Discussion Paper:

Development of a national Index of Access for Primary Health Care in Australia

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Acronyms list

2SFCA	Two Step Floating Catchment Area (method)
ABS	Australian Bureau of Statistics
AHPRA	Australian Health Practitioner Regulation Agency
AMPCo	Australasian Medical Publishing Company
ARIA	Accessibility and Remoteness Index for Australia
ASGC-RA	Australian Standard Geographical Classification - Remoteness Areas (pre 2011)
ASGS-RA	Australian Statistical Geography Standard – Remoteness Area (from 2011)
CRERRPHC	Centre of Research Excellence in Rural and Remote Primary Health Care
DALY	Disability Adjusted Life Years
DWS	District of Workforce Shortage
FTE	Full-Time Equivalence
FWE	Full-time Workload Equivalence
GP	General Practitioner
GPARIA	General Practitioner Accessibility and Remoteness Index for Australia
IRSD	Index of Relative Socio-Economic Disadvantage
MBS	Medicare Benefits Schedule
PhARIA	Pharmacy Accessibility and Remoteness Index for Australia
PHC	Primary Health Care
PHN	Primary Health Networks
PPR	Provider to Population Ratio
RRMA	Rural, Remote and Metropolitan Areas classification
SA1 & SA2	ASGS Statistical Area Level 1 & 2
SEIFA	Socio Economic Indexes For Areas
SES	Socio Economic Status
SLA	Statistical Local Area
UCL	Urban Centre / Locality

Preface

A key function of Commonwealth, State and Territory Government Departments of Health is the allocation of resources to fund health services and to recruit and retain adequate and appropriate workforce in their various jurisdictions. Given the significant geographical variation in health needs, access to health services and the ability to obtain health care at times of need, a critical aspect of resource allocation and health service planning is determining the basis on which health policy decisions are made, such that some geographical areas receive more support than others.

For more than two decades, health authorities dealing with rural and remote health workforce policy and support have used a number of classifications, none of which was specifically 'fit-for-purpose'. That is, these classifications were based solely on geography, with no regard for any meaningful measure of 'health access', which is the fundamental concept that determines the ease with which a household can obtain health care at times of need.

Historically, three key geographical classifications have been used – the *Rural, Remote and Metropolitan Area* (RRMA) classification[1] (which differentiated Australia into seven categories), the *Accessibility/ Remoteness Index of Australia* (ARIA) classification[2] (five categories), and most recently the *Australian Standard Geographical Classification - Remoteness Area (ASGC-RA)* [3, 4] classification (five categories). Although these classifications have underpinned resource allocation and decision-making for many national and state rural and remote health programs, none took specific account of the sentinel factors of access to health care in a way that meaningfully groups 'like-with-like' and separates 'unlike-from-unlike'. As a result, there has been considerable criticism over many years about the inequities that result from use of these classifications as the basis for resource allocation and workforce planning.

It was against this background, that the authors undertook research to develop a 'fit-for-purpose' classification for workforce planning. This geographically-sensitive "index of access" was specifically designed to provide an improved and empirical basis for rural health service planning and resource allocation decisions. This Discussion Paper:

- describes the need for a new "index of access",
- outlines the principles that underpin its construction,
- details the methodology adopted within the constraints of limited data,
- outlines the resulting pattern of geographical differentiation, and
- discusses the strengths and limitations of the work completed to date.

It is hoped that this Discussion Paper will not only provide a basis for strong academic debate and consideration by health planners and policymakers, but also highlight the need for governments to increase access to available data-sets that they routinely collect, and which could assist to strengthen the methodology and outcomes from this research.

The authors welcome comments from anyone interested in this important and contentious issue. Persisting with the use of existing classifications and measures will only result in inefficient use of scarce resources and questionable program effectiveness. In contrast, the development of an improved basis to guide health service planning and resource allocation to rural and remote areas will help to overcome the existing inequities and facilitate planning to improve population access to primary health care services. We hope this research will stimulate further work in this area.

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Introduction

Poorer access to health care remains a key issue for rural residents. Rural and remote area populations have for too long unfairly received a reduced level of access to health care, with long-term consequences of poorer health outcomes. Two recent Australian reports, the 2009 *National Health and Hospital Commission's Report*[5] and the 2013 *National Primary Health Care Strategy*[6] reaffirmed the need to improve access to Primary Health Care (PHC) as a priority area of interest for the government.

One key objective of the *Centre of Research Excellence in Rural and Remote Primary Health Care* (CRERRPHC) is to develop 'Better measures of access to guide resource allocation relating to primary health care in small rural and remote communities'. This objective has led to the development of a new national measure of access to PHC in Australia, henceforth known as the *Index of Access*.

The development of a national Index of Access is a complex process. Currently, no off-the-shelf product exists which adequately measures PHC access. Instead, the solution requires a long iterative process which is built upon principles, current methodologies, pragmatism from data limitations, and redesign from unintended perverse outcomes. This discussion paper will identify the steps taken in developing a new national Index of Access for Australia, including decisions made along this process timeline. Further information relating to the Index of Access can be found within our published academic papers. Please see the reference list for further citation information.

Section 1: Why do we need a new Index of Access?

Standard (generic) geographical classifications are attractive to policymakers to underpin government policies because they remain relatively stable over time and are normally updated on a regular period. Australian rural health policies over the last 20 years have been predominantly underpinned by the Rural, Remote and Metropolitan Areas (RRMA) classification[1], which is largely determined by population size, and the Australian Standard Geographical Classification Remoteness Areas (ASGC-RA) system,[3, 4] which is solely determined by geographical remoteness. A brief overview of the methodology underpinning each of these classifications is provided in Appendix 1.

In addition, a number of non-standard classifications which measure “access” have supported rural health programs in this period. These classifications included General Practitioner Accessibility and Remoteness Index for Australia (GPARIA), developed to reflect the relative remoteness of General Practitioners, Pharmacy Accessibility and Remoteness Index of Australia (PhARIA), a relative remoteness measure of Pharmacists, and DWS (relative shortage of GPs or Specialists). However, none of these classifications, either the generic geographical classifications or non-standard ‘access’ measures, are the ideal solution for resource allocation and workforce planning in rural health policy. That is, for most policy applications they are not ‘fit-for-purpose’. [7-9] (See Postscript on Page 28).

What follows is a rationale of the need for a fit-for-purpose index of access, and an outline of the approach and decisions made in its construction.

Intrinsic value of the Index of Access

- For the purpose of health planning, more appropriate than using a generic geographic classification like Australian Statistical Geography Standard – Remoteness Area (ASGS-RA);
- Finer geographical discrimination of access is possible;
- Better measure than existing simple approach of provider-to-population ratios.

Applied value of the Index of Access

- Provides a good baseline, enabling inequities of access to be identified; and therefore indicate where best to respond with service provision support;
- New knowledge for service planning. E.g. State or regional networking of PHC services;
- Facilitates evaluation of effect of changes in service provision on patient access and helps assess risks and benefits of workforce planning;
- Has a potential role/relevance as basis for resource allocation; the Index could be most helpful when used in combination with local area experts (e.g. the future Primary Health Networks).

The Index of Access provides a summary measure of access to primary health care **from the patient’s perspective**, based on their place of residence – “What is my access to PHC, where I live?”

In contrast, our related work on the Monash Model (and the Mason review’s Modified Monash Model) [8, 10] provides a summary measure of working and living as a GP **from the provider’s perspective**, based on their place of work – “How ‘rural’ is my place of work?” (which is directly applicable to workforce support and retention incentives).

Section 2: Index of Access aims, objectives, principles and premises

Project Aim

To develop a national Index of Access for primary health care (PHC) that can be used to guide service planning and resource allocation in order to increase equity of rural health outcomes.

Objectives

- To formulate an Index which incorporates the key factors that contribute to differentiation in levels of access to PHC in rural and remote Australia (***Capture key factors***);
- To formulate a measure of access (Index of Access) that can be viewed spatially in order to show policymakers the existing geographical pattern of access to PHC in rural and remote Australia at any point in time (***Reveal patterns***);
- To formulate an Index that can guide the redistribution of PHC resources in order to bring about improved and more equitable access to PHC services in rural and remote Australia (*the Index*), and which can be used to test the effect of policy decisions on improving access to PHC in rural and remote Australia (***Enables modelling***).

Context and principles that emerge

- Equity of access to health care is important nationally and a fundamental principle underpinning Medicare in Australia, but its achievement needs an "**operational system**" that translates ideals into practice, usually around how to allocate resources equitably.
- The Index of Access is focused on non-metropolitan (**rural and remote**) Australia because these regions are characterised by worse health outcomes and face greater equity problems compared with urban areas when accessing PHC at times of needs.
- The Index of Access has been constructed at the **national scale**. This decision was taken because so much planning and resource allocation by the Australian government occurs at this scale in its quest to ensure equity of access to PHC for all Australians. Moreover, a key aspect of national planning and resource allocation is to ensure that *similar* communities and regions receive similar shares of the limited resources available, and that those communities/regions which are most disadvantaged are allocated resources proportionate to their needs vis-à-vis other more advantaged communities/regions.
- The Index of Access focuses on **PHC**. PHC represents the first point of access to Australia's excellent but complex health care system. Moreover, over 90% of all health presentations occur outside of the hospital setting and PHC has been shown to deliver the best return in bringing about improved health outcomes.[11, 12]
- The Index of Access takes into account three **major dimensions** that account for a person's ability to access PHC services, namely: (1) PHC service availability; (2) geographical impediments to accessing services and their ability to transcend distance in any geographical location; and (3) variation in the health needs of the population.
- The Index of Access is based on the best and most up-to-date **PHC data** (provider availability), available at the national level which maintains the confidentiality and privacy of any individual PHC service provider and users of these services.

- The Index of Access is constructed using the smallest available **geographical unit** of analysis for which data are nationally available. This notwithstanding, the spatial representation of the index is distorted because of the fact that Australian Bureau of Statistics jurisdictions for which data are collected do not necessarily accord with "functional catchments areas" and need to be interpreted with considerable care. This applies particularly in remote areas of Australia.

Overarching axioms and caveats

- Any model (or index) is underpinned by assumptions, decisions and criteria relevant to the goal.
- To the maximum extent possible, decisions required in the construction, and improvements to the Index of Access, have been guided by and based on empirical evidence, peer-reviewed literature or 'normative' (i.e. expert) consensus. This approach has been adopted in order to minimise subjectivity and avoid arbitrariness in decision-making.
- The Index of Access will take account of those key factors which contribute to differentiation in patterns of "who can get what PHC services at a time of need".
- The concept of health "need" is multidimensional, and it is extremely difficult to capture this in one measure. In the absence of national health outcomes (morbidity and mortality data, arguably the best measures of health needs) at a suitable geographical scale, three separate but related surrogate measures that are known to be highly correlated with morbidity / mortality are used – socio-economic, demographic and Indigenous indicators. See Section 5 for more information relating to measuring health needs (see also McGrail PhD, 2008).[13]
- Critical functions that underpin the construction of the Index of Access are based on the best available relevant evidence – for example, variations in the distance-decay function are based on the results of our health care related travel behaviour study undertaken in five small rural communities located in areas of different population density (see also McGrail Appl Geog, 2014).[14]
- A key goal is to provide a mechanism that will assist policymakers to redress existing geographical inequities in the provision of PHC services across the country. Because resources are not unlimited or ubiquitously available, this can only occur with some redistribution in the absence of more resources being available. Given that the smallest, most remote communities are the ones characterised by poorest access to care, we made the decision that a favourable Index of Access result should not be used to 'penalise' places with populations less than 5,000 in ASGS Remoteness Areas 3-5 (see Appendix 1 for more information on the ASGS-RA classification). These locations are often isolated, with a higher workforce turnover rate, and where access is highly sensitive to the loss of even 1 or 2 staff, so an observed high Index score is often short-lived. This decision parallels the evidence generated in the research that led to the "Monash model" for resource allocation and the current "core services" research being undertaken by the CRERRPHC.[8, 15]

Section 3: Methodology, including key decisions based on evidence from the Victorian Index of Access

The Index of Access, prior to the CRERRPHC, was tested at the state-level in Victoria in 2008, albeit within the limitations associated with using the Australasian Medical Publishing Company (AMPCo) dataset (www.ampco.com.au). This provided a good starting point on methodology. See resulting publications:

- McGrail MR. Spatial accessibility of primary health care utilising the two step floating catchment area method: an assessment of recent improvements. *International Journal of Health Geographics*. 2012; 11:50[16]
- McGrail MR, Humphreys JS. A new Index of Access to primary care services in rural areas. *Australian and New Zealand Journal of Public Health*. 2009;33(5):418-23[17]
- McGrail MR, Humphreys JS. The index of rural access: an innovative integrated approach for measuring primary care access *BMC Health Services Research*. 2009;9:124[18]
- McGrail MR, Humphreys JS. Measuring spatial accessibility to primary care in rural areas: improving the effectiveness of the two-step floating catchment area method. *Applied Geography*. 2009;29(4):533-41[19]
- McGrail MR. *The McGrail Index of Access to primary care for rural Australians* [PhD]. Moe, Australia: Monash University; 2008[13]

Whilst the limitations of this Victorian model are acknowledged, this body of work provides important learning outcomes which are applicable to a national Index. These learnings directly underpin key decisions made in the initial development of the national Index of Access in Section 3, and contribute to key decisions which evolve in Sections 4 and 5.

Key decision:	The two-step floating catchment area (2SFCA) method significantly advances the measurement of access to primary health care in rural geographies, and therefore was chosen to underpin our Index.

In brief (also see Table 1 below for further explanation):

- The 2SFCA method produces an outcome measure of access in the well-understood provider-to-population ratios (PPRs) format.
- The 2SFCA method, in the last 10 years, has become a widely accepted measure because of its advantage of enabling catchments that are specific to each population rather than relying on pre-artificially defined regions which apply to ordinary or crude PPRs.

Table 1: How does the 2SFCA method work?

The two-step floating catchment area (2SFCA) method is closely related to the simple provider-to-population ratios (PPRs) method. PPRs provide a crude measure of "access" as a ratio between supply (volume of services) and demand (population size). However, PPRs are restricted to differentiating access using fixed geographical or administrative boundaries (e.g. Statistical Areas or Postcodes) and they ignore both cross-border movement between boundaries and distance decay within boundaries. The 2SFCA method also utilises PPRs within its calculation, but instead of being limited to only using fixed administrative boundaries, the 2SFCA method uses catchments that originate from provider and population locations.

As the name suggests, the final 2SFCA score is calculated using two connected steps:

- Step 1: Calculate service catchments – for each provider or service location (j) of volume S_j, determine what population size (summed P_k adjusted by health needs HN_k) can potentially access that provider (up to the catchment border = d_{max}) and, as per ordinary population-to-provider ratios, calculate the ratio score(R_j)

$$R_j = S_j / \sum_{k \in [djk < dmax]} P_k * HN_k * f(d_{jk})$$

- Step 2: Calculate population catchments – for each population location (i), determine what services (j) can potentially be accessed by that population (up to the catchment border = d_{max}), and aggregate the PPRs for these services (R_j) as calculated in Step 1. The resultant score (A_i) is also the Index of Access value for each location (i).

$$A_i = \sum_{j \in [dij < dmax]} R_j * f(d_{ij})$$

As discussed later in this report, the 2SFCA method is improved through the relatively easy integration of health needs (HN_k), distance-decay functions *($f(d_{ij})$ and $f(d_{jk})$)* and variable catchment sizes (d_{max}) – which all help to improve the accuracy of the 2SFCA method and resulting "access" scores. Each of these components were not part of early developments of the 'basic' or original 2SFCA method, detailed elsewhere. [18-22]

Key decision: Distance-decay is an essential addition to the 2SFCA method – see McGrail 2012[16] and McGrail 2009[18] for further information.

Whilst the original 2SFCA method enables more appropriate catchments to be defined, it assumes equal access anywhere within a catchment. In rural and remote areas, where catchments may extend for hundreds of kilometres, this is clearly not the case and so a distance-decay function MUST be added to the 2SFCA method (the exact format of this function is discussed in Section 4). Moreover, the omission of distance-decay results in "access" models identifying maximum access for populations located mid-way between multiple service locations rather than at the actual service location, a nonsensical outcome. For example, without distance-decay and a catchment size = 60 minutes, populations with maximum "access" are often determined to be those located midway between multiple services centres – each of which could be 50-59 minutes away.

Key decision: Distance-decay works differently for population access (Step 2) compared to service access (Step 1) – see McGrail 2012 IJHG[16] and McGrail 2009 BMC HSR[18] for further information.

The likelihood of a service providing access to a distant population depends upon the relative attractiveness (or pulling power of competing services). Stouffer's work[23] called this 'intervening opportunities' – for example, Bendigo residents have many local opportunities so are unlikely to access services from smaller centres elsewhere, such as in Inglewood or Elmore. In contrast, Inglewood residents have few local opportunities so are more likely to travel to access services from larger centres elsewhere, such as in Bendigo. In our model, this contrast is applied to Step 1 with distance-decay more readily applied to small service centres (because they are less likely to be 'serving' larger nearby populations), but not applied to large service centres (because they are more likely to be 'serving' nearby populations).

Key decision: In our access modelling, "distance" is measured using road networks and equals the time impedance from population locations to services locations (assuming a car is used for travel).

Whilst many studies have demonstrated only small gains from using road networks rather than straight line distance ('as the crow flies'), this 'simpler' option is less applicable to rural Australia, so we have used the Australian road network dataset (purchased from MapData Services - mapdataservices.com). In its calculation, different maximum speeds (limits) are assumed for different road types and the ability to travel at these speeds is assumed to deteriorate with increasing population density. This, of course, is in addition to the legal speed limits and normative advice relating to road safety. A simple percentile (modified by ASGC-RA), reflecting the ability to travel near the legal speed limits, is multiplied as below:

- Freeway = 100 km/h
- Highway = 90 km/h
- Main / Major Rd = 80 km/h
- Secondary Rd / Service Lane = 60 km/h
- Other Sealed / Unsealed Rd = 50 km/h

1. ASGC-1 = 60%
2. ASGC-2 = 80%
3. ASGC-3 = 90%
4. ASGC-4 = 100%
5. ASGC-5 = 100%

Key decision: Access should be capped (Step 2) once a saturation of access opportunities is reached – see McGrail 2009 BMC HSR[18] for more detail.

Whilst this issue has limited application to rural areas (no effect for most locations), it is critical to measuring access for fringe rural/metropolitan populations. Without capping, large metropolitan populations will be modelled as 'swamping' smaller fringe areas – however this scenario is highly unlikely because of a saturation of access opportunities nearby for metropolitan residents. A cap of 200 services is used (rarely reached within a catchment in rural areas); however a minimum catchment size of 10 minutes is applied in very high density metropolitan areas (where a cap of 200 is reached very quickly).

Key decision:	The concept of mobility (the ease with which an individual can transcend distance) is not applied within our national Index of Access.

Mobility can be a critical factor of access for individuals – for example, individuals without ready access to a car may struggle to access nearby services. However, this is an issue very specific to an individual's household situation so it is problematic to apply to a population-level Index of Access. The true level of individual or household mobility depends greatly on individual-level issues like work-life hours, proximity to work-life activities, personal mobility and family size and status. The number of cars per household provides a simple proxy measure of mobility; however, this proxy does not reliably measure the concept of mobility. Other than cars, differences of public transport access are negligible in rural areas so this indicator is generally non-discriminatory. Additionally, personal mobility restrictions due to disability / older age again are very individual-level issues and difficult to apply to a population-level access measure. For these reasons, and until comprehensive empirical data are available that take account of individual differences, mobility is not a component of the Index of Access.

Key decision:	The concept of health needs is difficult to measure, but is central to the Index of Access which is focused on minimising inequities.

Unlike mobility, the 'burden' of health needs is directly related to a population's need for services. That is, a population with increased burden of health (poorer health) will also have an increased need for access to health care. However, the specific methodology for measuring health needs is highly problematic – and the approach previously tested in Victoria will not necessarily work at the national level – see McGrail 2008 PhD[13] and McGrail 2009 BMC HSR[18] for more information on previously used methods to calculate health needs. An improved approach for factoring health needs into a national Index of Access is detailed in Section 5.

Key decision:	The full complexity of access as a concept (e.g. Penchansky 1980, Russell 2013[24, 25]) cannot be included in a population-level Index of Access.

The three key reasons are:

1. Data do not exist (e.g. accommodation, acceptability) or are not available at the required geographic scale. It is more important to have an accurate measure (or no measure), rather than a poor proxy measure.
2. Little is known about the relative weightings of different access dimensions in their contribution to a national access measure.
3. Policy requirements that any 'tool' to measure access must be simple, doable and up-to-date (current).

Section 4: Methodology - Moving to a national Index of Access

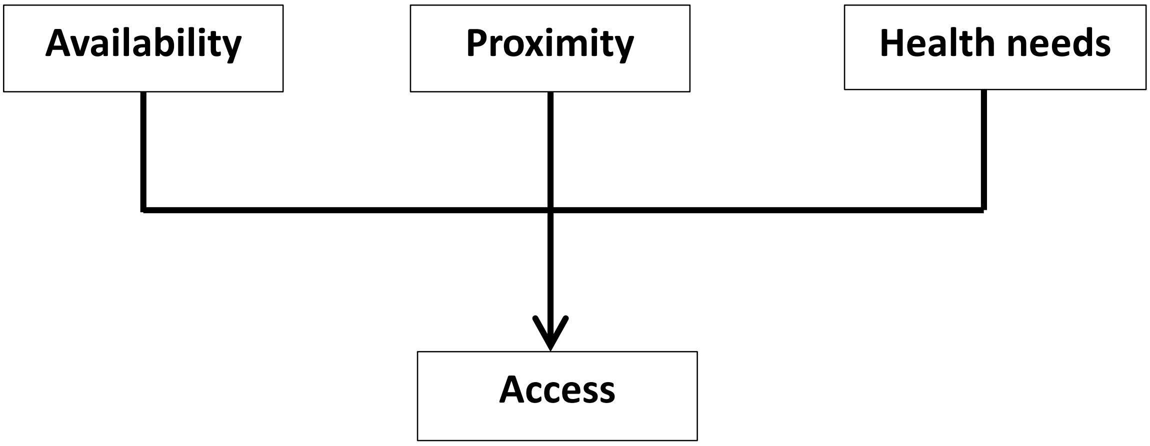
The development of a national Index of Access at a suitable scale requires a more sophisticated approach than was previously developed for Victoria. Some of the methodological issues are addressed below:

Key decision: Index of Access is a function of availability, health needs, proximity

The national Index of Access consists of 3 key related components (see Figure 1):

- Availability – the relative volume of services compared to the population size is a critical component. Service providers clearly have a limit to the number of services that they can provide so the number of services is critical to PHC access.
- Proximity is also critical, especially for rural populations –that is, the distance that is required to be overcome by the population to utilise (access) services readily determines whether access can be achieved. Residents clearly have limits on their preparedness to travel (and mobility), and the likelihood of services and populations being linked drops with decreased proximity.
- Health needs – the required volume of services is determined by both the crude population size and the morbidity of that population. Rural and remote populations are readily acknowledged as being characterized by poorer health, which equates to a need for increased health care. This is especially important in rural and remote areas with significantly poorer socio-economic levels, health behaviour and also the size of their Indigenous populations, as well as age adjustments.

Figure 1: Conceptual model for the Index of Access



Primary health care data: measuring availability

Key decision: There are limited national datasets readily available for non-General Practitioner (GP) PHC services at a suitable scale, so they are not part of the Index of Access.

Ideally, we would like this new national Index of Access to include a range of primary health care services, such as nurses, pharmacists, physiotherapists, diabetes educators & nurses, dentists, psychologists and other allied health clinicians. The Australian Health Practitioner Regulation Agency (AHPRA) is one potential source of these data. However, a key limitation of this dataset is the inability to differentiate between healthcare sector. Additionally, it is not possible to capture the volume of services, notably to differentiate between part-time and full-time. Similarly, it is not possible to capture (part-time) services delivered to multiple locations.

Development of the Index of Access is a staged process, to date built upon GP services. It relies upon accurate and national coverage data, at the locality/town level. Our methodology has been developed using GP services data, but should appropriate data become available for some of these non-GP services, then a similar process can be applied to calculate an Index of Access that includes the availability of PHC nurses, for example.

We recommend keeping the different service layers (e.g. GPs, nurses) in separate models if another PHC service dataset becomes available, for example rural PHC nurses. Otherwise, the volume of services (Sj) is difficult to aggregate and the resulting access score is difficult to interpret. In this example with combined PHC nursing and GP services, a low access score could be due to an undersupply of doctors, nurses, or even both. One exception is Remote Area Nurses (see Appendix 3), who are a direct substitute for GPs in such areas and thus included where data were available.

Key decision: The Medicare Benefits Schedule (MBS) will provide the main dataset for our Index of Access, supplemented in metropolitan (ASGC-1) areas by AMPCO data.

The only service type with a good national dataset are general practitioners (GPs). These data are available through the MBS, which records nearly all GP services in Australia via the Medicare insurance / billing system. The CRERRPHC successfully gained access to the MBS data for the 2011/2012 twelve month period with the full-time equivalence (FTE) load for each doctor (not identifiable) in each rural location provided. The total FTE load in each location (rural town or UCL) is simply calculated by aggregating these data by location. This dataset was acquired for all rural locations in Australia (that is, all ASGC 2-5 regions).

In addition to the MBS dataset, the CRERRPHC acquired the full AMPCo dataset of GPs as at March 2012 (similar period to MBS). Notably, for the purpose of our access model, the AMPCo dataset has service availability data in all metropolitan regions (ASGS-1). Despite our clear focus on modelling national access for rural populations, the 2SFCA method requires data for neighbouring regions to complete its calculation appropriately. Without metropolitan data, access scores in fringe rural / outer metropolitan regions would be problematic.

Measuring availability: FWE vs FTE

One issue from the MBS dataset is whether to use FWE (fulltime workload equivalence, equal to the total volume of services currently available in a location) or to use FTE capped at 1.0, henceforth known as FTE_1.0 (where the total volume of services for each GP is capped at a “reasonable” or manageable load). Whilst FWE provides a more accurate picture of actual availability experienced by a population, we argue that FTE_1.0 provides a more meaningful picture of the relative need by a population for more services – especially for long term workforce sustainability. That is, it takes account of the importance of avoiding medical practitioner ‘burn-out’ due to work overload, and the consequences of poor retention leading to increased recruitment costs by the practice.

Key decision:	Our preference is to use FTE_1.0 but data limitations mean that all results in this document have used FWE counts.

The use of FTE_1.0 in place of FWE values in access modelling would paint a worse picture of the current access landscape. However, it is not reasonable to expect that the current access provision which may be dependent on doctors providing a volume of services significantly higher than 1.0 FTE can be sustained. Unfortunately, the ability to implement this decision is limited by our dataset being non-identifiable, so it is not possible to identify doctors who work in multiple locations (and above 1.0 FTE). Thus, for example, if a doctor worked 0.6 FTE and 0.8 FTE in two different locations, giving a total of 1.4 FTE, there is no way to identify from our dataset that this doctor has worked >1.0 FTE. With our dataset, whilst we can crop FTE values >1.0 FTE to 1.0, this would be an inappropriate step due to the inability to identify possible additional FTE work time from the same provider.

Australian Bureau of Statistics census / geography data: measuring proximity to services

It is not practical to measure proximity of residents to GP services at the individual (household) level. Instead, some form of spatial aggregation is required. In 2011, the Australian Bureau of Statistics (ABS) moved their geography system to the Australian Statistical Geography Standard.[26] At the smallest level, Mesh Blocks are the building blocks of the ASGS but again it is not practical or necessary (except, perhaps in the most remote areas) to use Mesh Blocks (Mesh Blocks cover approximately 30-60 households). The next level is Statistical Area Level 1 (SA1) regions, which are the most appropriate and practical for usage across rural Australia. SA1 regions contain around 200-800 persons and are similar in size to the old Collection Districts (as defined in the 2006 and previous census periods). Finally, Statistical Area Level 2 (SA2) regions, which are similar to the old Statistical Local Areas, are the most appropriate for usage across metropolitan Australia.

Without household location data, residents need to be located within SA1 and SA2 regions using a geographically weighted centroid. For the most part this option is effective, except for two scenarios. Firstly, on several occasions in remote Australia the centroid was located too far from the road network (a 2km tolerance was used within the GIS software). This outcome was readily identifiable because these residents were (incorrectly) calculated as having no access. A manual relocation of the centroid onto the road network fixed this issue at all of these locations. Secondly, the centroid was located too far from where the population / services are – this was seen as a problem in two very different types of areas. (i) Very remote – these areas are often very large, and so the placement of residents was often sensitive to the end result. These areas were adjusted when vagaries were observed. (ii) Fringe metropolitan – in early testing it was found that many fringe SA2s had much lower access scores compared with nearby metropolitan areas. Closer investigation revealed (usually) that the population households were mostly located in one corner of these regions, and so these were adjusted towards the population centroid rather than the geographic centroid.

Key decision:	Rural populations are approximated by SA1 centroids whilst metropolitan populations are approximated by SA2 centroids.

The second part of calculating proximity between residents and services is the location of GP services. Both of our datasets from Medicare and AMPCo contain the town / city / suburb and state / postcode information. Service locations are, therefore, not defined by an exact street address but instead are geocoded to the centre of each town. The effect of this data precision limitation on GP services, especially for rural Australia, is negligible.

Key decision: Service locations are approximated by town / city / suburb centroids.

Distance decay function

As earlier stated in Section 3, a key component of the 2SFCA method is the use of a distance-decay function to define the probability that residents would travel to the service location. The omission of distance-decay implies that all residents within a catchment are equally likely to access all services within that catchment, whether the service is very close (e.g. 5 minutes away) or distant (e.g. 55 minutes away). This is clearly problematic, especially in more sparsely-populated rural areas with large (area) catchments. Distance-decay is measured as a score between 0 and 1, where 0 indicates no access and 1 indicates full geographical access. A score somewhere in between, for example 0.7, indicates that there is a 30% chance of residents in that location would not have access to the service.

In the Victoria model, distance decay (time separation = d minutes) was calculated using:

Decay function =	E.g.
• 1 for d<10; • ((60 – d) / (60 – 10)) ^1.5 for d > 10 and d<60; • 0 for d>60	decay = 1.0, d = 10 minutes decay = 0.85, d = 15 minutes decay = 0.46, d = 30 minutes decay = 0.16, d = 45 minutes decay = 0, d = 60 minutes

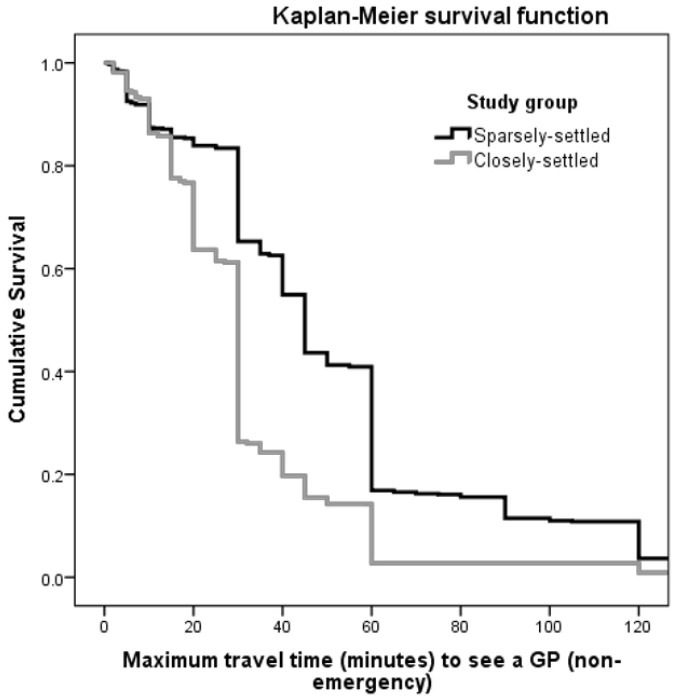
There were 3 elements, which applied to all (rural) areas.

(1) Initial period of 10 minutes seen as negligible barrier, so no decay applies
(2) Catchment is capped at 60 minutes, so access to all services > 60 minutes = 0
(3) Decay applies more quickly than linear (with a slightly skewed tail); i.e. Beta = 1.5

In 2012, the CRERRPHC undertook an empirical study where data were collected from 5 towns in NSW and Victoria from ASGC-2 (densely populated) and ASGC-3 (sparsely populated) areas.[27] The findings from this research, relevant to distance-decay, are summarised elsewhere.[28] The first key outcome is that the shape of distance-decay adequately matched our model, so our initial choice of Beta=1.5 remained. The second and main outcome of interest was the significant difference in maximum time respondents are prepared to travel to see a doctor – average 32 minutes vs 54 minutes for densely-settled and sparsely settled populations (see Figure 2 below). Use of this information and the corresponding survival functions (representing the probability of travelling to utilise GP services, which decays to 0 as the time separation increases) of these two groups helped us to choose more appropriate maximum catchments of 45 minutes (ASGC-2) and 70 minutes (ASGC-3). While we do not have empirical data for remote areas, local knowledge and discussions with remote staff enabled us to select, with some confidence, catchment sizes which continue to increase in size. Our catchment size list =

- ASGC-1 = 30 minutes (or where cap = 200 services, minimum = 10 minutes)
- ASGC-2 = 45 minutes
- ASGC-3 = 70 minutes
- ASGC-4 = 120 minutes
- ASGC-5 = 200 minutes

Figure 2: Distance-decay of resident's maximum time prepared to travel to access a doctor (GP) in a non-emergency



		Percentiles (minutes)					
	Mean	10th	25th	50th	75th	90th	95th
Closely-settled (minutes)	31.9	10	20	30	35	60	60
Sparsely-settled (minutes)	54.1	10	30	45	60	120	120

More details on the empirical health-related travel behaviour outcomes in dense vs sparsely populated rural areas are found in our published paper: *"Accessing doctors at times of need – distance tolerance of rural residents for health-related travel".* [28]

Whilst increasing catchment sizes in line with remoteness seemed an appropriate decision within the 2SFCA method, its implementation led to two key perverse outcomes. Details of these problems are described in Appendix 2 and published elsewhere[14] but, in short they related to some remote areas being (inappropriately) modelled as having higher access than neighbouring areas of less remoteness.

Our solution required the use of dynamically-defined (within the 2SFCA method calculation) catchment sizes that created a smoother transition to larger catchments rather than a sudden change at the remoteness level border. More information on the design and reasoning behind our dynamic catchment size function is found in Appendix 2.

Key decision: All catchment regions are defined as 1 of 3 types – (i) If most nearby services are located within the same remoteness-area (RA), then catchment size remains unchanged; (ii) If only some (25-50%) nearby services are located within the same RA, then reduce catchment difference between it and the neighbouring RA by 33%; (iii) If most nearby services are located within the lower (less remote) RA, then reduce catchment difference by 66%. The resultant list of catchment sizes is shown in Table 2.

Table 2: Dynamically-defined maximum PHC catchment sizes (minutes) by remoteness (5 levels) and remoteness sub-type (3 levels)

Cell values = new catchment sizes (minutes)	**Most (>50%) nearby services located in same RA**	**Only some (25-50%) nearby services located in same RA**	**Most (>75%) nearby services located in lower RA**
RA-1	30 minutes *	N/A (default = 30)	N/A (default = 30)
RA-2	45	40.1	35.1
RA-3	70	61.7	53.5
RA-4	120	103.5	87.0
RA-5	200	173.6	147.2

Footnote: *More details on the setting of dynamically-defined catchment sizes are found in the 2014 Applied Geography published paper.*[14]

Access within remote areas is likely to be noticeably different to other regional areas, due to their vast geography, the impact of extreme weather-related barriers, reliance on air rather than road travel and the high proportion of remote communities comprising mostly Indigenous people. Most of these remote-specific methodology issues present considerable difficulties in addressing them in a population-level model such as the proposed Index of Access. Many of these remote-area issues are summarised in Appendix 3.

Section 5: Measuring health needs for the national Index of Access

In Section 3, the need to include Health Needs – which is critical when trying to minimise population inequities – was noted. If health needs are omitted, then *demand* is modelled simply by the size of the population. A more realistic view is that there are large differences in the health needs requirements between different populations – thus demand should be adjusted accordingly. Unfortunately, health needs data at a small geographic scale are mostly not publicly available.

Health needs can be measured either directly or indirectly. Whilst direct measures of mortality and morbidity are generally preferred measures of health needs, they are not readily available for small geographic areas. Indirect (or proxy) measures, such as socio-economic status (SES), are more readily available at a small scale via regular data collections like the national census.

A key principle of the Index of Access is that data supporting its calculation must be readily available, valid, robust, accurate, and able to be updated as required. For these reasons, indirect measures of health needs using ABS censes data provide the only feasible option.

Victorian approach (2008 thesis)

In McGrail's PhD thesis in 2008,[13] an alternative method to directly using SEIFA (Australian Bureau of Statistics' Socio-Economic Index For Areas scale)[29] as a proxy health needs measure was developed. McGrail's improved approach, adopted in his study of Victoria, was to break down SEIFA into its individual components (consisting of about 30 variables in the 2001 version). These 30 measures were tested for their association with each other in order to: (1) examine autocorrelations; (2) reduce the number required as inputs; and (3) test the significance of their contribution. These data helped to choose sentinel indicators which best measured the geographical variation of health needs (where observed health needs consisted of burden of disease DALY or Disability Adjusted Life Year scores). From this selection process, 6 indicators were chosen which captured ~ 72% of the variance of DALYs when modelled at the Local Government Area level: 2 * education measures, 2 * occupation/work measures, 1 * family type measure and 1 * Indigenous measure.

The second step was to run a Principal Components Analysis on these 6 indicators, together with a 7th indicator of high need demographics (<5 years, >65 years, females 15-44 years). Two components emerged which captured 60% of the variance between these 7 variables. The 1st component measured "disadvantage" amongst these sentinel indicators, whilst the 2nd component was weighted mostly to identifying high need age groups.

One key issue, after combining these 2 factors, was how to transform the health needs score so that it can be integrated within the 2SFCA methodology. This was achieved using a fairly simple transformation which rescaled all small area weightings (at Collection District level) to an approximate range of 0.5 (i.e. require half the healthcare volume compared to the population) and 2.0 (require twice healthcare volume compared to the population). This decision to use a range of 0.5 – 2.0 weighted health needs was based on approximating the observed range in DALYS. When applied to the 2SFCA methodology, the "net" effect of the health needs factor was a range between 20% reduced access (e.g. Moe/Morwell, Maryborough/Castlemaine, Lakes Entrance/East Gippsland, Shepparton) and 15% increased access (Eastern Melbourne, Apollo Bay, Woodend/Macedon, Mount Beauty, Edenhope). More detail on the Victorian approach is published elsewhere.[13, 18]

New national approach

Unfortunately, there is no national and relatively small-scale measure of health needs available that meets the criteria underpinning the Index of Access (notably, preferred measure of direct morbidity outcomes at a small geographic scale). Following initial testing with national SEIFA data and a review of previous work, it is our belief that the previously developed 'Victorian' approach is not appropriate for a national measure of health needs. Chiefly, this is because the characteristics of Indigenous populations are vastly different in remote areas compared with Victoria. For example, predominant Indigenous communities (who are widely recognised as having higher health needs) are generally much younger (which would be incorrectly seen as a low health needs group based on their demographic profile).

The basic elements of low socio-economic status, namely poor education, low status employment, low incomes, reliance on public housing and larger households (per bedrooms) apply nationally. The downstream health effect of having low education (or any of the other factors) is mostly independent of where a person lives. Thus, a lower socio-economic status has a similar effect on health needs irrespective of their place of residence, though geography can further exacerbate this effect.

However, there are two additional contributors to health needs which are not solely determined by socio-economic status but also have a strong association with primary level health needs, specifically ethnicity and indigeneity, and age – in this case we used (1) Indigenous population % and (2) very young and older population % - defined as 0-4 and 65+. Notably, Indigenous populations have a significantly shorter life expectancy which means that most communities with large indigenous populations will likely have a smaller 'older' population than otherwise might be expected. Additionally, communities which attract large numbers of 'older' populations usually have small Indigenous populations.

Key decision: For the purpose of the national Index of Access, health needs is a composite measure that is weighted as follows:

Health needs = 50% SES + 25% Indigenous + 25% young/old.

Similar to the Victorian approach which weighted health needs predominantly by socio-economic status, for a national approach we propose that socio-economic status is the most significant component (as measured by the Index of Relative Socio-economic Disadvantage or IRSD),[29] with an additional 'loading' from 2 demographic variables - proportion Indigenous and proportion very young / old. We have chosen weightings of 50%, 25% and 25% respectively. This decision is based on the extant literature and expert understanding of health needs.

Key decision: All 3 components of health needs can only contribute to measuring an increase in an area's health needs (i.e. one-sided measures).

It would be unfair to artificially improve access scores (and thus penalise communities by reducing their eligibility for policy support) in small communities that are characterised by 'good' SES, since their need to access basis PHC at times of need remains. As mentioned earlier in this section, a penalty was applied in some locations in the Victoria approach to areas like Woodend and Apollo Bay, but we now consider this approach to be inappropriate. Thus for all rural and remote communities, the health needs weighting for the national Index of Access cannot be less than 1.

Key decision:	It is most appropriate to apply health needs adjustment at the town-level (using SA2-level indicators) in rural areas.

With our previous decision to only consider low SES areas contributing to the overall health needs, this created a slightly perverse outcome of weakening differences between towns. Most towns, when measuring small-area SES (at the SA1 level), will invariably have pockets of both high and low SES. The net effect, if we remove the high-SES scores, is that towns considered as having above average SES will have a health needs score only slightly 'better' (that is, smaller weighting) than other towns which are readily acknowledged as being low SES. Thus, for health needs, it is most appropriate to only use indicators aggregated at the SA2 level.

The net effect of this decision is not massive, but ensures that maximum 'between-town' differences are captured in the health needs weighting. The following example, comparing a low-SES town and a medium-high SES town in Gippsland, illustrates the change. The low SES town has a health needs weighting = 1.48 using SA1-level indicators, which increases to 1.61 using SA-2 level indicators. The medium-high SES town has a health needs weighting = 1.19 using SA1-level indicators, which decreases to 1.01 using SA-2 level indicators. Thus, the difference in health needs weightings of these 2 towns has largely increased from 0.29 to 0.60.

Further details on rescaling our three health needs indicators and the overall health needs measure, for integration within Step 1 of the 2SFCA method (see Table 1) are provided in Appendix 3.

Section 6: What does the national Index of Access look like?

There are several ways of presenting the Index of Access outcomes. What follows is a brief description of how we have presented them in this discussion paper.

As with the ASGC-RA (or 2011's ASGS-RA) classification, the Index of Access score is a continuous outcome. The ASGC-RA scale groups all areas into 1 of 5 categories - Major City, Inner Regional, Outer Regional, Remote and Very Remote (see Appendix 1). The continuous score (0-15) upon which these 5 categories are formed is not readily seen, and for many users it is irrelevant.

In contrast, the Index of Access score itself is more meaningful. Notably, the Index of Access score is scalar, where a score of 0 is readily interpreted as meaning that a population has no access and an Index of Access score of 0.0006 is equivalent to "twice as much access" when compared to a score of 0.0003. Thus the raw Index of Access score provides a very useful indication of the differences in the degree of access characterising different rural and remote communities. However, it is still desirable to collapse the Index of Access into categories in order for it to be useful to many end users, either for tabulation or mapping.

In order to achieve this goal, we have used the following 5-level categorisation to summarise our results. Thus, for example, a place with an index of 0.0008 would be considered to have 33% better access that one with a score of 0.0006, which in turn would be 50% better access than one with a score of 0.0004. Whilst access scores are in the form of PPRs (for example, 0.0008 equals a ratio of 1 provider to 1250 residents), these have been adjusted by distance-decay functions in both Steps 1 and 2 and health needs in Step 2 of the 2SFCA method. For example, areas with an Index of Access score in category 1 have access to better than 1 GP per 1250 population after adjustments:

1. >0.0008 (above $8*10^{-4}$) (>1:1250)
2. >0.0006 and <0.0008 (>1:1667)
3. >0.0004 and <0.0006 (>1:2500)
4. >0.0002 and <0.0004 (>1:5000)
5. <0.0002 (under $2*10^{-4}$) (<1:5000)

These categories can be displayed visually using choropleth maps. Unfortunately, visualisation is not easy, with Australia divided into geographic regions (e.g. SA1 or SA2) which vary greatly in size. Invariably, using choropleth maps, the eye is drawn to large geographic areas in maps, although in rural and remote Australia these large areas frequently have very few residents in them. On the other hand, the majority of rural residents are located in geographically small regions (but which are populated rural towns or regional centres) and so they are hidden from the view of the choropleth map, without significant zooming into a region.

To help overcome the scale issue, we have tabulated the proportion of areas that fall within each category – which is cross-tabulated against the ASGC-RA scale for comparison. Table 3 includes results from using the 5-level categorisation methods.

All maps and tables are presented for all of Australia and then for single states. Note that state results have used national data in their calculation, so there are no border issues to worry about. This issue of cross-border arrangements is very important in delineating patterns of access to nearby PHC services.

Figure 3: Index of Access scores - Australia

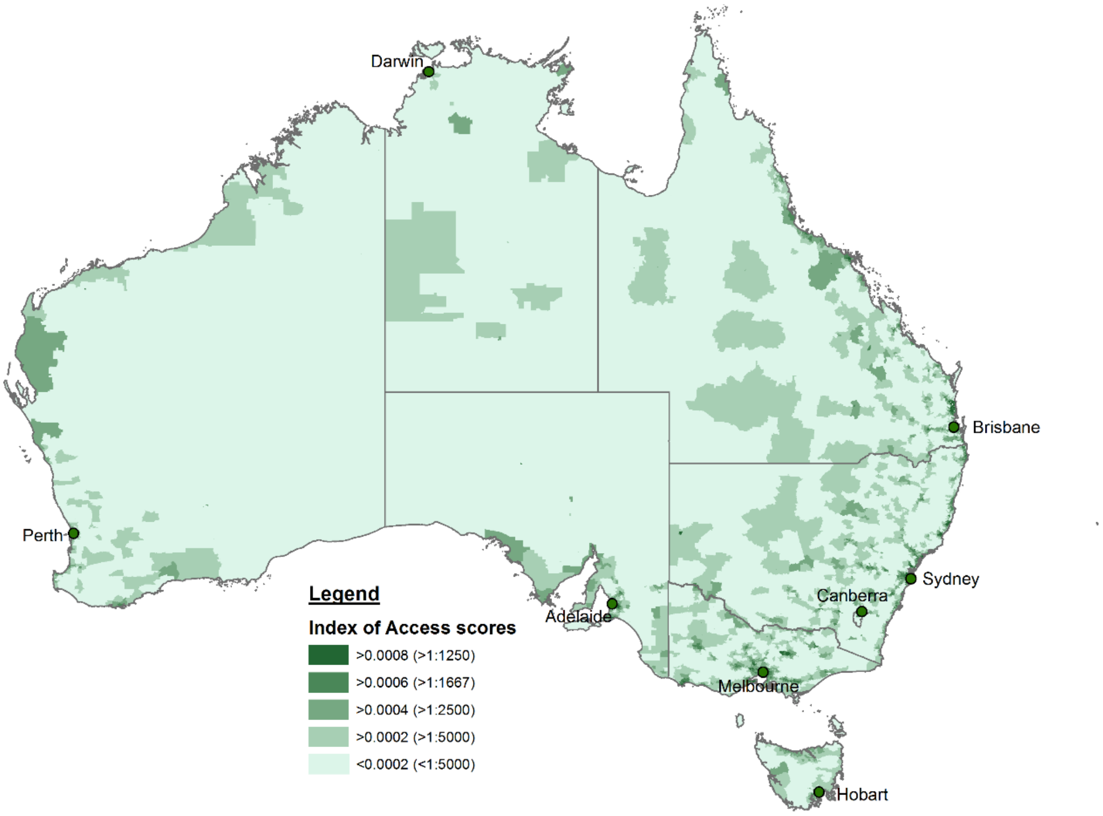


Figure 4: Index of Access scores – New South Wales

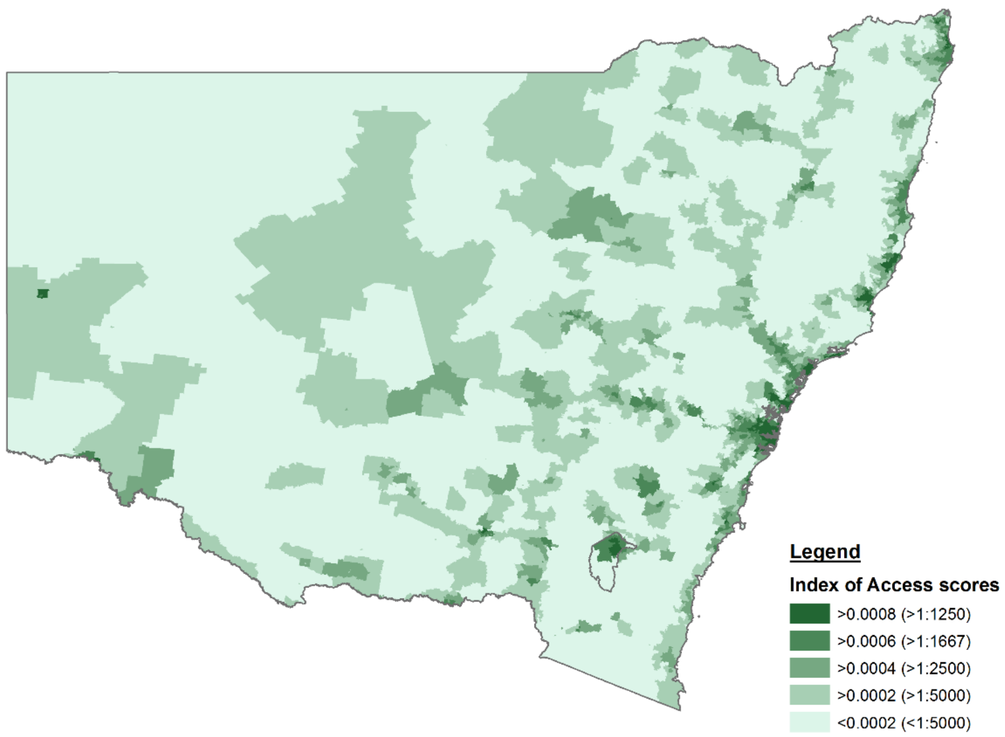


Figure 5: Index of Access scores – Western Australia

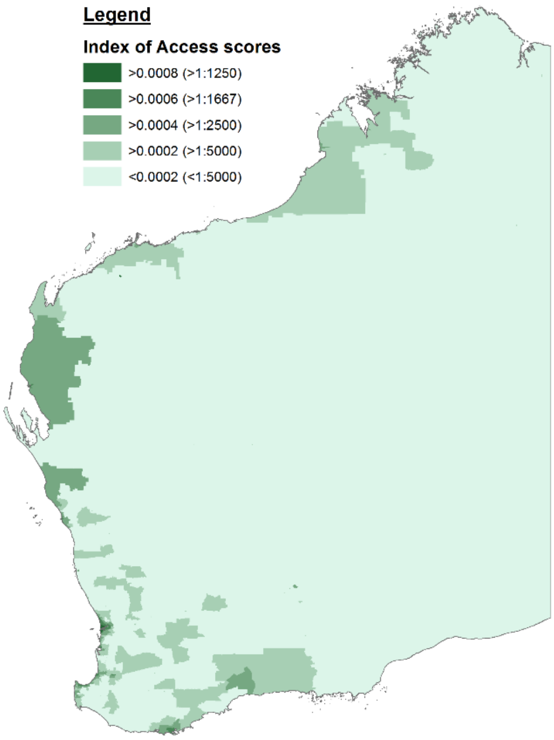


Figure 6: Index of Access scores – South Australia

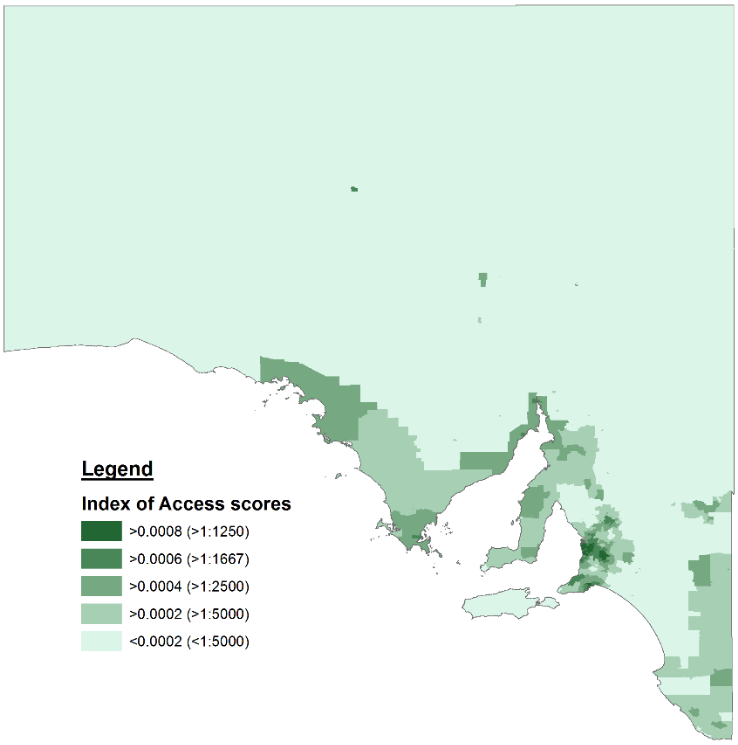


Figure 7: Index of Access scores – Victoria

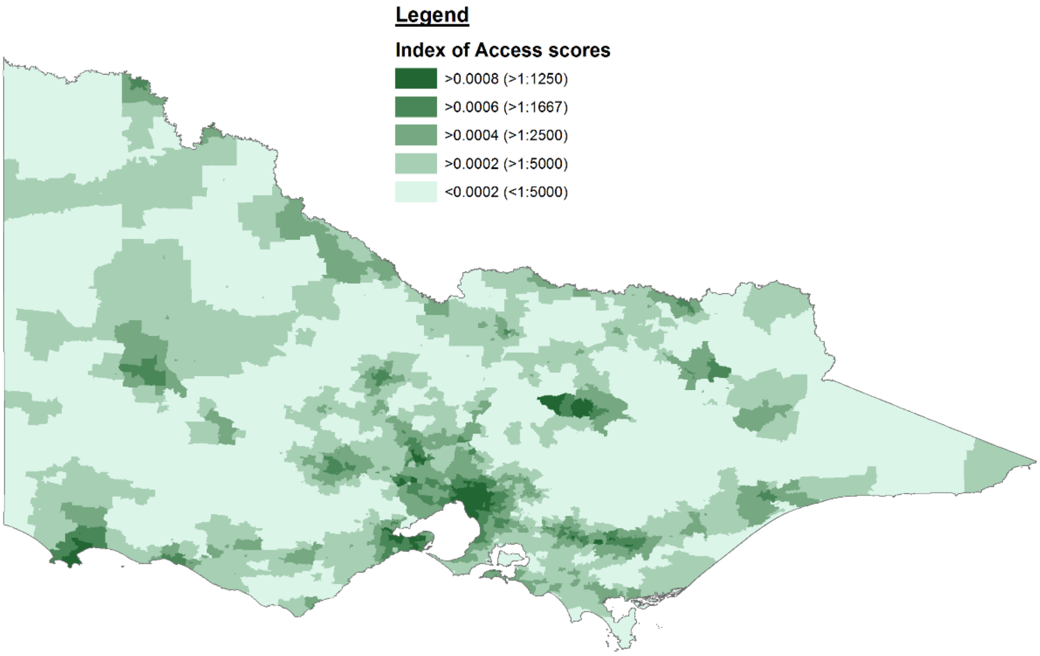


Figure 8: Index of Access scores – Tasmania

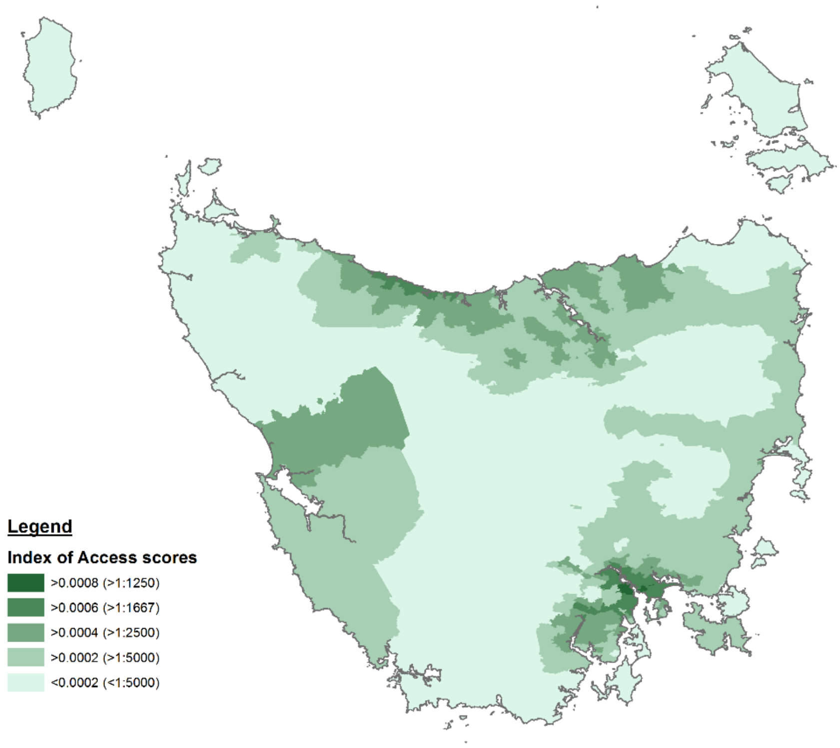


Figure 9: Index of Access scores – Queensland

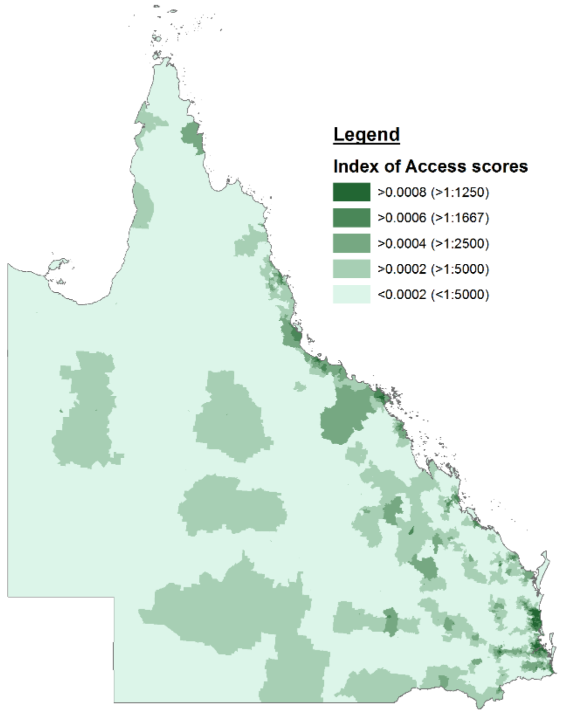


Figure 10: Index of Access scores – Northern Territory

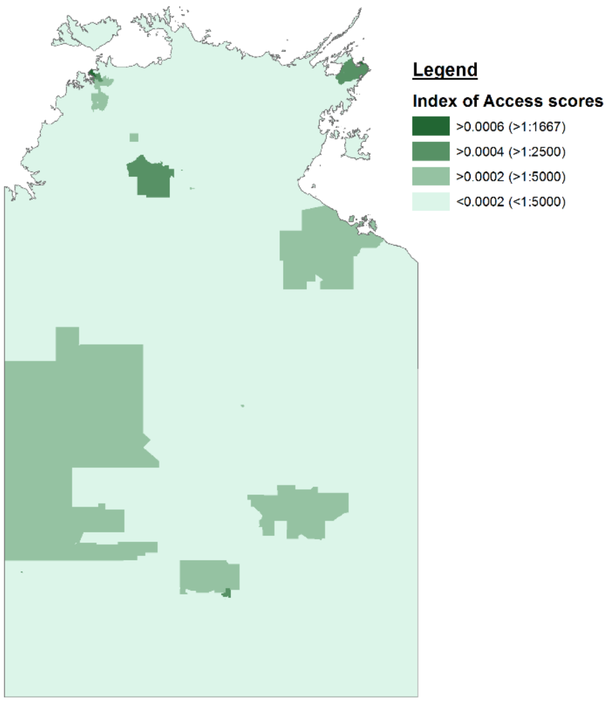


Table 3: Distribution of Index of Access scores, by State and ASGS-RA levels

Index of access scores	Australia				New South Wales				Queensland			
	Inner regional	Outer regional	Remote	Very remote	Inner regional	Outer regional	Remote	Very remote	Inner regional	Outer regional	Remote	Very remote
(1) >0.0008 (>1:1250)	10%	5%	0%	0%	9%	3%	0%	0%	11%	11%	1%	0%
(2) >0.0006 (>1:1667)	35%	32%	10%	4%	37%	8%	3%	0%	37%	43%	9%	0%
(3) >0.0004 (>1:2500)	30%	29%	40%	10%	26%	38%	20%	0%	32%	20%	42%	7%
(4) >0.0002 (>1:5000)	18%	22%	31%	26%	21%	28%	56%	58%	13%	18%	20%	48%
(5) <0.0002 (<1:5000)	7%	12%	18%	59%	7%	22%	22%	42%	7%	9%	28%	45%
% State population	18.5%	9.2%	1.4%	0.9%	18.6%	5.9%	0.4%	0.1%	20.5%	14.8%	1.7%	1.3%

Index of access scores	Victoria				Tasmania				South Australia			
	Inner regional	Outer regional	Remote	Very remote	Inner regional	Outer regional	Remote	Very remote	Inner regional	Outer regional	Remote	Very remote
(1) >0.0008 (>1:1250)	6%	7%	0%	-	20%	0%	0%	0%	23%	0%	0%	0%
(2) >0.0006 (>1:1667)	34%	33%	0%	-	34%	27%	0%	0%	19%	18%	33%	12%
(3) >0.0004 (>1:2500)	33%	27%	12%	-	39%	34%	59%	0%	30%	51%	29%	41%
(4) >0.0002 (>1:5000)	20%	20%	66%	-	7%	32%	24%	0%	19%	23%	23%	14%
(5) <0.0002 (<1:5000)	6%	14%	22%	-	0%	7%	17%	100%	10%	8%	14%	33%
% State population	19.6%	4.5%	0.1%	0.0%	65.8%	32.1%	1.6%	0.5%	10.3%	12.4%	2.8%	0.9%

Table 3 (continued): Distribution of Index of Access scores, by State and ASGS-RA levels

Index of access scores	Western Australia				Northern Territory			
	Inner regional	Outer regional	Remote	Very remote	Inner regional	Outer regional	Remote	Very remote
(1) >0.0008 (>1:1250)	0%	6%	6%	6%	-	0%	0%	0%
(2) >0.0006 (>1:1667)	32%	34%	34%	34%	-	77%	0%	12%
(3) >0.0004 (>1:2500)	27%	33%	33%	33%	-	17%	82%	1%
(4) >0.0002 (>1:5000)	22%	20%	20%	20%	-	4%	2%	18%
(5) <0.0002 (<1:5000)	18%	6%	6%	6%	-	1%	15%	70%
% State population	9.1%	19.6%	19.6%	19.6%	0%	57.4%	20.4%	22.2%

Section 7: Index of Access results: Interpretation and discussion

In Section 6, the Index of Access results were presented both visually in a choropleth maps as well as being tabulated. Whilst all Index of Access scores have been calculated using a national approach, the examination of results at a smaller ‘regional’ level such as each State or smaller levels such as for Primary Health Networks is encouraged. Using a national approach to present results in smaller subset areas ensures that concerns about results at the borders of regions are avoided.

The Index of Access scores are generally in the range of 0.0001 to 0.002, where the inverse of these scores provides a more readily understood provider-to-population ratio (PPR) value. A score of 0.002 is equivalent to 1:500, whilst a score of 0.000001 is equivalent to 1:10,000 (i.e. only 1 doctor for every 10,000 residents). However, we caution about using these scores in direct comparison to other reported PPRs. PPRs within the Index of Access will generally be lower than PPR scores in Government reports (e.g. number of GPs per Division of General Practice or Medicare Local population) because of the distance-decay function applied within the calculation of the Index of Access.

Maps vs tables

Maps are essential to provide the reader with a spatial representation of the relative access scores. However, because of the vastly different size of SA1 regions across Australia, they can be difficult to read. For example, it is almost impossible (without zooming in) to see what the Index scores are within most rural towns – which can mean that too much focus is paid to scores seen in the geographically largest areas (but these are often of low importance, because only a tiny part of a region’s population live there).

Tables are helpful because they quickly summarise the Index scores and help to categorise / group places which are similar in terms of their access to services. For example, the reader can quickly determine what proportion of RA-2 residents have low access compared to RA-4 residents. However, tables by themselves do not reveal which specific geographical areas are performing well or poorly with respect to their access to GPs.

It is only in combination of both the tables and maps that the full extent of heterogeneity of access scores can be observed.

Specific Index of Access scores

In Appendix 5, an illustrative list of 135 rural towns has been aggregated with each of Rural, Remote and Metropolitan Areas classification (RRMA), ASGC-RA and Modified Monash categories (as per the Mason Review methodology[10]), as well as the Index of Access scores. The finer discrimination of the Index of Access is highlighted by the 3 small NSW towns of Moama, Molong and Mullumbimby. It is seen that they are all of similar size and are located within Inner Regional. However, access is considerably different across these locations, with Mullumbimby having nearly 3 times as good access compared to Molong, whilst Moama’s access is approximately twice as good as Molong.

In the same way, regional centres can be directly compared to see which have poorer access. The Index of Access shows that, of the following list, poorest to best access in order is Launceston (poorest at 0.000544), Bunbury, Bendigo, Albury-Wodonga, Cairns, Ballarat, Bundaberg, Wagga Wagga, Toowoomba and Port Macquarie (best at 0.000789). If we set the best access score as the target for all regional centres, then Launceston would require an additional 20-30 FTE GPs (this is a crude estimate only, without consideration for demand from surrounding populations). Similarly, Bendigo would require at least an addition 10-15 FTE GPs.

Conclusion – Value of the Index of Access

In Section 1, a list of applied and intrinsic benefits from the 'fit-for-purpose' Index of Access was prepared. These are briefly summarised below:

This Index of Access provides a unique and significantly-improved contribution to guide rural health service and workforce planning, resource allocation decisions and the provision of PHC services. For the first time in Australia, a specific-purpose national access measure has been developed. With governments striving to improve equity of access to health care, and knowing that rural populations have long been characterised by poorer access, this new access measure enables much improved identification of those areas characterised by poor access. Moreover, the Index of Access is accurate at a much finer geographical scale than ever before.

Such an index has many potential applications in national health policy and planning. Firstly, identification of poor access areas can be used to better target workforce recruitment and retention programs. Secondly, accurate access scores can provide more specific location information to local service planners in relation to where to target workforce incentives and support. Thirdly, workforce planners can evaluate the effect of changes in service provision on patient access, helping to assess both the risks and the benefits of workforce programs as well as a better basis for evaluating the effectiveness of their policies.

For too long, governments and health policymakers have relied upon the use of generic geographic classifications or inadequate access measures such as PPRs and DWS status. This new national Index of Access provides a timely solution to the identification of areas of low or high access for health service planning and use in better targeting government rural and remote health funding. Used in conjunction with other population health and resource allocation tools, the Index of Access will undoubtedly assist regional health service and workforce planning. For example, use of the Index of Access can assist the newly-formed Primary Health Networks (PHN) or Rural Health Workforce Agencies and, more broadly, both State and Federal governments to accurately measure current access levels at a fine geographical scale, as well as measuring future access levels based on differing workforce (supply) and population (demand).

Postscript

In December 2014, the Assistant Minister of Health Fiona Nash convened an Independent Expert Panel to consider the redesign of the General Practice Rural Incentives Program using a new classification system, the Modified Monash Model. In 2015, the MMM classification system was adopted by the Australian Government. More details at the Commonwealth Department of Health website:

http://www.doctorconnect.gov.au/internet/otd/publishing.nsf/Content/Classification-changes

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Appendices

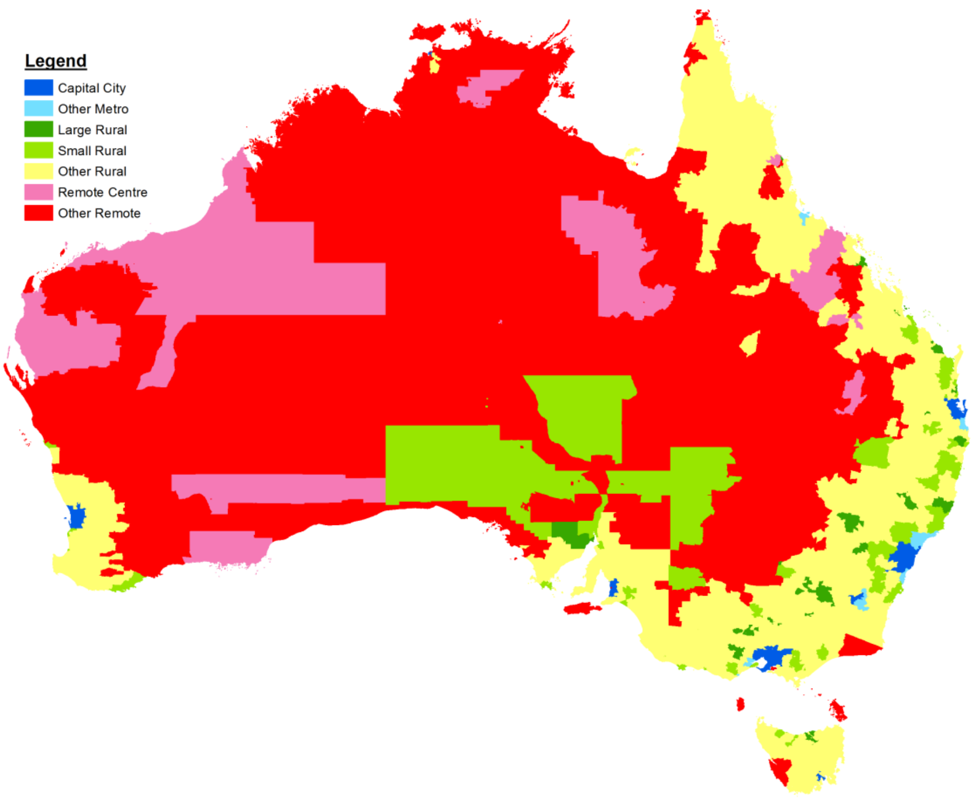
Appendix 1: Summary of the RRMA and ASGS-RA classifications

RRMA – Rural, Remote and Metropolitan Area

The RRMA classification had its origins in the Department of Primary Industries and Energy and the Department of Community Services and Health, and was released in 1994.[1] This classification divides all Statistical Local Areas (SLAs) of Australia into three zones, namely metropolitan, rural and remote and a total of seven categories across these zones. The separation of rural and remote zones is determined using a method earlier developed by Arundell,[30] by weighting five indicators that measure population density and straight-line distances to various population centres. Notably, after the identification of remote areas, separation into the seven categories of rurality was determined solely based on the size of the largest population centre within each SLA. Specifically, the seven categories are:

1. Metropolitan zone: Capital Cities
2. Metropolitan zone: Other Metro (urban centre population >=100,000)
3. Rural zone: Large Rural (urban centre population 25,000 – 99,999)
4. Rural zone: Small Rural (urban centre population 10,000 – 24,999)
5. Rural zone: Other Rural (urban centre population <10,000)
6. Remote zone: Remote Centres (urban centre population >=5,000)
7. Remote zone: Other Remote (urban centre population <5,000)

Figure 11: Australian map of the 1994 RRMA classification



Footnote: *This map is an approximation, based on 2006 ABS (census defined) postcode regions*

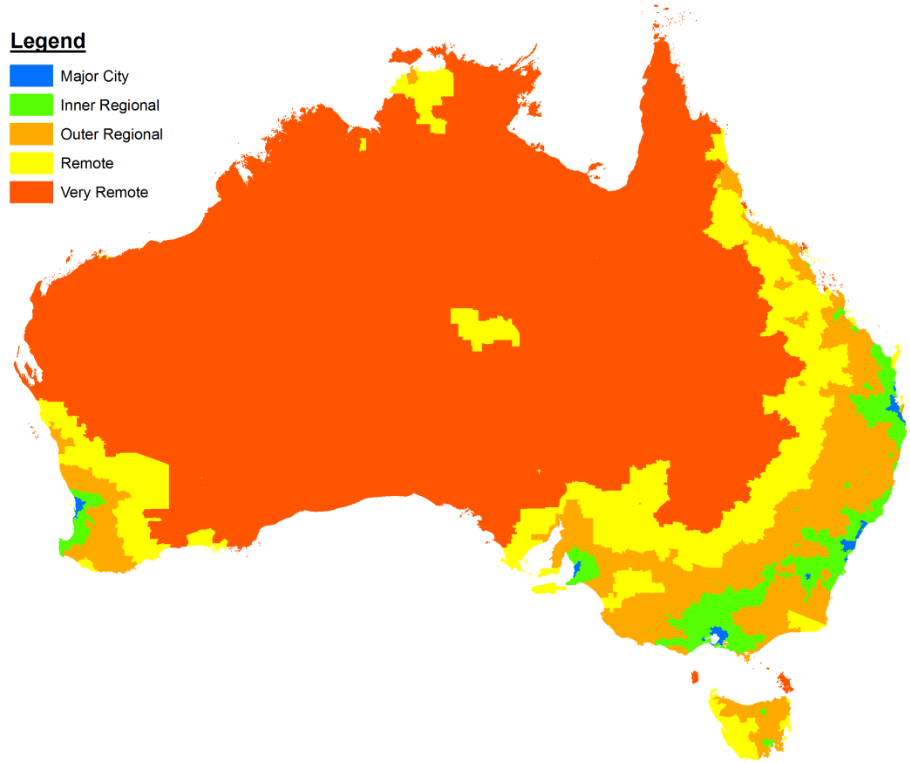
The Accessibility/Remoteness Index of Australia (ARIA) methodology was developed in 1999[2] by the GISCA team. One of ARIA's key methodology advancements (over RRMA) was that it defined a scale which is not restricted to using pre-defined spatial units (e.g. SLAs) because it utilises a one square kilometre grid that covers all of Australia. The ARIA classification, intentionally designed to measure geographical "remoteness", is calculated using road distances separating localities from four levels of service centres distinguished by population size. These are: >250,000; 48,000 – 249,999; 18,000 – 47,999; and 5,000 – 17,999. The final ARIA score is determined by aggregating these four measures of remoteness, which are then separated into five hierarchical ('natural break') categories.

In 2001, the Australian Bureau of Statistics (ABS) adopted a slightly altered methodology, referred to as ARIA+ with one key difference being the addition of a fifth service centre level, namely distance to centre of 1,000 – 4,999 population. From this, the ABS defined a new classification known as Australian Standard Geographical Classification Remoteness Area (ASGC-RA), which superseded ARIA.[3] Additionally, ASGC-RA adopted a different set of hierarchical categories, with five defined again but utilising a different range of scores and a different set of category labels.

In 2011, the ABS updated their overall geographical structure to the Australian Statistical Geography Standard (ASGS). This restructure included a redefinition of the remoteness classification to the ASGS-RA, which maintained the underlying ARIA+ methodology used in its calculation as well as the same 5 levels of the ASGC-RA in its definition:

1. ASGS-1 Major City
2. ASGS-2 Inner Regional
3. ASGS-3 Outer Regional
4. ASGS-4 Remote
5. ASGS-5 Very Remote

Figure 12: Australian map of the 2011 ASGS-RA classification



Appendix 2: Implementing variable catchment sizes

Initial application of the new variable catchment size method (based on the five ASGS-RA categories), was generally effective. "Effectiveness" was not quantified using any test – there is no 'gold standard' to test our outcomes against. Instead, the Index of Access scores were mapped for Australia and then evaluated for inconsistent or unexpected patterns. Patterns suggesting a problem included: sudden jumps between high and low access score, low access scores in towns known (personal knowledge) to have good access and high access scores in areas known to have zero or minimal services. This identified a few minor problems with our datasets, such as the digital road network having gaps at a few road section joins, or some population centroids being located without access to the roads in that area. These dataset 'mistakes' were fixed before repeating calculation of the Index of Access.

Further investigation was done in a few areas that were unchanged after the removal of dataset errors. The next stage of investigation examined whether the resulting access scores were a true reflection of access in that area. This investigation involved closer examination of the data inputs – notably, service volumes and distance decay values. As a result, two 'errors' were identified as being caused by the introduction of the five different catchment sizes within the distance-decay function. These errors are exemplified in the following two scenarios:

(1) Ingham – Townsville, where regions nearby to Ingham (RA-4) but further from Townsville were modelled as having access to Townsville and Ingham (RA-3) was modelled as not having access to Townsville despite Ingham actually being closer to Townsville than the nearby regions.
(2) Kempsey – Port Macquarie (both RA-2), where regions that sit midway between (RA-3 here) these larger towns are classed as 'more rural', thus their access scores were higher due to 2 factors: (i) midway locations have more opportunities; and (ii) the larger catchment due to the different remoteness means smaller distance decay to these opportunities.

It is seen that introducing a five-level dynamic catchment size has caused two types of perverse outcomes. Setting an appropriate maximum catchment size for respective regions is critically important to the resultant access scores because of two reasons:

- Extending the catchment size will increase a population's access (Step 2) because it makes more services (theoretically) accessible to that population. However, this increase is offset (in Step 1) by the larger service catchment meaning that a service is providing services (theoretically) to a larger population area and size.
- Extending the catchment size will increase a population's access score (for most locations, affecting Step 2 only) because it reduces the distance-decay fraction.

The key problem is that our catchment size increases by a moderate-large amount AND this change in catchment size applies to all populations. Intuitively, populations who are located near each other will behave similarly; however, this is not always applied in our current model. For example, populations located in RA-4, but near the RA-3 border have a catchment size = 120 minutes. We accept in our dynamic catchment size model that a 'more remote' area should have a larger catchment size, but the increase is unlikely to increase dramatically, as currently applied in our model. The solution to this problem is to apply a smoother transition at remoteness level boundaries so that catchment sizes don't dramatically change.

Populations located close to 'less remote' boundaries (e.g. within RA-4 but nearby to RA-3) will behave more like the less remote population (RA-3). The proximity of a population to the catchment boundary is measured by aggregating all nearby services to test what percentage is located in the lower remoteness level. If few nearby services are located in the lower remoteness level then that population must be located far from the RA-level boundary. In our refinement of the dynamic catchment sizes, we define three sub-types using the following rules:

1. If most (>50%) nearby services are from the same (or higher) RA level then that location should have no reduction to its catchment size. e.g. if population is located in RA-4 and 70% nearby services are also located in RA-4, then the catchment size is unchanged at 120 minutes.
2. If only some (25-50%) nearby services are from the same or higher RA level, then that location should have a moderate reduction (defined as 33% of the catchment size difference) to its catchment size. e.g. if RA-4 population and only 40% nearby services are also located in RA-4, then catchment size is moderated to: 120 (RA-4 size) - 50 (RA-4 to RA-3 difference) * 33% = 103.5 minutes.
3. If few (<25%) nearby services are from the same or higher RA level, then that location should have a significant reduction (defined as 66% of the catchment size difference) to its catchment size. e.g. if RA-4 population and 85% nearby services are located in RA-3 then catchment size is moderated to: 120 (RA-4 size) - 50 (RA-4 to RA-3 difference) * 66% = 87 minutes.

The distribution of nearby services by RA level is calculated by aggregating the volume of services for each community located within the catchment, after weighting each service by its distance separation within the catchment. Services close to the population are weighted highest whilst services close to the catchment boundary are weighted as nearly zero. As an example, 8 services located at 75% distance towards the catchment boundary (e.g. 90 minutes if RA-4) are weighted 0.25 and contribute a score of 2 (that is, 8 * 0.25); alternatively, 5 services located only 20% distance are weighted 0.80 and contribute a score of 4.

The decision to apply a linear reduction of catchment sizes, those being 0%, 33% and 66%, for each of the 3 sub-types was heuristic. There is minimal empirical evidence to guide this decision; however, they are based on expert academic judgement. The result of applying these rules is a 5x3 level catchment size definition, shown in Table 2, which provides a smoother progression through the different remoteness levels and is more closely tied to expected travel behaviour.

The new dynamic catchment size definition is summarised in Table 3 and further described in our 2014 published paper in Applied Geography.[14] Whilst the number of levels (5) and sub-levels (3) could be increased, there remains little empirical evidence to justify such a decision.

Appendix 3: Other issues relevant to "remote" area access

Access within remote areas is likely to be noticeably differently to other regional areas, due to their vast geography, the impact of extreme weather-related barriers, and the high proportion of remote communities comprising mostly Indigenous people. A population-level model such as here for the 2SFCA method is unable to adjust for most of these issues. Most of the issues listed below remain unanswered because there is no easy solution or we don't yet have the evidence necessary to support a solution with confidence. That is, the Index of Access currently does not account for most of these "remote area" characteristics.

Specific issues for "remote" areas:

1. *Where do 'resident' populations get allocated in areas of very small dispersed communities? Similarly, where do MBS service providers get allocated to when their location is defined as an area/region rather than a specific town or community?*

   This decision can have significant implications for the resultant pattern of accessibility. For residents, a key problem is that many SA1s in Very Remote regions of Australia are large. In fact, there are 129 SA1s whose area is greater than 10,000 square kilometres. Whilst we do not have specific information on the location of households within these large SA1s, to minimise the effect of this problem the geographic 'centroids' were manually adjusted for many of these large areas to where the largest community was known to be located. Another potential solution could have been to use Mesh Blocks in these areas; however, this would have complicated the proximity calculations and created problems in applying health needs to smaller regions.

   With respect to provider locations, a number of data items from the MBS dataset were only identified to a region instead of a specific town. Examples include: East Arnhem, Gibson Desert North, Kosciuszko National Park, Tanami and Gibson Desert South. In our model, these locations were allocated to the (single) main community in that region; this decision may be problematic when the actual behaviour is that services are delivered to multiple community locations in that region, but information is not available to enable identification of this scenario.

2. *How are the services provided by the Royal Flying Doctor Services (RFDS) factored into the access model? Similarly, what is the effect of current billing practices of non-GPs, such as RANs, in remote areas on the MBS data?*

   Our dataset comes from services billed under Medicare. The RFDS are prohibited from Medicare (they are salaried employees), and so their services are not included in our model. This is likely to then 'underscore' access in areas serviced by the RFDS (i.e. access may look worse than it actually is). Should these data (RFDS FTE service counts by location) become available, they could easily blend into the Index of Access; however, to date they have not been included.

   The Medicare dataset predominantly includes services only from GPs. One exception is the data from remote locations, where Remote Area Nurses (RANs) can bill their services under the MBS. Thus, our Index of Access currently includes these non-GP services, which we believe to be appropriate.

3. *How appropriate are the 'rural' distance-decay functions in remote areas of Australia?*

   See Section 4 of this document. Primary data was collected on primary care utilisation behaviour with respect to distance barriers for 5 rural towns of NSW and Victoria. Unfortunately, it was not feasible to collect the equivalent data for remote communities, meaning that the distance-decay functions applied to remote areas represent an educated estimate. Remote communities are often very different to rural areas, notably their isolation from other communities. Even with an increased preparedness to travel longer, in many areas this still does not get you to the next major community, thus it is questionable whether the same distance-decay function applies to remote areas.

4. *How are islands dealt with in developing a national Index of Access?*

   In order to calculate the ASGS-RA (remoteness classification) for island locations, special adjustments are made to account for sea/air travel. For the purposes of the Index of Access, it was decided that it was not appropriate to model island locations under the 2SFCA methodology (with the exception of Tasmania being self-sufficient and a few other islands that were directly accessible by road, such as Phillip Island in Victoria or Boyne Island in Queensland). Outside of these two types of islands, all other island locations are automatically classified in the poorest access category.

5. *How is "seasonal access" accounted for with respect to roads in remote areas of Australia?*

   Road access for populations in the far-north of Australia can vary enormously between wet and non-wet seasons, with the wet periods making many roads inaccessible for significant periods of time. Our model does not account for seasonal access - it is beyond the scope of this project to develop access models specifically for these areas. To do so probably requires the Index of Access to have two scores – one each for wet and dry seasons.

6. *How are "catchment areas" modelled for remote centres such as Broken Hill, Mt Isa, Kalgoorlie?*

   Remote centres are often seen to be well-serviced with respect to the immediate population size, but this ratio ignores the fact that these remote centres are often service hubs for nearby small communities. Often, services are taken to these small communities (i.e. they are not all provided within the regional centre); however, it is not clear how these data are captured in the MBS dataset or what impact they may have on access scores in such regions.

Appendix 4: Rescaling the health needs indicators and overall measure of health needs

Section 5 of this document outlined the method change in measuring health needs, from a Victorian approach to a national approach. In short, the national approach utilised a 'simple' formula for measuring health needs, with 50% Socio-Economic Status (SES using SEIFA-IRSD)[29] weighting and 25% weighting for both Age and Indigenous. This provides the basic framework to calculate health needs; however, recoding of the 3 measures/components is required before its calculation. The 2 demographic variables are simple percentages of the population within that region. As stated earlier in Section 5, these variables only contribute to health needs when they can be considered as a "burden" – i.e. they exceed the national average size in that community. The median score (across all SA1 rural and SA2 metro areas) for the size of the indigenous population = 2.1%; that is, half of all areas have less than 2.1% of their population indigenous. The median score for young/old = 20.6%, with most (>60%) communities having slightly below this average, in the range of 15-20.6%.

We argue that the required health needs of a community should NOT be reduced if either of these scores is below average; however, if these scores are above average, then the loading should be proportional to the margin that it is above the average and rescaled to a range 0 to 1. Both of these measures have a maximum score of 100% in some communities, thus their respective rescaled scores are calculated using:

Indigenous: if below average (2.1%) = 0, otherwise = ([score] – 0.021) / (1.0 - 0.021)

Young/old: if below average (20.6%) = 0, otherwise = ([score] – 0.206) / (1.0 - 0. 206)

This 'simple' approach is NOT appropriate for the SEIFA IRSD (SES) measure because it has already been scaled to the Normal (bell-shape) distribution with a mean = 1000 and standard deviation = 100. Thus, we typically expect about 95% of SEIFA observations will be in the range of 800 – 1200 (i.e. mean ± 2 standard deviations).

Instead, SEIFA scores need to be transformed to their Z scores using ([score] – 1000) / 100 and then using the cumulative probability score (that is, the inverse of the Z distribution). SEIFA scores which are <1000 (below average, as per Age and Indigenous) are then rescaled to a range of (0, 1) using: 1 – 2 * cum prob. For example, if the SEIFA score = 850, then Z = -1.5 and the cumulative probability (of the Z bell-curve) = 0.067 and thus its rescaled score for inclusion in the measure of health needs = 1 – 2*0.067 = 0.87.

One potential concern with this approach for SEIFA is that there are about 600 SA1 areas skewed to extremely low SES scores (defined as <750, which puts them in the bottom 1% of the Z-distribution) with 100 SA1s even having scores below 500 (bottom 0.0001% of the Z-distribution). In our calculation of the Index of Access, all areas with a SEIFA score < 750 are not differentiated, which means that they are all scaled at the maximum weighting of 1. One notable result is that a high percentage of these areas with extremely low SES scores also have very high (>80%) indigenous population levels, which will be captured in the overall health needs weighting.

Aggregating the 3 weighted components results in about 53% of areas having a negligible health needs weighting (<0.05), whilst about 7% of areas have a health needs weighting of >0.50, with a maximum value = 0.76. For integration into the Index of Access, health need scores are rescaled to a range of (1,2) using 1 + [score]/0.76.

Appendix 5: Index of Access scores, compared with alternative classifications

Table 4: List of 135 Australian rural town, with Index of Access scores and other generic classification levels

State	Town Name	Population Size (2011)	ASGC-RA	RRMA	Modified Monash	Index of Access
NSW	Armidale	19,818	2	4	3	6.50E-04
NSW	Batemans Bay	11,334	2	5	4	3.17E-04
NSW	Bathurst	31,294	2	4	3	7.53E-04
NSW	Bega	4,155	3	5	5	4.28E-04
NSW	Bourke	2,047	4	7	7	3.85E-04
NSW	Broken Hill	18,430	3	4	3	7.95E-04
NSW	Condobolin	2,755	3	7	5	4.35E-04
NSW	Dubbo	32,327	2	3	3	6.35E-04
NSW	Gundagai	1,926	2	5	5	4.82E-04
NSW	Hay	2,298	3	7	5	2.76E-04
NSW	Inverell	9,347	3	5	4	5.82E-04
NSW	Kempsey	10,374	2	5	4	3.77E-04
NSW	Kurrajong	1,090	2	1	2	3.82E-04
NSW	Maitland	67,132	1	2	1	2.80E-04
NSW	Moama	4,198	2	4	4	5.30E-04
NSW	Molong	1,629	2	5	5	2.75E-04
NSW	Mullumbimby	3,164	2	5	5	7.60E-04
NSW	Narrabri	5,890	3	5	4	4.92E-04
NSW	Nyngan	2,073	4	7	6	2.27E-04
NSW	Parkes	10,026	3	5	4	5.77E-04
NSW	Port Macquarie	41,491	2	3	3	7.88E-04
NSW	Taree	17,820	2	4	3	7.72E-04
NSW	Tocumwal	2,154	2	5	5	3.43E-04
NSW	Ungarie	322	3	5	5	4.92E-05
NSW	Wagga Wagga	46,913	2	3	3	7.68E-04
NT	Adelaide River	237	4	5	6	1.88E-04
NT	Alice Springs	24,208	4	6	6	5.18E-04
NT	Borroloola	926	5	7	7	3.52E-04
NT	Jabiru	1,129	4	7	6	1.08E-04
NT	Katherine	6,094	4	6	6	5.32E-04
NT	Maningrida	2,293	5	7	7	2.11E-04
NT	Nhulunbuy	3,933	5	7	7	6.86E-04
NT	Santa Teresa	555	4	7	6	1.52E-04
NT	Tennant Creek	3,062	5	7	7	3.17E-04
NT	Yuendumu	687	5	7	7	4.48E-05

Qld	Atherton	6,676	3	5	4	4.44E-04
Qld	Ayr	8,392	3	5	4	7.33E-04
Qld	Beerwah	4,340	2	5	2	9.48E-04
Qld	Blackwater	4,837	3	6	5	5.15E-04
Qld	Bundaberg	49,750	2	3	2	7.21E-04
Qld	Cairns	133,893	3	3	2	7.10E-04
Qld	Cardwell	1,176	4	5	6	6.19E-04
Qld	Charleville	3,318	4	7	7	3.38E-04
Qld	Charters Towers	8,234	3	5	4	3.29E-04
Qld	Cloncurry	2,313	4	7	6	5.45E-04
Qld	Cunnamulla	1,194	5	7	7	2.94E-04
Qld	Dalby	10,861	2	5	4	4.98E-04
Qld	Gladstone	32,073	2	4	3	7.10E-04
Qld	Goondiwindi	5,509	3	5	4	5.91E-04
Qld	Innisfail	7,176	3	5	4	3.45E-04
Qld	Kingaroy	9,586	2	5	4	4.16E-04
Qld	Longreach	3,137	5	7	7	3.95E-04
Qld	Mackay	74,219	2	3	2	6.01E-04
Qld	Maryborough	21,777	2	4	3	5.34E-04
Qld	Mount Isa	20,570	4	6	6	5.69E-04
Qld	Proserpine	3,390	3	5	5	8.66E-04
Qld	Roma	6,906	3	6	4	6.59E-04
Qld	Toowoomba	96,567	2	3	2	7.76E-04
Qld	Weipa	3,334	5	7	7	3.02E-04
Qld	Yeppoon	15,141	2	5	3	7.45E-04
SA	Bordertown	2,549	3	5	5	3.32E-04
SA	Ceduna	2,289	5	7	7	5.63E-04
SA	Clare	3,278	3	5	5	5.29E-04
SA	Coober Pedy	1,584	5	7	7	6.73E-04
SA	Kadina	4,470	3	5	5	5.40E-04
SA	Kingston SE	1,612	3	5	5	2.42E-04
SA	Loxton	3,795	3	5	5	4.11E-04
SA	Millicent	4,798	3	5	5	4.60E-04
SA	Mount Gambier	25,199	2	4	3	4.70E-04
SA	Murray Bridge	15,967	2	4	3	5.47E-04
SA	Naracoorte	4,908	3	5	5	5.16E-04
SA	Nuriootpa	5,215	2	5	4	6.94E-04
SA	Peterborough	1,486	3	5	5	2.28E-04
SA	Port Augusta	13,504	3	4	4	6.29E-04
SA	Port Lincoln	14,088	4	4	6	6.31E-04
SA	Quorn	1,206	3	5	5	3.38E-04
SA	Roxby Downs	4,702	4	5	6	5.31E-04
SA	Victor Harbor - Goolwa	23,485	2	5	3	7.95E-04

SA	Waikerie	1,633	3	5	5	2.12E-04
SA	Whyalla	21,736	3	3	3	6.55E-04
Tas	Beaconsfield	1,008	3	5	5	4.33E-04
Tas	Bicheno	647	4	5	6	3.35E-04
Tas	Burnie-Somerset	19,819	3	4	3	6.56E-04
Tas	Devonport	22,770	2	4	3	4.60E-04
Tas	Launceston	74,085	2	3	2	5.44E-04
Tas	Queenstown	1,975	4	5	6	4.89E-04
Tas	Rosebery	922	3	5	6	5.08E-04
Tas	Smithton	3,240	3	5	5	2.98E-04
Tas	Stieglitz	643	3	5	5	2.87E-04
Tas	Ulverstone	12,110	3	5	3	7.03E-04
Vic	Bairnsdale	11,820	3	4	4	6.60E-04
Vic	Ballarat	85,935	2	3	2	7.12E-04
Vic	Beechworth	2,789	2	5	5	3.10E-04
Vic	Bendigo	82,794	2	3	2	6.63E-04
Vic	Drouin	9,368	2	5	4	7.65E-04
Vic	Foster	1,089	2	5	5	4.34E-04
Vic	Heathcote	1,688	2	5	5	3.03E-04
Vic	Kyabram	5,642	2	5	4	3.53E-04
Vic	Lorne	1,046	2	5	5	4.24E-04
Vic	Maldon	1,236	2	5	5	2.58E-04
Vic	Mildura	31,361	3	4	3	6.84E-04
Vic	Mt Beauty	1,654	3	5	5	7.59E-04
Vic	Nagambie	1,547	2	5	5	2.76E-04
Vic	Ouyen	1,081	3	7	5	2.46E-04
Vic	Portland	9,950	2	4	4	9.81E-04
Vic	Rutherglen	2,125	2	5	4	3.88E-04
Vic	Stawell	5,736	2	5	4	4.13E-04
Vic	Swan Hill	9,894	3	5	4	5.89E-04
Vic	Timboon	743	3	5	5	3.93E-04
Vic	Warracknabeal	2,340	3	5	5	4.56E-04
Vic	Warrnambool	29,284	2	4	3	7.27E-04
Vic	Woodend	3,415	2	5	5	7.01E-04
Vic	Wycheproof	628	3	5	5	2.57E-04
Vic	Yea	1,086	2	5	5	2.91E-04
Vic	Yinnar	575	2	5	3	4.60E-04
WA	Albany	26,643	3	4	3	7.12E-04
WA	Broome	12,766	4	6	6	5.08E-04
WA	Bunbury	64,385	2	4	2	6.06E-04

WA	Carnarvon	4,559	4	6	6	7.33E-04
WA	Denmark	2,280	3	5	5	3.85E-04
WA	Esperance	9,919	4	6	6	3.91E-04
WA	Kalgoorlie-Boulder	30,841	3	6	3	5.38E-04
WA	Katanning	3,745	3	5	5	2.93E-04
WA	Margaret River	5,314	3	5	4	4.66E-04
WA	Meekatharra	734	5	7	7	2.63E-04
WA	Merredin	2,586	3	7	5	2.20E-04
WA	Narrogin	4,219	3	5	5	3.68E-04
WA	Newman	5,478	5	6	7	1.27E-04
WA	Norseman	777	4	7	7	2.58E-04
WA	Northam	6,580	2	5	4	3.30E-04
WA	Northampton	868	3	7	5	2.53E-04
WA	Pinjarra	4,255	2	5	2	5.78E-04
WA	Port Hedland	13,772	4	6	6	3.40E-04
WA	Tom Price	3,134	5	7	7	1.86E-04
WA	Wickham	1,651	4	6	6	3.34E-04

 # Stratified random selection of 135 non-metropolitan towns – New South Wales, Victoria, Queensland – 25 each; Western Australia, South Australia – 20 each; Northern Territory, Tasmania – 10 each. Strata used were State/Territory, population size, coastal/inland location and remoteness.

Footnote: Map projections

Throughout this document, we have used a geographic coordinate system (GDA94) to map Australia. This display method is characterised by vertical lines at the State boundaries, but horizontal stretching in southern areas (furthest from the equator), notably Victoria and Tasmania.