

# Transport systems in remote Australia: Transport costs in remote communities

Bruno Spandonide

Working paper  
**CW017** | **2014**



An Australian Government Initiative





Cooperative Research Centre for Remote Economic Participation Working Paper CW017

ISBN: 978-1-74158-231-4

#### Citation

Spandonide B. 2014. *Transport systems in remote Australia: Transport costs in remote communities*. CRC-REP Working Paper CW017. Ninti One Limited, Alice Springs.

#### Acknowledgement

The Cooperative Research Centre for Remote Economic Participation receives funding through the Australian Government Cooperative Research Centres Program. The views expressed herein do not necessarily represent the views of CRC-REP or its Participants.

#### Acknowledgements

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**Bruno Spandonide**



An Australian Government Initiative



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## Executive summary

This report assesses transport costs in remote Australia at a community level and is aimed at community stakeholders and people involved in planning and operational community development activities. Travellers themselves do not have always clear knowledge of transport costs and may find useful information to better understand some of the main economic parameters of transport activities.

### How are transport systems in remote Australia?

In remote Australia overall, transport systems are less safe, less efficient and less reliable than in non-remote Australia. There is a shortage of transport infrastructures and services. These shortages are likely to be increasing in the context of demographic, economic and climate changes.

### How much does transport cost in Australia?

Annual transport costs range from \$8,000 to \$18,000/person in Australia. In Australia, people pay \$600–\$7,500 per year as personal transport expenses. These expenses are on average two to three times higher in non-remote Australia than in remote Australia. The externalities associated with ineffective transport activities range between \$6,500 and \$17,000 per person per year. These costs are much higher (average of two times higher) in remote Australia than in non-remote Australia.

### What are the cost differences between transport modes in remote and non-remote Australia?

For people who have access to a car, combined annual transport costs are relatively comparable between non-remote and remote Australia. For people who regularly use public transport, combined annual costs (personal expenses and externalities) are around \$3,000 higher in remote Australia. For people who do not have access to public or private motorised vehicles, combined annual costs are \$4,000–\$7,000 higher for people living in remote Australia than for people living in non-remote Australia. Ineffective public transport and a lack of appropriate motorised vehicles increase socio-economic exclusion. This is particularly a concern for Aboriginal and Torres Strait Islander people living in very remote communities.

### What do transport costs represent compared to median incomes?

Total transport costs as a proportion of the median income are 20–40% higher in remote Australia. One factor is the lower median incomes; however, transport access is the primary factor, with combined costs of personal expenses and externalities representing 60–80% of the median annual income of people living in very remote communities, who are more susceptible to being left without regular access to motorised transport.

### How transport costs could be decreased?

Providing multimodal infrastructure; more affordable, more appropriate and more efficient motorised vehicles, with maintenance facilities; more affordable and regular public transport services; and more affordable and regular community transport services could help to decrease transport personal expenses and transport externalities. In the long term, the use of alternative fuels could enhance the resilience of remote communities and enterprises.

### Synthesis of key issues

The tyranny of distance is an everyday reality in remote Australia, where transport systems have been continuously improving over the last century through great achievements. Remote Australia has a

small population increase, high living costs, high unemployment rates, low incomes, high inequalities in terms of access and an ageing population.

In remote Australia, at a community level, transport costs vary considerably from one person to another and from one community to another. However, several trends can be identified: the fact that people travel more is compensated by the fact that people pay less of their personal money per kilometre to travel around than in non-remote Australia. Non-business trips tend to be undertaken by sharing and more use of the vehicles that are accessible and more reliance on non-motorised transport, which is considerably slower. Furthermore, there are fewer transport services available, and the people who are financially disadvantaged invest less in vehicles and equipment, insurance and administration, operating costs and public transport. Critically low private spending and public investment in terms of the size of the areas covered by the public transport network create in turn significant health, social, productivity and wellbeing externalities.

This situation is exacerbated by the facts that transport needs are generally greater in remote Australia, that transport activities have to be regularly undertaken in hazardous conditions, and that there is a larger proportion of people with reduced mobility than in non-remote Australia. Employment opportunities are also restricted by high transport costs. As a result, the most disadvantaged communities in terms of transport costs are the most disadvantaged communities in terms of remoteness, income and living costs. For people who are the most underprivileged, which include a higher proportion of women, elderly, disabled, ethnic minorities and low-income people (Dodson et al. 2004b), transport restrictions result in more intense socio-economic forms of exclusion with adverse effects for the communities and the remote Australia economy in general.

In a context of population growth and climate change, developing the access to appropriate private motorised transport and efficient public transport as well as opportune policies would help to achieve substantial results.

## 1. Scope

The Transport Futures research has been designed according to the recommendations of the scoping study of Raicu et al. (2011), which determined a need to develop methods for a comprehensive economic evaluation of transport services in remote Australia integrating health, social and time costs and for studying alternative transport options. The results are presented in three reports. The first report focuses on remote communities conceptualised as regional centres of transport network. The second report discusses the implications of transport costs for social and business enterprises. The third report refers to legislation-related issues associated with transport costs; it provides early recommendations for policy development.

This report discusses transport costs for people with different types and levels of accessibility and is based on the results of a comprehensive evaluation of well-established secondary data for different transport systems.

### 1.1 Transport futures research sites

This research evaluates the overall costs of transport for eight diverse sites, to inform understanding across remote Australia more generally (Table 1).

Table 1: Research field locations and characteristics

Locations	Population	Function	Climate	Transport
Alice Springs	24,208 in Alice Springs, and over 40,000 regionally	Large urban centre, multimodal hub	Semi-arid	Large airport, national highway, bus, plane and rail services
Santa Teresa (Ltyentye Apurte)	555	Locality approx. 90 km from Alice Springs	Semi-arid	Unsealed road, bus and charter plane services
Hermannsburg (Ntaria)	625	Locality approx. 120 km from Alice Springs	Semi-arid	Sealed road, bus and charter plane services
Tennant Creek	3,062, and over 5,000 regionally	Medium-sized urban centre of the Barkly region	Semi-arid	Regional airport, national highway, bus, plane and rail services
Lajamanu	656	Very remote locality	Semi-arid	Unsealed road, bus and charter plane services
Broome	12,766, and over 15,000 regionally	Large urban centre, multimodal hub	Tropical	Large airport, national highway, bus, plane and shipping services
Aurukun	1,288	Very remote small urban centre	Tropical	Unsealed road, bus and charter plane services with a maritime facade
Thursday Island (Waiben)	2,610, and over 6,000 regionally	Small urban centre, Torres Strait major multimodal hub	Tropical	Regional airport, bus, plane and shipping services, rail services

Figure 1 shows the study sites.

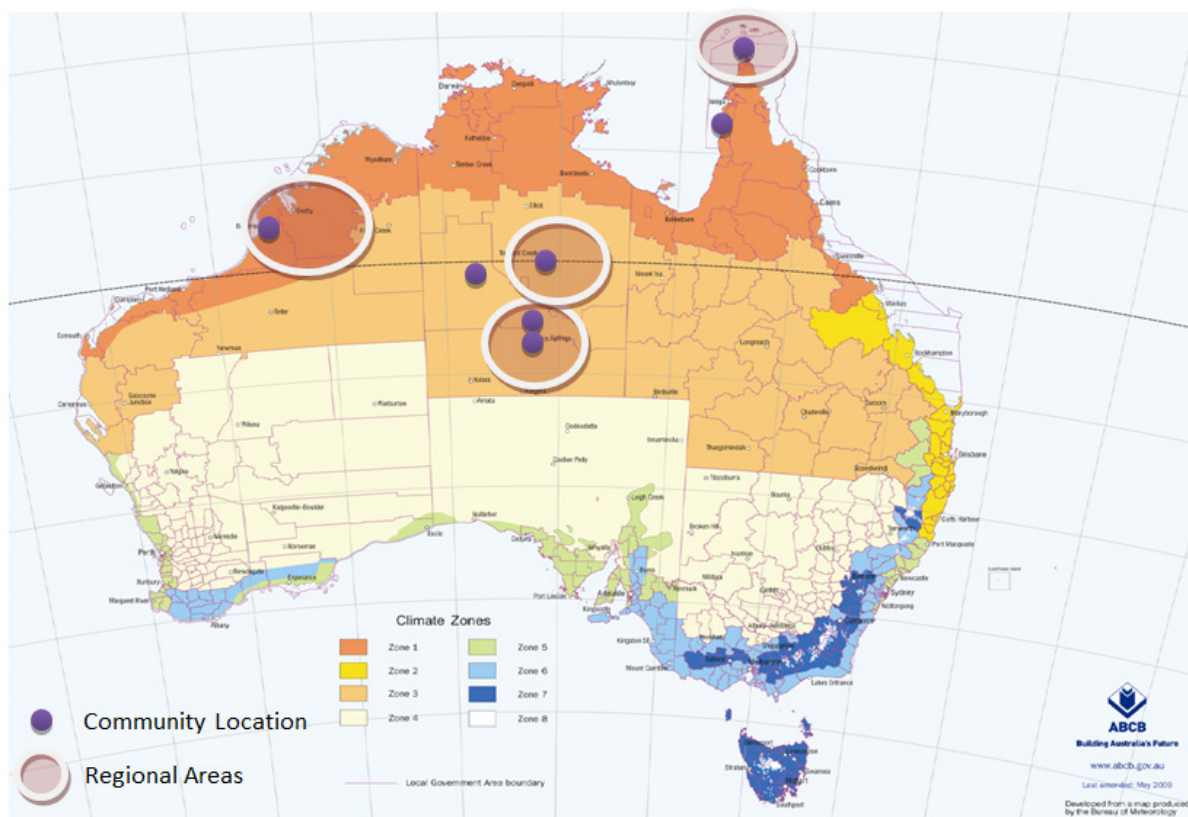


Figure 1: Research field sites

Source: Adapted from the Australia Wide Climate Zone Map (Australian Building Codes Board 2012)

These eight communities are representative of the diversity of remote Australia in terms of:

- population sizes: with communities ranging from 500 inhabitants, in order to undertake a comparative study which would not be affected by critical mass issues, to several thousand, which allows issues to be examined that affect smaller communities that commute to regional hubs. Population figures in this document will refer to the 2011 ABS census
- locations: Aurukun and Lajamanu are very remote communities; Tennant Creek and Thursday Island are in very remote locations but carry important hub functions; Hermannsburg and Santa Teresa are small, remote communities with and without a sealed-road access; and Alice Springs and Broome are considered as major regional centres
- climatic conditions: Aurukun, Broome and Thursday Island are in tropical areas, and Alice Springs, Santa Teresa, Hermannsburg, Tennant Creek and Lajamanu are in a semi-arid environment.

Australia is referred to in this report as comprising both remote and non-remote Australia, with remote Australia not being restricted to Aboriginal and Torres Strait Islander communities. Four categories of remoteness specific to transport access are considered in this report. These categories have been refined according to the ARIA+ categories, taking into consideration the size and geographical remoteness of the different locations, with the objective of focusing on remote Australia (Table 2).

Table 2: Remoteness areas for Australia and Transport Futures remoteness categories

RA Name	Statistical Area Level 1 average ARIA+ value ranges	Transport access categories	Transport Futures communities
Highly Accessible: Major cities of Australia	0–0.2	International non-remote and non-remote Australia	
Accessible: Inner and outer regional Australia	0.2–2.4	Non-remote Australia	
Moderately Accessible: Remote Australia	2.4–5.92		
Remote	5.92–10.53	Large Remote	Alice Springs (6), Broome (9)
Very Remote	10.53–15	Small Remote	Santa Teresa (9), Hermannsburg (11)
		Very Remote	Tennant Creek (12), Aurukun (12), Thursday Island (15), Lajamanu (15)

Sources: Australian Bureau of Statistics (2011) and [http://www.spatialonline.com.au/ARIA\\_2011/default.aspx](http://www.spatialonline.com.au/ARIA_2011/default.aspx)

A size distinction is added with small, and large remote and very remote communities. The 2006 Census of Population and Housing classification indicates that population clusters of over 1000 persons are classed as urban centres, and population clusters between 200 and 999 persons are classed as localities. In this study, urban centres of more than 5,000 inhabitants are considered as large.

## 1.2 Remote communities and transport modes

The Transport Futures research sites are also characterised by different industry profiles – including communities with remote enterprises, such as farming, mining, pastoralism, and tourism – and a large range of transport characteristics. A great variety of transport modes operate in remote Australia, with different types of public and private transport services ranging from mass passenger air services to urban and regional public transport services. In remote Australia, road transport is the primary transport mode. Rail can be very important and is of particular use for primary industries, but is less dominant for passenger services. Aviation supplies the majority of long-distance passenger services. Maritime transport is vital to some of the most remote coastal locations. Non-motorised or low-powered forms of transport provide affordable access to goods, activities and services at a local scale (Figure 2).

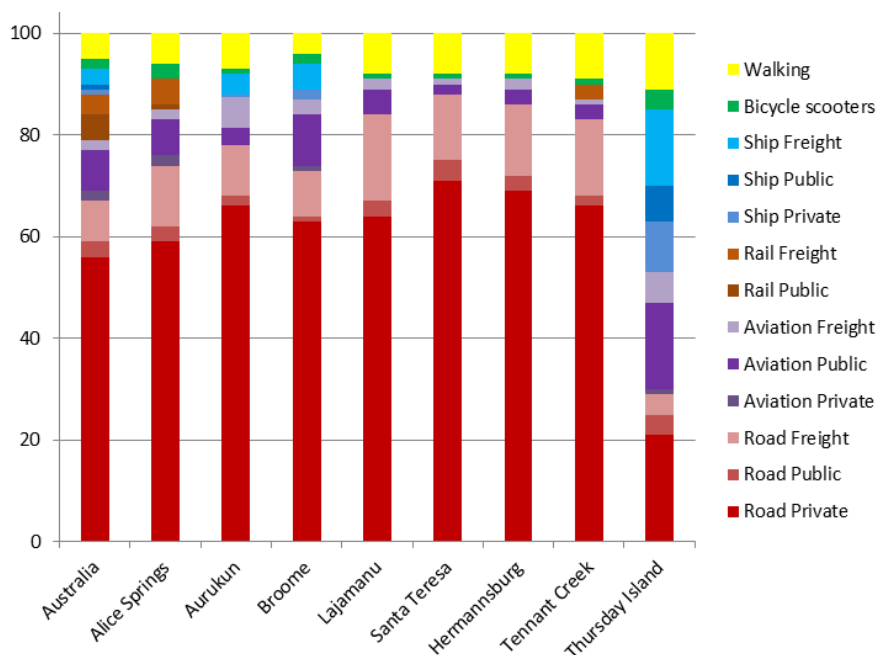


Figure 2: Transport modes in remote Australia

These figures are estimates extracted from the data of the 2012 survey of the Australian Bureau of Statistics (ABS) of combined freight and passenger trips (Australian Bureau of Statistics 2008, 2012a, Bureau of Infrastructure and Regional Economics 2012, Loader 2011).

In a remote Australian context the transport systems consist of several vital components:

- Long-distance transport (maritime, rail, air and road services)
- Community commuting (cars and buses) and special transport services
- Local mobility.

Transport access is articulated around the ability to regularly reach these forms of transport via different modes.

### 1.3 Remote communities and transport access

The comprehensive mix of transport modes included in this study is classified in three access groups because of the predominance of private motorised vehicles and the importance of walking being more accentuated in remote Australia, with the exception of Thursday Island. Combined road freight and passenger transport represents 68% in Australia overall, but between 75% and 87% of trips in remote Australia (as seen in Figure 2), which shows that inequalities in terms of access are particularly a concern in Aboriginal and Torres Strait Islander communities (Currie & Senbergs 2007) and represent one of the most important issues for maintaining and developing sustainable livelihoods. There is still a chronic shortage of private vehicles in remote areas, even if the motorisation rate has steadily increased over the years. According to the (Australian Bureau of Statistics 2010a) a nationally 51% of Aboriginal and Torres Strait Islander households have access to a motor vehicle compared with 85% of non-Aboriginal and Torres Strait Islander households, and 30% of Aboriginal and Torres Strait Islander adults living in non-remote areas use public transport at least once per fortnight against 13% in remote areas. In remote Australia in terms of access, 66% of Aboriginal and Torres Strait Islander adults could access motor

vehicles whenever needed, 32% had no access to motor vehicles and 7% had access to motor vehicles in case of emergencies.

Of Aboriginal and Torres Strait Islander adults living in remote areas, 50% had no public transport, and 15% were unable to reach places when they needed to due to lack of transport. In non-remote areas, 18% of Aboriginal and Torres Strait Islander people reported having no public transport access, and only 2% were unable to reach places when they needed to in non-remote areas (Australian Bureau of Statistics 2010bb) (Table 3).

Table 3: Aboriginal and Torres Strait Islander (ATSI) people's public transport access

Access	Non-remote	Remote
Aboriginal and Torres Strait Islander without car	12%	32%
Aboriginal and Torres Strait Islander without public transport	18%	50%
Aboriginal and Torres Strait Islander unable to reach places	2%	15%

According to Holcombe (2006), these figures are inflating real access observation. In order to evaluate the costs of not having access to effective motorised private and public transport – which is a critical issue in remote Australia – three types of access are studied:

- private motorised vehicles: (not accessible to the public) including aviation, rail, maritime and road transport, public transport, and low-powered / non-motorised transport
- public transport: motorised public transport including aviation, rail, maritime and road transport
- non-motorised / low-powered: device under 40 km/hr (for example walking, but also the use of motorbike, bicycle, animal power, scooter, skateboard, small dinghy)

In this research it is considered that people with access to a private motorised vehicle, public transport and non-motorised/low-powered vehicles as access groups are undertaking over 85%, 80% and 75% of their travelling (in number of trips) via these respective transport modes; however, the average number of non-motorised and public transport trips is around 5–10% in distance and 10–30% in number of trips, all transport modes included (Litman 2005, Litman 2012, Litman 2014a, 2014b, 2014c). A very large majority of people do undertake some of their travel via non-motorised transport (walking, wheelchair) to access motorised transport. Furthermore, given that Australia-wide less than 15% of household do not have access to a private vehicle, the people who do not have access to a motorised vehicle are undertaking a very significant number of trips via non-motorised transport. While the substitutions between motorised and non-motorised access modes cannot be directly established, it has been estimated that people who do not have regular access to a motorised vehicle in non-remote Australia were undertaking around 60% of trips via walking (Currie et al. 2009). In remote Australia, a higher benchmark would be appropriate due to the relatively smaller number of transport options (preliminary observations allow a benchmark to be set at 75% of trips via walking):

These benchmarks are further studied and discussed in the joint technical document (Spandonide 2014).

## 1.4 Transport costs evaluation

Transport costs are complex to evaluate by nature, as data are collected at different scales and with different methodologies. Traditionally, transport economics is used to differentiate cost categories. The work of Litman and Doherty (2011) offers a comprehensive framework for economic studies specific to transport issues. Similarly, the comparative study of transport costs undertaken in this study has adopted a

systematic approach in costs evaluations. In the choice of costs aggregation, the recommendations of Raicu et al. (2011) have been taken into consideration: safety costs and the costs of ineffective transport systems (externalities conceptualised as social costs, time or environmental costs) are estimated as indirect forms of costs of transport activities. For this research, four main categories (private market costs, private non-market costs, public market costs and public non-market costs) have been refined to provide a consistent assessment of the different types of costs of transport systems (Litman 2013b; Table 4).

Table 4: Accounting categories of transport costs

	<b>Private market costs</b>	<b>Private non-market costs</b>	<b>Public market costs</b>	<b>Public non-market costs</b>
<b>Payers</b>	Individuals	Individuals / people affected by transport externalities	Individuals as tax payers (local and national level)	Society / people affected by transport externalities
<b>Nature of costs</b>	Monetised	Non-monetised	Monetised	Non-monetised
<b>Source</b>	Private expenses	Personal costs of ineffective systems	Public expenses	Public costs of ineffective systems

Private costs are costs borne by private individuals, households or private organisations. Public costs are the costs for the transport needs of private individuals and enterprises as well as the transport needs of public organisations borne by the general public. Estimating private and public costs is justified by the fact that public organisations and agencies are a major transport actor in remote Australia (Aboriginal and Torres Strait Islander Affairs Committee 2009, Memmott et al. 2013). Market costs are costs expressed in monetised terms (e.g. vehicle purchase, transport fares, fuel costs), and non-market costs are non-monetised costs (e.g. time, environmental costs).

Evaluating market and non-market costs is motivated by the fact that transport activities generate substantial non-market costs in remote Australia that have not been explored in a holistic way to date. These categories have been refined to provide a consistent and comprehensive assessment of transport costs (Litman 2013b). The types of costs included in these categories are detailed in Table 5.

These costs are calculated as average costs per person per year for individuals with access to different transport modes.

Well-established data for different transport systems have been reviewed and classified. Some of the most important key indicators used in this study include annual/daily travelled distances, casualty/accident rates, transport-related crime rates, private and public transport costs (including fuel costs and public transport subsidies), vehicle energy consumption/km, infrastructure costs per capita, relative travelling speed, frequency of public transport, transport component of average weekly goods and services expenditure (and portion of this expenditure of the median income), annual travelling times, access to private vehicles (vehicle per capita and vehicle occupancy rates) and environmental costs.

To provide a basis for the broad evaluation of transport externalities, a large range of information has been integrated with conservative estimates. However, it is acknowledged that there might be a variable degree of inconsistency over the timeframe and the nature of the gathered data reviewed in the calculations.

Table 5: Costs categories for cost types and different transport modes

Transport modes	Private market costs	Private non-market costs	Public market costs	Public non-market costs
<b>Motorised Vehicles</b>	Purchase costs	Health costs	Health costs	Health costs
	Administration/ insurance costs	Social costs	Social costs	Social costs
	Fuel costs	Infrastructure costs	Infrastructure costs	Infrastructure costs
	Long-distance costs	Time/access costs	Long-distance costs	Time/access costs
	Maintenance costs	Environmental costs	Public subsidies for small- and large-scale systems	Environmental costs
	Other infrastructure costs		Time/access costs	
	Environmental costs		Environmental costs	
<b>Public transport</b>	Public transport fares	Health costs	Health costs	Health costs
	Other transport costs	Social costs	Social costs	Social costs
	Long-distance transport costs	Infrastructure costs	Infrastructure costs	Infrastructure costs
		Time/access costs	Long-distance costs	Time/access costs
		Environmental costs	Public subsidies for small- and large-scale systems	Environmental costs
			Time/access costs	
			Environmental costs	
<b>Non-motorised vehicles</b>	Public transport fares	Health costs	Health costs	Health costs
	Other transport costs	Social costs	Social costs	Social costs
	Long-distance costs	Infrastructure costs	Infrastructure costs	Infrastructure costs
		Time/access costs	Long-distance costs	Time/access costs
		Environmental costs	Public subsidies for small- and large-scale systems	Environmental costs
			Time/access costs	
			Environmental costs	

Transport-related health costs have been estimated for people with access to private motorised vehicles in the following ways:

- Private market health costs: CTP part of registration, vehicles insurance, and other insurance
- Private non-market health costs: Costs others than CTP, vehicles insurance and other insurance (uninsured and loss of productivity)
- Public market health costs: Costs of the public health system other than the cost recovery from private expenses (taxes and debts)
- Public non-market health costs: Costs for the society in loss of wellbeing and productivity.

Access and time costs are commonly evaluated as being associated with a loss of income. Time itself has a complex non-market value and involves the duration of organising, waiting, boarding, travelling and off-loading transportation activities, as well as the unexpected delays or the disturbances, rescheduling or cancellation that affects other socio-economic and cultural activities and which can have significant costs in terms of productivity and wellbeing. People's accessibility is also closely linked to different forms of wellbeing (such as economic, social, financial or physical wellbeing) and productivity. Public access costs are directly linked to the productivity of community and businesses (Djankov et al. 2006, Ferguson 2013, IBM Institute for Business Value 2011, Moving People 2030 Taskforce 2013, p. 11, Nguyen & Cairney

2013, Siemens 2011, South Australian Centre for Rural and Remote Health (SACRRH) 2001). Access to goods and services has also been discussed extensively (Douglas 1999, Landrigan & Pollard 2010, National Rural Health Alliance 2007a, 2007b, Northern Territory (NT) Department of Health and Community Services (DHCS) 2007, Prout 2008, Prout & Yap 2010). Access to employment can be facilitated when transport access is widely available (Biddle 2009, Biddle 2010, Biddle & Prout 2009, Biddle & Taylor 2008, Mitiku 2009).

However, while the benefits for productivity of local economies having better transport systems have been acknowledged, measuring these benefits is a complex task (Australian Bureau of Statistics 2010c, McKinsey 2007, Schwab 2010). Therefore wellbeing and productivity have been integrated with different sets of indicators identified from the review of several transport economy reports and studies. In this sense, difficulties in evaluating both the access to services and the impacts of the disruptions of this access imply that the estimates may not correctly reflect the lack of affordable transport, cost of services, reduced access to administrative services, decreased land value or the inappropriateness of available services resulting in decreased productivities and livelihoods (Lucas 2012). These costs are evaluated as average costs per person per year for individuals with access to different transport modes.

Within the remote Australian context, many costs associated with transport activities are not well documented, even though the reduced number of people included in transport activities allows examination of parts of the transport costs with a deeper perspective. In particular, while it is possible to accurately evaluate the transport costs of individuals, households, businesses, regional and national organisations and governmental agencies from data publicly available (from governmental and private organisations), other indicators do not provide clear quantitative cost breakdown accountability relevant to the scope of remote Australia and had to be extrapolated from a general context. This represents a significant limitation, and the results presented in this paper can only be considered as a first attempt to broadly analyse transport costs in a comprehensive way. The figures will be refined through surveys and interviews.

## 2. Background information

### 2.1 Livelihoods and transport

In remote Australia, transport plays both critical and multifunctional roles. More specifically, transport is involved with different components of livelihoods (Figure 3).

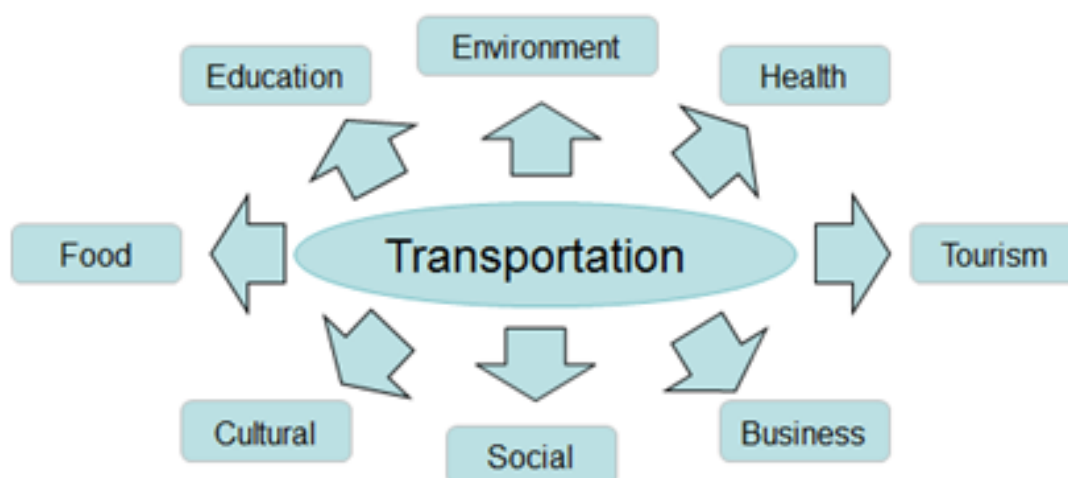


Figure 3: Components of livelihoods involved with transport in remote Australia

With effects across different types of livelihoods capitals, improved transport systems provide support and attract networks of financial resources. In particular, livelihoods and enterprises are affected at different scales by high transport costs (Miles et al. 2006). Social inequities, economic competition and environmental impacts related to climate, demographic and energy changes have the potential to exacerbate an existing rural drift (Garnett & Lewis 2000). The level of transport infrastructure supplied in remote Australia necessitates people to get equipped with higher levels of transport equipment in order to maintain a reliable access to goods and services.

## 2.2 Transport infrastructure in remote Australia

Despite a great variety of transport means, major inequalities in terms of access to transport exist within remote Australia. In particular, transport infrastructure is under-developed in the most remote parts of the country, which contributes to isolating the population and the social and business enterprises located in these areas. In terms of transport systems, remoteness is characterised by both the distances and durations travelled and the accessibility of transport services (Figures 4 to 6).

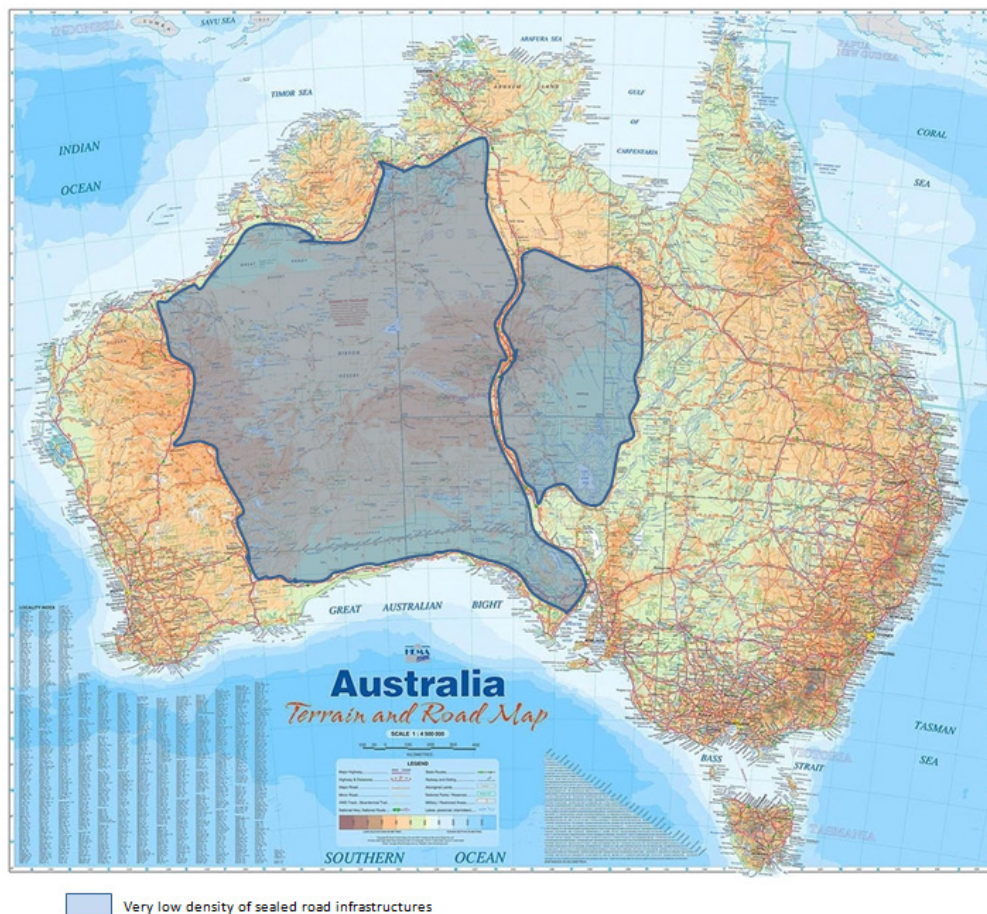


Figure 4: Lowest density of road infrastructure and Australia terrain and road map  
Source: modified from Hema (2008)

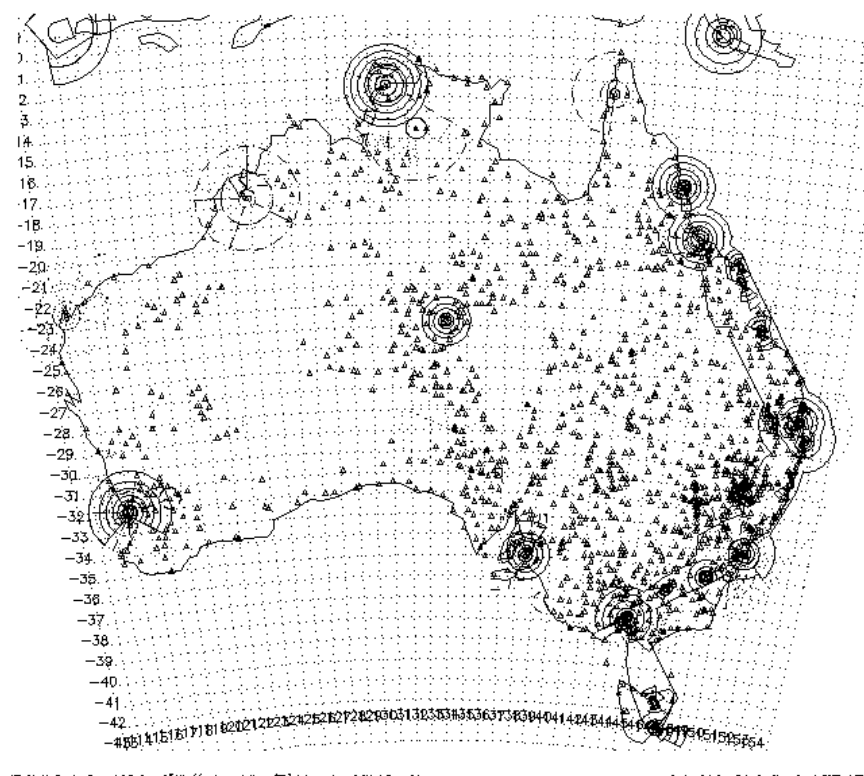
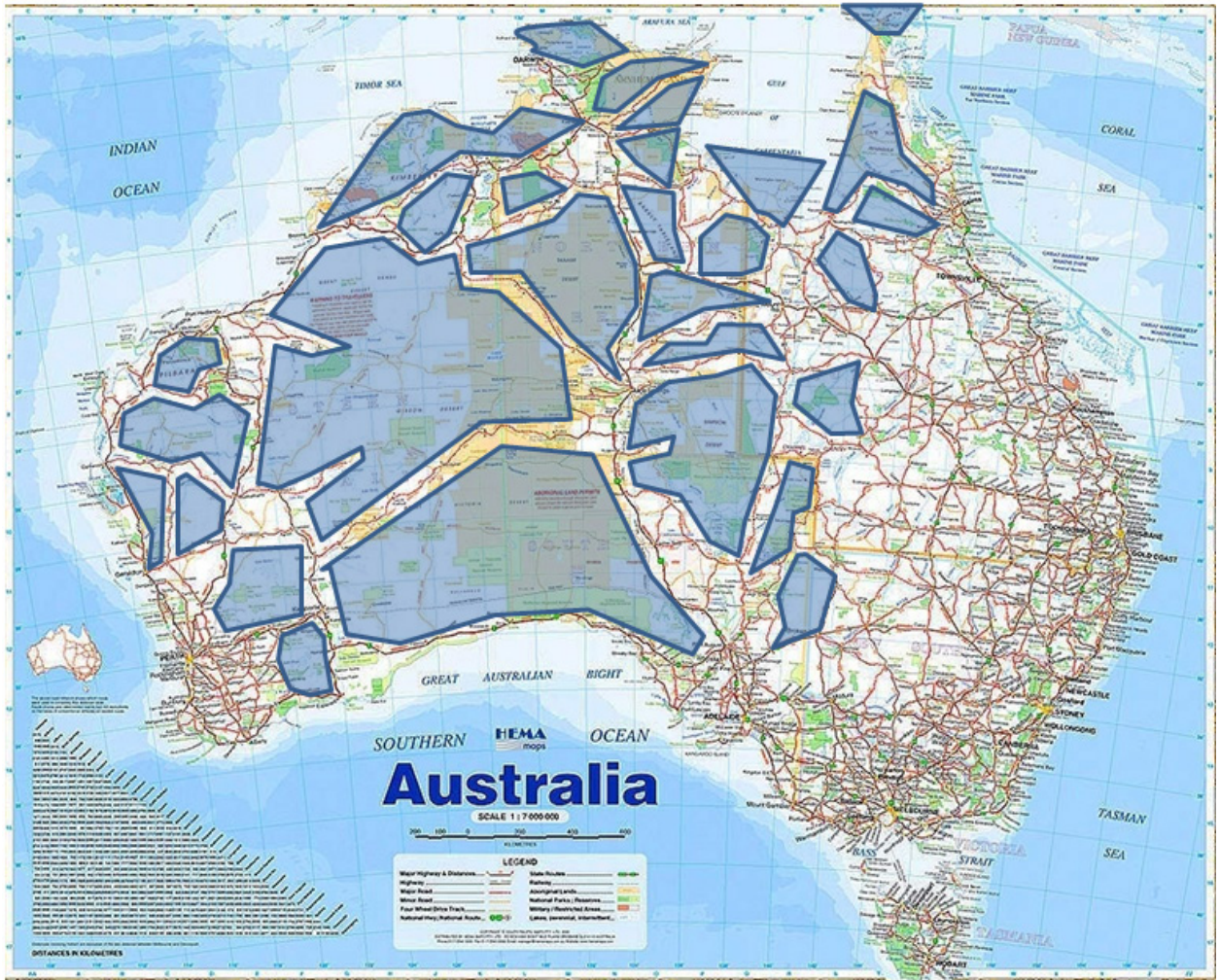


Figure 5: Airports in Australia

Source: Meier (2006)

The geography of the network of services and goods deliveries, which is centralised around urban zones where a very large majority of non-Aboriginal and Torres Strait Islander people live, reflects the existence of a locational transport disadvantage. This creates geographic forms of isolation (and thus transport issues) further resulting in both physical and psychological forms of isolation, shifting Aboriginal and Torres Strait Islander communities away from services, employment and training (NSW Aboriginal Transport Network 2006). Figures 6a and 6b indicate that the areas of high proportion of Aboriginal and Torres Strait Islanders populations are the most disadvantaged in terms of transport infrastructure (Smoker 2011).



Very Remote Areas in Terms of Road Transport Access

Figure 6a: Very remote areas in terms of transport access on modified Hema Australia road map (Hema Maps 2010)

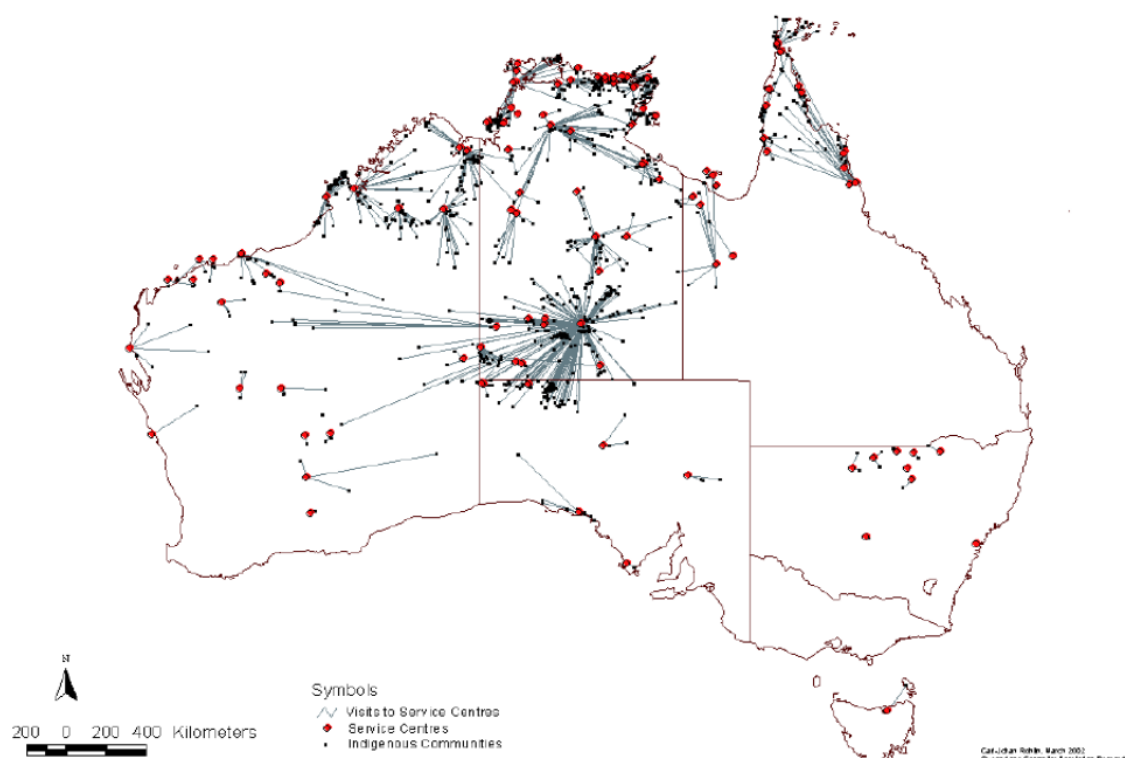


Figure 6b: Map of journey to services from discrete Aboriginal communities in arid and savannah Australia

Source: Queensland Centre for Population Research / Rohln 2002 in Taylor and Prideaux (2006)

In remote arid and savannah Australia, residents living in almost half of Aboriginal communities have to travel between 1 and 4 hours to reach services (Taylor & Prideaux 2006). This is highly correlated with a lack of access to transport infrastructures (sealed roads).

A majority of the remote long-distance transport network is in poor condition (Holcombe 2006). Raicu et al. (2011) reported that the vast majority of roads are unsealed, have a restricted life span and require regular and costly maintenance processes.

Transport infrastructure costs are two to three times higher in very remote Australia than in the rest of the country (Bureau of Transport Infrastructure and Regional Economics 2009).

### 2.3 Transport services in remote Australia

Transport services in remote Australia are more expensive, with high purchase costs of private new and second-hand vehicles and high fuel costs (Table 6), especially compared to average income (Crough & Pritchard 1991, Holcombe 2006, Lawrence 1991).

Table 6: 2013 Petrol prices

Locations	Petrol Prices (AUD)
Aurukun	\$ 2.00
Thursday Island	\$ 2.40
Hermannsburg	\$ 2.00
Santa Teresa	\$ 2.05
Alice Springs	\$ 1.70
Tennant Creek	\$ 1.90
Lajamanu	\$ 2.20
Broome	\$ 1.70
<b>Australia</b>	<b>\$ 1.60</b>

Source: <http://www.aip.com.au/> September 2013

In very remote communities, the average vehicle is of lower quality and often inappropriate for unsealed road driving. This results in a higher deterioration rates of vehicles (Gerrard 1989, Young 2001). A large majority of the private vehicles used are in the last stages of their viable life (Young 2001) which creates a situation where private vehicles become a particularly dynamic resource (Holcombe 2006). In the most isolated areas, a widespread bush-mechanics practice of fixing vehicles through unconventional repairs has been the most common form of transport-related alternative response over the past two decades.

The provision of public transport services is limited (Dodson et al. 2004a, Finlayson & Auld 1999), with very low frequencies (a maximum of twice weekly for long distances, five daily for inner city distances), and high prices of concession tickets. Denmark (2012) reports that in the Tennant Creek region, information about the use, access and time schedule of bus services is not widely known. While a majority of the private operators' fleets are used for tourism transport services, governmental agencies' transport resources are also mainly used for specific purposes such as aged care support (Holcombe 2006).

Transport accessibility can be excessively unreliable and travel times excessively long in remote Australia (Raicu et al. 2011). In remote Australia, residents living in almost half of Aboriginal communities have to travel 1–4 hours to reach services (Taylor & Prideaux 2006). Transport mobility involves travelling long distances (Dockery & Colquhoun 2012). Significant inequalities of access to transport between males and females have also been reported (Australian Bureau of Statistics 2002).

## 2.4 Transport crisis in remote Australia

To fully understand transport disadvantage, it is necessary to recognise the difference between transport disadvantaged areas and transport disadvantaged groups (Hurni 2007). The combination of poor access to transport services as well as extreme distances and transport conditions and lower incomes (Figure 7) creates a situation where good transport becomes one of the primary barriers to the wellbeing of communities.

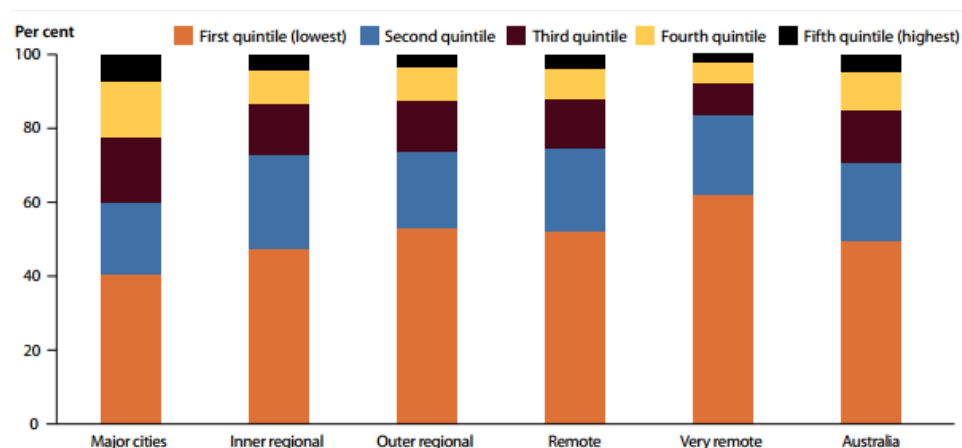


Figure 7: Household income distribution of Aboriginal and Torres Strait Islander people, by remoteness area, 2008

Source: in Australian Institute of Health and Welfare (2011) from AIHW analyses of 2008 NATSISS

This leads to striking differences in terms of access: while the most privileged people benefit from transport conditions similar or better than in non-remote Australia, the most disadvantaged people experience difficult situations requiring the adoption and the maintenance of innovative and creative forms of semi-collective transport systems to minimise the financial weight of transport costs, even to simply permit travel to occur. In general in remote Australia, there are large financial inequalities in terms of public transport accessibility (aviation, maritime or road services) between larger population centres, which attract the majority of services, and very remote communities. For these people, the increased maintenance and fuel costs result in economic limitations, increased costs for goods and services and reduced overall mobility. Within very remote communities with ARIA+ scores over 12, this transport crisis has significant adverse effects on economic participation and livelihoods:

- Road casualty rates are relatively high. For Central Australia, Pleshet (2007) reported casualty rates of eight times the national average (54.1/100,000 against 7.7). There is a strong correlation between remoteness and the incidence of road casualties on national highways (Australian Road Assessment Program 2012).
- Due to high transport costs, goods and services are more expensive in remote Australia, resulting in a decrease in competitiveness for social and business enterprises (Memmott et al. 2013).
- The fly in/fly out (FIFO) model can be associated with decreased livelihood and very high expenses which are compressed into short periods for both workers and very remote communities (Sibbel 2010).

In a survey conducted by Hoye et al. (2011), the main concerns related to the current transport systems in rural Australia appear to be cost- and access related:

1. petrol price increase
2. time (low frequency) and access to public transport
3. lack of roads
4. public transport fares
5. connection between services and benefits for the local economy.

Minimising the financial burden of transport costs and improving the access to transport appear to be important elements in enhancing the sustainability of remote communities.

### 3. Transport costs in remote communities

This paper reports the differences of transport costs for people with different types and levels of accessibility. A comprehensive evaluation of transport costs based on the review of secondary data across well-established data for different transport systems has been undertaken. More details on costs calculations are available in a joint technical document. This section examines transport costs for different transport modes.

#### 3.1 Travelling in remote Australia

In remote Australia average distances travelled per year vary significantly, as shown in Figure 8 which gives the annual estimations of combined freight and passenger trips in various locations across remote Australia (these locations are the locations studied in detail in the technical documents).

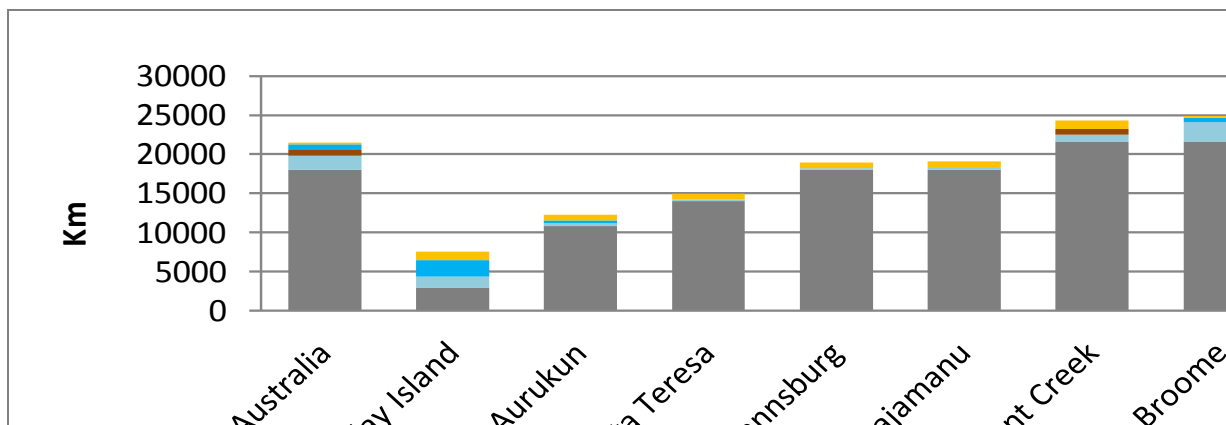


Figure 8: Average distances in remote Australia, by year, by mode

In Australia in 2012, the average is close to 14,000 km per vehicle per year for passenger cars and 3,000 km for freight. In Queensland it reaches 15,000 km per vehicle per year; in the Northern Territory it is close to 13,000 km per vehicle per year; and in Western Australia it is close to the national average. This is consistent with the ABS *Survey of Motor Vehicle Use* (Australian Bureau of Statistics 2006). There is more travelling in large population centres in remote Australia than in very remote communities or smaller remote communities (as vehicle occupancy rates are higher). In remote Australia, most of the transport is undertaken via driving cars (Figure 8).

Walking is significant in places where there is a majority of Aboriginal and Torres Strait Islander people. Passenger air services represent between less than 5% of trips in Aurukun, Hermannsburg and Tennant Creek to more than 15% of trips in Thursday Island, where the use of passenger maritime services is also significant (5%). For private forms of transport, road transport is often in the 60% range of transport trips. Freight commonly represents under 20% of the trips, with more than half of the freight carried by road.

## 3.2 Transport costs and expenses per transport mode

The most common forms of transport are private motorised vehicles (cars, trucks, large motorcycles, boats and, more rarely, planes), public transport (planes, buses, trains, boats) and non-motorised or low-power transport (e.g. bicycles, walking). People travel with a combination of these forms of transport. This report studies the costs associated with using these forms of transport in remote and non-remote Australia. For the transport costs calculation it is considered that the groups of people with access to a private motorised vehicles, public transport and non-motorised / low-powered transport are undertaking over 75% of their travelling (distance wise) via these respective transport modes. Real-world figures would differ (it can be vaguely estimated that people who do not have access to motorised transport undertake 25–75% of their travelling, distance-wise, via non-motorised/low-powered transport, while people who have access to public transport but not to private motorised transport undertake less than 25% of their travelling via motorised/non-motorised private transport).

### 3.2.1 Transport costs and expenses for private transport

Table 7 summarises transport costs for motorised vehicle users in remote and non-remote Australia.

Table 7: Transport costs for motorised vehicle users in very remote and remote/non-remote Australia

Motorised vehicle	Non-remote / large remote communities	Small remote and very remote communities
Market costs	\$5,000–7,000	\$3,000–6,000
Major factors	Administration, insurance, vehicle purchase and maintenance	Fuel, maintenance
Non-market costs	\$6,500–9,500	\$8,000–12,000
Major factors	Time and environmental costs	Health, social, time and access costs
<b>Total</b>	<b>\$11,500–16,500</b>	<b>\$12,000–17,000*</b>

\* Note: the total figure represents the range of the total, not a sum total of costs; see Table 13.

At the community level, driving a car costs between \$3,000–6,000 in very remote Australia and \$5,000–7,000 annually in non-remote Australia. Fuel costs represent the majority of market transport costs in very remote Australia, and administration, insurance, vehicle purchase and maintenance costs are substantially higher proportions of the total cost in non-remote Australia. This includes an Australia-wide average of \$1,000 per capita of tax-payer money spent as public subsidies with little variations. Fuel costs are the primary type of expenditure in remote Australia and represent more than a third of the market transport costs for people having access to a private motorised vehicle, alongside vehicle purchase and operating costs. Transport costs for people having access to a private motorised vehicle represent a very high portion of total income for people in remote Australia. Fuel costs alone represent 3–7% of individuals' annual income in remote Australia and up to 10% in very remote communities. Increasing fuel prices would provide additional limitations to the use and the safety of private motorised vehicles in a context of increased transport demands. As fuel costs represent the main operational cost for people using motorised vehicles, fuel price increase would have strong repercussions on other living costs.

Climate change could also further affect operational costs. Transport infrastructure in coastal areas should be planned, designed and retrofitted with new standards, including standards for potential impacts of flood, storm surge, sea level rise and intense precipitation (Lu et al. 2013). In particular, non-market travel costs could be significantly increased by network-wide impacts of infrastructure failure. Similarly, travel behaviour might be significantly changed by extreme climatic events, resulting in a decrease in fuel

availability and an increase in non-work trips (Leotta 2007). Public transport provision, fuel requirement and fuel shortage planning at a local level should be included in emergency response strategies.

The high costs associated with accessing a private motorised vehicle explain why almost a third of the Aboriginal and Torres Strait Islander population in remote Australia does not have regular access to private motorised vehicles. Combined with limited public transport services, supplying only half of the population in remote Australia, this results in a critical transport access shortage which could isolate community members from employment opportunities and socio-cultural activities.

Non-market costs are substantial: health, social, time and access costs start from \$8,000 in remote Australia and \$6,500 in non-remote Australia, with health, social and access costs being higher in remote Australia and time and environmental costs being higher in non-remote Australia.

A private, motorised vehicle is the most effective transport method in very remote, small remote and large remote Australian communities, with an almost linear trade-off between private investments in motorised vehicles and costs in loss of productivity and wellbeing: the more money people can spend on their vehicle, the more their productivity and livelihoods improve.

### 3.2.2 Transport costs and expenses for private transport

Table 8 presents transport costs for public transport users in remote and non-remote Australia.

Table 8: Transport costs for public transport users in very remote and remote/non-remote Australia

Public transport	Non-remote / large remote communities	Small remote and very remote communities
Market costs	\$1,800–2,600	\$2,000–3,000
Major factors	Ticketing	Ticketing
Non-market costs	\$10,000–16,000	\$7,000–12,000
Major factors	Time and access costs	Time and access costs
<b>Total</b>	<b>\$12,400–18,000*</b>	<b>\$9,000–15,000</b>

\* Note: the total figure represents the range of the total, not a sum total of costs; see Table 13.

For individuals, public transport is more affordable, ranging between \$1,800–2,600 in remote Australia and \$2,000–3,000 in non-remote Australia, where it is much more regularly available. However, public transport regularly costs significantly more in non-market terms, particularly in time and access costs: in the current best case scenario in remote Australia, the loss of productivity and wellbeing represents the equivalent of more than \$7,000 per year in missed opportunities. As a comparison, best-in-class public transport systems with optimised time management reduce the time costs to \$4,000 per year: time and access costs are minimised in agglomeration such as Moscow (Russia), Hong Kong (China), Tokyo (Japan), Paris (France), Seoul (South Korea), New York (USA), Taipei (Taiwan), Berlin (Germany) or London (UK) with 95% 500 m coverage of inner-city areas and waiting times of under 3 minutes in peak hour and under 8 minutes in off-peak. Total public transport costs are considerably lower in urban areas in Europe or Asia (about \$6,000–8,000 annually).

There can be substantial multiplier effects of decreased time and access costs if less time needs to be allocated to transport organising, waiting, undertaking, connecting and landing; as well as decreased goods and services prices; increased employment (tourism, community work, business and social enterprises), community development and service opportunities (health, education and housing being some of the major types of services); increased regional attractiveness and land value; and increased socio-cultural cohesion and wellbeing. In remote Australia, a change from a single-link weekly transport option available for

people relying on public transport to a multiple-link daily access can provide significant changes in non-market costs. In well-connected (frequency and coverage of public transport) hubs such as Alice Springs, Broome, or Thursday Island, unemployment levels are below national average (17.1%), while in locations with less frequent and less connected public transport, unemployment levels tend to be higher than the national average (Lajamanu, Aurukun, Tennant Creek regional area). For people who are located close to regular public transport, time costs are minimal. But people who have restricted access to irregular public transport and have to rely on it have a direct barrier to work opportunities and prosperous livelihoods.

### 3.2.3 Transport costs and expenses for non-motorised/low-power transport

Table 9 shows transport costs for non-motorised/low-power transport users in remote and non-remote Australia.

Table 9: Transport costs for non-motorised/low-power transport users in very remote and remote/non-remote Australia

Non-motorised/low-power transport	Non-remote / large remote communities	Small remote and very remote communities
Market costs	\$300–800	\$600–1,300
Major factors	Personal equipment, taxes	Personal equipment, taxes
Non-market costs	\$7,500–11,000	\$10,000–17,000
Major factors	Time and access costs	Time and access costs
<b>Total</b>	<b>\$7,800–11,800</b>	<b>\$10,800–18,300*</b>

\* Note: the total figure represents the range of the total, not a sum total of costs; see Table 13.

At a community level, non-motorised or low-powered transport is by far the cheapest transport mode: in market costs, a few hundred dollars per year, mostly as personal equipment and (\$0–400/year for walking equipment, \$100–700/year for bicycles and other non-motorised devices in maintenance and capital expenditure (amortised over 5 years) tax-payer money for public infrastructure (\$50–800/year per person). There is a striking contrast with non-market costs: time and access costs can reach up to \$17,000 per year in remote Australia. This reflects the fact that people using non-motorised or low-powered transport are less likely to have access to desired work opportunities, public services and socio-cultural activities.

## 3.3 Remote and non-remote transport costs

Transport costs are composed of market costs that people pay directly (purchases or fares) or indirectly (taxes) and non-market costs (mostly in time, loss of income or inconvenience).

### 3.3.1 Market costs

The market transport costs corresponding to what people pay privately include capital and operating costs, ticketing costs, insurance, tax and other associated with transport. These costs are detailed in Table 10.

Table 10: Market costs per mode in very remote and remote/non-remote Australia

Market costs	Non-remote / large remote communities	Small remote and very remote communities
Motorised vehicle	\$5,000–7,000	\$3,000–6,000
Public transport	\$1,800–2,600	\$2,000–3,000
Non-motorised/low-power transport	\$300–800	\$600–1,300

People living in very remote communities pay around 15–30% less for transport than people living in remote Australia, when using motorised or non-motorised/low-power private transport. The fact that these costs are lower is caused by a shortage of transport options as well as a need to minimise transport costs in market terms. Both in remote and non-remote Australia, using a private car or a boat to travel costs the most in market terms (\$3,000–7,000 per year), while using non-motorised or low-power transport costs the least (\$300–1,300 per year). Using public transport costs around 10% more on average in remote Australia. Additionally, the portion of transport expenditure relative to median income is similar for people in remote and non-remote Australia.

### 3.3.2 Non-market costs

The non-market transport costs corresponding to health, social, time and access or environmental costs associated with transport are detailed in Table 11.

Table 11: Non-market costs per mode in very remote and remote/non-remote Australia

Non-market costs	Non-remote / large remote communities	Small remote and very remote communities
Motorised vehicle	\$6,500–9,500	\$8,000–12,000
Public transport	\$10,000–16,000	\$7,000–12,000
Non-motorised / low-power transport	\$7,500–11,000	\$10,000–17,000

In non-market terms, using motorised vehicles and non-motorised or low-power vehicle costs more for people in very remote communities than for people in large remote communities or in non-remote Australia. It is most advantageous to use public transport in very remote communities, despite a relatively poor frequency of public transport, and least beneficial to use only non-motorised/low-powered transport, because very remote areas are more likely to experience higher time and access costs, travelling occurs in an intermittent way, and not being able to travel regularly is a barrier to sustainable and resilient livelihoods. In non-remote Australia, it is the contrary.

### 3.3.3 Total costs

Table 12 shows total costs of transport per mode in remote and non-remote Australia.

Table 12: Total costs per mode: transport costs in very remote and remote/non-remote Australia

Total	Non-remote / large remote communities	Small remote and very remote communities
Motorised vehicle	\$11,500–16,500	\$12,000–17,000
Public transport	\$12,400–18,000	\$9,000–15,000
Non-motorised / low-power transport	\$7,800–11,800	\$10,800–18,300

In large remote and non-remote communities using non-motorised transport is by far both the most affordable option. Walking or using a bicycle instead of using a car or taking public transport saves up to \$10,200 per person per year. In very remote communities using public transport (when it is available) is the cheapest form of transport and would save up to \$9,300 per person per year. Although there appears to be not much difference between using motorised vehicles and non-motorised or low-power ones in very remote communities, the costs are different: using a car costs a lot to individuals in market costs, while walking or using a bicycle costs a lot in non-market costs of time and access.

Table 13 presents the results and highlights the costs for different types of communities (for daily representations of these, see Tables A1–A3).

Table 13: Transport costs depending on transport modes access and remoteness

Access	International non-remote urban centres	Australian non-remote urban centres	Remote urban centres	Small localities	Very remote
Motorised market costs	\$7,000–9,000	\$6,000–7,000	\$5,000–7,000	\$4,000–6,000	\$3,000–5,000
Motorised non-market costs	\$8,000–10,000	\$8,000–9,500	\$6,500–9,000	\$8,000–10,000	\$9,000–12,000
<b>TOTAL motorised costs</b>	<b>\$15,000–19,000</b>	<b>\$14,000–16,500</b>	<b>\$11,500–16,000</b>	<b>\$12,000–16,000</b>	<b>\$12,000–17,000</b>
Public transport market costs	\$1,600–1,800	\$2,400–2,600	\$1,800–2,000	\$2,000–3,000	\$2,000–3,000
Public transport non-market costs	\$4,000–6,000	\$10,000–12,000	\$14,000–16,000	\$7,000–9,000	\$9,000–12,000
<b>TOTAL public transport costs</b>	<b>\$5,600–7,800</b>	<b>\$12,400–14,600</b>	<b>\$15,800–18,000</b>	<b>\$9,000–12,000</b>	<b>\$11,000–15,000</b>
Non/low-powered market costs	\$300–500	\$300–500	\$600–800	\$800–1,200	\$600–1,300
Non/low-powered non-market costs	\$6,000–8,000	\$7,500–8,500	\$9,000–11,000	\$10,000–12,000	\$12,000–17,000
<b>TOTAL non/low-powered costs</b>	<b>\$6,300–8,500</b>	<b>\$7,800–9,000</b>	<b>\$9,600–11,800</b>	<b>\$10,800–13,200</b>	<b>\$12,600–18,300</b>

International urban centres are characterised by lower costs for using non-motorised/low-powered transport and public transport than for using private motorised transport (both in terms of market costs/personal expenses and non-market costs/externalities). Public transport is particularly more effective than in Australia, with non-market costs/externalities being at least 50% smaller.

In Australian agglomerations, using motorised transport is associated with less non-market costs than travelling via public transport and non-motorised/low-powered transport. Non-motorised transport is the most affordable and the most efficient travelling method.

Australia-wide, the economic analyses demonstrate that it is more costly for individuals to use cars than public transport (three to four times more with \$3,000–7,000 per person per year against ~\$1,800–3,000) but it is a little more effective (approx. \$6,500–12,000 per year against \$7,000–16,000), and people using cars have higher productivities and livelihoods than people using other transport modes. Total costs are comparable (annual costs of \$11,500–17,000/person for motorised vehicles against \$9,000–18,000/person for public transport users) despite lower public and private expenses for public transport users.

This confirms that public transport is particularly appropriate for small remote and very remote communities where there is a larger proportion of low-income households: having access to public transport would represent an increase in disposable income of \$1,000–3,000 annually compared to spending money on private motorised transport. In remote Australia, there is a contrast between the most privileged people, who can afford effective and safe private and public motorised transport, and the most

disadvantaged people, who are experiencing very low accessibility. This contrast is particularly relevant in larger remote communities. In general, health, time and access costs represent the vast majority of non-market costs and the bulk of the negative externalities generated by the current transport system.

Transport-related health costs are very significant in remote Australia, with an average of \$1,500 annually (double the national average) for people using motorised vehicles. Time and access costs represent on average around \$4,000, \$6,000 and \$7,000 respectively for people with access to private motorised vehicles, public transport and low-powered or non-motorised vehicles against \$3,000, \$5,000 and \$5,500 nationally. This corresponds to an increased cost of 33%, 20% and 27%. Other non-market costs are environmental; for these, the health benefits associated with reduced emissions (toxic air pollution) would be comparable with the health costs associated with road accidents in urban environments (up to \$700 annually) but significantly less in remote areas. In Australia, fuel types (fossil or renewable) and sources (from the grid or not) play a crucial role in transport-related emissions (Rauland 2014). Low-carbon transport modes, such as walking, cycling and efficient public transport, can also dramatically reduce the amount of GHG emissions.

In very remote communities a shortage of services (especially for people with reduced mobility) and a situation of financial disadvantage leave people with unsafe and unreliable transport options. Not everyone can operate or even afford to maintain a private vehicle. People with low mobility represent a substantial proportion of the population of very remote communities, and the number of people with low mobility is likely to increase in the demographic context of an ageing population. In current conditions in remote Australia, the shortage of transport infrastructure and services with the required equipment to effectively and safely transport people with low mobility will directly impact the viability of communities' wellbeing and become one of the main barriers towards sustainable economic participation and livelihoods. The fact that public transport and private motorised vehicle access are reduced in very remote communities reveals the full impact of socio-economic disadvantage resulting from a chronic shortage of appropriate and affordable transport systems: not having access to private or public motorised transport represents a loss of productivity and wellbeing (non-market costs) of \$500–4,000 per year per person. Developing effective public transport services for very remote communities could lead to positive results both in terms of increased productivity and wellbeing and disposable income.

These results are corroborated by the responses of user-oriented studies. According to Hoye et al. (2011), in rural communities, transport affordability is the number one concern with respect to transport, closely followed by safety. Not having regular access to public transport services contributes to a decreased transport affordability, effectiveness and safety. Transport systems in very remote communities tend to fit a niche market influenced by specific scales and demographic and geographic characteristics (Ames et al. 2014) and are not developed on a national scale. The heavy segmentation of transport services in remote Australia creates significant transport inefficiencies; remote public transport operates with limited coverage, low frequencies, relatively high fees, and most often within a monopolistic business environment.

This is also consistent with international research. Litman (2013a) identified that for low income earners, affordability, access and safety are the most important criteria for transport systems, and travelling time is the most important criteria for high income earners (access and affordability are also considered as critical).

In the current context, most of the transport systems in place are not adapted to sustain a growing economy, an ageing population and a potential increase in extreme climatic events in remote Australia.

## 4. Remote Australia in 2030

Demographic, climatic and economic changes will shape the future of remote Australia.

### 4.1 Demographic change in remote Australia

Population projections in remote and urban Australia (Table 14) suggest that the population growth in remote Australia will be between 100,000 and 400,000 people by 2030.

Table 14: Population projections in remote and urban Australia

	Australia	Urban Australia	Remote Australia
2013 population	23 million	17.5 million	0.6 million
2030 low increase	26.5 million	20 million	0.7 million
2030 moderate increase	28.5 million	22 million	0.8 million
2030 strong increase	31 million	25 million	1 million

In a scenario of moderate population growth, the Aboriginal and Torres Strait Islander population in remote areas will increase by around 33% by 2030. While the population in coastal areas would increase by nearly five million inhabitants, with major capital cities having growth rates of around 2% per year, remote Australia would have a more moderate increase (around 0.5%), with larger communities experiencing stronger increase (1%) and some very remote communities undergoing population losses (Australian Bureau of Statistics 2012b). In particular, some of the regional areas currently experiencing a deficit of transport infrastructure are anticipated to face a strong population loss (Figure 9). These areas include central areas of Western Australia and the Northern Territory, south-western areas of Queensland and north-western areas of New South Wales as well as south-eastern areas of South Australia. In these regions, the transport infrastructure and service funding gap from the low population basis is expected to increase.

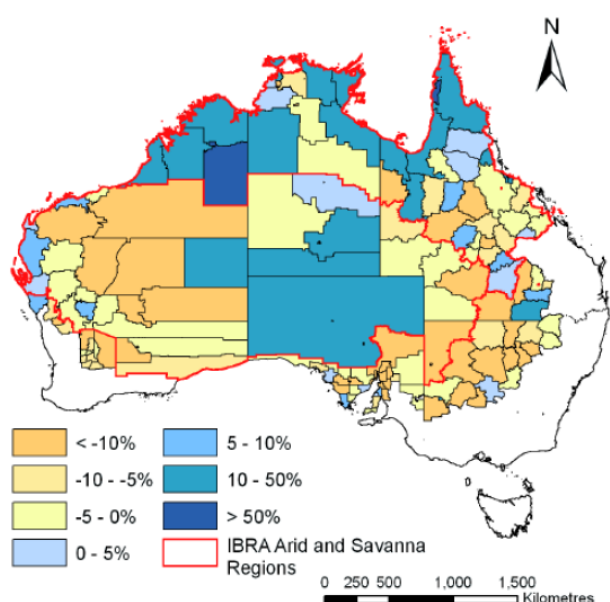


Figure 9: Per cent total population change by Statistical Local Area (2006–2021)

Source: Taylor and Prideaux (2006)

In Central Australia and the Top End regions, a potential population increase is going to exacerbate network deficiency (Australian Academy of Technological Sciences and Engineering 2011).

In a moderate ageing scenario, a doubling and a tripling of the populations aged respectively over 60 and 85 is anticipated (McCrindle 2008) as illustrated in Figures 10 and 11.

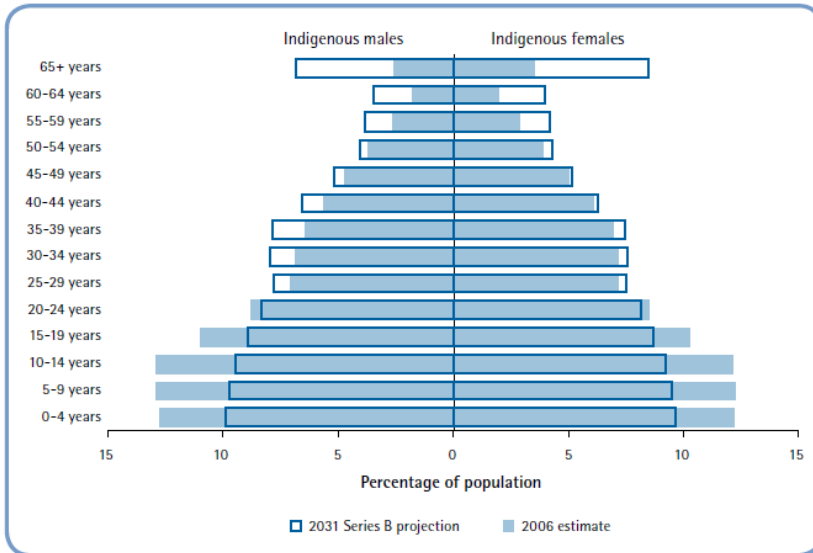


Figure 10: Age distribution of the Aboriginal and Torres Strait Islander population – Series B projections, 2006 and 2031

Source: Biddle and Taylor (2009; p. 13)

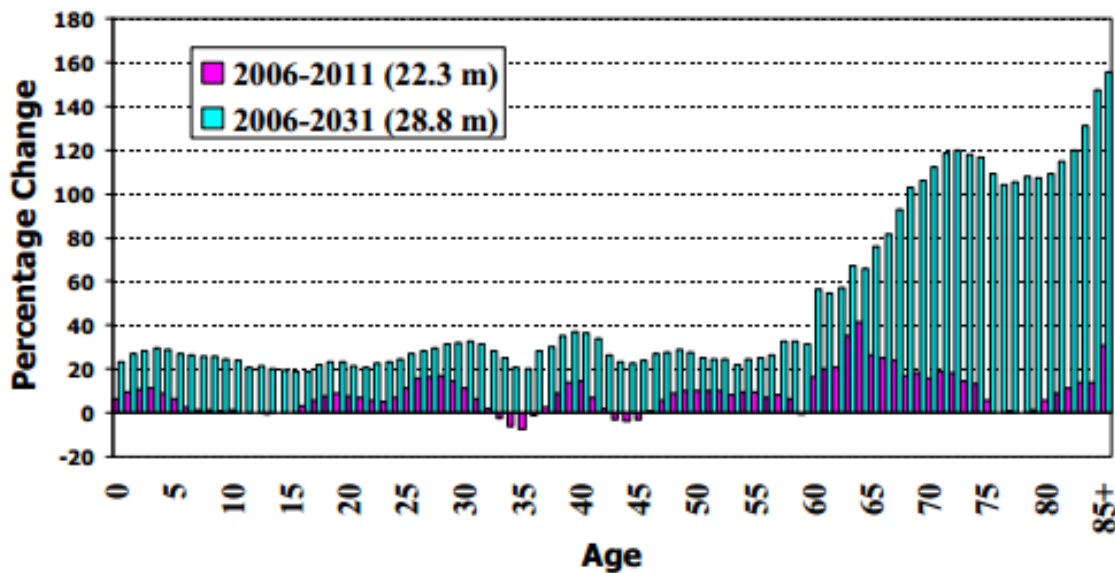


Figure 11: Structural ageing, Australia, change by age, 2006–2011; 2013 (Series B), ABS 2008 projections

Source: Hugo (2012)

This suggests that it will become increasingly important to address the specific needs of older commuters. In particular, enhancing transport access for low mobility people by reducing transport interchanges and ensuring an appropriate and convenient access to transport systems will have a major impact on transport

costs for remote communities. At a business level, transport services recovery strategies will need to be adjusted to a greater proportion of concession commuters and possible reduced revenue collection (Tourism and Transport Forum 2010).

Very remote communities rely heavily on transport access for health services: in the Northern Territory very remote Aboriginal and Torres Strait Islander communities, people are hospitalised for reasons associated with poor environmental health at a rate up to seven times higher than for other Australians (SGS Economics and Planning Submission 2013); with a potential climate change related increase in average temperature (1°C) in a moderate scenario (Garnaut 2011), health services requirements for this ageing population are likely to boom (Table 15).

Table 15: Average number of days per year above 35°C at selected sites for the 'current' climate (average for 1971–2000), and for 2030 and 2070, CSIRO and BOM, 2007, p. 61

Current		2030			2070			2070		
		A1B	A1B	A1B	B1	B1	B1	A1F1	A1F1	A1F1
		low	median	high	low	median	high	low	median	high
Adelaide	17	21	23	26	24	26	31	29	36	47
Alice Springs	90	102	109	118	112	122	138	132	155	182
Brisbane airport	1.0	1.5	2.0	2.5	2.1	3.0	4.6	4.0	7.6	20.6
Broome	54	71	86	107	89	119	173	147	220	281
Cairns	3.8	5	7	9	8	12	22	19	44	96
Canberra	5	7	8	10	8	10	14	12	18	26
Darwin	11	28	44	69	49	89	153	141	227	308
Dubbo	25	31	35	39	35	40	51	44	61	87
Hobart	1.4	1.6	1.7	1.8	1.7	1.8	2.0	2.0	2.4	3.4
Melbourne	9	11	12	13	12	14	17	15	20	26
Mildura	32	36	39	43	39	45	51	48	60	76
Perth airport	28	33	35	39	36	41	46	44	54	67
St George	47	56	63	72	64	74	91	80	103	135
Sydney	3.5	4.1	4.4	5.1	4.5	5.3	6.6	6	8	12
Wilcannia	63	71	77	82	79	85	96	92	106	129

Source: Hugo (2012; p. 35)

## 4.2 Climate change in remote Australia

By 2030, transport infrastructures and networks are likely to be more frequently and more severely impacted by extreme climatic events (Addison 2013, Beer 2012, Beer et al. 2012, Committee on Climate Change and U.S. Transportation & Transportation Research Board Division on Earth and Life Studies 2008, Eisenack et al. 2011, International Road Federation 2012, Jongman et al. 2014, Maddocks et al. 2010, Maru et al. 2012, McGuirk 2011, Memmott et al. 2013, Peterson et al. 2008, Race 2012, Rowan et al. 2014, Sheehan & Symons 2008, Wall et al. 2014). Details of these impacts appear in Tables 16–18 and Figure 12.

Table 16: Climate change effect, direct impact and consequences for road infrastructure

Climate change effect	Direct impact on road infrastructure	Consequences for road infrastructure
<ul style="list-style-type: none"> <li>• Increased temperatures and solar radiation</li> <li>• Increased rainfall</li> <li>• Rising sea levels</li> <li>• Flooding</li> <li>• Bushfires</li> <li>• Salinity effects</li> </ul>	<ul style="list-style-type: none"> <li>• Embrittlement and cracking of bitumen</li> <li>• Loss of water seal causing potholing</li> <li>• Low-lying roads may be submerged</li> <li>• Damage to road foundations as a result of prolonged drought and low rainfall</li> </ul>	<ul style="list-style-type: none"> <li>• Temporary or permanent blocked road access</li> <li>• Interruption to commercial activities that depend on road transport</li> <li>• Increased maintenance costs to increase resilience</li> <li>• Re-routing to avoid climate change-affected roads</li> <li>• Increased risk of liability resulting from road damage</li> <li>• Higher insurance costs</li> </ul>

Source: Maddocks et al. (2010, p. 11)

Table 17: Climate change effect, direct impact and consequences for port infrastructure

Climate change effect	Direct impact on port infrastructure	Consequences for port infrastructure
<ul style="list-style-type: none"> <li>• Increased severity of weather events, (including rainfall, wind, cyclones and sea storms)</li> <li>• Sea level rise</li> <li>• Increased ocean swell</li> <li>• Ocean acidification</li> </ul>	<ul style="list-style-type: none"> <li>• Corrosion</li> <li>• Infrastructure damage and deterioration resulting from heavy storm activity</li> <li>• Inundation of infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>• Increased frequency and duration of port closures</li> <li>• Shipping delays</li> <li>• Damage to cargo and goods</li> <li>• Increased costs of sea trade and shipped goods</li> <li>• Increased maintenance and replacement costs</li> <li>• Increased risk of liability resulting from port damage</li> <li>• Higher insurance costs</li> </ul>

Source: Maddocks et al. (2010, p. 13)

Table 18: Climate change effect, direct impact and consequences for air infrastructure

Climate change effect	Direct impact on port infrastructure	Consequences for port infrastructure
<ul style="list-style-type: none"> <li>• Increased rainfall and storm events</li> <li>• Increased severity and speed of winds</li> <li>• Increased intensity and frequency of storms</li> <li>• Increased temperature and solar radiation</li> <li>• Bushfires</li> </ul>	<ul style="list-style-type: none"> <li>• Damage to terminals</li> <li>• Expansion of joints, protective cladding, coatings and sealants on aerobridges and other airport infrastructure</li> <li>• Flooding of runways and access roads</li> <li>• Reduced life of asphalt on airport tarmacs</li> <li>• Reduced airlift</li> <li>• Reduced visibility</li> </ul>	<ul style="list-style-type: none"> <li>• Disruption to airline operations</li> <li>• Increased maintenance and replacements costs</li> <li>• Need to construct longer runways to compensate for reduced airlift</li> <li>• Need for ground-cooling mechanisms</li> <li>• Increased risk of liability resulting from air infrastructure damage</li> <li>• Higher insurance costs</li> </ul>

Source: Maddocks et al. (2010, p. 18)

In remote Australia, the Top End region is particularly vulnerable, with likely rising sea levels, higher air temperatures and increased severe weather events. In the Top End remote areas, the number of annual temperature-related deaths is expected to quadruple, and extreme infrastructure impact from storm surge and localised flash flooding is anticipated (Brook 2012).

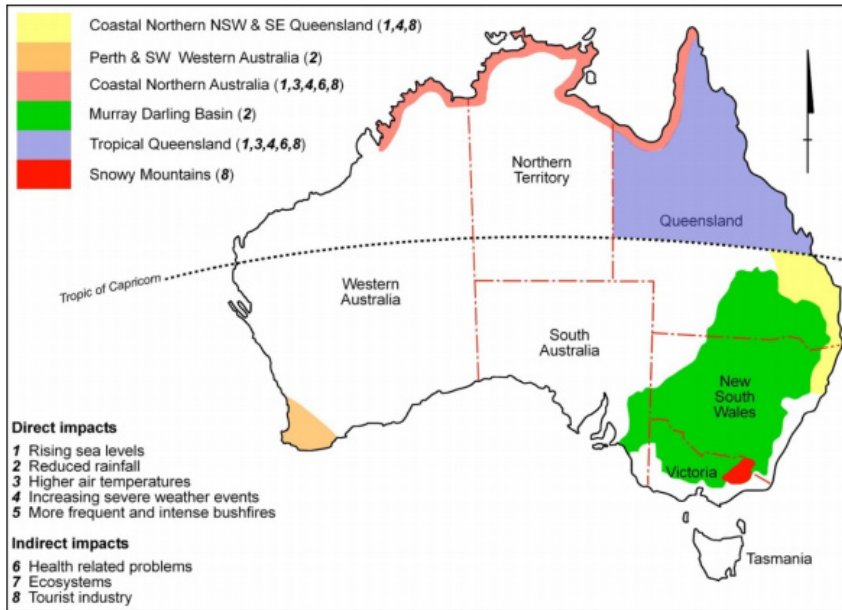


Figure 12: Climate change impacts hot spot, climate action network, 2006

Source: Hugo (2012; p. 41)

In this sense it is important to notice that very remote communities rely heavily on transport access for infrastructure services: in Northern Territory very remote Aboriginal communities, for the year 2012–2013, 30% of the population experienced five or more interruptions to their water supply, 20% experienced 20 or more interruptions to their electricity supply, and around 40% of people were affected by sewerage system overflows or leakages (SGS Economics and Planning Submission 2013). Climate change impacts will increase the frequency and the operational costs of infrastructure maintenance services and result in additional health, social and access costs.

### 4.3 Economy-related mobility change in remote Australia

Transport costs are also likely to rise. Fuel prices are expected to increase: in a moderate scenario they could reach \$2–\$3 per litre by 2030 (Gargett 2010, p. 15; Figure 13).

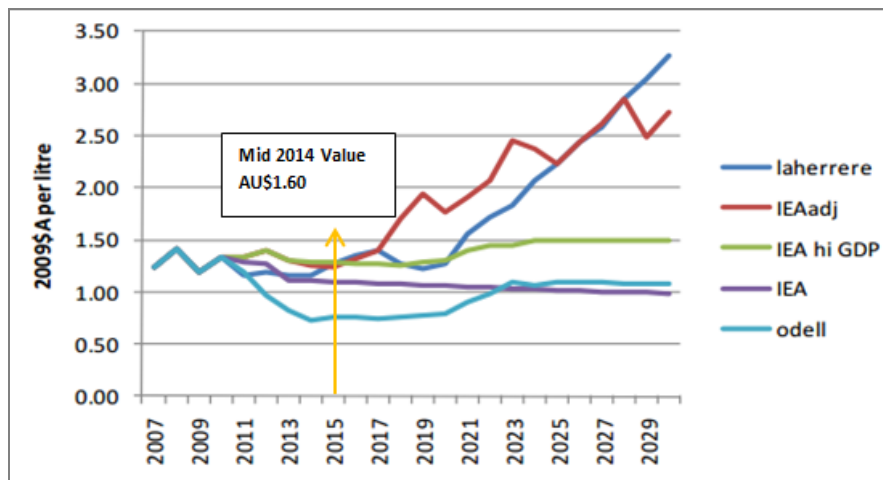


Figure 13: Australian retail petrol price scenarios

Source: modified from Gargett, 2010

In remote Australia fuel prices are around 15% higher in large remote communities and 45% higher in very remote communities compared to non-remote Australia. In 2030, fuel prices could range between \$2.60 and \$3.50 per litre in large remote Australian communities and \$2.90 and \$4.70 per litre in very remote communities in a moderate fuel price increase scenario (in 2014 real terms).

However, innovations in road vehicle technologies are anticipated to half the average fuel consumption to around 5 litres per 100 km in a moderate innovation scenario (Australian Bureau of Statistics 2006, British Petroleum 2014; Figure 14).

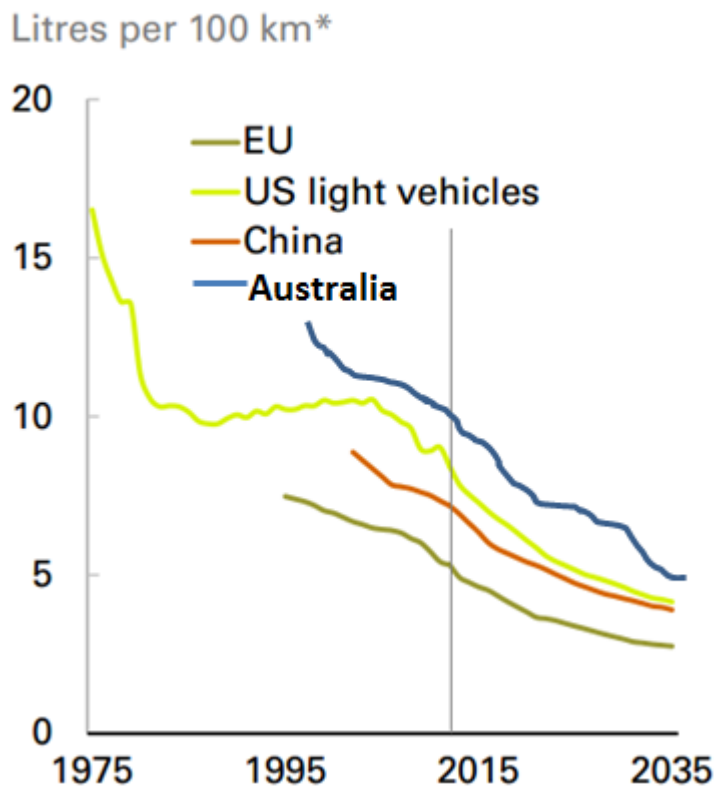


Figure 14: Average fuel consumption

Source: modified from British Petroleum (2014)

This would compensate for the fuel price increase and moderate the weekly fuel bill increase to a 10% figure compared to the 2014 levels. However, both increased transport demands and the high proportion of second-hand and four-wheel-drive vehicles in remote Australia result in 30–75% more expensive average weekly fuel bill.

Average new and second-hand car purchase prices would be moderately higher compared to today's average: an increase of 10–20% in real value, corresponding to US\$5,244–US\$11,290, is anticipated (Center for Automotive Research 2011). This would result in average new car purchase prices between AU\$27,000 and \$32,000 and second-hand prices (after five years) of between AU\$15,500 and \$19,500. Annual costs in servicing/maintenance might increase significantly more (in the 20–30% range in real terms, from AU\$750–\$1,000 as an average to AU\$1,500–2,000). While car occupancy rates would slightly increase in non-remote Australia, they would fall by 10–20% in remote Australia. However, with increased access to motorised vehicles, travelled distance might increase as well with already high levels of local and interstate mobility (Figure 15 shows recent trends in interstate migration with a negative balance for remote Australia).

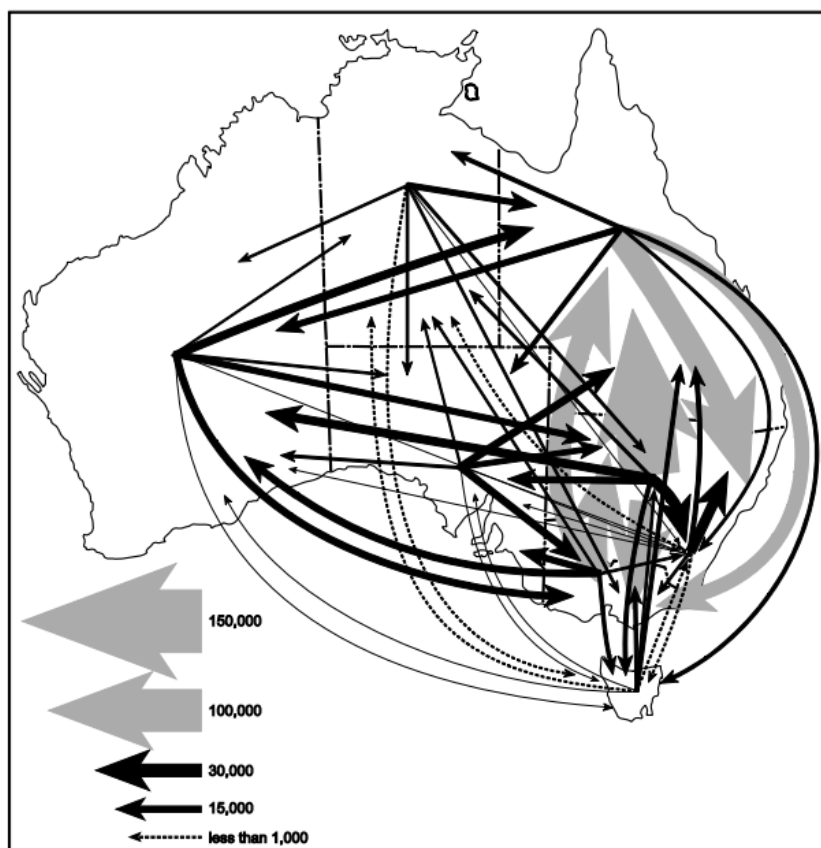


Figure 15: Australia: major internal migration flows between states, ABS, 2006 Census of Population and Housing

Source: Hugo (2012)

Currently, both private motorised transport and public transport are deficient. In a business-as-usual scenario, transport costs would be likely to increase by 25% in real terms by 2030 (-50% in nominal value). In the best case scenario (based on high economic growth with median wages increased by 25% by 2030 and low transport cost increase), the transport bill would still increase by more than 10%, exacerbating social exclusion and loss of wellbeing for the most vulnerable remote communities. In the worst case scenario (low growth and high transport cost increase), the transport bill would effectively double.

Tables 19 to 27 provide an evaluation of transport costs (approximate value) depending on transport modes access and remoteness.

Table 19: Transport market costs evolution for private motorised transport depending on remoteness

Motorised market costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$7,000–9,000	\$9,000–11,500	\$7,700–10,000	\$10,500–13,000	\$9,000–11,500
Australian non-remote	\$6,000–7,000	\$7,500–9,500	\$6,600–7,500	\$9,000–10,000	\$7,500–9,500
Large remote	\$5,000–7,000	\$6,000–8,500	\$5,500–7,500	\$7,500–10,000	\$6,000–8,500
Small remote	\$4,000–6,000	\$4,800–7,200	\$4,500–6,500	\$6,000–8,500	\$4,800–7,200
Very remote	\$3,000–5,000	\$3,600–6,000	\$3,300–5,500	\$4,500–7,000	\$3,600–6,000

Table 20: Transport non-market costs evolution for private motorised transport depending on remoteness

Motorised non-market costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$8,000–10,000	\$10,000–13,500	\$9,000–11,000	\$12,000–15,000	\$10,000–13,500
Australian non-remote	\$8,000–9,500	\$10,000–11,000	\$9,000–10,500	\$12,000–14,500	\$10,000–11,000
Large remote	\$6,500–9,000	\$8,000–10,500	\$7,000–10,000	\$9,750–13,000	\$8,000–10,500
Small remote	\$8,000–10,000	\$10,000–11,500	\$9,000–11,000	\$10,000–14,500	\$10,000–11,500
Very remote	\$9,000–12,000	\$11,250–14,000	\$10,000–13,000	\$13,500–16,000	\$11,250–14,000

Table 21: Total transport costs evolution for private motorised transport depending on remoteness

Motorised total costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$15,000–19,000	\$18,750–23,000	\$16,500–21,000	\$22,500–28,500	\$18,750–23,000
Australian non-remote	\$14,000–16,500	\$17,500–19,000	\$15,500–18,000	\$21,000–24,500	\$17,500–19,000
Large remote	\$11,500–16,000	\$14,500–20,000	\$12,500–17,500	\$17,000–24,000	\$14,500–20,000
Small remote	\$12,000–16,000	\$15,000–18,500	\$13,500–17,500	\$18,000–24,000	\$15,000–18,500
Very remote	\$12,000–17,000	\$15,000–18,000	\$10,000–19,000	\$18,000–25,500	\$15,000–18,000

Table 22: Transport market costs evolution for public motorised transport depending on and remoteness

Motorised market costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$1,600–1,800	\$2,000–2,500	\$1,750–2,000	\$2,500–2,750	\$2,000–2,500
Australian non-remote	\$2,400–2,600	\$3,000–3,500	\$2,500–3,000	\$3,600–4,000	\$3,000–3,500
Large remote	\$1,800–2,000	\$2,200–2,500	\$2,000–2,250	\$2,750–3,000	\$2,200–2,500
Small remote	\$2,000–3,000	\$2,500–3,750	\$2,200–3,300	\$3,000–4,500	\$2,500–3,750
Very remote	\$2,000–3,000	\$2,500–3,750	\$2,200–3,300	\$3,000–4,500	\$2,500–3,750

Table 23: Transport non-market costs evolution for public transport depending on remoteness

Motorised non-market costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$4,000–6,000	\$5,000–7,500	\$4,500–6,500	\$6,000–9,000	\$5,000–7,500
Australian non-remote	\$10,000–12,000	\$12,500–15,000	\$11,000–13,250	\$15,000–18,000	\$12,500–15,000
Large remote	\$14,000–16,000	\$17,500–20,000	\$15,500–17,500	\$11,000–14,000	\$17,500–20,000
Small remote	\$7,000–9,000	\$8,750–11,000	\$7,750–10,000	\$12,000–14,500	\$8,750–11,000
Very remote	\$9,000–12,000	\$11,000–15,000	\$10,000–13,000	\$14,000–16,000	\$11,000–15,000

Table 24: Total transport costs evolution for public transport depending on remoteness

Motorised total costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$5,600–7,800	\$7,000–10,000	\$6,000–8,500	\$8,500–12,000	\$7,000–10,000
Australian non-remote	\$12,400–14,600	\$15,500–17,500	\$13,500–15,500	\$19,000–21,000	\$15,500–17,500
Large remote	\$15,800–18,000	\$20,000–22,500	\$17,500–20,000	\$24,000–27,000	\$20,000–22,500
Small remote	\$9,000–12,000	\$11,500–15,000	\$10,000–13,000	\$13,500–18,000	\$11,500–15,000
Very remote	\$11,500–15,000	\$14,500–18,750	\$12,500–16,500	\$17,500–22,500	\$14,500–18,750

Table 25: Transport market costs evolution for non-motorised transport depending on and remoteness

Motorised market costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$300–500	\$375–625	\$330–550	\$500–750	\$375–625
Australian non-remote	\$300–500	\$375–625	\$330–550	\$500–750	\$375–625
Large remote	\$600–800	\$750–1,000	\$660–880	\$900–1,200	\$750–1,000
Small remote	\$800–1,200	\$1,000–1,500	\$880–1,320	\$1,200–1,800	\$1,000–1,500
Very remote	\$600–1,300	\$750–1,650	\$660–1,500	\$900–2,000	\$750–1,650

Table 26: Transport non-market costs evolution for non-motorised transport depending on remoteness

Motorised non-market costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$6,000–8,000	\$7,500–10,000	\$6,600–9,000	\$9,000–12,000	\$7,500–10,000
Australian non-remote	\$7,500–8,500	\$9,500–10,500	\$8,000–9,500	\$11,000–13,000	\$9,500–10,500
Large remote	\$9,000–11,000	\$11,000–14,000	\$10,000–12,000	\$13,500–16,500	\$11,000–14,000
Small remote	\$10,000–12,000	\$12,500–15,000	\$11,000–13,500	\$15,000–18,000	\$12,500–15,000
Very remote	\$12,000–17,000	\$15,000–21,500	\$13,500–19,000	\$18,000–26,000	\$15,000–21,500

Table 27: Total transport costs evolution for non-motorised transport depending on remoteness

Motorised total costs	2014	2030 conservative nominal (25%)	2030 conservative real (10%)	2030 high price increase nominal (50%)	2030 high price increase (real) 25%
International non-remote	\$6,300–8,500	\$8,000–10,500	\$7,000–9,500	\$10,000–13,000	\$8,000–10,500
Australian non-remote	\$7,800–9,000	\$10,000–11,500	\$9,000–10,000	\$12,000–13,500	\$10,000–11,500
Large remote	\$9,600–11,800	\$12,000–15,000	\$10,500–13,000	\$14,500–18,000	\$12,000–15,000
Small remote	\$10,800–13,200	\$14,000–16,500	\$12,000–14,500	\$16,500–20,000	\$14,000–16,500
Very remote	\$12,600–18,300	\$16,000–23,000	\$14,000–20,500	\$19,000–28,000	\$16,000–23,000

These figures were calculated assuming that there would be a reasonably linear costs increase of both transport expenses and externalities associated with demographic, economic and climatic changes. These figures might follow a more exponential trend in the most extreme scenarios of climatic or economic

change (in particular, insurance, maintenance and infrastructure costs for transport expenses and time and access costs for externalities).

Technological and logistical improvement as well as the evolution of transport practices and demands could also attenuate or reverse these projections.

## 5. Recommendations on how to decrease transport costs

The objective of effective transport systems is to provide people with a safe, affordable, fast (and therefore regular and reliable) and effective access to goods, services and other people. The optimal transport system would have all of these four components reach levels of excellence. However, there is no silver bullet when it comes to transport systems. To accommodate the needs of people and businesses with a great variety of profiles, both private and public transport options at both small and large scales need to be implemented. Achieving a high level of connectivity and accessibility for people and businesses in remote Australia requires improving transport systems for several modes. Remoteness puts a premium on local knowledge and technical and social innovations to address problems that mainstream Australian approaches may fail to resolve (Foran et al. 2014). Appropriate technical innovations in the transport sector as well as business, social and institutional developments could lead to more effective transport systems at the level of specific regions and communities. At this early stage in the research, indicative costs and benefits estimations are provided in the technical joint study (these costs are composed of expenditures and externalities while the benefits are composed of the costs recovery, profits and wider co-benefits). Table 28 presents the different types of responses that could help decrease transport costs.

Table 28: Responses to decrease transport costs in remote Australia

	Component of transport system	Issue	Type of response
<b>Transport Infrastructure</b>	Primary infrastructure	Fragmentation of the labour market	Extending the coverage
	Connectivity of infrastructure	Fragmentation of the labour market	Demand-oriented, multifunctional and multimodal transport infrastructure with integrated residential and business activities around it
	Infrastructure life cycle	Decreased use of infrastructure over time	Reconversions
<b>Transport Services</b>	Public transport for remote communities	Transport disadvantage in terms of access to employment, education, health and cultural activities	Better coverage Higher frequencies Higher affordability
	Air, rail and maritime services	High capital costs	Improved cost recovery models, multimodal services with timetable coordination, combined fares, concession, subscriptions and client services
	Government and non-government organisations' fleets	Capital and operational costs	Fuel efficiency in vehicle auditing as well as combined use of vehicles
	Fuel	Fuel prices 60% higher with fuel costs 100–150% higher in remote Australia	Audit of innovative fuels (electric, LPG, fuel cell) which could decrease fuel costs
	Community transport	Huge shortage while the population with low mobility increases	Low-powered private vehicles

	Component of transport system	Issue	Type of response
	Emergency response planning	Increasing costs with a growing population	Integrated planning and enhanced coordination of evacuation responses
<b>Private Vehicles</b>	Private vehicles	High costs and restriction in the choice of appropriate vehicles	Affordable appropriate vehicles (low-cost vehicles with off-Road capabilities)
	Maintenance	Very short life cycle, high maintenance costs	Effective maintenance support, mobile services and local workshops
	Fuel	Fuel prices 60% higher with fuel costs 100–150% higher in remote Australia	Audit of innovative fuels (electric, LPG, fuel cell) which could decrease fuel costs
	Demand management	The level of transport demand can be unsustainable	Enhanced telecommunication capabilities and functionality of remote communities with higher self-sufficiency
<b>Freight</b>	Planning of transport systems for goods	Seasonal demands for very remote communities	Community freight bulk/mobile services with capped prices (ranges)

## 6. Alternative transport futures scenario

At the scale of remote Australia, the most conservative estimate of improved transport systems suggests net benefits of \$300–\$500 million per year, with very optimistic estimates in the \$3 billion range.

From preliminary estimates, improving time and access standards by 10% would represent an annual saving of \$75–\$125 million for remote Australia itself.

For communities of 500–1,000 inhabitants, minimising vehicle purchase and maintenance costs, public transport ticket fees as well as time, health and social costs could represent combined levels of benefits ranging from \$0.5 million to \$5 million dollars over ten years (\$5,000–\$50,000/person), representing 5–50% of the median income.

With successful implementation of the alternative responses considered earlier, it would be possible to maintain the level of expenses of an individual's income allocated to transport. This would occur because of more effective logistics and technologies, which would allow the costs to stay at their current levels (in real terms). Table 29 displays approximated predicted market costs for remote and non-remote communities in 2030 in real (and nominal) terms.

Table 29: Market travel costs in very remote and remote/non-remote Australia in 2030 in real (and nominal) terms

What people pay	Non-remote / large remote communities		Small and very remote communities	
	2014	2030	2014	2030
Timeframe				
Motorised vehicle	\$5,000–7,500	\$5,000–7,500 (\$5,500–8,500)	\$3,000–6,000	\$3,000–6,000 (\$3,300–6,600)
Public transport	\$1,800–2,600	\$1,800–2,600 (\$2,000–2,850)	\$2,000–3,000	\$2,000–3,000 (\$2,200–3,300)
Non-motorised/low-power transport	\$300–800	\$300–800 (\$330–880)	\$800–1,300	\$800–1,300 (\$900–1,500)

These market costs are relatively comparable to the business-as-usual moderate increase scenario. In the alternative transport scenario, technological improvements in logistics and vehicle design, as well as extended public transport services, provide substantial improvements in the next decade.

Table 30 shows approximated predicted non-market costs for remote and non-remote communities in 2030 in real (and nominal) terms. In such a scenario, people would lose less in time and inconvenience for their travelling in remote Australia, and the overall productivity and wellbeing levels would improve. In such a scenario with improved infrastructure and public and private transport services, people would pay 10% more for their travelling in remote Australia, but their median incomes would also increase by 10% (in real terms) due to the benefits from the more effective transport systems (increased employment, decreased costs of goods and services, increased regional attraction).

Table 30: Non-market travel costs in very remote and remote/non-remote Australia in 2030 in real (and nominal) terms

Externalities	Non-remote / large remote communities		Small and very remote communities	
	2014	2030	2014	2030
Motorised vehicle	\$6,500–9,500	\$6,500–8,500 (\$7,500–9,500)	\$8,000–12,000	\$8,000–11,000 (\$9,000–12,000)
Public transport	\$10,000–16,000	\$8,000–14,000 (\$9,000–15,500)	\$7,000–12,000	\$6,000–10,000 (\$6,500–11,000)
Non-motorised/low-power transport	\$7,500–11,000	\$5,500–9,000 (\$6,000–10,000)	\$10,000–17,000	\$9,000–15,000 (\$10,000–16,500)

Specific policies in place to promote active transport would also have positive impacts, especially considering that the Australian population is ageing. Public transport services would be more efficient at carrying people around, and generally it is anticipated that people would be driving safer vehicles with substantial savings in terms of health and environmental costs. However, in remote Australia, time and access costs will still represent the bulk of transport costs (from 70% to around 60%) even if they are expected to decrease by 10–20% for freight Australia-wide and decrease by 5–30% for passenger transport. In non-remote Australia, connected transport (vehicles, accessories) and non-transport (phones, connected glasses, connected smartwatches) communication devices could develop opportunities to enhance productivity during transport activities and further decrease these costs. Table 31 presents the approximated total transport costs (combined market/non-market costs or private expenses and externalities) with the successful implementation of alternative scenarios.

Table 31: Predicted total costs per mode 2030 in real (and nominal) terms in very remote and remote/non-remote Australia

Total	Non-remote / large remote communities		Small and very remote communities	
	2014	2030	2014	2030
Motorised vehicle	\$11,500–17,500	\$11,500–16,000 (\$13,000–17,500)	\$12,000–17,000	\$11,000–17,000 (\$12,000–18,500)
Public transport	\$16,000–18,000	\$10,000–16,500 (\$11,000–18,000)	\$9,000–15,000	\$9,000–14,000 (\$10,000–15,500)
Non-motorised/low-power transport	\$8,000–12,000	\$6,000–10,000 (\$6,500–11,000)	\$11,000–18,000	\$10,000–17,000 (\$11,000–18,000)

In such a scenario people in remote communities are likely to pay slightly more for travelling compared to 2014, but they will be travelling in significantly better conditions and benefit from improved levels of productivity and wellbeing. Promoting the use of non-motorised/low-powered transport would be the best

option in large remote communities, while in small remote and very remote communities, motorised transports (both public and private) would be more widely accessible, efficient and reliable. Compared to a business-as-usual scenario, total transport costs could be reduced by 5–10%.

## 7. Conclusion and future research

This report consists of a comprehensive review of transport costs in remote Australia. It is possible to distinguish the role of the specific geographic (very long distances and very low densities) and environmental (extreme climates) conditions that characterise the transport systems of remote Australia from other factors explaining the existence of significant transport inequalities.

Both locational and social inequalities create a double transport disadvantage of under-developed transport infrastructures and limited provisions of public and private transport services, which directly and durably affects remote communities. The relatively low level of private and public transport investment in regards to the size of the serviced areas generates disproportionately high operational and socio-economic costs for remote communities. The restricted access to transport systems results in very high transport costs and externalities, which are magnified by the importance of transport systems for the maintenance of sustainable livelihoods for the remote Australian society. The restrictions in terms of access to transport divide remote Australia into highly isolated spatial clusters and highly connected areas, and exacerbate the socio-economic exclusion of the most disadvantaged communities, including a vast majority of Aboriginal and Torres Strait Islander ones. The most critical issues associated with transport access in remote Australia include a lack of private and public transport services (with a shortage of affordable appropriate vehicles and the low frequencies of some public transport services), a shortage of appropriate infrastructures, high petrol prices, and a lack of synergies between transport systems and local economies (supply chains, connectivity and travelling durations). In current conditions, transport systems will not be able to effectively sustain an ageing population and a growing economy: the proportion of the budget allocated to transport relative to the median income in remote Australia is relatively comparable with non-remote Australia (8–20%). While people who cannot afford an appropriate vehicle tend to minimise their personal expenses, they face higher externality costs. The high levels of transport-related externalities in remote Australia represent a very significant socio-economic barrier: transport-related externalities (as a decrease in wellbeing and productivity) are comparable with a loss of 15–25% of the median income in non-remote Australia and 40–80% in remote Australia.

Despite a structural context of very low densities, transport systems play a fundamental role for the economy and the society of remote Australia: ineffective and unsustainable transport systems are already generating very significant externalities in terms of health, socio-economic exclusion and cultural values, which are an extreme cost in a remote context. Not having effective transport systems will jeopardise the development, and in some cases the existence, of remote communities and enterprises.

In a business-as-usual scenario, conservative estimates suggest that by 2030 transport costs are likely increase by 10–20% in real terms (between 25–50% in nominal value). In the best case business-as-usual scenario (based on high economic growth with median wages increased by 20% by 2030 and a low transport cost increase) the transport bill would still increase by 10%, exacerbating the current social exclusion of some of the most vulnerable remote communities. In the worst case scenario (low growth and high transport cost increase), the combined proportion of the budget allocated to transport relative to the median income and the transport-related externalities as a loss of income would double.

In a context of reduced capital investment capacity, ways of reducing health, social, productivity and wellbeing costs need to be further documented. Beyond a critical need for new transport infrastructures, practical innovations could help decrease transport costs for remote communities; these innovative technologies and practices concern transport logistics, services and planning and include the extension and the rationalisation of the current public transport services coverage, higher frequencies, multimodal services with timetable coordination, combined fares, improved cost recovery models and client services, the provision of fuel efficient affordable appropriate vehicles (low-cost vehicles with off-road capabilities), the implementation of appropriate local workshops, the provision of low-powered private vehicles, the development of community transport services, the adoption of integrated planning considerations, the provision of telecommunication capabilities and enhanced coordination of evacuation responses.

This study offers an opportunity to integrate cost-reflective metrics of transport externalities with a broad measurability of transport expenses. As an informative tool, it can help consumers to develop a more comprehensive economic rationality as part of their decision-making process when identifying sustainable transport practices and innovations.

The Transport Futures research is focusing on exploring the technical feasibility of alternative transport systems for communities in remote Australia. This implies investigating the use of more appropriate infrastructure, the development of existing public transport systems, the optimisation of non-motorised or low-powered transport networks and the design of new forms of community transport, more affordable and more appropriate vehicles, the potential use of alternative fuels and the implementation of ways to promote self-sufficiency and reduce transport needs. These alternative transport options will be examined in a context of climatic, demographic and economic changes at a community level with the aim to identify appropriate strategies and practical knowledge to develop sustainable transport systems that could have positive impacts.

## Appendix 1

Table A1: Daily transport expenses in remote and non-remote Australia per transport access mode (AU\$)

Daily expenses	Non-remote	Remote
Motorised	4–7	9–30
Public transport	6–8	9–25
Non-motorised	4–6	3–4

Table A2: Daily transport externalities in remote and non-remote Australia per transport access mode (AU\$)

Daily externalities	Non-remote	Remote
Motorised	20–40	20–40
Public transport	25–35	20–30
Non-motorised	20–35	30–50

Table A3: Daily combined transport expenses/externalities in remote and non-remote Australia per transport access mode (AU\$)

Combined daily expenses and externalities	Non-remote	Remote
Motorised	24–47	29–70
Public transport	31–43	29–55
Non-motorised	24–41	33–54

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