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ONE CITY MANY PERSPECTIVES - HOW WELL DOES THE CITY SERVE THE VARYING NEEDS OF ITS RESIDENTS

Different people need different things – families need access to jobs and schools, whereas retirees may be more focused on retail and medical services. The transport network also appears different to different travellers - school children cannot drive themselves, older people will generally be reluctant to ride bicycles and may walk slower, but may have cheaper taxi and PT fares. Because of these factors, the aggregate accessibility of different groups can vary widely.

This paper examines the accessibility profiles for a number of key demographic groups in Brisbane, Melbourne and Sydney using results from multi-modal modelling of these cities. Using the model results we identify the regions that service the transport disadvantaged the best and worse. These are then compared to the Socio-Economic Indexes for Areas provided by the ABS, highlighting the regions most impacted by poor transport options.

1. BACKGROUND

Cities provide a range of opportunities to its residents, from workplaces to schools, shops and entertainment. However taking advantage of these opportunities requires some degree of travel, which may limit their ability to take full advantage of these opportunities. This is particularly true for those who have some limitations in their ability to travel, whether due to their physical, economic or locational constraints. This paper explores the nature of transport disadvantage, and uses the detailed modelling capabilities of a new transport modelling structure to numerically assess the impacts of disadvantage in a number of Australian cities.

The key analytical tool that is used to explore the quality and ease of access to opportunities is **accessibility**.

Accessibility is highly correlated to the liveability of an area and is related to the opportunities available to people and the ease of accessing them using all modes of transport. As such it provides a useful measure to asses a cities performance. Historically there have been two key ways to assessing accessibility, Hansen accessibility measure (Hansen (1959)) and Log-Sum accessibility (Train (2009) ch. 3). The first approach focuses on what can be reached and the second focuses on costs or travel time. These two methods are explained in detail in part 1 of Davidson (2019).

This work uses TransPosition's multi-model strategic model, the 4S model, which allows the accessibility across all modes of transport, walking, cycling, car and public transport, to be determined simultaneously. The 4S model uses a generalised utility function with a specific component for the utility attained from the attraction location itself, due to the nature of the 4S model it is very easy to prepare an accessibility measure. Here the accessibility measure is simply the average utility that can be attained at a location, averaged across all Monte Carlo draws. The utility structure of the 4S model is explained in detail in part 2 of Davidson (2019).

To assess Brisbane, Melbourne, and Sydney's performance we focus on the accessibility for the transport disadvantaged, as these are the demographic group most impacted by poor city layouts and transport options. The accessibility plots produced by the 4S model allow the areas within the city that have the poorest service to this demographic group to be identified. To see how much these poor service options affect current residents of the city, we compare the model results to the ABS measure of socio-economic advantage and disadvantage called the Socio-Economic Indexes for Areas.

2. UNDERSTANDING TRANSPORT DISADVANTAGE

There are a number of reasons why people might suffer transport disadvantage. The most obvious one is that they have few transport alternatives, but the spatial component of transport disadvantage will be explored through accessibility analysis. The key groups that are typically identified as suffering some degree of transport disadvantage are

- People with a disability
- People on low income
- Older people
- Young people

The reasons why these groups suffer transport disadvantage is mainly due to the fact that they are constrained to some degree in making use of the full range of travel choices available. People with disabilities may be unable to drive, and may have limited mobility. People on low income may not be able to afford to own a car, or may be constrained in its use due to parking and operational costs. Older people may have physical impairments that prevent car use, and limit active transport use.

The transport disadvantage of young people is complex because as well as having limited mode choice, they may have limited agency. Children are often subject to their parents choices but assessing their degree of disadvantage is complicated by the fact that they are also provided with free transport services by their parents. Young adults who are independent but are not yet able to drive share some characteristics of other people who have limited car availability. For this paper we will not explicitly consider the transport disadvantage associated with youth, partly because of the difficulties of modelling serve-passenger trips, and the lack of good data within the model on school bus services.

2.1. SEIFA

The ABS prepares a measure of socio-economic advantage and disadvantage called the Socio-Economic Indexes for Areas (SEIFA). As indicated in the name it is an area measure rather than an individual measure and is based on a number of aggregate variables for each SA1. There are actually four separate indicators

- The Index of Relative Socio-Economic Disadvantage (IRSD)
- The Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD)
- The Index of Education and Occupation (IEO)
- The Index of Economic Resources (IER)

For the purposes of this paper the most useful is IRSAD, since it measures both advantage and disadvantage on a single scale. It incorporates such variables as

On the disadvantage side

- People with income in the lowest two deciles
- People aged 15 and over with the highest level of education is Year 11 or lower
- People classified as Labourers, Machinery Operators, Low Skilled sales or unemployed
- People under 70 with long term health conditions or disabilities
- Dwellings without an internet connection

On the advantage side

- People with incomes in the top two deciles
- Households with mortgages > $2800/month or rent > $470/week
- People classified as Professional and Managers

2.2. Car ownership and social disadvantage

As discussed above, one of the key constraints to travel choices is either having no driver license, or not having access to a car. To explore the first issue, an analysis was done of the Victorian Integrated Survey of Travel and

Activity (VISTA). The survey included a question on whether participants had some sort of driver license (from learners to open), as well as their age.

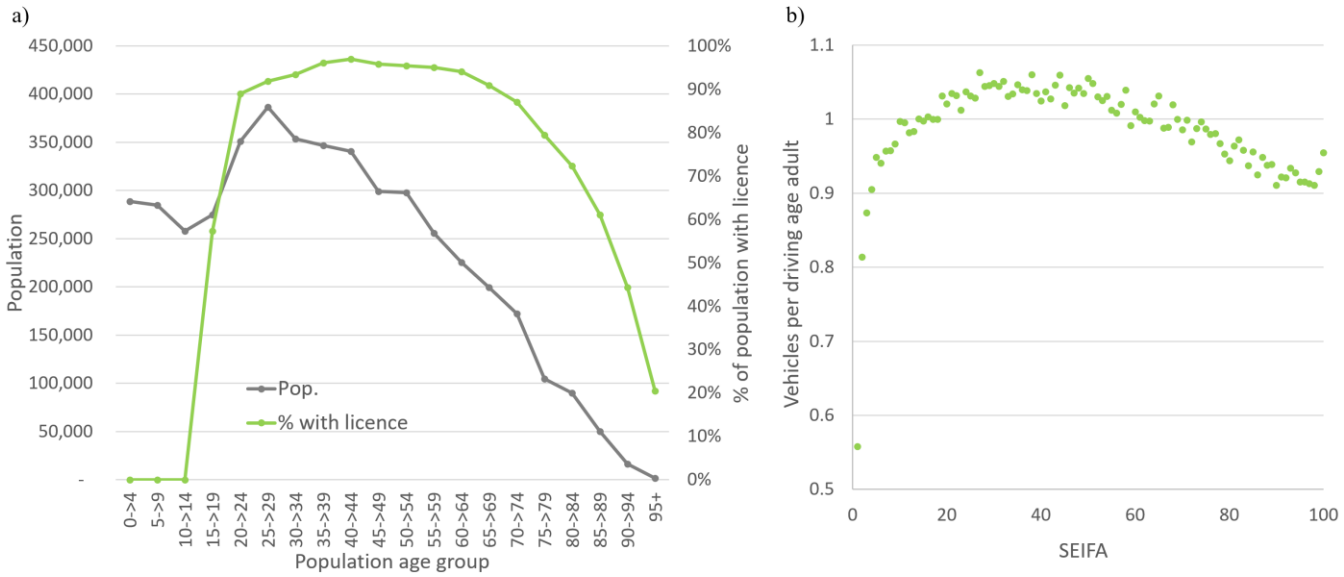

Figure 1: a) Driver's licence availability by age, b) Car ownership and SEIFA

This analysis (fig. 1 a) shows that there is an age related component to driver licence availability, but that it remains fairly constant between the ages of 20 and 75, with a sharp drop-off after that age.

The second element of being able to drive is having access to a vehicle. Vehicle availability is somewhat complex, because often the members of a household will share a vehicle. The more people there are in the household for the number of vehicles the less likely that it will be available for any given traveller. For this analysis it seemed best to exclude those who are unlikely to be able to drive – children and those aged over 80 years. The measure of vehicle availability that has been used here is calculated at the SA1 level and is equal to the total number of vehicles in the SA1 divided by the total number of driving-age adults (17-79).

An examination of the distribution of vehicle availability showed an interesting but not unexpected result; the regions of low car ownership were clustered in two areas – the centre of the city and in outlying centres. The characteristics of these areas are quite different – the CBD is generally an area of high income and high advantage but the outlying centres are often areas of disadvantage.

This effect can be seen if car availability (vehicles per driving age adult) is plotted against SEIFA as shown in fig. 1 b.

The most logical explanation for this is that car ownership is voluntary for those with higher levels of advantage, made possible because their residential location makes car ownership less necessary. But for those with a higher level of disadvantage, car ownership is more likely to be involuntary due to financial constraints.

This leads to the conclusion that the areas that are likely to be experiencing constrained travel choices are those with lower than average car ownership AND on the lower end of the advantage/disadvantage spectrum. The following three plots show these areas for Brisbane, Melbourne and Sydney. It can be seen that the city with the biggest areas of problematic car ownership is Sydney, with fewer in Melbourne and only isolated areas in Brisbane.

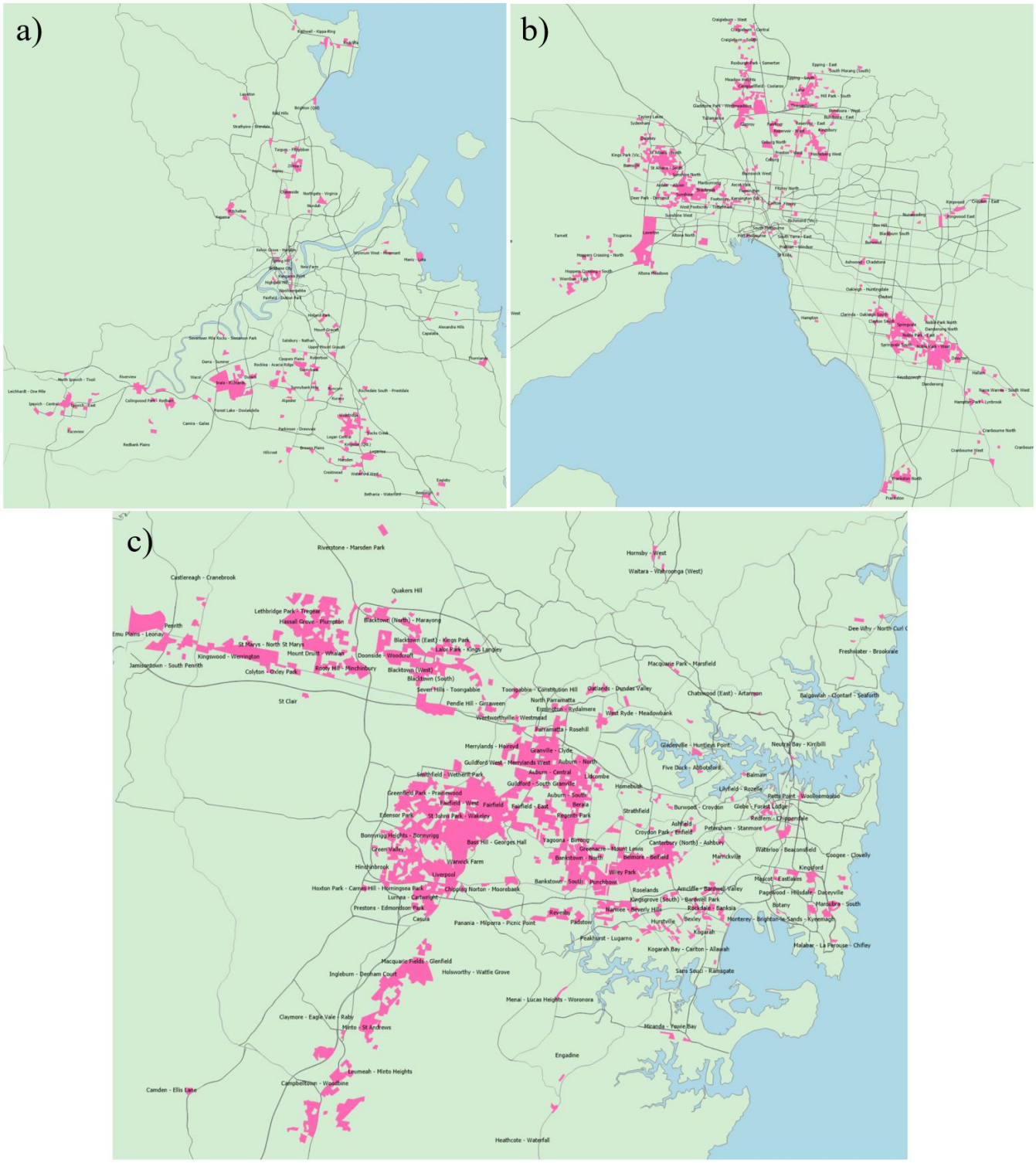

Figure 2: Areas of low car ownership and low SEIFA - a) Brisbane b) Melbourne c) Sydney

3. THE ACCESSIBILITY IMPACTS OF CONSTRAINED TRAVEL CHOICES

Having identified these areas, the next question is "what is the experience of living in these locations with constrained travel choices?" This is where accessibility analysis is useful.

Accessibility is a combined measure of the range and quality of activity opportunities available from a location, taking into account the cost, time and difficulty of reaching those locations. Davidson (2019) describes the theory of accessibility, and gives detail on the measure used in the 4S model. In summary, the accessibility values shown in this report are measured in dollars, with lower values representing higher accessibility. They can be conceptualised as the cost of travel to the rest of the city, if the city were treated as all being at a single location. Thus a value of zero would mean that I have everything I could ever want with no time or cost of travel.

Accessibility measures can be constructed for any type of travel or for any trip purpose – for example work or education. It is also possible to prepare a composite accessibility measure for a person type – it is simply a weighted average of the accessibility values for all of the types of activities that are important to that person, weighted by the number of times that they make that sort of trip. It can be viewed similarly to the Consumer Price Index, in that it represents the combined cost of a specific bundle of goods (activities).

It should be noted that the accessibility values given here are correlated with consumer surplus. In fact it is possible to compare two scenarios by summing the accessibility values for all people across the city – this is done simply by summing the product of the accessibility at a location by the population at that location. Differences in the combined measure are given in dollars and represent the total cost or benefit of the change under consideration.

4. MODELLING SCENARIOS

In order to test the impacts of transport disadvantage on the identified areas, the 4S model was run for Brisbane, Melbourne and Sydney.

The analytical results presented below include assessments of accessibility for people with different levels of travel constraint.

- Base model (unconstrained mode choice for most people, with small proportions of people unable to drive, and significant proportions of people unwilling to consider cycling)
- PT and active transport only (no car, no taxi)
- PT, active transport and taxis (standard fares)

Two additional cases are considered to focus on the transport disadvantaged. The first case looks at those who are unable to drive, but are also physically constrained in their walking ability. Walking speed is modelled as a truncated normal distribution with a mean speed of 5km and a standard deviation of 2km/hr. The impacts of slow walking speed is tested by modifying traveller characteristics to have a mean walking speed of only 2.5km/hr. This limits the ability of people to make use of public transport.

The second case looks at the policy of providing taxi subsidies to those with severe disabilities. For example the Taxi Subsidy Scheme in Queensland subsidised half of the total taxi fare, up to a maximum subsidy of $25/trip (on a $50 fare). The eligibility requirements in Queensland require applicants to meet at least 1 of the following criteria.

1. Physical disability requiring dependence on a wheelchair for all mobility outside the home.
2. Severe ambulatory problem that cannot functionally be improved and restricts walking to an extremely limited distance.
3. Total loss of vision or severe visual impairment (both eyes).
4. Severe and uncontrollable epilepsy with seizures involving loss of consciousness.

5. Intellectual impairment or dementia resulting in the need to be accompanied by another person at all times for travel on public transport.
6. Severe emotional and/or behaviour disorders with a level of disorganisation resulting in the need to be accompanied by another person at all times for travel on public transport.

4.1. Transport Accessibility (4S model Results)

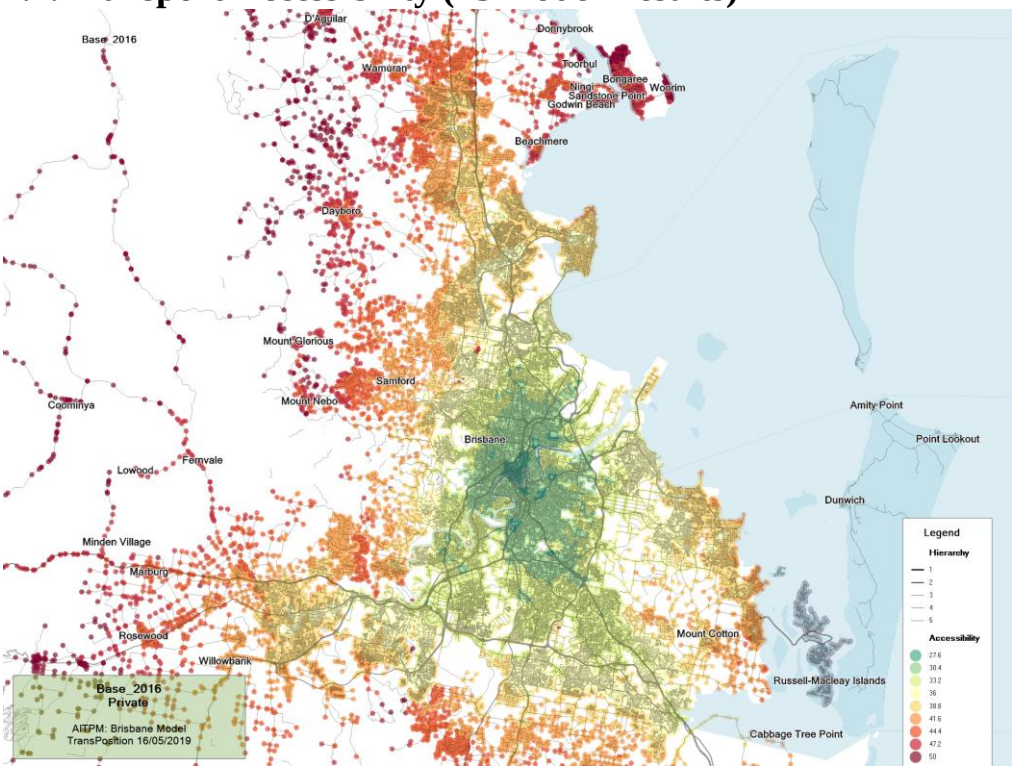

Figure 3: Accessibility of Brisbane for the base model

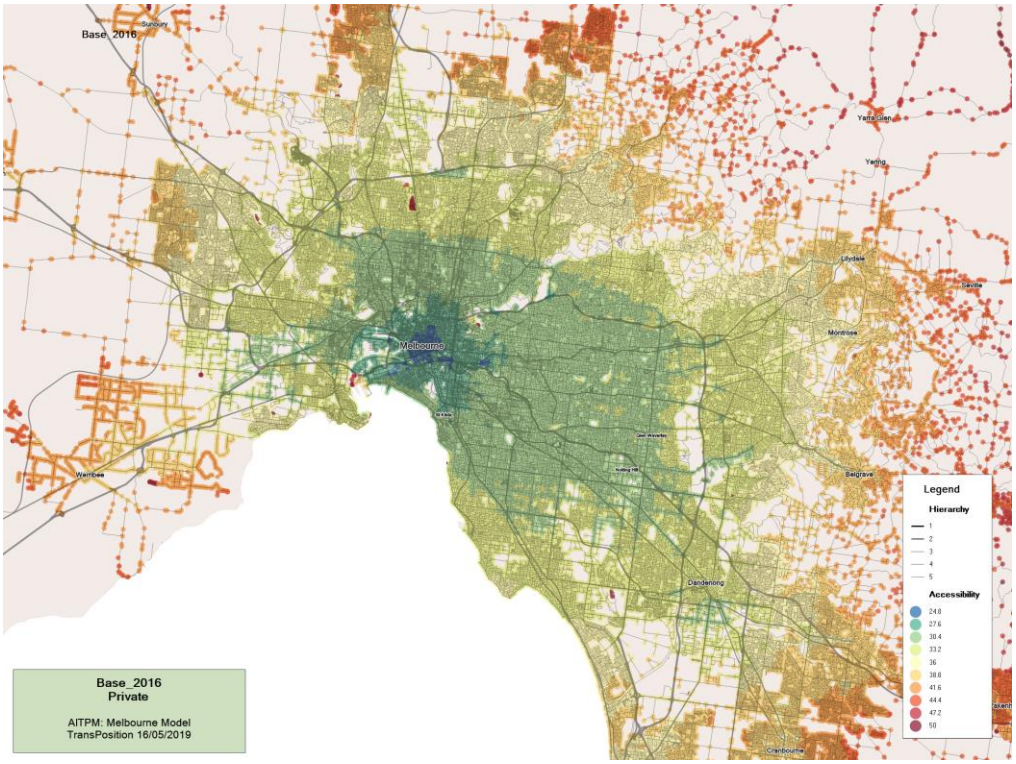

Figure 4: Accessibility of Melbourne for the base model

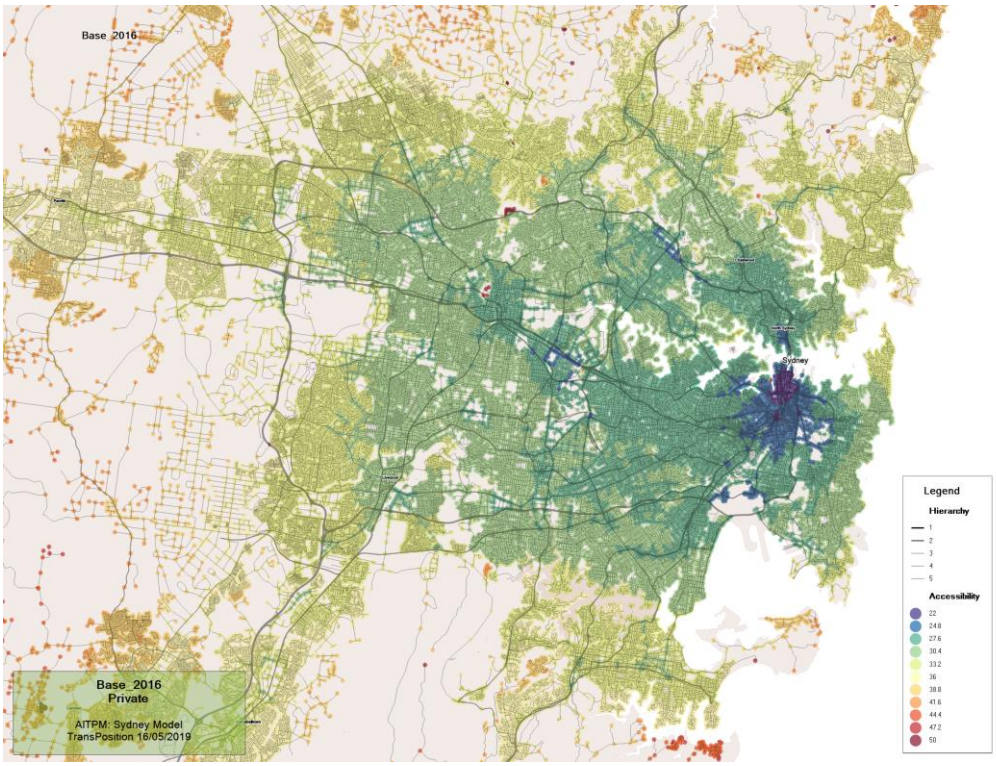

Figure 5: Accessibility of Sydney for the base model

These results use a common scale, and show the overall accessibility in the three cities for all types of people. It assumes that most people have flexibility in the modes that they take, but does include a small proportion of the population who are unable to drive, as well as a portion of people who do not consider public transport as their car is necessary for their travel (for example, tradespeople travelling between jobs). It can be seen that the larger cities (Sydney and Melbourne) reach higher levels of accessibility (lower centrality) in their centres than Brisbane, and have large areas of moderately high accessibility. The role of the transport corridors can be seen; for example in Brisbane the green band extends along the Pacific Mwy to the south-east, but accessibility falls away quickly to the west where the city is constrained by mountains. In Melbourne the stronger Melbourne-Dandenong corridor is apparent, with large areas of high accessibility to the east and south-east. In Sydney the dividing effect of the harbour is apparent, with relatively higher accessibilities on the southern side.

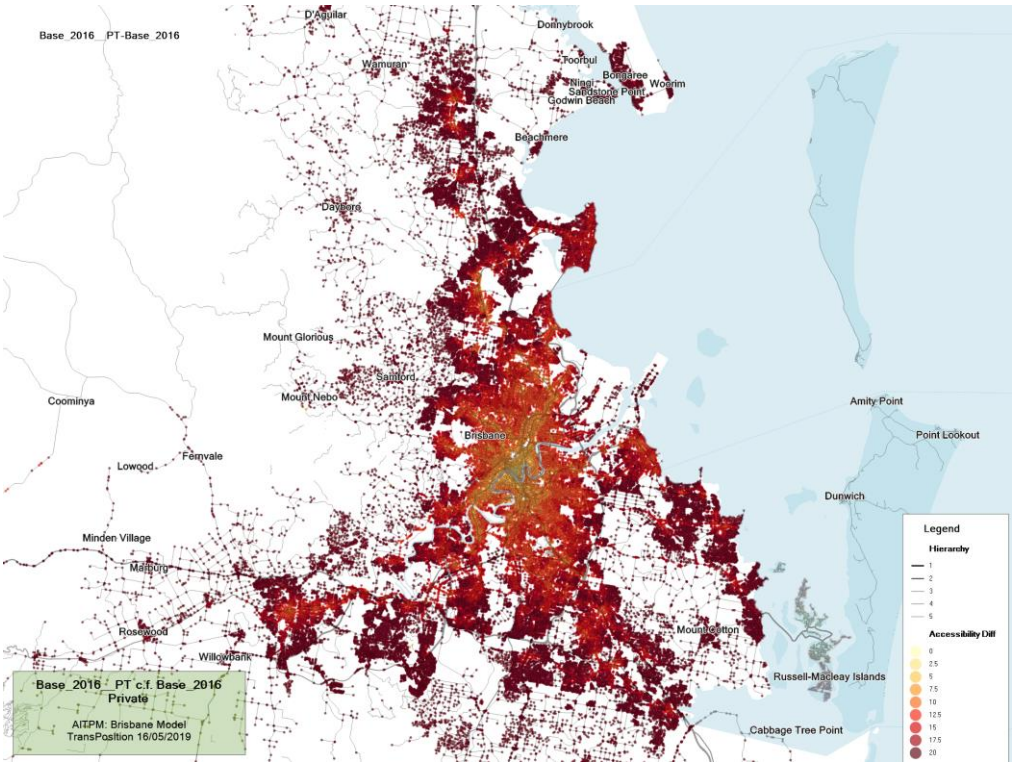

Figure 6: Change to Brisbane's accessibility when only PT and active transport modes are available

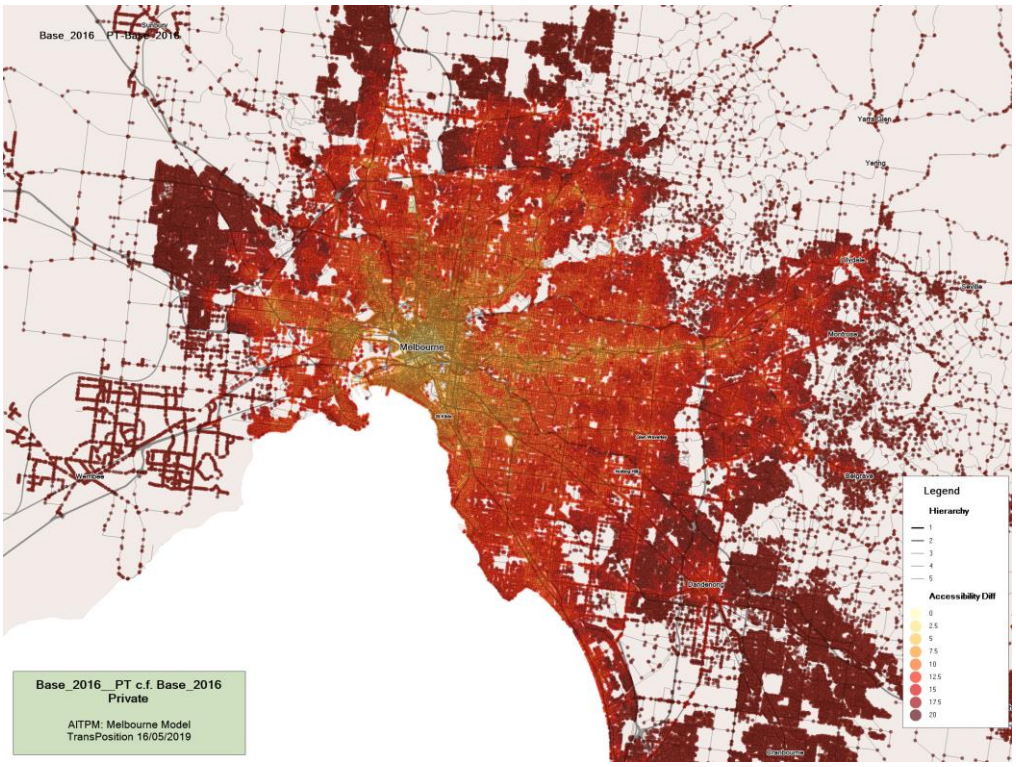

Figure 7: Change to Melbourne's accessibility when only PT and active transport modes are available

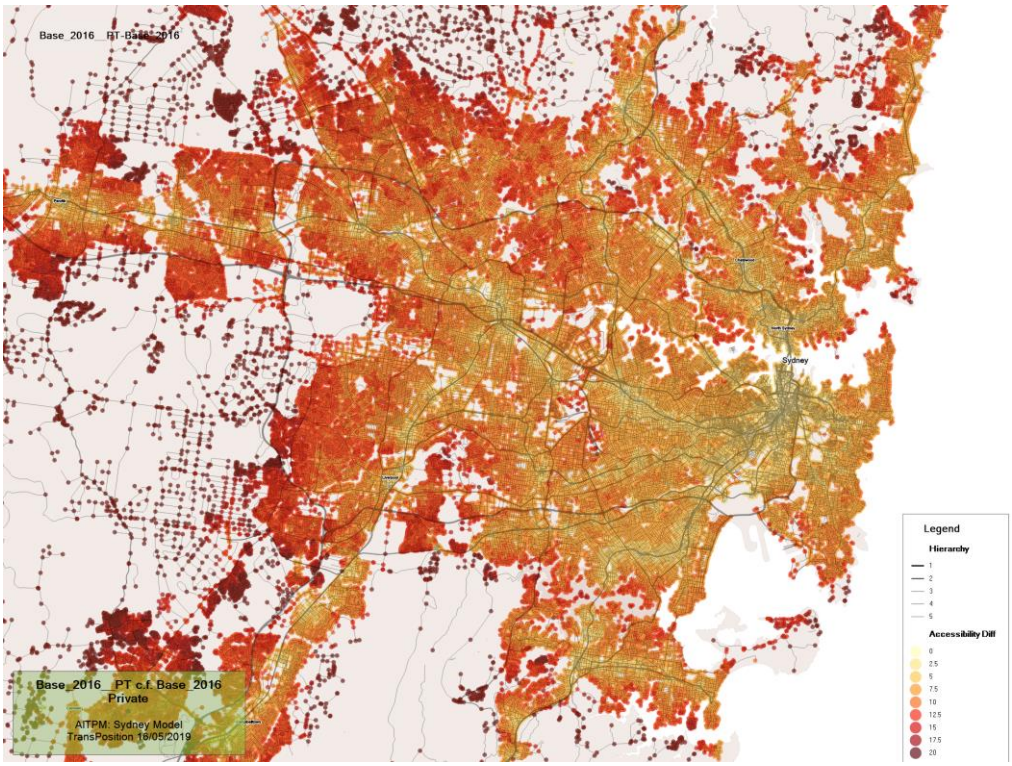

Figure 8: Change to Sydney's accessibility when only PT and active transport modes are available

These plots show the effect of transport constraints, and show the loss in accessibility (increase in centrality) due to the removal of car travel as an option. Every area suffers some loss of accessibility, but the effect is much less where there are effective alternatives. In Brisbane only the central areas remain effective – in the outer areas the loss in accessibility is severe, at over $20 per trip. This reflects the fact that for people in many of these areas there are no real travel alternatives, and so people must either walk long distances or forego the benefits that would have been available to them. In Melbourne the area with effective non-car alternatives is much larger, although it is clear that there are large parts of the population with few effective alternatives. Sydney fares the best of all, with much of the city experiencing a relatively lower loss in accessibility.

By comparing these plots with those shown earlier (fig. 2) we can identify those areas where car ownership is low due to disadvantage, and the public transport alternatives are weak. In Brisbane the areas in Woodridge, Logan and Inala seem most problematic. In Melbourne the key impacted areas are in the outer suburbs to the west (St Albans, Delahey), north (Craigieburn) and south-east (Springvale, Cranbourne and to a lesser extent Dandenong and Frankston). Many of the disadvantaged areas in Sydney do have non-car options, but the areas west of Liverpool (such as Bonnyrigg) and between Blacktown and Penrith (Mt Druitt, Plumpton) have fewer choices than elsewhere.

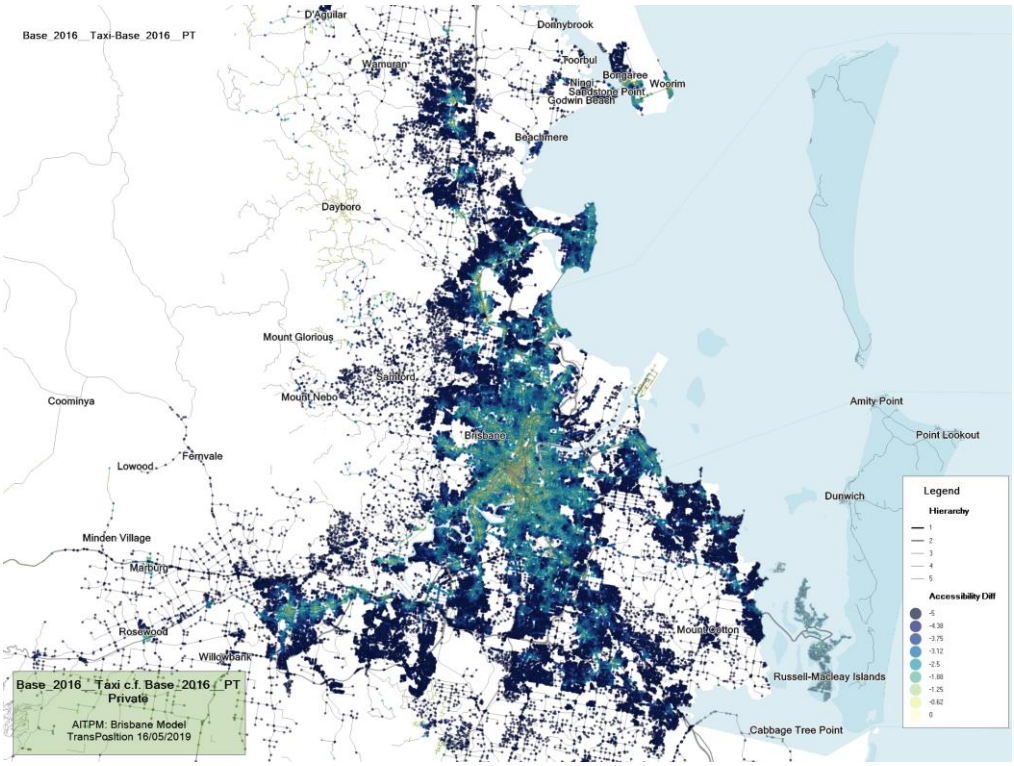

Figure 9: Change to Brisbane's accessibility when taxis are available in addition to the PT and Active transport modes

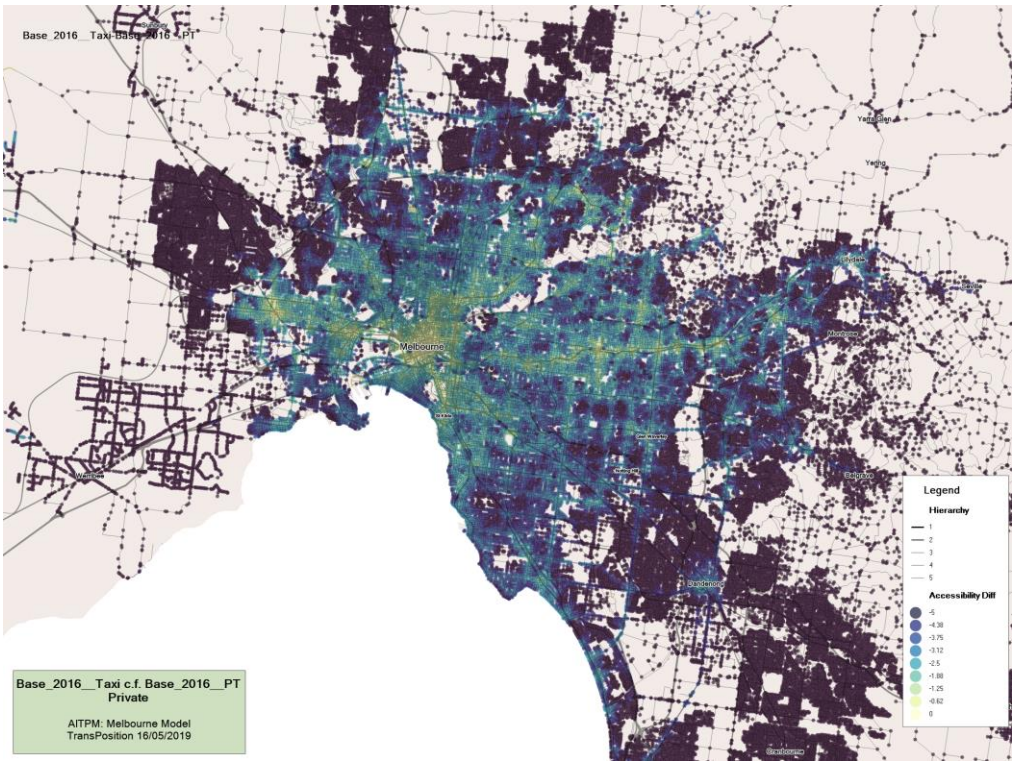

Figure 10: Change to Melbourne's accessibility when taxis are available in addition to the PT and Active transport modes

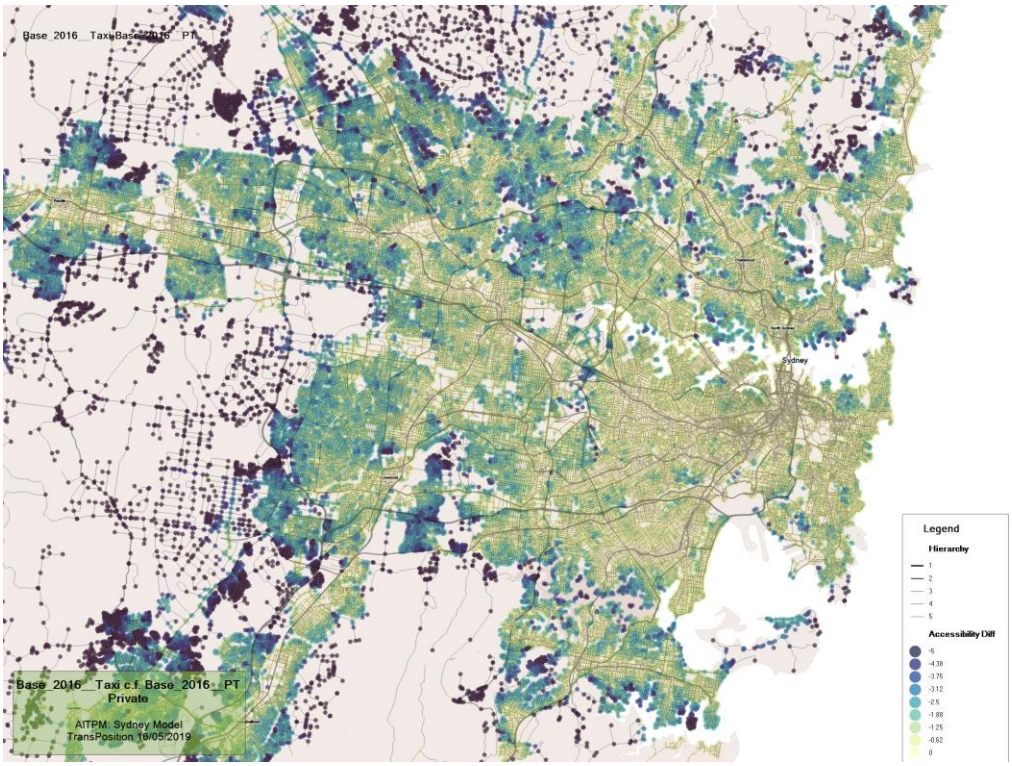

Figure 11: Change to Sydney's accessibility when taxis are available in addition to the PT and Active transport modes

If we assume that people can make use of taxis then the range of transport alternatives open up somewhat. Even taking account their high costs, by allowing effective access to more distant public transport alternatives, taxis significantly improve the accessibility of many locations. Note that we have assumed that services are available in every area and have not included any surcharges for more isolated locations. In each case it can be seen that taxis increase the effective catchment of the public transport corridors, leading to significant improvements in many parts of Brisbane that have few local options. In the inner areas taxis make less of a difference since effective public transport options are within walking distance. In much of Sydney the impact of Taxis is much more limited, again as there are effective options within walking distance of many locations.

For people with physical disabilities that limit their ability to walk we look at two more scenarios – one where walking speeds are significantly reduced and taxis are unavailable, to reflect the diminished options available to people with constrained personal mobility; and one where these people have subsidised taxi services.

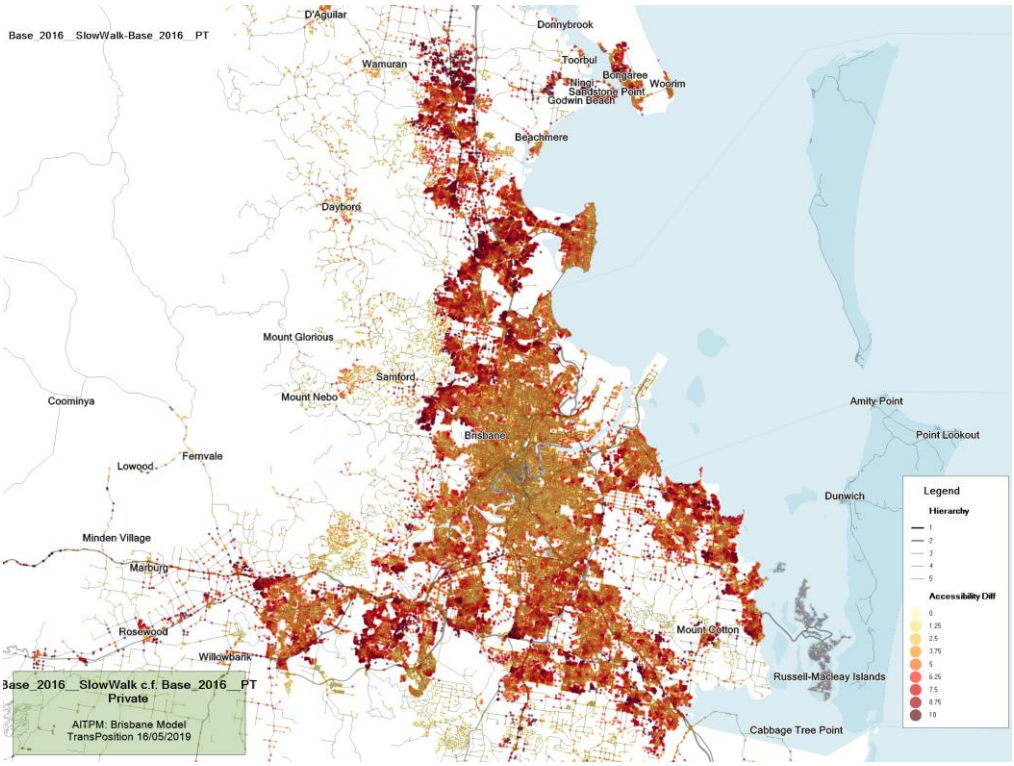

Figure 12: Change in Brisbane's accessibility for residents with restricted walking speeds when only PT and active transport modes are available

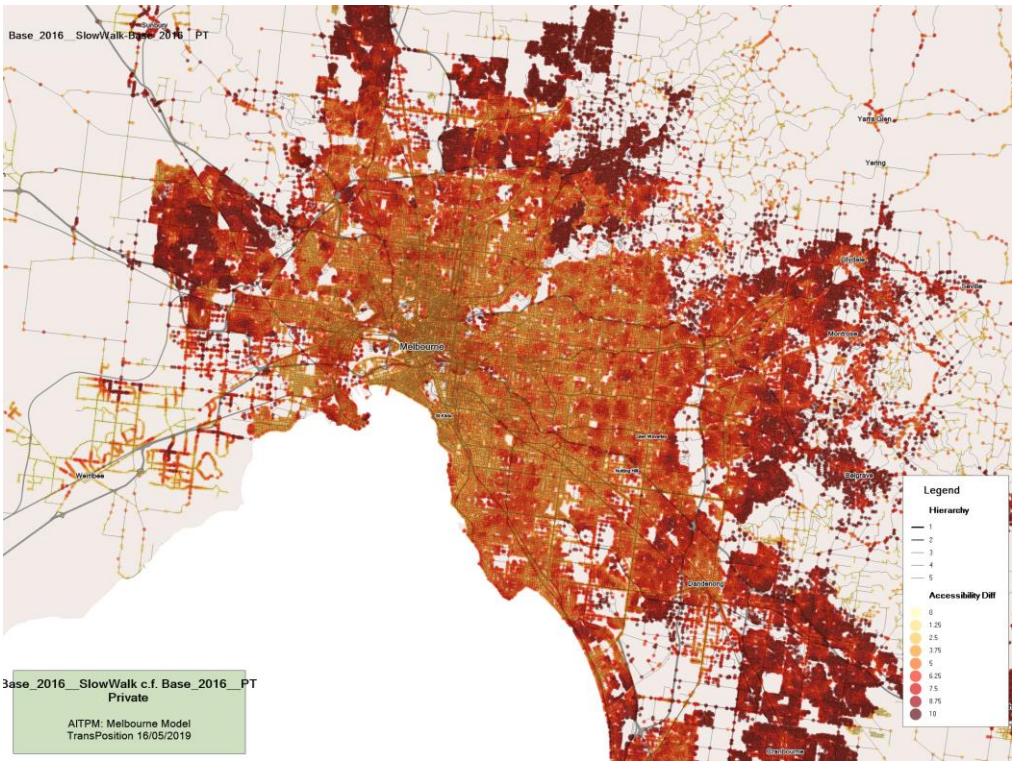

Figure 13: Change in Melbourne's accessibility for residents with restricted walking speeds when only PT and active transport modes are available

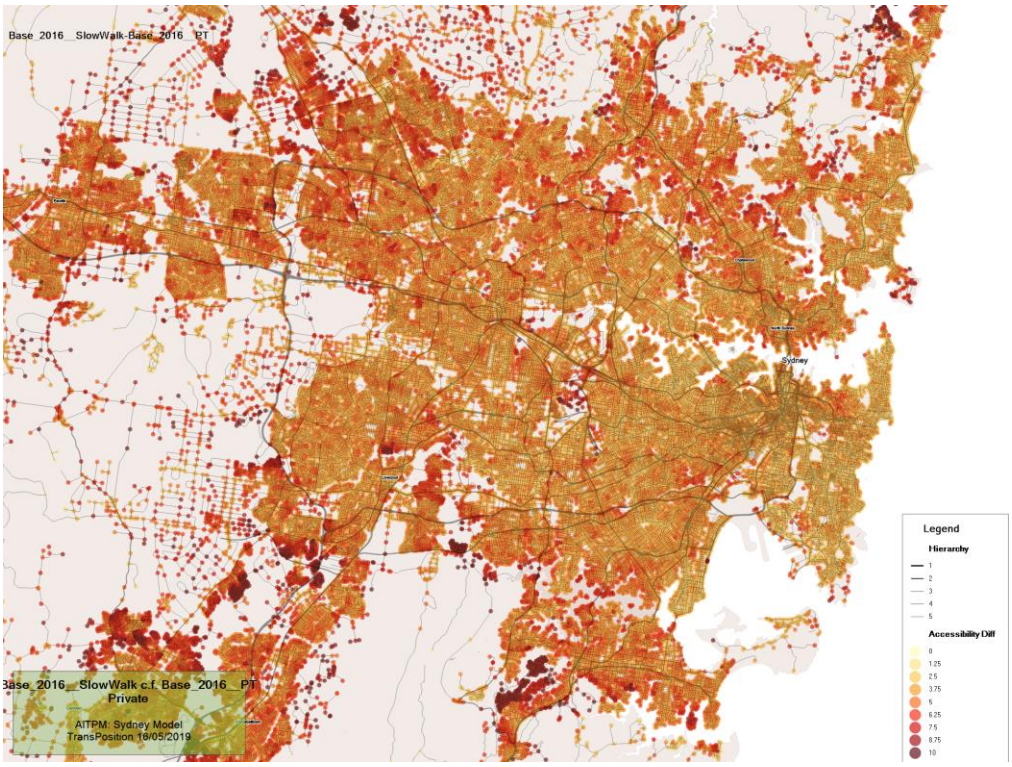

Figure 14: Change in Sydney's accessibility for residents with restricted walking speeds when only PT and active transport modes are available

It can be seen that the reduction in walking speeds has a significant impact on non-driver's overall accessibility. It limits the choices of public transport services and increases the extent of areas that are severely affected by non-car use. However much of this loss can be mitigated through the use of subsidised taxi services, as shown in the following plots.

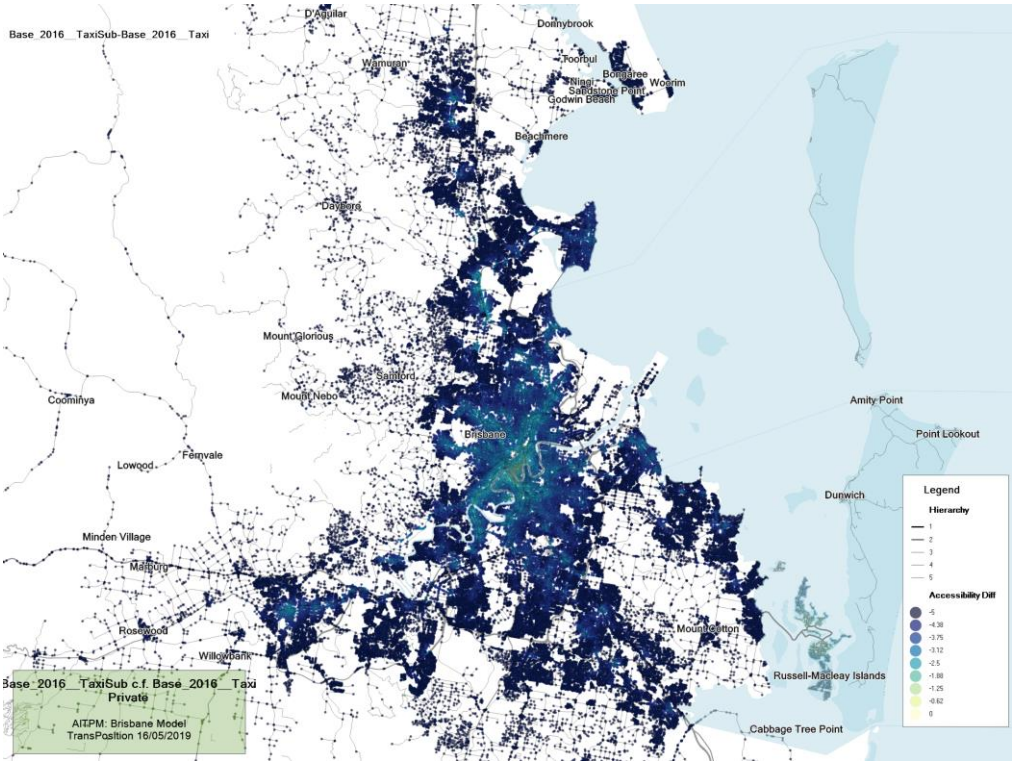

Figure 15: Improvement to Brisbane's accessibility when severely disabled residents are offered subsidized taxi fares instead of standard fare

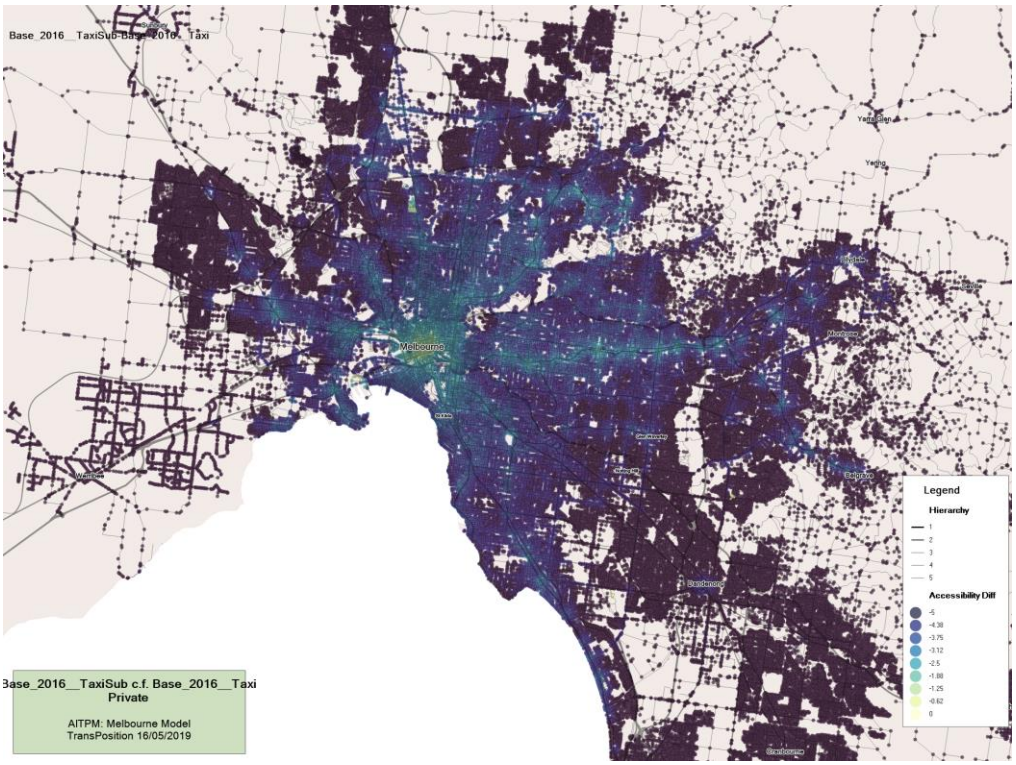

Figure 16: Improvement to Melbourne's accessibility when severely disabled residents are offered subsidized taxi fares instead of standard fare

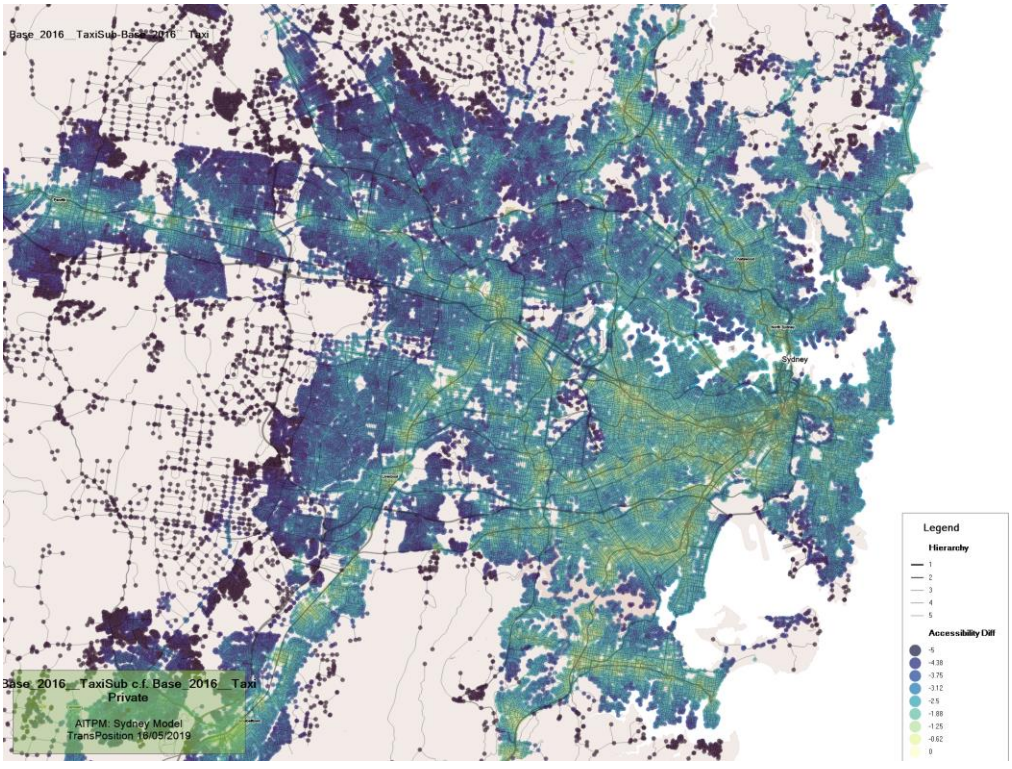

Figure 17: Improvement to Sydney's accessibility when severely disabled residents are offered subsidized taxi fares instead of standard fare

5. CONCLUSION AND RECOMMENDATIONS

The work described in this paper is just a preliminary attempt to bring transport modelling insights into the important areas of transport disadvantage. By modelling the effects of limited choices it is possible to get a better understanding of the loss of accessibility that results from personal constraints to travel. The work has identified a number of areas that currently have high levels of disadvantage, low car ownership and poor non-car alternatives. These areas could be targeted for a more detailed assessment to assess the scope of the problem and identify possible travel improvements. In one case, the Brisbane suburb of Logan, demand responsive transport trials are currently underway that could already be improving the situation (due to time constraints we were not able to include the impacts of this trial on the accessibility analysis).

There are limitations to the work done here – for simplicity we have assumed that the travel needs of those with transport disadvantages are similar to those of the general population. It is likely that there are different mixes of activities that are important – particularly for older people and those unable to work due to disability. Household travel survey analysis, or more targeted surveys, could be used to refine the bundle of activities that go into the accessibility calculation.

Nonetheless, this seems a promising approach to investigate the ways in which transport disadvantage can be mitigated through improved services or pricing policy (such as subsidised taxi services).

6. REFERENCES

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