that public transport usage could be expected to increase.

## 4. Improving Coverage

The previous section has demonstrated that the South East Queensland region is far from being able to provide the level of public transport service that it would like to. This section examines how regional services may be improved.

Fig. 2 and Fig. 4 have illustrated that there are spatial effects associated with public transport service provision. In fact, some percentage of the population is unlikely to ever utilize such services, so it may be more beneficial to focus on those groups of the population which are prone or could be convinced to use public transportation. As an example, in South East Queensland the inland areas away from the populated coastal sub-regions are predominantly rural. It is difficult to envisage public transport services capable of meeting the needs and requirements of people in the rural areas at reasonable operating costs. Given this, it makes sense to adjust the notion of service coverage to reflect the spatial, socioeconomic and demographic characteristics of potential patronage rather than attempting to set public transport goals for the entire region. In addition, the extent to which cost recovery by public transport services is expected needs to be assessed when setting performance goals. The standards of coverage would then be somewhat modified and perhaps much more realistic. Depending upon policy objectives, priority would be given to improving access to areas that contain a high proportion of transport disadvantaged groups (such as the elderly, invalid pensioners, low income earners) or areas which contain a high probability of increasing public transport patronage. Such an approach may not seek to improve service to the entire population, but rather focus attention on providing service access to those that would most likely use it.

Another approach for improving service is to strengthen and extend the coverage of the transport system. For the greater Brisbane region, many of the improvements suggested in the Integrated Regional Transportation Plan are aimed at enhancing public transport quality, such as increasing travel speed through the addition of

separate bus lanes. This may potentially increase system use by making existing service more efficient, and thus an attractive travel alternative. Such an approach for increasing coverage is extremely speculative and may have little net effect. A few projects in the Queensland transport plan are associated with providing new public transport corridors over the next 25 years. This is an extension to the current system network. Examining the impact that such extensions would have on regional coverage in South East Queensland, however, indicates that these corridors will provide service access to at most an additional 3% of the population. Thus, such a myopic and uncoordinated view on service provision planning fails to achieve even long term strategic goals. Furthermore, the first major transportation project announcement following the Integrated Regional Transport Plan, the Briztram light rail project, was not one of the strategic transport opportunities considered in the plan and will only enhance public transport in areas already provided relatively good public transport access. Central to improving service provision and perhaps increasing system coverage is the issue of sustainability. With respect to transportation planning, sustainability has been discussed by Nijkamp (1994) in terms of reducing energy consumption and environmental impact. The efficiency of the public transport system very much influences these aspects of sustainability. Specifically, well placed stops and good service routes both help reduce fuel use. Thus, it is important to examine the efficiency of transport stops and travel routes in terms of redundancy and suitability. That is, can the same level of service provision be obtained by reducing the number of stops maintained, coupled with new route design in the current service system. In South East Queensland, suburbs within a five kilometer radius of the central business district have been particularly well served by public transport. Routes and stops have been added incrementally through the years. This is a result of evolving population growth and service expansion, often implemented by separate planning agencies. Such a process is very much susceptible to inefficiencies. Nyerges, 1995 demonstrates the benefits of better routing schemes in order to increase service provision (see also Giannopoulos, 1992). Strategic decisions associated with relocating stops in order to increase the total population served can contribute to the efficiency and sustainability of a public transport system. The research of Current and Schilling (1994) may hold some promise in assisting in such a modeling exercise. Significant improvements to service coverage and system efficiency through better planning and design of stop locations and route networks can be expected to contribute to the enhanced performance and sustainability of the transport system. However, location and routing optimization model size will undoubtedly prove to be challenging. For the Brisbane region, there are 3 793 collection districts and 10,911 public transport stops, so the problem magnitude is quite significant.

The economics associated with increasing public transportation service coverage suggest that more creative options are necessary. An interesting alternative for improving regional coverage is through the incorporation of personalized public transit options. This is a means of providing patrons (or potential patrons) with a range of price differentiated public transport options. For example, a person at a personalized public transit stop would be able to choose between a taxi, a multiple fare taxi, a mini-bus on a flexible route or a conventional bus on an established route. A personalized system would provide the patron with real time information, showing available services and anticipated arrival times. The advantages of a personalized system is that it is able to provide the customers with choice and control, which makes public transit use more attractive. More importantly, numerous stops for personalized

service are able to be established in low density areas, where scheduled public transport services are expensive and underutilized.

While personalized systems appear to be an attractive solution for the provision of additional public transport services, there are cost issues worth considering. First, stops for personalized service are expensive as they would need to incorporate global positioning system (GPS) and communications technology. However, such technologies are already commonplace in most taxi services, at least in Australia. Second, for a personalized system to be worthwhile, the fares associated with this alternative would have to be structured so that they were significantly lower than the cost of calling a taxi. In other words, for a personalized system to survive in low density areas, it would most likely require ongoing subsidies, although these subsidies may well be lower than the cost of increasing public transport access through the approaches detailed above. Worth noting is a benefit-cost analysis of a proposed personalized public transport system in G6teborg, Sweden, which found that there would be only marginal gains from its introduction (Johansson, 1997). The problem with increasing public transport access in low density areas is the expense involved coupled with the already weak demand for public transport services. A further issue involves the integration of the personalized system into the broader public transportation network.

## 5. Discussion

The likely failure of the public transport access goal stipulated in the Integrated Regional Transportation Plan for South East Queensland suggests that more pragmatic access targets for sub-regions should be considered. Specifically, a more defined focus on providing access to those that are likely to utilize such services should be an explicit policy objective. Such factors include spatial location, urban and rural features, demographics, and socioeconomic status. As an example, the Sunshine Coast region is not well served by public transport. This is a concern given that it has a high proportion of elderly residents. Proximity to public transport services is an especially important issue for this group. Thus, access goals should address specific issues rather than being overly generic.

This analysis has examined access as a single distance or threshold measure of proximity from populated areas to public transport stops. By incorporating more detailed spatial information such as roads and service route locations as well as topography, a greater representation of public transport access could be developed based on dynamic and more realistic travel distances or times.

Extending the interpretation of service access is another important consideration. Investigated in this paper was the notion of proximity to public transport. However, this service has a temporal component as well. How often and at what times is a particular access stop visited? Does this meet the needs of the people that are likely to frequent this stop? In the South East Queensland region some public transport stops have fewer than four services per day. A more accurate measure of access should take into account service opportunity.

The issue of origin access has been a significant focus throughout this paper. However, destination access is certainly an important consideration. A difficulty in conducting such analysis is that travel patterns are not well understood. As an

example, a trip from home to work or work to home may include numerous stops along the way to accomplish personal or work related tasks, such as going to the bank and shopping for groceries. This is known as trip chaining and makes the analysis of travel behaviour quite complex. This creates a need for more detailed travel pattern information, rather than merely knowing the residential locations of individuals. Further, it should be recognized that residential information corresponds to where individuals live and not where they work or frequently travel to and from. Where individuals go during their travel is an important factor for public transport use and should be accounted for to the greatest extent possible, if demand for public transport is to be increased.

A final consideration in the planning of effective public transportation is the influence of land use configurations. Mentioned previously was an example discussing the benefits that certain land use categories (high density dwellings and public housing) could gain from good access to public transport. Urban form is intimately connected to land use and transportation (Anderson et al., 1996). Thus, the efficiencies gained through better public transport provision would need to be accomplished through coordinated land use planning and policy development.

## 6. Conclusions

The development of an adequate public transportation system is critical for achieving regional sustainability. The performance of a public transport system will be affected largely by the proximity of public transport stops to the regional population. This paper has discussed methods for evaluating public transport access. In doing this, the relatively poor performance, based on their own strategic access goal, of the public transport system in South East Queensland is apparent. This paper has examined methods for increasing public transport access and their likely effects. In areas in which public transport access is high, performance improvements may be realized by altering the placement of stops and modifying route service. The evaluation of public transport access could be improved by incorporating more dynamic proximity measures, service considerations, demographic and socioeconomic factors. Increased efficiencies identified through advanced monitoring and evaluation processes will help to ensure that adequate and appropriate regional public transportation service is provided.

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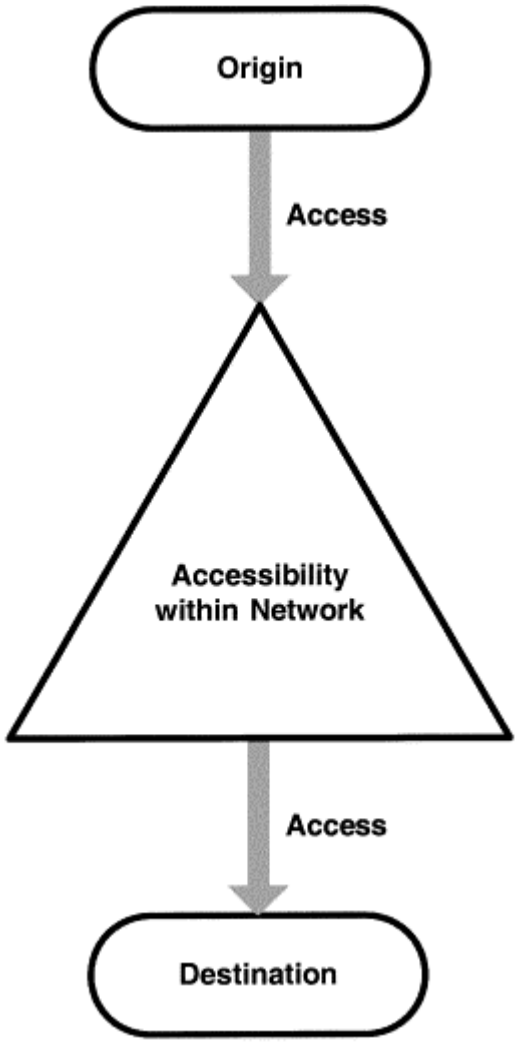


Fig. 1.

Public transport system access

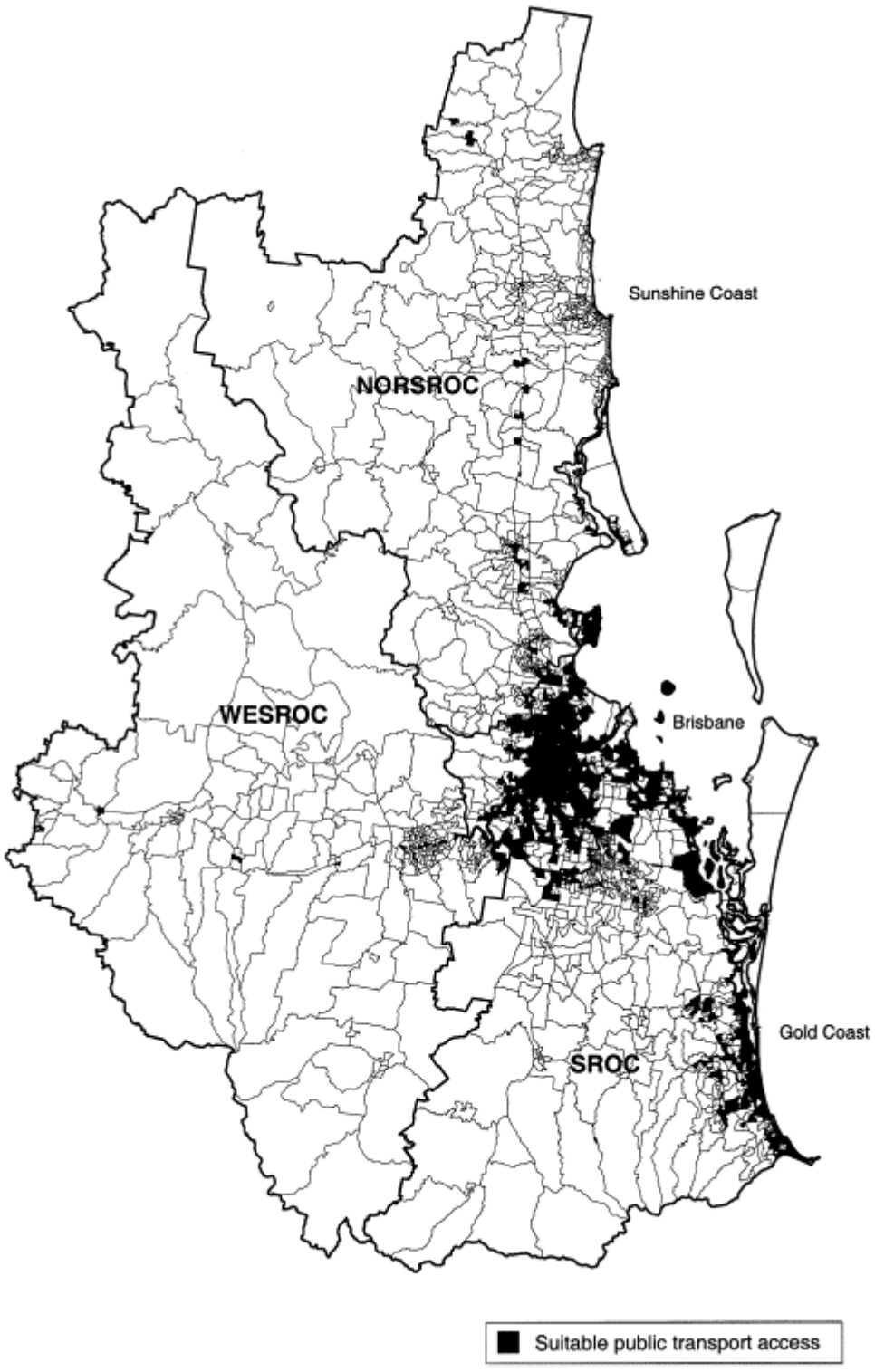


Fig. 2.

South East Queensland public transport coverage

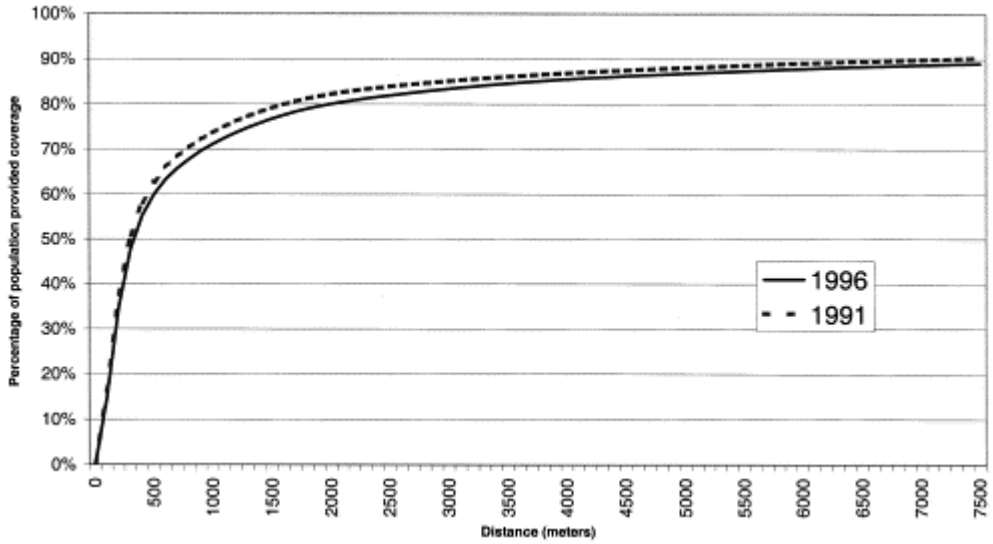


Fig. 3.

Public transport access for South East Queensland

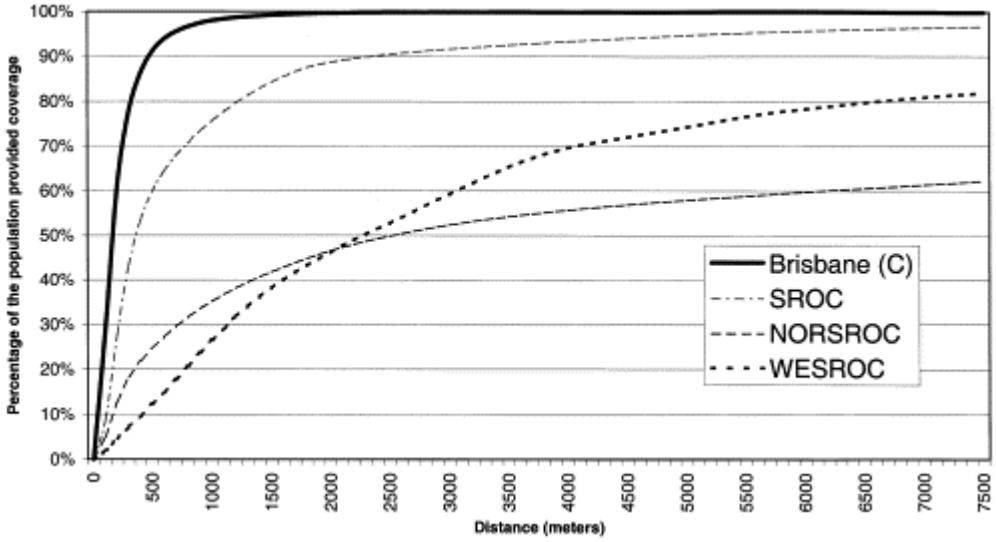


Fig. 4.

Regional breakdown of public transport access for 1996.