Applied Demography Series 7

Tom Wilson
Elin Charles-Edwards
Martin Bell *Editors*

Demography for Planning and Policy: Australian Case Studies

Springer

Applied Demography Series

Volume 7

Series editor
David A. Swanson, University of California Riverside, Riverside, CA, USA

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Tom Wilson • Elin Charles-Edwards
Martin Bell
Editors

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Editors
Tom Wilson
Northern Institute
Charles Darwin University
Darwin, NT, Australia

Martin Bell
Queensland Centre for Population Research,
School of Geography, Planning
and Environmental Management
The University of Queensland
Brisbane, QLD, Australia

Elin Charles-Edwards
Queensland Centre for Population Research,
School of Geography, Planning
and Environmental Management
The University of Queensland
Brisbane, QLD, Australia

ISSN 2352-376X ISSN 2352-3778 (electronic)
Applied Demography Series
ISBN 978-3-319-22134-2 ISBN 978-3-319-22135-9 (eBook)
DOI 10.1007/978-3-319-22135-9

Library of Congress Control Number: 2015957250

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

Foreword

As the first book to provide a look at the broad range of potential demographic applications in Australia, this volume fills a long-standing gap and does so very admirably. The ten substantive chapters along with the Introduction show that demographers in Australia are using demographic data, methods, and perspectives to help solve important issues in both the public and private sectors. Assembling these studies in a single location is a great service to Australians.

While these chapters represent case studies in Australia, the methods and perspectives described in them can be profitably used in many other countries. In this sense, the book can be viewed as an update to the collection of case studies assembled over 20 years ago by Kintner et al. (1994) that focused on applied demography in the United States. Taken together, both books provide not only an international perspective but also a glimpse at the evolution of applied demography over time; importantly, they also show the commonalities in methods and perspectives found among applied demographers across more than 20 years and several thousand miles. In terms of the evolution of applied demography, Chap. 9 (Bell and Cooper) is an example of how far spatial demography has come since the work by Kintner et al. (1994). A similar perspective is provided in Chap. 10 (Tang et al.).

In terms of commonalities, the main links between Kintner et al. (1994) and the current volume are found in the areas of population estimation and forecasting. The computer platforms, software, internet services, and data access are very different now than what was found 20 years ago, and the ability to generate estimates and forecasts of populations reflects these changes as can be seen in Chaps. 3 (Charles-Edwards), 4 (Wilson), and 7 (Pullar et al.). However, underlying these new developments are demographic perspectives and methods that have not changed much. Another common area is the use of demographic information by governmental entities to allocate resources. The description provided in Chap. 2 (Corr) may vary in the details, but the general framework is very similar to that found in the United States 20 years ago and today.

In addition to common perspectives and methods found between applied demographers currently practicing in Australia and elsewhere in space and time, there is a common interest in how best to communicate demographic information to stakeholders. Advice found in Chap. 5 (Johnstone) underscores the importance placed upon communicating demographic information by applied demographers across time and space and the need to continually evaluate how this is best done.

Applied demographers also share a common heritage with demographers who are generally found in academic units, ones who do little, if any, applied demography. Examples of the commonalities between applied demographers and academic demographers can be found in several chapters, including: Chap. 6 (Taylor) which discusses population aging and its consequences; Chap. 8 (Argent et al.), which explores demographic change and its links to population dynamics; and Chap. 11 (Norman et al.) which examines the links between population dynamics and inequalities in health, socioeconomic status, and life chances.

As was the case with the book by Kintner et al. (1994), the present volume will become a classic in applied demography, a collection of case studies that illustrate the range of problems that applied demographers deal with and the creative solutions they have come up with. It will make a nice addition to the shelves of applied demographers around the world as well as to classrooms where applied demography is taught.

University of California Riverside
Riverside, CA, USA
David A. Swanson

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Acknowledgements

The editors are most grateful to Rosabella Borsellino for formatting all the chapters.

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Contributors

Neil Argent Division of Geography and Planning, University of New England, Armidale, NSW, Australia

Martin Bell Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Elin Charles-Edwards Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Jim Cooper Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Jonathan Corcoran Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Patrick Corr Australian Bureau of Statistics, Canberra, Belconnen, ACT, Australia

Trevor Griffin Department of Geography, Environment and Population, University of Adelaide, Adelaide, SA, Australia

Kim Johnstone Demography and Economics Branch, Department of Planning and Environment, Sydney, NSW, Australia

Paul Norman School of Geography, University of Leeds, Leeds, UK

David Pullar School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Francisco Rowe Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Thomas Sigler Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD, Australia

Peter Smailes Department of Geography, Environment and Population, University of Adelaide, Adelaide, SA, Australia

Robert Stimson Australian Urban Research Infrastructure Network (AURIN), The University of Melbourne, Parkville, VIC, Australia

Angelina Zhi Rou Tang Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, Faculty of Science, The University of Queensland, Brisbane, QLD, Australia

Andrew Taylor Northern Institute, Charles Darwin University, Darwin, NT, Australia

Tom Wilson Northern Institute, Charles Darwin University, Darwin, NT, Australia

Abbreviations

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
AGS	Australian Graduate Survey
ARIA	Accessibility/Remoteness Index for Australia
ASGC	Australian Standard Geographical Classification
ASGS	Australian Statistical Geography Standard
CAP	Comparative Age Profile
CCD	Census Collectors' District
COAG	Council of Australian Government
GCA	Graduate Careers Australia
GDS	Graduate Destination Survey
GST	Goods and Services Tax
HEI	Higher Education Institutions
HFE	Horizontal Fiscal Equalisation
IMD	Indexes of Multiple Deprivation
IR	Inner Regional Australia
IRSD	Index of Relative Socioeconomic Disadvantage
LGA	Local Government Area
LSUM	Large Scale Urban Model
MC	Major Cities of Australia
MDB	Murray-Darling Basin
MYEFO	Mid-Year Economic and Fiscal Outlook
NBN	National Broadband Network
NIM	Net Internal Migration
NOM	Net Overseas Migration
NSW	New South Wales
NT	Northern Territory
OECD	Organisation for Economic Co-operation and Development
OR	Outer Regional Australia
POPACTS	POpulation Projections for rural Areas, Cities and Towns of a State
QLD	Queensland

RA	Remoteness Area
RAI	Relative Ageing Index
SA	South Australia
SA1	Statistical Area Level 1
SA2	Statistical Area Level 2
SEIFA	Socio-Economic Indexes for Areas
SEQ	South East Queensland
SLA	Statistical Local Area
TAS	Tasmania
TFR	Total Fertility Rate
TOD	Transit-Oriented Development
VIC	Victoria
WA	Western Australia

Chapter 1
Introduction

Tom Wilson, Elin Charles-Edwards, and Martin Bell

Demography for Planning and Policy

Demography is often defined as the study of population, particularly with regard to its size, age-sex structure, socio-economic composition, geographical distribution, change over time, and processes driving change (Shryock and Siegel 1976). The specialist area of applied demography, which is the focus of this volume, has been summarised as “the subfield of demography focusing on practical applications of demographic materials and methods” (Siegel 2002, p. 2). Applied demography, in turn, is sometimes divided into two discrete areas of interest - business demography and public sector demography (Swanson and Pol 2008) – based on the audience for the work. This book focuses primarily on the latter.

In terms of the type of data being handled, a large component of applied demography is concerned with creating population estimates (population numbers describing the past or present) and population projections (which endeavour to chart likely population futures) (Swanson and Pol 2005). Estimates and projections provide an important foundation for understanding demographic change, but applied demography also involves the interpretation and use of these data, often in conjunction with other forms of information, to address problems and issues, help formulate policy and guide decision making (Fig. 1.1). However one might characterise applied demography, its ultimate aim is to provide answers to questions such as: ‘Where do we need to build new dwellings?’, ‘Will a new primary school soon be required in this suburb?’, ‘Has population change altered the number of political representatives

T. Wilson (✉)
Northern Institute, Charles Darwin University, Darwin, NT 0909, Australia
e-mail: tom.wilson@cdu.edu.au

E. Charles-Edwards • M. Bell
Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia
e-mail: e.charles-edwards@uq.edu.au; martin.bell@uq.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_1

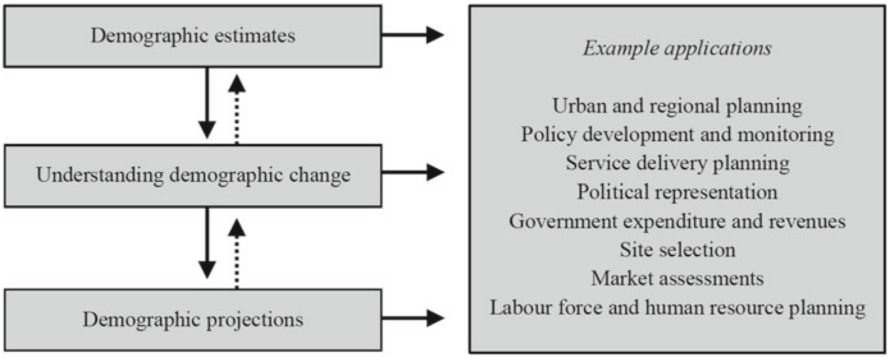

Fig. 1.1 The main components of applied demography, with example applications

each State and Territory is entitled to?', 'Where are the most disadvantaged people living, what services do they need, and how might these best be provided?'

This book presents a series of Australian case studies in applied demography, most of which have an explicit or implicit public sector focus. It provides a complement to volumes such as *Consumer Demographics and Behaviour* by Martins et al. (2012) which deal with business demography. The case studies included in this volume are necessarily selective of a much larger range of work, but they do illustrate the breadth of work in applied demography being undertaken in Australia today. Given the lack of an Australia-specific demography or population studies journal, this work is often scattered across a wide range of outlets, websites, or hard-to-find reports, or is not published at all. This book brings together in a single volume a selection of interesting or innovative applied demography case studies. Although a number of general books on Australian demography have been published over recent decades (e.g. Newton and Bell 1996; Khoo and McDonald 2003; Markus et al. 2009) this is the first edited volume on Australian applied demography with a planning and policy focus. A particular feature of the book is that it contains contributions by population specialists working outside the academic sector, which provide insights into the applications of demographic data that would otherwise remain obscured.

Applied demography is probably more important in Australia now than ever before. Population growth is high relative to most developed countries but it varies spatially from rapid urban and coastal growth to widespread decline inland; population ageing has begun to accelerate with the movement of the earliest of the baby boom generation into the 65+ age groups (Wilson 2012); increasing longevity is raising questions about healthy life expectancy and the provision of aged care (Salomon et al. 2012); and climate change is prompting questions about the demographic implications of warmer temperatures, higher sea levels and more frequent extreme events (Bailey 2011). At the same time, there is an increasing supply of detailed demographic data, often via web-based tools, the emergence of new demographic data sources generated by electronic commerce and mobile devices, and new software with which to analyse and visualise patterns and trends (Deville et al.

2014; Sander et al. 2014). Yet user expectations of demographers and demographic data seem to be rising faster than the development of new data, methods and tools. In an era when both public and private agencies are under increasing pressure to provide efficient, cost effective services while maintaining high levels of equity, there is rising pressure for accurate, timely information to support 'evidence-based' decision-making. These developments present exciting challenges and opportunities for Australian applied demography.

We hope the book will prove interesting and useful to demographers, geographers, planners, regional scientists, statisticians and others working on population topics across the academic, government and private sectors. We also hope the case studies will prove helpful for students studying applied demography and related subjects.

Overview of the Book

Following this Introduction the book is divided into three main parts. These are concerned with population estimates, population projections, and understanding demographic change. Part I, 'Estimates for planning and policy,' begins with *Democracy and dollars* (Corr, Chap. 2) a detailed account of the role of official population estimates in providing for political representation and the apportionment of tax revenue among Australian States and Territories. Democratic representation and equitable distribution of government revenue are fundamental to effective planning and policy making, and, as recognised in the Australian Constitution, are contingent upon the timely and accurate provision of official population statistics.

The estimation of temporary populations in Australia (Charles-Edwards, Chap. 3), continues this theme, but draws into question the adequacy of usual resident counts (e.g. Estimated Resident Population (ERP)) in localities experiencing significant temporary population flux. This chapter reviews a range of methods and data sets for the estimation of temporary populations in Australia, and seeks to develop an integrative framework for temporary population estimates, set alongside usual resident statistics.

Planning and policy is not just contingent on accurate population estimates, but also the provision of reliable and sensible projections of future population size and structure. Part II, 'Projections for planning and policy', contains contributions on different aspects of the projection process. The part begins with *POPACTS: simplified projection software for State, regional and local area population projections* (Wilson, Chap. 4). Local area projections are fundamental to regional planning. POPACTS is a multi-bi-regional model, which attempts to simplify and lower the costs of the projections process without compromising on the principal strengths of the multi-regional approach. A key emphasis in this chapter is that the skills of government demographers are often best utilised in the setting of assumptions and communication of projection results, rather than the programming of complex demographic models. POPACTS attempts to facilitate this by providing a conceptually sound, but user friendly platform for regional and local population projections.

Communicating population projections to stakeholders: a case study from New South Wales (Johnstone, Chap. 5) expands on the central role communication plays in ensuring the appropriate use and interpretation of demographic data. The chapter argues that the role of demographers is not simply to undertake modelling and analysis but also to ensure that the outputs are understood. This is crucial as many end users of demographic projections have limited understanding of the models that generate them. Moreover, the projections and the assumptions that underpin projection models are often framed in a highly politicised context, which calls for thoughtful communication of results.

Not just ageing: policy and service delivery implications from changing population compositions in the Northern Territory of Australia (Taylor, Chap. 6) demonstrates the utility of population projections in the planning and provision of services in sparsely populated areas. Building on results of a hierarchical multistate cohort-component model (NTPOP), data are used to project future demand for a range of services including aged care, health services, housing and disability services, as well as the likely capacity of governments to provide those services based on dependency ratios, workforce entries and exits, and income personal tax contributions. The discussion draws attention to the range of demographic challenges facing sparsely populated areas, which extend well beyond simple population ageing.

Forecasting patterns of metropolitan growth using an optimised allocation procedure (Pullar et al., Chap. 7) presents the results of a large scale urban model (LSUM) which links demographic forecasting with urban modelling to generate a range of future growth scenarios for South East Queensland. The chapter highlights the close links between policy and demography at the local level, with planning interventions clearly impacting on urban density and form. LSUM also enables the impacts of population growth on the housing market and natural environment to be assessed under a range of scenarios, thus highlighting the central role of urban modelling and demographic forecasting to inform future policy decisions.

Part III, 'Understanding demographic change for planning and policy', explores a range of population characteristics, their links to demographic processes, and how these vary across space. *Migration and ageing processes in non-metropolitan Australia: an analysis of 30 years of dramatic change* (Argent et al., Chap. 8) examines the ageing of communities in the Murray Darling Basin (MDB) of Australia, an important Australian agricultural "food bowl". Growth in the MDB over the past 30 years has been accompanied by significant ageing of the population, with far-reaching implications for service provision, exacerbated by the loss of public and private services since the mid-1980s. Utilising two novel indices of ageing, the paper explores the pace and degree of population ageing across the settlement system over the 30 years 1981–2011, and its links to fertility and migration. Results show significant variability across the settlement hierarchy. Planning for ageing in rural communities needs to recognise this spatial variability and respond to challenges of caring for elderly residents in small and dispersed rural settlements.

Measuring spatial variations in wellness among Australia's rural aged (Bell and Cooper, Chap. 9) contributes to further understanding of diversity in ageing in rural Australia through the development of an "aged wellness" classification of rural communities. The analysis combines a range of individual and community level variables to generate an objective measure of aged wellness for rural communities in Victoria and Queensland, refining conventional socio-economic indices, to facilitate precision targeting of service delivery and policy intervention. The results reveal a patchwork of wellness levels across rural and regional Australia but also demonstrate that objective indices do not always match subjective assessments of wellbeing among older people themselves.

Spatial mobility patterns of overseas graduates in Australia (Tang et al., Chap. 10) moves beyond static patterns of areal differentiation to examine the migration of overseas students within Australia following completion of their studies. Many parts of non-metropolitan Australia are experiencing both population ageing and population decline, resulting in labour and skills shortages. The attraction and retention of skilled graduates has been proposed as one potential remedy. Using data from the Australian Graduate Survey (AGS), the chapter compares the post-graduation mobility of international students with their domestic counterparts, showing that overseas graduates are more likely to study in non-meropolitan areas but less likely to stay. The apparent mismatch between employment opportunities and the skill profiles of overseas graduates underlines the need for careful understanding of demographic processes when formulating labour market policies.

The final chapter *Relationships between population change, deprivation change and health change at small area level: Australia 2001–2011* (Norman et al., Chap. 11) explores the links between population change, fertility, migration and deprivation across Australia. Demography can alter the level deprivation, as migrants move from more to less deprived areas, but deprivation also shapes demography, with mortality often higher in more deprived areas. Understanding the links between demographic processes and population characteristics is of fundamental importance if planners and policy makers are to design policy to ameliorate spatial inequities. Critically, deprivation and demography have a clear spatial dimension in Australia. As with much applied demography, it is not enough to understanding what is happening, but also where.

Together, the material presented in these chapters represents no more than a selection of the diverse array of applied work in demography that is continuously underway in various parts of Australia. In a federated system, where responsibility for policy and planning is widely devolved to States, Territories and local authorities, much of this work is fragmented across multiple jurisdictions, and is often undertaken by individual analysts or small groups, working in relative isolation. The common theme that characterises their work is its endeavour to assemble, analyse and interpret demographic data in a way which sheds light on real world problems, and enables informed decisions to be made. In a very practical sense, applied demography calls for a link to be made between the understanding of population processes and the creative use of demographic data to address planning and policy issues. Good decisions start with good demography. The chapters in this volume illustrate the scope and complexities that this challenge involves, and highlight some of the quality work being done in this rapidly growing field.

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Part I
Estimates for Planning and Policy

Chapter 2
Democracy and Dollars: Use of Demography in Distribution

Patrick Corr

Introduction

The Commonwealth of Australia was established on 1 January 1901 under the *Commonwealth of Australia Constitution Act 1900* (Imp.) (*Constitution*) (Commonwealth of Australia 2013a) when the six self-governing colonies of the British Empire, being New South Wales, Victoria, Queensland, Western Australia, South Australia and Tasmania, came together under the new nation. The six former colonies then became the six Original States[1] of Australia. The process is commonly referred to as *Federation*. The governance of Australia is set out in the Constitution as a federal system of government whereby powers are divided between the national Australian Government and the governments of the six states of Australia. Section 122 of the Constitution also provided the Parliament of Australia with powers to make laws for the government of current and future territories including representation in either House of Parliament to the extent and on the terms to which it sees fit (Commonwealth of Australia 2013a). There are currently 10 territories in Australia. However, only three territories, the Northern Territory, the Australian Capital Territory and Norfolk Island, are self-governing.

Sub-section 51(xi) of the Constitution (Commonwealth of Australia 2013a) enables the Parliament of the Commonwealth of Australia to make laws on census and statistics. The *Census and Statistics Act 1905* (Cwlth) (Commonwealth of

[1] The Original States are defined in section 6 of the Constitution as being such States as are parts of the Commonwealth at its establishment (Commonwealth of Australia 2013a).

P. Corr (✉)
Australian Bureau of Statistics, Locked Bag 10, Canberra, Belconnen, ACT 2616, Australia
e-mail: patrick.corr@abs.gov.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_2

Australia 2006) sets out the legal basis for the taking of the Australian Census of Population and Housing under section 8:

> **8 Taking of Census**
>
> (1) The Census shall be taken in the year 1981 and in every fifth year thereafter, and at such other times as are prescribed.
> (2) The Census day shall be a day appointed for that purpose by proclamation.
> (3) For the purposes of the taking of the Census, the Statistician shall collect statistical information in relation to the matters prescribed for the purposes of this section.

The *Census and Statistics Act 1905* (Cwlth) also provides for the collection of statistical information on other prescribed matters (section 9(1)), and the specific collection of information on the number of people of each State under section 9(2):

> The Statistician shall collect such statistical information as is necessary for the purposes of the compilation and analysis, under section 12, of statistics of the number of the people of each State as on the last day of March, June, September and December in each year… ,

and the compilation, analysis and publication of results (section 12). The prescribed matters referred to in section 9(1) are contained in the *Statistics Regulations 1983* (Commonwealth of Australia 2010) which include at section 5(c):

> population and the social, economic and demographic characteristics of the population.

Australia's Demography and Geography in Context

It is worth outlining by way of introduction the demographic statistical context of Australia's population and history, as well as the distribution of population across the geographic area. It is also important to acknowledge the settlement history of the Australian continent, initially by the original inhabitants, the Aboriginal and Torres Strait Islander peoples (Smith 1980), followed much later in 1788, by British colonisation initially on the east coast in the Colony of New South Wales (based at what is now the city of Sydney), and subsequently other parts of Australia. There have also been significant waves of international migration (Borrie 1994) and other demographic change (Khoo and McDonald 2003) which has altered the relative population distribution across the States.

Another important element of Australia's demographic statistical history is that until 1967, section 127 of the Constitution (Commonwealth of Australia 2013a) prevented the inclusion of the Aboriginal peoples of Australia in the reckoning of the number of people of the Commonwealth, or any State or any part of the Commonwealth. In practice, while some Aboriginal peoples were enumerated in the Censuses of Australia prior to 1971, questions in the Censuses identified those who were Aboriginal peoples so that they would be excluded from official counts (Australian Bureau of Statistics 1996). For three censuses from the 1947 Census, Torres Strait Islanders were included in official counts as they were regarded as Polynesians (1947 Census) or Pacific Islanders (1954 and 1961 Censuses) and not

Aboriginal peoples of Australia. However, this was reversed in the 1966 Census when they were regarded as Aboriginal people and excluded from official counts (Australian Bureau of Statistics 1996).

The geographic area and population of each state and territory for 1901 and 2011 are provided in Table 2.1. At the time of establishment in 1901, Australia's population consisted of almost 3.8 million people (excluding the Aboriginal peoples of Australia under section 127 of the Constitution as explained above) distributed over the six Original States and the Northern Territory which was, at the time, annexed to South Australia. Following an offer from South Australia soon after Federation, from 1 January 1911, the Northern Territory was transferred to the Commonwealth as a territory (The Parliament of the Commonwealth of Australia Joint Standing Committee on Electoral Matters 2003). Separately, the Australian Capital Territory was formed out of, and transferred from New South Wales from 1 January 1911 (The Parliament of the Commonwealth of Australia Joint Standing Committee on Electoral Matters 2003).

Table 2.1 States and Territories of Australia (a) Population and Geographic Area

State/territory	Population, 30 June 1901 (b)	Estimated Resident Population, 30 June 2011 (c)	Geographic area (square kilometres) (d)	Persons per square kilometre 30 June 2011
Original states-				
New South Wales	1,361,736	7,218,529	800,642	9.0
Victoria	1,203,000	5,537,817	227,416	24.4
Queensland	502,279	4,476,778	1,730,648	2.6
Western Australia	188,566	2,353,409	2,529,875	0.9
South Australia	356,074	1,639,614	983,482	1.7
Tasmania	171,703	511,483	68,401	7.5
Territories-				
Australian Capital Territory	n.a.	367,985	2,358	156.1
Northern Territory	4,765	231,292	1,349,129	0.2
Jervis Bay Territory	n.a.	389	73	5.3
Territory of Cocos (Keeling) Islands	n.a.	561	14	40.1
Territory of Christmas Island	n.a.	2,167	135	16.1
Australia	3,788,123	22,340,024	7,692,173	n.a.

(a) Not listed separately are the other remote offshore external territories of Australia comprising Ashmore and Cartier Islands, Australian Antarctic Territory, Coral Sea Islands, Heard and McDonald Islands and Norfolk Island

(b) Based on place of enumeration and without adjustment for Census net underenumeration. Table 1.2 (Australian Bureau of Statistics 2008)

(c) Based on place of usual residence (Australian Bureau of Statistics 2013a, b, 2014a, b)

(d) (Australian Government Geoscience Australia 2010)

At the time of Federation, the states of New South Wales and Victoria accounted for more than two-thirds (almost 68%) of the population of the Commonwealth of Australia. In contrast, the population of the states of Queensland and Western Australia comprised a further 18% of the population. At the time, South Australia was the fourth largest state in population, with Western Australia the 5th largest in population followed closely by Tasmania.

Since 1901, the relative shares of population in New South Wales and Victoria have declined while the shares of population in Queensland and Western Australia have increased. In 2011, the population of Australia comprised over 22 million people. By 2011, the share of the national population resident in the states of New South Wales and Victoria decreased to just over 57%. Between 1901 and 2011, the states of Queensland and Western Australia increased their shares of the national population to collectively account for 30%. Over the same period, the shares of the national population resident in South Australia and Tasmania declined such that they are now the 5th and 6th respectively in population size of the Original States. Each of the territories is smaller in population size than the island state of Tasmania.

The Australian population continues to be unevenly spread over a landmass of 7.692 million square kilometres including the mainland and islands (Geoscience Australia 2010). The differing geographic size and population distribution over the states and territories become important factors for public policy and planning when considering the distribution of representative democracy and equitable delivery of public sector services across a geographically large country such as Australia. The practical use of demographic statistics in the distribution of parliamentary representation (democracy) and nationally collected Goods and Services Tax (GST) revenue (dollars) are illustrated in this chapter. The implementation of representative democracy by apportioning shares of representative chambers in parliaments in proportion to population, and the distribution of public resources and revenue, partly in proportion to resident population, is applied in other decision-making within Australia's states and territories. Although not specifically covered in this chapter, these include distributional decisions to regional areas and to the third level of government in Australia, local government (city councils, municipalities and shires).

Electoral Apportionment and Representative Democracy

The Constitution of the Commonwealth of Australia (Commonwealth of Australia 2013a) sets out the form of the Parliament of the Commonwealth of Australia, and that it will be a representative democracy with direct elections. Procedures are set out with in the *Commonwealth Electoral Act 1918* (Cwlth) (Commonwealth of Australia 2014b) (*Electoral Act*) and other legislation.

As set out in section 1 of the Constitution, the Parliament of the Commonwealth of Australia comprises the Queen (represented by the Governor-General of

Australia) and two chambers, a Senate, and a House of Representatives (Commonwealth of Australia 2013a). Section 7 of the Constitution provides that the Senate is comprised of equal numbers of senators chosen by the people from each Original State. Section 7 originally provided for six senators for each Original State at Federation (Commonwealth of Australia 2013a). This has been increased by the Parliament and is now 12 senators per Original State with the enactment of the *Representation Act 1983* (Cwlth) (Commonwealth of Australia 1983). Section 40 of the Electoral Act provides for two senators each to be elected from the Northern Territory and the Australian Capital Territory, and scope to increase the number of senators selected for each of these territories should the number of members in the House of Representatives for these territories reach six (Commonwealth of Australia 2014b).

The number of senators in the Original States is central to the determination of the total number of members in the House of Representatives. Section 24 of the Constitution of Australia (Commonwealth of Australia 2013a) provides (*emphasis added*):

> The House of Representatives shall be composed of members directly chosen by the people of the Commonwealth, *and the number of such members shall be, as nearly as practicable, twice the number of the senators*.

Section 24 of the Constitution also sets out a formula by which the number of members for each state is to be determined:

> The number of members chosen in the several States shall be in proportion to the respective numbers of their people, and shall, until the Parliament otherwise provides, be determined, whenever necessary, in the following manner:
>
> (i) a quota shall be ascertained by dividing the number of the people of the Commonwealth, as shown by the latest statistics of the Commonwealth, by twice the number of the senators;
> (ii) the number of members to be chosen in each State shall be determined by dividing the number of the people of the State, as shown by the latest statistics of the Commonwealth, by the quota; and if on such division there is a remainder greater than one-half of the quota, one more member shall be chosen in the State.

The section concluded by specifying a minimum number of members for each Original State. This was an important provision to attract some of the smaller colonies to join the federated Commonwealth, and is still relevant today whereby the State of Tasmania continues to rely on this provision:

> But notwithstanding anything in this section, five members at least shall be chosen in each Original State.

Sections 45–54 of the Electoral Act set out the procedures, methods and related matters for the calculation, determination and notification of the entitlement to members in the House of Representatives for the states and territories (Commonwealth of Australia 2014b).

Latest Statistics of the Commonwealth

Two decisions by the High Court of Australia (Attorney-General (Cwlth) (Ex relator McKinlay) v Commonwealth 1975); (Attorney General (New South Wales) (Ex relator McKellar) v Commonwealth 1977) led to changes to the legislative arrangements for the conduct of the Australian Census of Population and Housing and the collection of information, compilation and publication of estimates of the population of the States. As noted previously, subsection 51(xi) of the Constitution (Commonwealth of Australia 2013a) enables the Parliament of the Commonwealth of Australia to make laws on census and statistics. However, Justice Barwick noted (Attorney-General (Cwlth) (Ex relator McKinlay) v Commonwealth 1975):

> Thus, there is no constitutional requirement that the latest statistics of the Commonwealth be up-to-date. At the present time, the Census and Statistics Act 1905–1973, required the taking of a census every tenth year following on 1911: s. 8.[2] But regulations made under that Act now provide for a census each fifth year. However, the statistician is to collect, at least annually, statistics in relation to population: s. 16. He must complete and tabulate such statistics and publish them as ministerially directed: s. 20. Such statistics would qualify, in my opinion, as the latest statistics for the purposes of s. 24. But from the point of view of the construction of the Constitution, the absence of any constitutional requirement of the holding of a census or of the compilation of statistics is significant. So far as concerns the Constitution itself, the latest statistics may be, though the latest, yet stale.

Consequently, the Parliament made amendments to the *Census and Statistics Act 1905* (Cwlth) in February 1977 (Commonwealth of Australia 1977) in cognate with amendments to the *Representation Act 1905* (Cwlth) and the *Commonwealth Electoral Act 1918* (Cwlth). The amendments updated the requirement for the taking of a Census at section 8 to:

> … in the year 1981 and in every fifth year thereafter, and at such other times as are prescribed.

Accordingly, the Australian Census of Population and Housing which had been taken on a quinquennial basis since 1961, has continued to be held every fifth year since 1981 (Australian Bureau of Statistics 2011b). This contrasts with the ten yearly population census-taking in England and Wales, the United States of America and the continuous population register based methods for counting the population in many Nordic countries.

Another amendment introduced sub-section 9(2) to the Census and Statistics Act 1905 (Cwlth) (Commonwealth of Australia 1977) requiring the Statistician to collect statistical information for the purposes of the compilation and analysis of statistics

> … of the number of the people of each State as on the last day of March, June, September and December in each year …

[2] s. 8, s. 16 refer to sections of the Census and Statistics Act 1905–1973 as at the time of the High Court of Australia judgement.

and their publication under section 12. This amendment provides for the public availability of quarterly estimates of the population of the states, so that, should there be a requirement for the calculation of member entitlement in the House of Representatives, a very recent set of population estimates would be available at the time. However, it is worth noting that the provision was only for the states, and was not specified at the time to include the territories. Rather, statistical information on the population of the territories is collected, compiled, analysed and published contemporaneously with those for the States. These statistics on the population of each state and territory are now published quarterly in the Australian Bureau of Statistics release, *Australian Demographic Statistics* (ABS various years).

Further, following the consideration of issues arising in the Joint Standing Committee of Electoral Matters Report of the Inquiry into increasing the minimum representation of the Australian Capital Territory and the Northern Territory in the House of Representatives (The Parliament of the Commonwealth of Australia Joint Standing Committee on Electoral Matters 2003), the release dates of future issues of quarterly population statistics of the states and territories are announced by the Australian Bureau of Statistics up to 18 months in advance in *Australian Demographic Statistics*. This compares with the usual practice of announcing future issue release dates of Australian Bureau of Statistics releases 12 months in advance. This arrangement ensures transparency of the forthcoming availability of the requisite statistics for a future determination of House of Representatives member entitlement for each state and territory. The underlying principle of this practice is such that should a general election of the House of Representatives be contemplated by an incumbent Prime Minister and Government, then the scheduled release date for the requisite population statistics of each State and Territory for the subsequent entitlement apportionment will be publicly known well in advance of the calling of an election. The scheduling of elections is triggered by either the expiry or early dissolution of the House of Representatives by the Governor-General on the recommendation of the Prime Minister, and the issuance of writs by the Governor-General for the holding of the election (Australian Electoral Commission 2013a). An example of this transparency in practice is illustrated in respect of the announcement and subsequent conduct of the September 2013 general election, and the steps to the anticipated entitlement determination as set out in Table 2.2.

Implementing the Entitlement Calculation

The formula provided in section 24 of the Constitution (Commonwealth of Australia 2013a) has been replicated in section 48 of the Electoral Act. However, it is worth noting that section 122 of the Constitution states (*emphasis added*):

> **122 Government of territories**
>
> *The Parliament may make laws for the government of any territory* surrendered by any State to and accepted by the Commonwealth, or of any territory placed by the Queen under the authority of and accepted by the Commonwealth, or otherwise acquired by the Commonwealth, *and may allow the representation of such territory in either House of the Parliament to the extent and on the terms which it thinks fit.*

Table 2.2 Key dates for the 7 September 2013 general election and subsequent apportionment of member entitlement in the House of Representatives

Date	Event
20 June 2013	The Australian Bureau of Statistics published an announcement that the population statistics of each state and territory as at 31 March 2014 would be included in the March quarter 2014 release scheduled for 25 September 2014. The announcement also noted that the release including the 30 June 2014 statistics was scheduled for 18 December 2014 (a).
4 August 2013	The Prime Minister of Australia recommended to the Governor-General the proroguing of Parliament, the early dissolution of the House of Representatives(b), and the conduct of a general election for the House of Representatives and half of the Senate on 7 September 2013 (Prime Minister of Australia and Governor-General of Australia 2013).
4 August 2013	Parliament prorogued and general election announced for 7 September by Proclamation (Prime Minister of Australia and Governor-General of Australia 2013).
7 September 2013	Conduct of general election.
1 November 2013	Return of writs for the House of Representatives election to the Governor-General (c).
12 November 2013	Opening and first sitting day of the 44th Parliament of the Commonwealth of Australia.
25 September 2014	Publication of population estimates of the States and Territories as at 31 March 2014 by the Australian Statistician (d).
13 November 2014	Anticipated Electoral Commissioner's ascertainment of the latest statistics of the Commonwealth (e) (f).

(a) Announcement published in Australian Demographic Statistics, December Quarter 2012 (cat. no. 3101.0) and population statistics to be published in the March Quarter 2014 edition
(b) The House of Representatives was due to expire on 27 September 2013
(c) (Australian Electoral Commission 2013b)
(d) (Australian Bureau of Statistics 2014b)
(e) In accordance with the provisions of the Commonwealth Electoral Act 1918 (Cwlth) (Commonwealth of Australia 2014b)
(f) The ascertainment and determination were made and released on 13 November 2014 (Australian Electoral Commission 2014) and formally notified in the Commonwealth of Australia Gazette (Commonwealth of Australia 2014c)

Over the passage of time the Parliament has made some enhancements to the formula set out in section 24 in relation to the calculation and determination of the representation of the residents of Australia's territories in the House of Representatives. For example, section 45(2) of the Electoral Act enables the number of residents of Norfolk Island which for the purposes of sections 7 and 24 of the Constitution are regarded to be residents of a State or the Commonwealth, to be included in the population of those States, the Northern Territory or the Australian Capital Territory in the calculation of House of Representatives member entitlements.

Further provisions of the Electoral Act add additional elements to the calculation of a territory's entitlement to members in the House of Representatives than were originally set out for the Original States in the Constitution. The accumulation of these various provisions leads to a labyrinth of elements and considerations in determining the entitlement of each state or territory. By way of example, in a 1977 decision (Attorney General (New South Wales) (Ex relator McKellar) v Commonwealth 1977), the High Court of Australia confirmed that the number of senators in the territories were not to be included in the formula for determining the number of members in the House of Representatives. Further, with the passing of the Representation Act 1983 (Cwlth), there are now 12 senators for each of the six states (Commonwealth of Australia 1983), a total of 72 senators. Accordingly, as provided by subsection 48(2) of the Electoral Act, the quota is determined by dividing the population of the Commonwealth (the sum of the population of the six States) by two times 72, that is 144. This resulting population-based quotient, referred to as a quota in the Constitution and the Electoral Act is then used to determine the number of members (also referred to as seats or electoral divisions) to which each state and territory is entitled in the House of Representatives.

The 2011 apportionment of seats in the House of Representatives by the Electoral Commissioner (Electoral Commissioner Australian Electoral Commission 2011) resulted in 150 members being determined for the states and territories. The difference between 144 (being two times the 72 senators of the six States) and 150 is achieved by adding two seats each for the Australian Capital Territory, and the Northern Territory (calculated using the population quota, and the addition of the population of some of the other territories of the Commonwealth), plus the rounding upwards of quota shares greater than a half (see Tables 2.3 and 2.4 from the September 2011 Notification of Determination, Section 49 Certificate – *Commonwealth Electoral Act 1918* (Cwlth) (Electoral Commissioner Australian Electoral Commission 2011).

Sections 48 and 49 of the Electoral Act provides for the calculation, determination and notification of the seat entitlement

> … for each of the other territories.

Currently, this requirement applies to the several external territories which are either uninhabited or unlikely to be inhabited in the future such as the McDonald and Heard Island Territory and the Territory of Ashmore and Cartier Islands. The provision also applies to additional territories that are only temporarily inhabited by specialist or technical officials such as the Australian Government Bureau of Meteorology Station on Wallis Island in the Coral Sea Territory (Australian Government Department of Infrastructure and Regional Development 2014b), and the scientific research stations located on the Australian Antarctic Territory (Australian Government Department of the Environment 2012).

The Electoral Act also provides that if the population of two small external territories in the Indian Ocean (Cocos (Keeling) Islands and Christmas Island territories) is insufficient to individually be entitled to a member in the House of Representatives, then their population is to be added to the population of the Northern Territory for determining the Northern Territory's entitlement.

Table 2.3 Population, number of people ascertained and entitlement calculation outcome for the States (Electoral Commissioner Australian Electoral Commission 2011)

State	Population (a)	Adjustments applied and reason (b)	Population as ascertained by the Electoral Commissioner	Result of division by the quota (c)	Number of members (d)
New South Wales	7,272,158	(e) 72	7,272,230	47.8540	48
Victoria	5,585,566	(e) 7	5,585,573	36.7552	37
Queensland	4,548,661	(e) 39	4,548,700	29.9322	30
Western Australia	2,317,064	(e) 4	2,317,068	15.2472	15
South Australia	1,650,377	(e) 6	1,650,383	10.8601	11
Tasmania	509,292	(e) 0	509,292	3.3513	5
Sum of the six States	21,883,118	128	21,883,246	n.a.	146

(a) Population statistics published (Australian Bureau of Statistics 2011a, b) and supplied by the Australian Statistician to the Electoral Commissioner in accordance with section 47 of the Electoral Act and (Table 1 of the Determination)
(b) Adjustments made to the statistical information supplied by the Australian Statistician in accordance with section 46 of the Electoral Act (Tables 2–5 of the Determination)
(c) Quota = 151,966.9861. Calculated by dividing population of the six states including adjustments 21,883,246 by 144 (Table 6 of the Determination)
(d) Members of the House of Representatives to be chosen in the State or Territory at the next general election (Table 7, 9, 10 and 12 of the Determination)
(e) Norfolk Island residents to be included in accordance with section 46(2) of the Electoral Act (Tables 2, 3 and 4 of the Determination)

In contrast, the Electoral Act does not provide for a separate assessment of member entitlement for the Jervis Bay Territory. Rather, the estimate of the resident population of the Jervis Bay Territory is added to the population of the Australian Capital Territory for the purposes of assessing the entitlement. Elsewhere in the Electoral Act at subsection 74(5), there is a provision to include the Jervis Bay Territory in one electoral division of the Australian Capital Territory in any electoral boundary redistribution.

A parliamentary inquiry into minimum representation of the Northern Territory and the Australian Capital Territory (The Parliament of the Commonwealth of Australia Joint Standing Committee on Electoral Matters 2003) led to several amendments to the Electoral Act (Commonwealth of Australia 2004). These amendments removed doubt and scope for interpretation on the population estimates to be used in determining entitlements. They also enabled, in certain circumstances, the addition of statistical measures of sampling error to the published estimates of the population of the Northern Territory and the Australian Capital Territory should these territories fall marginally short of the number (0.5 of a quota) required for an additional seat in the House of Representatives. The methods are set out in section 47 of the Electoral Act and explained in an Australian Bureau of Statistics Information Paper (Australian Bureau of Statistics 2005b).

Table 2.4 Population, number of people ascertained and entitlement calculation outcome for the Territories (Electoral Commissioner Australian Electoral Commission 2011)

Territory	Population (a)	Adjustments applied and reason (b)	Population as ascertained by the Electoral Commissioner	Result of division by the quota (c)	Number of members (d)
Australian Capital Territory	361,914	(e) 115 (f) 395	362,424	2.3849	2
Northern Territory	229,874	(e) 2 (g) 606 (h) 1471	231,953	1.5263	2
Jervis Bay Territory	395	(i)			(i)
The Territory of Cocos (Keeling) Islands	606	(j)		0.0040	(j)
The Territory of Christmas Island	1471	(j)		0.0097	(j)
Australian Antarctic Territory	175				0
Territory of Heard Island and McDonald	0				0
Coral Sea Islands Territory	4				0
Territory of Ashmore and Cartier Islands	0				0

(a) Population statistics published (Australian Bureau of Statistics 2011) and supplied by the Australian Statistician to the Electoral Commissioner in accordance with section 47 of the Electoral Act and (Table 1 of the Determination)
(b) Adjustments made to the statistical information supplied by the Australian Statistician in accordance with section 46 of the Electoral Act (Table 2–5 of the Determination)
(c) Quota = 151,966.9861. Calculated by dividing population of the six states including adjustments 21,883,246 by 144 (Table 6 of the Determination)
(d) Members of the House of Representatives to be chosen in the State or Territory at the next general election (Table 7, 9, 10 and 12 of the Determination)
(e) Norfolk Island residents to be included in accordance with section 46(2) of the Electoral Act (Tables 2, 3 and 4 of the Determination)
(f) Population of Jervis Bay Territory included
(g) Population of the Territory of Cocos (Keeling) Islands included
(h) Population of the Territory of Christmas Island included
(i) Population added to the Australian Capital Territory in calculating entitlement
(j) Population added to the Northern Territory in calculating entitlement

Once the number of members of the House of Representatives to be chosen in each of the states and territories is determined, these are to be used in the next general election. If changes in the number of members to which a state or territory is entitled occurs as a result of the determination, the Australian Electoral Commission will need to make arrangements to conduct an electoral redistribution to determine the boundaries of each of the electoral divisions within a state or territory. For each redistribution of electoral boundaries within a state or territory, short range projections of the number of electors by small geographic areas are prepared, details of which are documented on the Commission's website (Australian Electoral Commission 2011). It is a noteworthy feature of the Australian electoral system that the member entitlement apportionment is based on the *total* population using the latest statistics whereas the drawing of electorate boundaries is based on number of *electors* projected into the future.

Comparison with Other Representative Democracies

While the procedures to distribute the number of members in the House of Representatives to the several states and territories have population statistics at the core of their computation in Australia, the method differs from that used in other countries which embrace representative democracy in their governance, such as the United States of America (Senate of the United States of America n.d.), the Dominion of Canada (Parliament of Canada (n.d.)) and the United Kingdom (Parliament of the United Kingdom n.d.). The United States of America has a much larger number of states (50), a fixed cap of 435 seats in its Congress, a minimum entitlement of one seat per state, certain inclusions and exclusions from the population counts to be used, and the application of the Method of Equal Proportions (United States Bureau of Census 2011).

The distribution of seats in the House of Commons in the Parliament of the Dominion of Canada also has its own method variations. A seat is reserved for each of the North West Territories, Nunavut and Yukon from the theoretical maximum cap of 282. The method also uses the population of the ten Provinces in calculating a quota which is then used to derive seat entitlements for the various Provinces (including upwards rounding for remainders greater than 0.50) (Parliament of the Dominion of Canada 2009).

The method of determining the number of constituencies in the House of Commons for the United Kingdom has been subject to some review and policy attention since the formation of the Conservative – Liberal Democrat coalition government following the 2010 general election. There was an aspiration to reduce the number of seats or constituencies in the House of Commons from 650 to 600 (Parliament of the United Kingdom 2011). However, while legislation passed to enact this, the 2013 reviews of boundaries were ceased and reports postponed until 2018 with the *Electoral Registration and Administration Act 2013* (Imp.) (Parliament of the United Kingdom 2013; Boundaries Commission for England 2013). An interesting point to note is that the United Kingdom's quota calculation for determining the number of seats and the sizes of constituencies is based on the number of enrolled electors, rather than in the case of Australia or the United States, the usually resident population.

Distribution of Goods and Services Taxation (GST) Revenue

At various times since Federation, revenue, grants and surpluses accumulated by the Australian Government have been distributed to states based, in part, on the population of each state (Australian Bureau of Statistics 2005a). In 1946, a significant codification of the methods for distributing grants was implemented with the continuation of the Uniform Tax policy introduced by the Australian Government during World War II. The methodology utilised the population of the states at the time, and adjusted populations which accounted for the additional financial requirements for provision of services to sparse populations and school-aged children resident in the various states (Australian Bureau of Statistics 2005a).

In July 2000, the Australian Government introduced a value-added tax model called the Goods and Services Tax (GST) (Commonwealth of Australia 2000) under a policy promoted as A New Tax System (Costello 1998). A key feature of the new policy was that the Goods and Services Tax revenue that was to be collected by the Australian Government would be divided up and distributed to the governments of each of the states and territories. This would represent a major source of revenue for the provision of services by the states and territories. The policy was implemented under an Intergovernmental Agreement included as an attached schedule to the Commonwealth legislation (Commonwealth of Australia 2000). The Intergovernmental Agreement provided for:

> B1. Subject to the transitional arrangements and other relevant provisions in this Agreement, the Commonwealth will distribute GST revenue grants among the States and Territories in accordance with horizontal fiscal equalisation (HFE) principles.
>
> B2. The pool of funding to be distributed according to HFE principles in a financial year will comprise GST revenue grants and health care grants as defined under an Australian Health Care Agreement between the Commonwealth and the States and Territories. A State or Territory's share of the pool will be based on its population share, adjusted by a relativity factor which embodies per capita financial needs based on recommendations of the Commonwealth Grants Commission. The relativity factor for a State or Territory will be determined by the Commonwealth Treasurer after he has consulted with each State and Territory.

The distribution of GST revenue to the states and territories is now administered under a subsequent piece of legislation implemented in 2009 following further reform of Federal-State financial relations (Commonwealth of Australia 2009b). Over time the Intergovernmental Agreement and its schedules have also been updated and revised (Council on Federal Financial Relations 2011). It is important to note that although these arrangements are not stable over time the use of population statistics as an input to calculations and decision making has endured.

The Australian Government Commonwealth Grants Commission describes Horizontal Fiscal Equalisation (HFE) (Commonwealth Grants Commission 2013) as:

> …the making of payments to State governments with the objective of equalising their fiscal capacities to provide public services. It is a feature of the financial arrangements in many federations that aims to reduce the inequalities in the fiscal capacities of sub-national governments arising from the differences in their geography, demography, natural endowments and economies. However the level of equalisation sought varies.
>
> Full equalisation is the objective in Australia. That is, after HFE, each of the six States, the Australian Capital Territory and the Northern Territory (the States) would have the capacity to provide services and the associated infrastructure at the same standard, if each State made the same effort to raise revenue from its own sources and operated at the same level of efficiency.

Fiscal equalisation is a feature of financial arrangements in several other federations (such as Canada and Germany) and other countries as noted by the Commonwealth Grants Commission (2014) with a more detailed comparison of methods used in various countries available (Commonwealth Grants Commission 2008).

The current calculation of the distribution of GST revenue to each state and territory for any year is based on three parameters (including forward projections, forecasts or assumptions for budgeting and planning purposes):

- the population of each state and territory and the sum of these,
- the pool of GST revenue to be distributed, and
- GST relativity factors.

In practice, the calculation of the distribution is developed and implemented in a multi-stage, iterative process over several years. This is best illustrated using the financial year[3] of 1 July 2012 to 30 June 2013 as an example. The Australian Government's Budget Papers presented to Parliament with Appropriation Bills in May each year include projected distributions of GST for the forthcoming financial year, and the following three financial years. Between each annual Budget, a *Mid-Year Economic and Fiscal Outlook statement* (referred to as MYEFO) is released as required by the Charter of Budget Honesty Act 1998 (Cwlth) (Commonwealth of Australia 2014a). The MYEFO statement for the budget year presents updated estimates of the distribution of GST revenue. So using the example of the 2012–2013 financial year, the Australian Government's Budget Papers presented to Parliament in May 2012 included estimated distribution for 2012–2013, 2013–2014, 2014–2015 and 2015–2016 (Commonwealth of Australia 2012a). Initial forecasts of GST revenue shares for each state and territory for 2012–2013 were first included in the Budget Papers for the 2009–2010 financial year (Commonwealth of Australia 2009a). For each Budget in the intervening years, a revised calculation of the

[3] A financial year in Australia is defined as commencing on 1 July in a calendar year and ending on 30 June in the following calendar year.

forecast GST entitlement for 2012–2013 were presented. The estimated shares of GST Revenue were also revised in the Mid-Year Economic and Fiscal Outlook 2012–2013 (Commonwealth of Australia 2012c).

For the purposes of the compilation of the annual Budget Papers, a set of short range projections of the population of each state and territory as at 31 December of the current financial year and the forward 3 years are compiled on behalf of the Australian Government Treasury[4] by the Australian Bureau of Statistics. These are then published within the Budget Papers (Commonwealth of Australia 2012a, b, c). Similarly, forecasts and assumptions of the GST revenue pool to be distributed and the GST revenue sharing relativity factors are prepared. Within a budget financial year these projections, forecasts and assumptions are updated in the *Mid-Year Economic and Fiscal Outlook* statement.

The Budget estimates of GST entitlements for a payment year are then used to make advance payments of GST revenue to the states and territories for the payment year. The entitlements are subsequently revised when the actual or determined amounts for the three parameters become known after the financial year is completed. Any change in entitlements is then reconciled by an adjustment to the entitlements paid in the forthcoming financial year in accordance with the Intergovernmental Agreement (Council on Federal Financial Relations 2011).

Continuing with the example for 2012–13, following the presentation of the Budget, in June 2012, on the advice of the Commonwealth Grants Commission, the Australian Government Treasurer made a determination of the GST Revenue sharing relativities for each state and territory (Commonwealth of Australia 2012b) pursuant to section 8 of the *Federal Financial Relations Act 2009* (Cwlth) (Commonwealth of Australia 2009b). The relativities for 2012–2013 that were determined by the Treasurer are listed in Table 2.5. The detailed data and analysis undertaken by the Commonwealth Grants Commission in developing their recommendation are published after consultation with the governments of the states and territories (Commonwealth Grants Commission 2012). These factors replace the earlier assumptions from earlier Budget cycles. Table 2.6 illustrates the input parameters and calculation of estimated entitlements as published in the Budget for the 2012–2013 financial year.

Following the release of the Budget, under section 7 of the Federal Financial Relations Act 2009 (Cwlth), the Australian Statistician makes a determination of the population of each State and Territory. The population estimates for 31 December 2012 were based on population estimates released by the Australian Statistician on 20 June 2013 (Australian Bureau of Statistics 2013a). The population estimates in the Australian Statistician's determination then replace the projections utilised in the 2012–2013 and earlier Budget Papers.

[4] Using The Treasury's agreed assumptions for components of population change.

Table 2.5 GST revenue sharing relativity factors, 2012–2013 (Treasurer of the Commonwealth of Australia 2012)

State	Relativity factor
New South Wales	0.95312
Victoria	0.92106
Queensland	0.98477
Western Australia	0.55105
South Australia	1.28472
Tasmania	1.58088
Australian Capital Territory	1.19757
Northern Territory	5.52818

Table 2.6 Calculation of estimated GST entitlements(a), 2012–2013 (Commonwealth of Australia 2012a)

	Projected 31 December 2012 population	GST relativities	Adjusted population	Share of adjusted population %	Share of GST pool $million
	(1)	(2)	(1) x (2) = (3)	(4)	(5)
New South Wales	7,424,410	0.95312	7,076,354	30.7	14,795.5
Victoria	5,749,634	0.92106	5,295,758	23.0	11,072.6
Queensland	4,694,804	0.98477	4,623,302	20.1	9666.6
Western Australia	2,427,901	0.55105	1,337,895	5.8	2797.3
South Australia	1,679,657	1.28472	2,157,889	9.4	4511.8
Tasmania	515,633	1.58088	815,154	3.5	1704.4
Australian Capital Territory	374,663	1.19757	448,685	1.9	938.1
Northern Territory	234,782	5.52818	1,297,917	5.6	2713.7
Total	23,101,484	na	23,052,954	100.0	48,200.0

(a) As at the 2012–2013 Federal Budget

In accordance with the requirements of the *Charter of Budget Honesty Act 1998* (Cwlth) (Commonwealth of Australia 2014a), the Treasurer must publicly release a final budget outcome within 3 months of the end of the financial year. Therefore, it was not until September 2013 that then remaining component, the final GST revenue pool available for distribution became known with the release of the *Final Budget Outcome for 2012–2013* (Commonwealth of Australia 2013b). For the calculation of the GST revenue entitlements in the Final Budget Outcome, the previously used projections of the population of each state and territory are replaced by the Australian Statistician's determination of the population. The population estimates are multiplied by the GST revenue sharing relativities as determined by the Treasurer result in an *adjusted population*. The adjusted populations of the states

Table 2.7 Calculation of final GST entitlements(a), 2012–2013 (Commonwealth of Australia 2013b)

	Estimated 31 December 2012 population	GST relativities	Adjusted population	Share of adjusted population %	Share of GST pool $million
	(1)	(2)	(1) × (2) = (3)	(4)	(5)
New South Wales	7,348,899	0.95312	7,004,383	30.7	14,733.5
Victoria	5,679,633	0.92106	5,231,283	22.9	11,003.8
Queensland	4,610,932	0.98477	4,540,708	19.9	9551.2
Western Australia	2,472,717	0.55105	1,362,591	6.0	2866.2
South Australia	1,662,169	1.28472	2,135,422	9.3	4491.8
Tasmania	512,422	1.58088	810,078	3.5	1704.0
Australian Capital Territory	379,554	1.19757	454,542	2.0	956.1
Northern Territory	236,869	5.52818	1,309,454	5.7	2754.4
Total	22,903,195	na	22,848,460	100.0	48,061.0

(a) As at the 2012–2013 Final Budget Outcome

and territories are summed, and for each state and territory a proportional share of the national adjusted population calculated. These shares are then applied to the final GST revenue pool to derive the GST share of each state taking into account both the resident population and the GST relativity. Table 2.7 illustrates the final calculation of entitlement for 2012–2013 as released in the Final Budget Outcome for 2012–2013.

Similar procedures are employed in other budget and grant distributive processes to and within states and territories. For example, the Australian Government's Financial Assistance Grants to local government programme provided over $41 billion since 1974–1975 to the states and territories. The general purpose component of the Grants programme is distributed to governments of the States and Territories according to population, which are then further distributed to local governments within each state and the Northern Territory according to a set of national principles for the allocation of grants (Australian Government Department of Infrastructure and Regional Development 2014a).

Conclusion

This chapter has illustrated the methods used and associated procedures which utilise statistics on the population of the states and territories in determining the entitlement to the number of seats in the House of Representatives and the distribution of Goods and Services Tax revenue. The regular collection of statistical information to enable the compilation, analysis and publicly transparent publication of estimates of Australia's resident population, and the distribution amongst its component states and territories, are key requirements for the implementation of planning and policy decision making in Australia. The transparent implementation of representative democracy proportional to population and distribution of taxation revenue according to the principles of horizontal fiscal equalisation are fundamentally reliant on the availability of regular and reliable population statistics including the geographic distribution across the country. Provisions are made in the Constitution of the Commonwealth of Australia for the Parliament to make laws on census and statistics, as well as electoral representation and taxation matters.

Acknowledgments The author acknowledges the useful advice and suggestions by officers of the Australian Bureau of Statistics, the Australian Electoral Commission, The Treasury, and the Commonwealth Grants Commission.

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Chapter 3
The Estimation of Temporary Populations in Australia

Elin Charles-Edwards

Introduction

The estimation of temporary populations has been of long-standing interest to demographers, planners and policy makers requiring estimates for local areas. Conventional single point population estimates, such as the Estimated Resident Population (ERP) produced by the Australian Bureau of Statistics (ABS), rely on the fact that resident populations change gradually and exhibit little short-term volatility. In reality, local populations fluctuate widely over the course of a day, week and year driven by temporary population movements. The impacts of short-term population flux are wide-ranging. For example, population surges in Australian coastal towns during the summer months alter demand for public services such as waste collection, health care and police, while simultaneously providing an economic boon to local businesses (SGS 2007). Diurnal variation in the populations of central business districts places significant demands on public transport infrastructure, and has implications for emergency preparedness and response (McPherson and Brown 2004). Across rural and remote Australia, population churn driven by Fly-in Fly-out (FIFO) mining arrangements places strain on local infrastructure and impacts on community wellbeing (McKenzie 2010). Overlying these localised impacts are broader issues relating to the adequacy of resident-based models of governance and fiscal allocation which characterise the Australian political landscape (McKenzie et al. 2008).

The estimation of temporary populations has traditionally fallen outside the remit of national statistics agencies. Instead such estimates have been generated on an ad hoc basis in response to requests from a range of end users including business, planners and local government agencies: a hallmark of applied demography. No

E. Charles-Edwards (✉)
Queensland Centre for Population Research, School of Geography,
Planning and Environmental Management, The University of Queensland,
Brisbane, QLD 4072, Australia
e-mail: e.charles-edwards@uq.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_3

standard methodology exists for the estimation of temporary populations although a range of techniques have been employed. Two basic approaches to estimating temporary populations can be distinguished: an indirect approach, in which periodic variation in population stocks is estimated from symptomatic indicators such as electricity and water usage (Smith 1989); and a direct approach, whereby estimates are derived from counts, surveys and censuses of temporary population stocks and flows. Recent years have seen the emergence of data collected by Information and Communication Technologies (ICT) such as mobile phones, Wi-Fi networks, and internet search engines to capture temporary populations. These data provide unparalleled detail on the spatiotemporal dynamics of temporary flows, enabling direct estimates of temporary populations, but have also been used as a symptomatic or indirect indicator of temporary population stocks. In practice, however, these data are often difficult to access (see e.g. Hugo and Harris 2013) and provide only limited detail on the characteristics of movers.

This chapter provides an overview of contemporary practice in the estimation of temporary populations in Australia, and assesses the utility of available data in a range of settings. It begins by defining the spatial and temporal extent of the temporary population mobility which drives the flux in population numbers. This is followed by a brief sketch of the Australian temporary mobility surface, identifying populations and localities of interest to planners and policy makers. The next section distinguishes key approaches to measuring temporary populations, and describes Australian data sources with utility for the estimation of temporary populations. These are used to present a set of temporary population estimates for Noosa, Queensland, a popular coastal centre host to significant temporary populations during the year.

Defining Temporary Mobility

Human spatial mobility encompasses a range of movements ranging from diurnal movements within local communities through permanent migration across international borders. Following Bell and Ward (2000), two temporal thresholds, 24 h and 6–12 months, are used to differentiate temporary mobility from diurnal and permanent movements respectively. The former is justified because ‘overnight visitors place much greater demand on certain types of goods and services than do daytime visitors’ (Smith 1989). In addition, 24 h is the point at which a same-day return is no longer possible, thus it represents an effective doubling of the distance that can be travelled in a daily travel budget.

The upper temporal limit for temporary population mobility, either 6 months or 1 year, also reflects differences in the level of demand for some goods and services (e.g. school enrolments) although day-to-day demand for many goods and services is unchanged. Nevertheless, it is convenient to differentiate temporary mobility from permanent changes in usual residence. In Australian (internal) migration statistics, ‘usual residence’ is defined as ‘the dwelling at which a person spends

6 months or more in a year' (ABS 2004). This distinction can be misleading. For example, ties to second homes may be more 'permanent', stretching over multiple generations, than ties to 'usual residences' (Müller 2002). Similarly, the usual residence for FIFO miners, as defined by the ABS, may be employer-supplied housing which the miners themselves may view as transient. In addition, some segments of the population have no single place of usual residence (children of divorced parents; indigenous Australians) but rather inhabit a 'network of places' (Taylor and Bell 2012). For the purposes of estimation, however, this definitional fuzziness is generally ignored in preference for clearly defined temporal limits.

The Australian Mobility Surface

Australia is among the most mobile societies in the world (Long 1991; Bell and Charles-Edwards 2013), with almost two fifths of Australians reporting a different address 5 years prior to the 2011 Census. While the scale of movement is impressive by international standards, these permanent and semi-permanent relocations are dwarfed by the movement of Australians as they go about their day-to-day business: transforming the population of city centres, suburbs and towns on a daily basis. Temporary movements (involving a stay of one night or more) also exert a major transformative effect. On the night of the 2011 Census around one million Australians were enumerated away from their place of usual residence, equivalent to 4.8% of the population. This represents only a fraction of temporary movements undertaken in Australia each year, with tourism, travel to second homes, FIFO mining, seasonal agricultural labour and the mobility of Indigenous Australians all contributing to substantial flux in local populations.

The impact of diurnal and temporary movements varies across space and over time, with different forms of mobility exhibiting distinct spatial and temporal signatures. Movement intensity varies by purpose, with tourism or recreational related moves arguably the most prevalent at the national level. When intensity is measured by reference to particular destinations, or for certain segments of the population, other forms of temporary mobility take centre stage. This reflects the spatial links, mobility circuits and distance relationships in some forms of mobility (e.g. FIFO), as well as the increased propensity to undertake moves at different stages of the life course (e.g. grey nomads). In addition to variations in the intensity and geography of different categories of temporary mobility, there is variation in the temporal dimensions of movement. Extended durations characterise the movement of grey nomads, some second home mobility, FIFO and seasonal labour, while many tourism moves are of short duration. Many, but not all, forms of temporary mobility also have a seasonal component. The frequency and periodicity of movement also varies across different movement purposes reflecting the strength of individual connections to the host community. The result is a spatially differentiated mobility system, with both the intensity and composition of visitor populations varying across regions, as well as a temporally varying one, with regional visitor populations fluctuating to varying extents and at different tempos, depending on the composition of moves. This is turn reflects both the location and function of individual localities and regions.

Figure 3.1 presents an abstracted representation of the Australian mobility surface. The Inner City of Australia's major metropolitan regions are host to significant temporary populations on weekdays, reflecting their central role in the Australian space economy (Bell and Ward 2000). On weekends, inner city populations are generally smaller and comprised of tourists and recreational day-trippers. Major events can produce periodic surges in inner city populations (e.g. New Year's Eve in Sydney). By contrast, the Suburbs of Australian cities are characterised by temporary absences of residents. Significant population churn is also present, driven by multi-locale households (e.g. children of separated parents) and couples "living apart together" (Reimondos et al. 2011). Outside major metropolitan conurbations, Coastal towns and localities are major magnets for temporary populations. Visits to coastal regions are highly seasonal, with the degree of seasonality tending to increase with distance from metropolitan centres. The timing of visitation varies along a north-south gradient, with visits to coastal areas in southern Australia concentrated in the summer months, shifting to the winter months moving north into

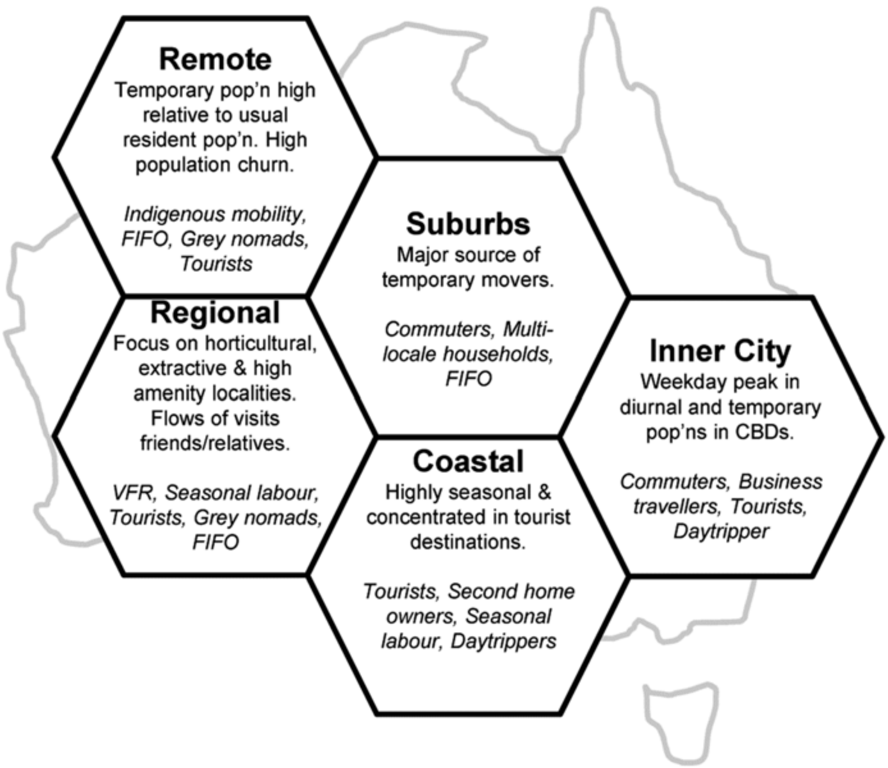

Fig. 3.1 The Australian mobility surface: composition and timing

the tropics (Charles-Edwards and Bell 2015). The intensity and timing of temporary movements to Regional areas is more variable, reflecting lower intensities and greater diversity in trip purpose. Visits to friends and relatives make up a significant component of visits to regional centres, with movements often occurring during school holiday periods. Seasonal agricultural labour is also a significant contributor to temporary populations in many rural areas, with the timing of visits reflecting the horticultural calendar (Hanson and Bell 2007). FIFO workers swell populations in selected resource communities, while tourists and grey nomads also contribute to population churn but are more widely diffused across the landscape. Temporary populations in Remote Australia are underpinned by high levels of indigenous mobility (Taylor and Bell 2012), FIFO and tourism, with available evidence pointing to high levels of seasonality particularly in the north and north-west of Australia (Charles-Edwards and Bell 2015). These differences in the intensity, timing and the degree of concentration present a considerable challenge for applied demographers interested in enumerating temporary populations. This diversity necessitates a range of data and methods targeted to specific regions and populations under study.

Measuring Stocks and Flows

Resident population statistics, such as the ABS's ERP, are produced at discrete time points with changes driven by births, deaths and migration, estimated at quarterly or annual intervals. Temporary populations can change much more rapidly, with significant variations in population numbers at hourly, daily and weekly intervals. The timing and periodicity of temporary population stocks ranges from regular weekday peaks in the population of inner city regions, through seasonal peaks in coastal tourist regions, to sharp pulses associated with local events. Apparent stability in the stock of temporary populations over the course of a day or week may mask significant temporary flows, with the total number of movers arriving and departing a locality potentially a magnitude larger than the average or peak population stock,

Estimation of Population Stocks

Temporary population stocks are defined as the visitor population in an area at a specific point in time. Due to flux in temporary populations, estimates are needed at more frequent intervals than is the case for resident populations. The exact frequency of estimates needed (e.g. daily, weekly, monthly) is dependent on the level and pattern of variation in these populations. In instances where the temporary populations ebb and flow in a regular and predictable manner (e.g. diurnal population of Inner Cities), simple estimates of the average or peak weekday population stock may be adequate. For regions with significant tourist populations (e.g. Coastal towns) estimates of average daily visitors by month may be needed to track seasonal variations in visitor numbers. The frequency and nature of stock measures ultimately depends on their end use (Bell and Ward 1998). For infrastructure planners, information on the peak population may be significant. For service providers and emergency responders, more frequent estimates of temporary population stocks may be required.

Estimates from Temporary Flows

Changes in regional temporary population stocks reflect underlying mobility between origin and destination pairs. Temporary movements are of variable duration, and may involve a simple return between origin and destination, or complex spatial circuits. To produce a complete set of estimates of temporary population accounts for Australian regions, data on temporary flows between origin-destination pairs are needed at daily intervals, reflecting the minimum duration of such moves. For diurnal populations, origin-destination flows are needed at much shorter intervals to track the build-up and attrition of populations over the course of the day. The data demands for a complete set of temporary population accounts would be prohibitive (Rees and Wilson 1977). In practice, estimates of temporary populations are only needed for certain types of destinations. Information on flows between origin and destination pairs can therefore be replaced by information on total inflows and outflows to and from individual localities. A further reduction in information needs can be achieved by increasing the interval over which flows are measured, for example from daily to weekly or monthly. A consequence of adjusting the time interval (from the logical minimum of one night in the case of temporary mobility) is a need to include a measure of visit duration. Because temporary moves are of variable duration, a simple estimate of the number of moves in a given interval will not reflect the size of temporary populations at destinations. Rather, visitor populations will vary proportionally with both the number of visits and with the average duration of stay. A doubling of either the number of visits or the average duration of visit to a destination will result in a doubling of the effective visitor population in a given period. Adding a duration term allows visitor populations for a single region in a specified interval to be estimated using Eq. 3.1.[1]

$$\textit{Visitor Nights} = (\textit{Number of visitors} \times \textit{Average duration of stay}) \tag{3.1}$$

Information on person days can be transformed to an estimate of the visitor population by dividing by the number of days in the observation interval (Eq. 3.2).

$$\textit{Average daily population} = \frac{\textit{Visitor Nights}}{\textit{Days in interval}} \tag{3.2}$$

[1] The population temporarily absent from a region can also be estimated by substituting information on the number of people temporarily away from a region and the average duration of absence.

To estimate temporary populations using Eq. 3.1, data are needed on the intensity and duration of visits to a region in a given time period. Where partial data available, it is possible to produce estimates by setting assumptions for missing components. For example, information may be available on the annual number of visitors to a region and average visit duration, but not the timing of visits. Annual visits may be apportioned using model profiles of seasonality (Charles-Edwards and Bell 2015). Similarly, for daytime populations, information may be available on the number of full-time workers in a CBD. By assuming a standard working time model of Monday to Friday, 9 am–5 pm, estimates of average daytime populations can be produced. This blended approach is discussed further below, following a review of available Australian data sources.

Data for the Estimation of Temporary Populations

Compared with many other parts of the world Australia is well served by data on temporary mobility. Nevertheless, at the time of writing, no single source of data exists for the estimation of temporary populations across the entire Australian settlement system. Table 3.1 summarises the main data sets available to researchers in Australia. Omitted from this table are purposive surveys conducted with reference to specific temporary populations in Australia such as non-resident ratepayers (Hugo and Harris 2013), FIFO workers (PIFU 2006) and international tourists (e.g. the International Visitor Survey (IVS)), as well as administrative sources (Markham et al. 2013). Three broad types of data on temporary populations can be identified. These are: national surveys run by statistical and government agencies; symptomatic indicators; and data derived from ICT. These three sources vary in the nature of estimates produced (e.g. stocks versus flows), the level and extent of geographic coverage, the temporal detail of estimates, and population coverage. In addition, these sources vary according to the dimensions of mobility captured, such as movement intensity (measured as visits to the destination or between origin–destination pairs); the timing or seasonal distribution of moves; and movement duration. Each of the main data sets summaries in Table 3.1 are now discussed in turn.

The Australian Census of Population and Housing

The quinquennial Australian Census of Population and Housing provides a snapshot of temporary populations across Australia on one night, every 5 years. While the Census is not designed to capture information on temporary populations, its de facto character provides direct estimates of temporary population stocks for approximately 55,000 Australian Statistical Areas Level 1 (SA1) (ABS 2013b). Furthermore, by cross-tabulating data on place of enumeration with data on place of usual residence, estimates of temporary flows between 2214 Statistical Areas Level

Table 3.1 Key sources for the estimation of temporary populations Australia

Data source		Nature of Estimate	Geographic coverage	Temporal detail	Population Coverage	Dimensions of mobility				Utility	Examples
						Intensity					
						Destination only	Origin-destination flows	Timing	Duration		
National Census and Surveys											
Australian Census of Population and Housing	1. Place of enumeration	Stocks & Flows	Australian SA1 Australian SA2 (Origin-destination flows)	Census night	Population enumerated at the census	Yes	Yes	No	No	Snapshot of temporary mobility every 5 years	Bell and Ward (1998)
											Taylor (1998)
											Charles-Edwards et al. (2008)
	2. Place of work	Stocks & Flows	Australian SA2	Week prior to the Census	Employed Australians 15+	Yes	Yes	No	No	Useful for CBDs for daytime populations, FIFO	Melbourne City Research (2013)
											ABS (2012)
	3. Unoccupied private dwellings	Stocks	Australia SA1	Census night	Unoccupied private dwellings	Yes	No	No	No	Limited to second home communities	Frost (2004)
											Hugo and Harris (2013)
National Visitor Survey		Stocks & Flows	SA2s	Continuous	Australians 15+; Moves > 40 km; Excludes long distance commuters	Yes	Yes	Yes	Yes	Tourist areas; affected by sampling variability	Charles-Edwards (2011)

Survey of Tourist Accommodation (Small Area)	Stocks	SA2	Monthly	Visitors in commercial accommodation	Yes (Ceased June 2013 (ABS 2013a))	No	Yes	Yes (Ceased June 2013 (ABS 2013a))	Tourist centres; CBDs	Hugo and Harris (2013)
Symptomatic data										
Various (e.g. Water consumption; Visitor Centre enquiries)	Stocks	Various localities	Continuous	Variable	Yes	No	Yes	No	Indicator of seasonal variation in populations in selected localities	Lee (1999) SGS (2007) Hugo and Harris (2013)
Information and Communication Technology										
Mobile phone data	Stocks & Flows	Areas with service	Continuous	Australians with a mobile phone – estimates at x per cent	Yes	Yes	Yes	Yes	Access and confidentiality concerns	Europe: Silm and Ahas (2010) Deville et al. (2014)
Social media data	Stocks & Flows	Localities	Continuous	Social media uses who geotag	Yes	Yes	Yes	Yes	Real-time information via geolocation	None known.
Google Trends ™	Stocks	Localities	Continuous	Web users	No	No	Yes	No	Real-time indication of temporal variation in tourist populations	Choi and Varian (2009) Smith and White (2011)

2 (SA2) can be generated. No information is collected on the timing, duration, or frequency of movements, nor the purpose of move, although cross-classifying by journey to work data (Bell and Brown 2006) and industry of employment (Erny-Albrecht et al. 2014) yields insights into movement purpose. Information on each individuals place of work can also be used to estimate diurnal population stocks in urban activity nodes in which workers make up the majority of the daytime population (see e.g. Melbourne City Research 2013), however, their utility is more limited for nodes such as University campuses (Charles-Edwards and Bell 2013). Distance between place of usual residence and place of work can be used to generate estimates of long distance commuters (e.g. FIFO miners). Moreover, the number of unoccupied private dwellings can be used as a proxy for second homes in selected localities (Hugo and Harris 2013; Paris and Thredgold 2014).

A key advantage of the Census is its population coverage and high level of spatial resolution. Estimates of the stock of visitors on census night, working populations and unoccupied private dwellings are all available down to the SA1 geography, while estimates of flows can be derived for the coarser SA2 geography. The Census also provides information on the characteristics of individuals enumerated away from home on census night. The major limitation of Census data is that they provide only a snapshot of temporary movements undertaken on a single (Tuesday) night in early August, with the date of the Census chosen to minimise the number of residents away from home.

The National Visitor Survey

A second major Australian source of data on temporary population mobility is the National Visitor Survey (NVS). Operating in its current guise since 1998, the survey annually samples around 120,000 Australians aged 15 and over on their domestic travel. Respondents are questioned on their domestic overnight travel (>40 km) over the previous four weeks and daytrips over the last 7 days. Information is sought on the location, timing, and purpose of travel, along with expenditure, accommodation, transport and other trip characteristics. Data are weighted to provide estimates of total travel based on age, sex, household size, region, month and length of travel and are benchmarked against the Australian population aged 15 years and over (TRA 2014). The NVS provides insights into key dimensions of mobility including the origin, timing, duration and purpose of move, and unit record data provide information on trip itineraries. This richness of detail is offset by significant sampling variability. The variability is such that, while we may be confident in aggregate annual estimates for regions and localities, when data is disaggregated to capture monthly variation, the 95% confidence interval is commonly in excess of +/100%. The NVS also excludes movement between multiple places of usual residence (e.g. FIFO mining) and trips less than 40 km in distance.

The Survey of Tourist Accommodation

The Survey of Tourist Accommodation (STA) is a quarterly survey of around 4000 accommodation providers administered by the Australian Bureau of Statistics. The survey collects data on occupancy in:

- hotels and resorts with 15 or more rooms;
- motels, private hotels and guest houses with 15 or more rooms;
- serviced apartments with 15 or more units.

Prior to June 2013, Variables collected by the STA include the number of guest arrivals, average duration of stay and total guest nights (i.e. Visitor Nights in Eq. 3.1) in commercial accommodation. From June 2013, data on guest arrivals and duration of stay are no longer collected, reducing the utility of these data for temporary population estimation (ABS 2013a). Data are coded to SA2s but information at that level of scale is frequently not disseminated due to confidentiality concerns. While these data provide useful information on the intensity, timing and duration of temporary moves, they exclude visitors staying in private dwellings, including with friends or family and in second homes. This omission is significant, as the majority of Australians enumerated away from home in the 2011 Census were enumerated in private dwellings (ABS unpublished data). The STA also fails to distinguish between domestic and international visitors.

Symptomatic Data – Various

Symptomatic data have been used for the estimation of temporary population stocks both in Australia and overseas. This approach utilises indicators 'such as residential electric or water customer data, traffic counts, postal deliveries, retail sales data, tax receipts, and hotel/motel occupancy data' (Smith 1989) to estimate the size and variation in populations over time. In Australia, estimates of seasonal populations have been made using a range of indicators including wastewater, visitor centre enquiries (SGS 2007), electricity consumption, chemical composition of sewage (O'Brien et al. 2013) and rubbish collection (Hugo and Harris 2013). While symptomatic variables can generate timely and cost effective estimates of non-resident populations, their application has generally been limited to well-defined localities. There remain a number of barriers in the widespread application of symptomatic methods to the estimation of visitor populations. First are the difficulties in identifying appropriate indicators, particularly when estimates are sought for multiple regions. A scoping study undertaken by the ABS failed to identify any symptomatic indicators that could be used to estimate visitor populations consistently across a sample of five Local Government Areas in Australia (Lee 1999). Second, is the lack of standard benchmarks for these data, and non-stationary in the relationship between indicators and temporary populations over both space and time.

Information and Communication Technology Data

The rapid growth in ICT over the past decade has generated a wealth of new data with demonstrated utility for the direct and indirect estimation of temporary populations. Principal among these are mobile phone data which have been used to estimate diurnal and seasonal variations in populations. Mobile phone data can be used in aggregate, with total call volumes being used to estimate changes in population stocks in individual locations (Reades et al. 2007; Sevtsuk and Ratti 2010); and with respect to individual (anonymised) trajectories, to track the movement of people across space and time (Silm and Ahas 2010; Statistics New Zealand 2012). The application of mobile phone for this purpose is increasingly common around the globe having been being utilised for this purpose in several European countries (Silm and Ahas 2010; Deville et al. 2014) and in Africa (Tatem 2014). Despite attempts by researchers (Hugo and Harris 2013), these data they have yet to be utilised for this purpose in Australia.

Social network and search engine data are another potential source of data on temporary populations. For example, geo-located data from Twitter, Facebook and LinkedIn have been used to estimate permanent migration flows (State et al. 2014; Zagheni et al. 2014). Google Trends™ data, which record the number of searches for specific terms over time and in different locations around the globe, have been used to estimate seasonal variability in tourist populations in Hong Kong (Choi and Varian 2009), Barcelona (Költringer and Wöber 2010) and selected UK tourist destinations (Smith and White 2011). Google Trends does not report the raw number of queries. Instead data are normalised by total Google Search Traffic in a location at a specified point in time (www.google.com/trends). While these data cannot be used independently to estimate temporary populations, they provide useful information on the seasonal variation in temporary populations in selected locations.

Model Estimates – VisPop

Each of these sources of data on temporary populations suffer from some form of limitation including limited temporal coverage (e.g. Census), poor spatial resolution (e.g. NVS and symptomatic indicators), omission of certain populations specific groups of movers (e.g. STA), difficulties of access (e.g. mobile phone data) or partial information on the underlying dimensions of mobility. While data issues present challenges to the practitioner interested in the estimation of temporary populations, these are not insurmountable. One strategy is to blend data multiple sources. Just as estimates of resident populations draw on a range of vital statistics, migration statistics and predicator variables, estimates of temporary populations can be made by combining information on the overall intensity of visits in a specified interval, with the distribution of visits over that interval, and the average duration of visits. This framework has been implemented in a single-region, stochastic model, VisPop

(Charles-Edwards 2011). VisPop combines information on the annual intensity of, the composition of move (e.g. Tourism, Business, Visits to Friends and Relatives), the seasonality of moves and movement duration in a Monte Carlo simulation operationalised in Microsoft Excel. This model is underpinned by a series of sampling distributions capturing the composition of visits; the seasonality of visits by purpose; and duration of visit by month and purpose to Australian regions. These distributions can be created using empirical data or based on expert opinion. For each region, the model is seeded with an estimate of aggregate annual intensity of visits to regions, apportioned across different movement purposes, and then distributed over the year using seasonal factors for each region and movement purpose. These estimates of visits, by month, and movement purpose, are then attributed a visit duration, which is summed to produce the output statistic, Visitor Nights. Repeating the process for multiple iterations, produces predictive distribution of monthly Visitor Nights spent within each destination. Model estimates have been produced using this model for a range of Australian Tourism Regions and Local Government Areas and the next section uses the model to generate a series of estimates for the coastal tourist resort town of Noosa, Queensland.

Case Study: Noosa, Queensland

At the 2011 Census, the usual resident population of Noosa Statistical Area Level 3 (SA3) was 35,896. The Noosa SA3 comprises a number of discrete centres (identified as SA2s in the ASGS), all with significant concentrations of tourist activity. These include Peregian, Sunshine Beach, Noosaville and Noosa Heads (Fig. 3.2). In 2011, the Noosa SA3 was host to 670,000 overnight domestic visitors, with almost three quarters (485,000) staying in the Noosa Heads SA2. The region is also host to 110,000 international visitors, 90% of whom stay in Noosa Heads (TRA 2014).

While these aggregate statistics indicate of the importance of temporary populations to Noosa, they do not contain the requisite detail for effective provision of goods and services, infrastructure planning, or economic modelling. For these purposes, estimates of average and/or peak (nightly) temporary populations are needed, along with information on how these vary over the course of the year. Table 3.2 sets out a series of point estimates of the temporary population for the Noosa Heads SA2 and Noosa Heads-Noosaville SLA derived from conventional sources as described in Table 3.1. On the night of the 2011 Census (Tuesday, 9th August), 1,906 visitors from elsewhere in Australia were enumerated in the Noosa Heads SA2, just under a third of the total enumerated population. A further 746 visitors from overseas were captured by the Census, bringing the total non-resident population to 2,652. The timing of the Census (a Tuesday night in winter) means that this is an underestimate of the average overnight population of Noosa Heads. To better understand the variability in population, alternative estimates are needed. Both the NVS and the STA measure Visitor Nights, which, as shown in Eq. 3.2, can be converted into an average temporary population.

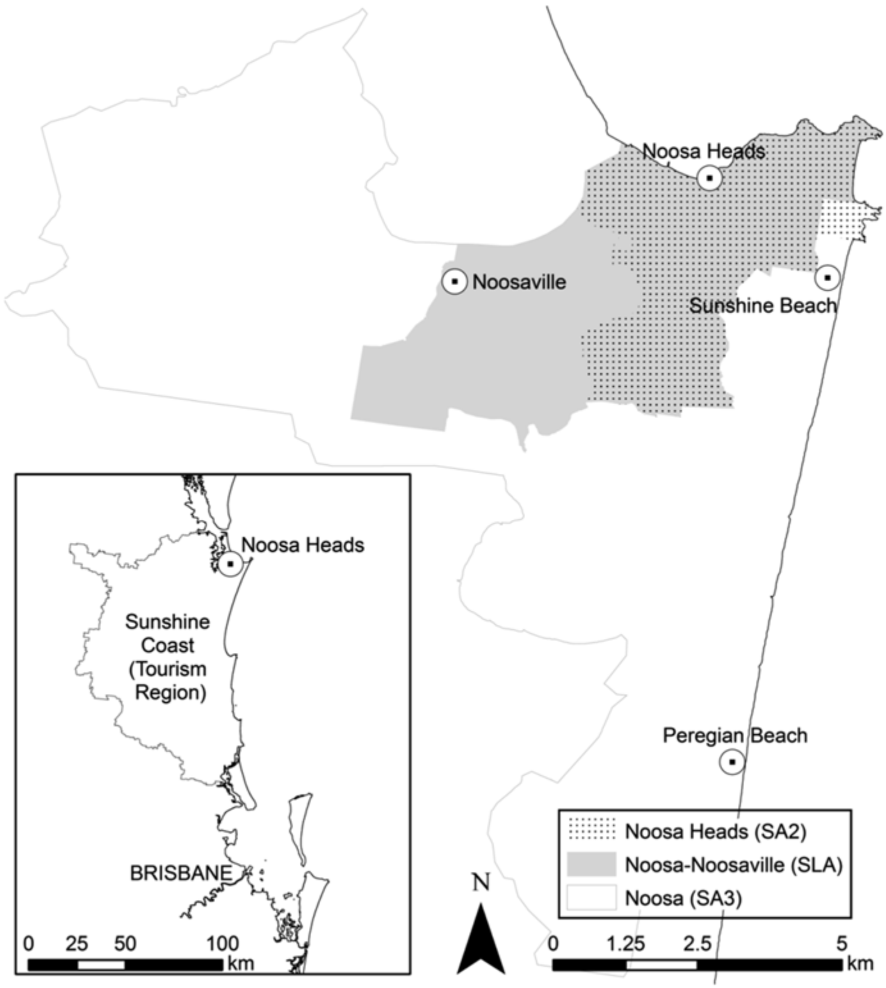

Fig. 3.2 Noosa, location and administrative geographies, 2011

Table 3.2 Estimates of the average night-time visitor population, Noosa Heads and Noosa-Noosaville, August 2011

	Noosa Heads SA2		Noosa-Noosaville SLA	
	Census	*NVS*	*Census*	*STA*
Domestic visitors	1,906	4,068	3,485	
Overseas visitors	746		1,341	
Total visitors	2,652		4,826	2,206

Turning first to the estimates derived from the NVS, the average overnight temporary population in Noosa Heads SA2 in August 2011 was 4,068. This is more than double the visitor population enumerated on Census night. This higher estimate is likely due to the inclusion of weekend visits in the monthly data from which the average was calculated, but may also be the result of sampling error in the NVS data, with the 95% confidence intervals of this estimate exceeding +/−100%. By contrast, the average night-time visitor population calculated from the STA data is less than half of the census count for the Noosa-Noosaville SLA. This likely reflects the limited sampling frame of the STA (limited to commercial accommodation providers), but may also be a product of the interval over which the data were collected, which spans the mid-winter through early spring (July–September).

Seasonality is a major feature of visitation to Noosa. The NVS provides data on monthly visits to Noosa Heads SA2, however, as noted above these suffer from excessive sampling variability The only NVS estimate for the region of which we can be relatively confident is the aggregate estimate of annual visitor numbers (483,000) which has a 95% confidence interval of around +/−15%. In order to generate monthly estimates, we combine this annual estimate with alternative information on the seasonality and duration of visits. Estimates are generated using the single-region estimation model VisPop. Two sets of estimates are generated drawing on NVS data and Google Trends. To address issues of sampling variability in NVS data, we use the seasonal profile of visits to the wider Sunshine Coast Tourism Region (within which Noosa Heads is located). The Google Trends data report the relative frequency of the search term "Noosa" from Australian IP addresses between January 2007 and December 2011. Both the NVS and Google Tends data were decomposed to remove the trend and random component in the time series and produced a seasonal profile of visits (Hylleberg 1992). Data on average visit duration (by month) were drawn from the NVS. Again we utilise data for the Sunshine Coast Tourism Region to minimise sampling variability.

Figure 3.3 shows the two VisPop estimates of Noosa Heads generated using data from Google Trends and the NVS data for the Sunshine Coast.[2] These are set aside the observed NVS data for Noosa Heads. The two sets of estimates generated using VisPop are highly positively correlated (Pearson r = 0.98), with the highest average temporary population occurring in January, and secondary peaks, coincident with school holiday periods, in April, July and October. Minor differences between the two estimates include the magnitude of the January peak and the November trough. By contrast the raw NVS estimates for Noosa Heads SA2 vary widely from month to month, peaking in October. The October peak corresponds to the Noosa Triathlon, a major event in the region. This, however is a relatively short run event, and unlikely to increase the average night-time population for October above the January figure.

[2] VisPop prediction intervals are not shown.

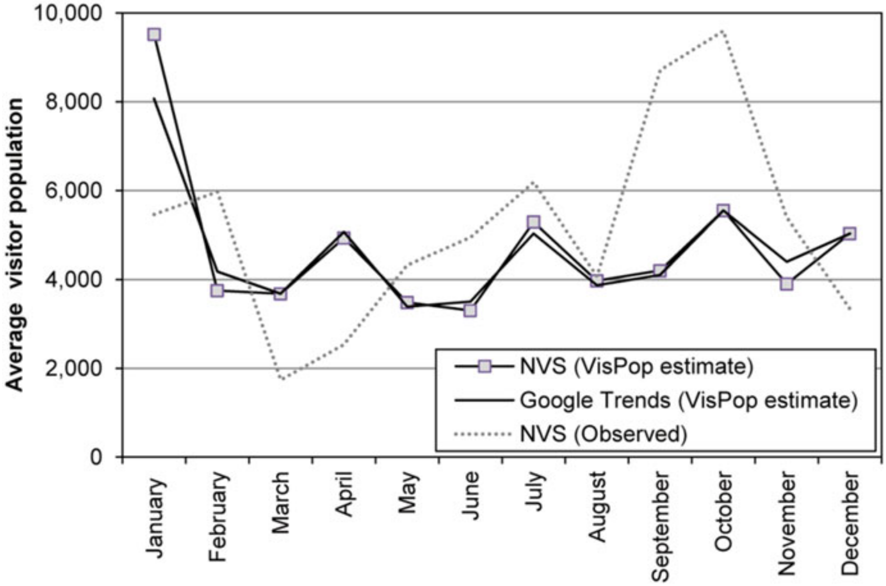

Fig. 3.3 Estimates of the Average night-time visitor population, Noosa Heads SA2, 2011

Similarly, the February peak in the raw NVS data does not match the widely accepted profile of visits to the region. Sampling variability is the likely culprit.

Additional data on seasonality and movement duration (for example from symptomatic data or a local accommodation survey) could be readily integrated into the model and would allow for triangulation of the estimates presented in Fig. 3.3.

Conclusions

The production of accurate and timely usual resident counts has been the raison d'etre of pure demographers working in National Statistical Offices. In contrast, developments in the estimation of temporary populations have largely emerged from applied contexts, driven by planners, policy-makers and business. As a consequence, developments in the field have been largely underpinned by data availability, rather than theory. Growing recognition of the importance of temporary populations has led to a renewed scrutiny of data and methods, and calls for better understanding of the underlying processes of mobility (United Nations 2008).

For the practitioner, there is a wealth of data sets that can be applied to the problem of temporary population estimation. These include data derived from traditional survey instruments, symptomatic data, and emerging ICT data. The increasing availability of multiple sources allow for data triangulation and increase confidence in estimates. A shift away from the measurement of population stocks toward population flows, as in the VisPop model, allows users to set underlying assumptions based on bespoke surveys and expert opinion. Such an approach has the advantage of transparency as well as the ability to incorporate uncertainty when operationalised in a stochastic framework (see Charles-Edwards 2011). It also facilitates the use and integration of multiple data sets to estimate populations in different types of regions, and for different sub-populations.

The emergence of new data sets, such as those derived from mobile phone records, has the potential to further transform the field. These are unlikely to be a panacea as they provide little detail on the characteristics of populations and make it difficult to identify sub groups of visitors. Despite this, the future for temporary population estimation looks bright, as recognition increases as to the inadequacy of single point population estimates in an increasingly connected and mobile world.

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Part II
Projections for Planning and Policy

Chapter 4
POPACTS: Simplified Projection Software for State, Regional and Local Area Population Projections

Tom Wilson

Introduction

The preparation of State, regional and local area population projections using a multiregional model is often a complicated, time-consuming and expensive endeavour. The necessary base period internal migration matrix with dimensions origin, destination, age, sex and time can be immense if there is a large number of spatial units and a single year of age breakdown. Input data often have to be ordered specially, typically costing thousands of dollars and requiring plenty of patience. Sparse sections of data matrices are subject to perturbation whereby values of 1 or 2 are randomly changed to 0 or 3. The greater the spatial and age disaggregation, the greater the amount of noise in the age schedules of intensities, and the greater the amount of smoothing and reconstruction required. For anything but the smallest multiregional systems a large number of projection assumptions will need to be formulated, a task rendered especially difficult given the limited guidance in the literature on assumption-setting. Furthermore, many projection programs are limited in their visualisation capability, a feature which is very useful for both inspecting draft projections and presenting final output. In sum, the time, cost and challenges of preparing projections for a large multiregional system can be considerable.

Because of these difficulties, much simpler single-region models with net migration rates or flows are still regularly used to produce population projections. Net migration can be estimated using residual methods, doing away with the need for origin-destination migration matrices, and thereby greatly simplifying the preparation of projections. Unfortunately such an approach contains several potential hazards. From a practical standpoint, age-specific net migration rate models can sometimes generate bizarre and implausible age structures, internal migration

T. Wilson (✉)
Northern Institute, Charles Darwin University, Darwin, NT 0909, Australia
e-mail: tom.wilson@cdu.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_4

which fails to sum to zero across all regions and, in some cases, 'negative' populations. From a theoretical standpoint, net migration models do not represent demographic processes well: there is no such thing as a net migrant, and net migration rates are not true demographic rates (Rogers 1990). Yet the challenges for large multiregional systems are huge. What is needed is projection software which:

(a) provides age-sex population projections for a large number of geographical areas,
(b) is multiregional in nature but has lower input data, and data preparation, requirements compared to the standard multiregional model,
(c) reduces data preparation and automates smoothing as much as possible,
(d) is much simpler in terms of assumption-setting and other aspects of user operation, and
(e) presents output graphically.

This chapter describes a new projection package designed for Australian State and Territory Governments in which an attempt has been made to meet these requirements. In designing the system, one of the principal objectives was to create user-friendly software suitable for analysts and researchers with a good knowledge of demography, such as government demographers or graduate students of population studies, but who lack the resources, programming skills or time to build their own models or use the more complex multiregional software currently available. In addition, it was constructed so that nearly all the input data could be accessed directly from the Australian Bureau of Statistics' (ABS) website, without the need to order any bespoke tables. The model also needed to make use of migration data from the census, the principal data source on regional and local migration in Australia. The result is POPACTS, Population Projections for rural Areas, Cities and Towns of a State, an Excel/VBA-based package which requires a fraction of the input data of a fully multiregional model and permits State, regional and local migration, fertility and mortality assumptions to be set using a limited number of variables. It allows the user to devote the majority of his or her time to the analysis of past trends, the formulation of assumptions and the analysis of projection results, rather than getting caught up in extensive data gathering and preparation.

The following section "POPACTS" describes key features of the POPACTS software and projection models while the section "Aspects of the future demography of New South Wales" presents selected results of local area population projections for New South Wales prepared using POPACTS. A summary and concluding remarks form the final section.

POPACTS

Overview

The POPACTS software package contains three linked models producing population projections for (1) the State and the Rest of Australia, (2) large regions of the State, and (3) local areas within these regions. Currently POPACTS can handle between 2 and 15 regions and up to 175 local areas. Projections are produced for 50 years at the State/Rest of Australia scale and 30 years at the regional and local scales, and by sex and 5 year age groups in 5 year projection intervals. Top-down constraining is applied so that regional projections are adjusted to sum to those for the State, and local area projections are adjusted to sum to those of their constituent regions. Table 4.1 summarises the main features of the POPACTS projection models.

The accounting framework of all models is that of transition population accounts (Rees and Wilson 1977). This is the appropriate accounting framework for migration data derived from the census, the principal source of migration data at the regional and local scale in Australia (available from the ABS website's TableBuilder service,

Table 4.1 Key features of the POPACTS projection models

Feature	Details
Geographical scales	(i) State/Rest of Australia.
	(ii) Sub-state regions (between 2 and 15).
	(iii) Sub-regional local areas (up to 175).
Age groups	Five year age groups up to 100+ at the State/Rest of Australia and regional scales; five year age groups up to 85+ at the local area scale.
Projection horizon	50 years at the State/Rest of Australia scale.
	30 years at the regional and local area scales.
Migration data	Census 5 year fixed-interval data.
Population accounts	Transition population accounts.
Projection models	(i) Bi-regional model at the State/Rest of Australia scale handling interstate and overseas migration.
	(ii) At the regional scale a multi-bi-regional model handles intra-state migration; interstate and overseas migration use bi-regional models.
	(iii) At the local area scale a multi-bi-regional model handles internal migration; overseas migration uses bi-regional models.
	All models are sequential transition accounts cohort-component models (following Rees (2002), United Nations (1992) and Isserman (1993)).
Dwelling-led projections	At the local area scale there is an option to project total populations via the housing-unit model.
Scaling	Top-down: projections at lower geographies are constrained to those at higher geographies.
Programmed in	Excel/VBA

Note: Based on Table 1 in Wilson (2014)

Table 4.2 State and Rest of Australia transition population accounts table for any cohort

		Survival at time t+5			Death during t, t+5			Total
		State	Rest of Australia	Overseas	State	Rest of Australia	Overseas	
Existence at time t	State (i)	K^{eisi}	K^{eisr}	K^{eiso}	K^{eidi}	K^{eidr}	K^{eido}	K^{ei**}
	Rest of Australia (r)	K^{ersi}	K^{ersr}	K^{erso}	K^{erdi}	K^{erdr}	K^{erdo}	K^{er**}
	Overseas (o)	K^{eosi}	K^{eosr}	n/a	K^{eodi}	K^{eodr}	n/a	K^{eo**}
Total		K^{**si}	K^{**sr}	K^{*+so}	K^{**di}	K^{**dr}	K^{*+do}	K^{****}

K population, *i* state, *r* rest of Australia, *o* overseas, *e* existence at time t, *s* survival at time t+5, *d* death during the t to t+5 interval, + summation over regions in the country, * summation over all states. e.g. K^{eisr} = population existing in the State at time t surviving in the Rest of Australia at time t+5 (i.e. surviving out-migrants, as obtained from the census)

www.abs.gov.au/tablebuilder). Census migration data originate from questions on usual residence on census night and usual residence x years ago, where x is generally 1 or 5 years. These data are counts of people living at different locations at two points in time, and are often described as *transition*, discrete-time transition or migrant status data (Willekens 2008). They differ both conceptually and empirically from *migrations*, counts of moves across a boundary, which are usually termed movement or event data. Transitions exclude multiple migrations and the internal migrations of those who entered or left the national population system during the time interval in question (through international migration, birth or death) whereas movements do not (Rees and Willekens 1986). The two data types lead to different accounting (or balancing) equations, as explained by Rees (1985, 1986). In the case of POPACTS, 5 year interval transition migration data form the basis of its population accounting framework. Table 4.2 shows the transition population accounts table for any cohort at the State and Rest of Australia scale. For a detailed treatment of transition population accounting see Rees and Wilson (1977) and Rees (1981).

There are many ways in which population projection models for multiple regions can be designed for a given population accounting framework (Rees 1994; van Imhoff et al. 1997; Wilson and Bell 2004; Wilson 2011). For POPACTS the overriding principle was to simplify as far as possible whilst maintaining directional migration flows. At the State/Rest of Australia scale a bi-regional model is implemented, characterised by its explicit modelling of interstate migration from the State to the Rest of Australia, and vice versa. International migration is handled as separate immigration and emigration flows for each geographical unit in the model. At the regional scale three types of migration are modelled: interstate, intra-state migration between regions of NSW, and international migration. Interstate and international migration are modelled as directional migration flows between each region and the Rest of Australia or overseas, whilst intra-state migration is projected using a multi-bi-regional model. This comprises a series of bi-regional models knitted together in which migration from each region to all other parts of the State, and vice versa, is projected in turn. This approach enables a huge saving in data, complexity and time compared to the fully multi-regional model (Wilson and Bell 2004). At the local area scale, the modelling of migration is made manageable by considering only two types of migration flow: international migration and all forms of internal migration. For the latter, a multi-bi-regional model is again employed. Thus, internal migration is projected as migration from any local area to all other parts of Australia, and vice versa.

At the local area scale, users have the option of creating dwelling-led projections via the housing-unit method (Foss 2002). It is particularly appropriate for urban areas undergoing rapid residential development because the size and type of housing available has a clear connection to population. Providing the demand for housing is fairly strong, dwellings and population increase in parallel at the local area scale. The projection model first calculates total population via the housing-unit method, and then runs the multi-bi-regional model with inward and outward migration adjusted in order to obtain the required population total.

The remainder of this section focuses on the simplified model structure, how input data and assumption-setting requirements were reduced and made easier for users, and on the ways in which inputs and outputs are presented graphically to aid the checking and interpretation of outputs.

Simplified Model Structure

The simplified nature of the projection models in POPACTS is achieved by:

(i) using 5 year age groups and projection intervals in place of single years,
(ii) replacing a fully multiregional origin-destination-age-sex migration matrix with a multi-bi-regional approach for intra-regional migration and internal migration at the local area scale.

The use of 5 year age groups results in about 40 age-sex population groups rather than 200 or so with a single year of age disaggregation, whilst the corresponding 5 year projection intervals similarly reduce the number of years for which projections are produced over a given projection horizon by a fifth. In addition, a 5 year age group breakdown is the level of detail often provided free of charge on the ABS website, whilst much demographic input data by single years of age requires a custom data request.

However, the most significant simplification is due to the use of multi-bi-regional models – those consisting of several bi-regional models linked together. Earlier research has demonstrated that a full origin-destination migration matrix can be replaced by a series of bi-regional models with negligible loss of forecasting performance, but a huge difference in the amount of input data needed (Wilson and Bell 2004; Rogers 1976). Instead of projecting migration between every region, it is modelled from/to each region and all other areas as one. In the POPACTS intra-regional migration model, for example, age and sex-specific migration from each region to the rest of the State is projected; then migration in the opposite direction is calculated. The same calculations are made for all regions. A slight adjustment is usually required to ensure that, for each age and sex, intra-state out-migration summed across all regions equals in-migration to all regions.

Reduced Input Data and Assumption-Setting

The amount of input data required, and formulation of projection assumptions, is reduced by both the simplified model structure mentioned above and the assumption of fixed relationships between variables. The latter includes:

(i) disaggregating age-specific fertility rates into the Total Fertility Rate and fertility age profiles,
(ii) making use of a standard mortality surface rather than area-specific mortality assumptions, and
(iii) modelling directional migration but adjusting the intensities of inward and outward migration through a total net migration assumption.

In addition, assumption-setting is further simplified by making available:

(iv) pre-loaded assumptions available via pull-down menus.

These four features are discussed in turn.

Disaggregating Age-Specific Fertility Rates

Instead of requiring age-specific fertility rates for every year, every spatial unit and every scenario, separate assumptions are made about the Total Fertility Rate and fertility age profiles. The age-specific fertility rate is projected as the product of the TFR and an age-specific fertility proportion:

$$f_a = TFR\, fp_a$$

This approach enables fertility assumptions to be made largely in terms of the summary indicator, the TFR, rather than a set of age-specific fertility rates. Changes to fertility assumptions only require changes to the TFR; age-specific fertility proportions can remain unchanged. Age-specific fertility proportions at the local area scale in POPACTS are further simplified by having only a small number of model fertility age profiles which vary according to the peak age group of fertility. This simplified approach not only reduces input data requirements, but can also be justified on the grounds that it is the *level* of fertility, as expressed by the TFR, which mostly impacts on the projected number of births, whilst different *distributions* of fertility rates across ages make little empirical difference.

Standard Mortality Surface

Mortality assumptions are kept simple by setting male and female life expectancy at birth assumptions by region and local area and then using sex-specific planes of national $_nL_x$ values to obtain age-specific death rates. Conceptually, these $_nL_x$ planes comprise a continuous two-dimensional space where age increases up the y-axis and mortality declines along the x-axis (Fig. 4.1). Operationally, $_nL_x$ values are provided for specific points on the x-axis from past and projected national life tables giving a life expectancy at birth range of about 30 years. The $_nL_x$ values corresponding to each regional life expectancy assumption are obtained by linearly interpolating between the two sets of $_nL_x$ values either side of the assumption. The interpolation is automated in the POPACTS Excel workbook and is easy to calculate because the life expectancy at birth of any set of $_nL_x$ values is simply the sum of $_nL_x$ over all ages divided by the radix l_0. Period-cohort death rates are calculated from these interpolated $_nL_x$ values as:

$$d_{s,c}^{i} = \frac{{}_5L_x - {}_5L_{x+5}}{\frac{5}{2}({}_5L_x + {}_5L_{x+5})}.$$

This approach permits spatial mortality differentiation but requires only national mortality life table projections. It is based on the simplifying assumption that all areas follow the mortality trajectory set out in the mortality planes but from different starting points and at different speeds.

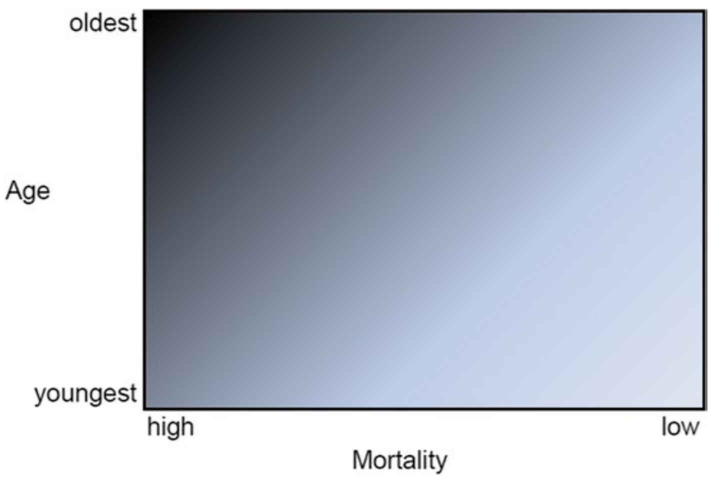

Fig. 4.1 The structure of the $_nL_x$ mortality surface; note: darker shading represents higher mortality

Using a Net Migration Assumption

Preliminary projections of directional migration (transition accounts) are adjusted to match the assumed levels of (movement accounts) net internal migration (NIM) and net overseas migration (NOM). This is possible because of a little-known connection between net migration in transition and movement population accounts in a bi-regional setting. Let the total number of in-migrants summed over sex and period-cohort be expressed as the sum of surviving and dying in-migrants:

$$K^{*r*i} = K^{ersi} + K^{brsi} + K^{erdi} + K^{brdi}$$

where superscript b refers to babies born during the projection interval rather than existing (e) at the start of the interval. Dying in-migrants born during the projection interval are calculated as:

$$K_{s}^{brdi} = \frac{5}{4} d_{s,b}^{r} K_{s}^{brsi}$$

whilst dying in-migrants for all other cohorts are estimated as (Rees 1981):

$$K_{s,c}^{erdi} = \frac{\frac{5}{2} d_{s,c}^{r}}{1 - \frac{5}{4} d_{s,c}^{r}} K_{s,c}^{ersi} .$$

Also let the total number of out-migrants summed over sex and cohort be expressed as the sum of surviving and dying out-migrants:

$$K^{*i*r} = K^{eisr} + K^{bisr} + K^{eidr} + K^{bidr} .$$

Dying out-migrants born during the projection interval are calculated as:

$$K_{s}^{bidr} = \frac{5}{4} d_{s,b}^{i} K_{s}^{bisr} .$$

and dying out-migrants for all other cohorts are estimated as (Rees 1981):

$$K_{s,c}^{eidr} = \frac{\frac{5}{2} d_{s,c}^{i}}{1 - \frac{5}{4} d_{s,c}^{i}} K_{s,c}^{eisr} .$$

Let M^{ir} represent out-migration, and M^{ri} in-migration, as measured from the movement perspective. It turns out that, in a bi-regional system, net internal migration in the movement accounting equation can be expressed in terms of transition population accounting terms (Rees 1977):

$$NIM^{i} = M^{ri} - M^{ir} = K^{*r*i} - K^{*i*r}$$

where NIM^{i} denotes Net Internal Migration. In the projections, therefore, we wish to adjust the numbers of (transition) in-migrants and out-migrants so that they give the required (movement) NIM assumptions. The migrant terms K^{*r*i} and K^{*i*r} are proportionally adjusted using the plus-minus technique (Smith et al. 2001; Shryock et al. 1980) and then disaggregated into surviving and dying terms. Dying out-migrants are calculated as:

$$K_{s,c}^{eidr} = \frac{\frac{5}{2} d_{s,c}^{i}}{1 + \frac{5}{4} d_{s,c}^{i}} K_{s,c}^{ei*r}$$

and

$$K_{s}^{bidr} = \frac{\frac{5}{4} d_{s,b}^{i}}{1 + \frac{5}{4} d_{s,b}^{i}} K_{s}^{bi*r}$$

with surviving out-migrants calculated as the difference between all and dying out-migrants. Dying in-migrants are estimated as:

$$K_{s,c}^{erdi} = \frac{\frac{5}{2} d_{s,c}^{r}}{1 + \frac{5}{4} d_{s,c}^{r}} K_{s,c}^{er*i}$$

and

$$K_{s}^{brdi} = \frac{\frac{5}{4} d_{s,b}^{r}}{1 + \frac{5}{4} d_{s,b}^{r}} K_{s}^{br*i}$$

with surviving in-migrants similarly calculated as a residual.

Whilst the use of total NIM and NOM assumptions simplifies the assumption-setting process it should be noted that net migration levels held constant are not realistic after several decades, and may cause problems if a region has substantial negative net migration relative to its population size. Because preliminary projections of in- and out-migration are scaled proportionally to achieve the set NIM total, it is possible, in extreme negative NIM cases, to generate negative populations. In practice, sensible net migration assumptions avoid this problem.

Simplified Assumption-Setting and User Operation

Assumption-setting is not only streamlined by the fertility, mortality and migration features noted above, but also by incorporating pre-loaded headline assumptions of TFR, life expectancy at birth, and net migration. This consists of alternative sets of assumptions which users can select via pull-down menus. Figure 4.2 shows an example from the POPACTS Excel workbook for the State TFR assumption. The user-defined scenario option allows advanced users to set their own fertility assumptions.

Visualisation

The graphical representation of data is a long-established way of checking the plausibility of draft inputs and outputs, and presenting final projection outcomes. When handling the large volumes of data required for a set of population projections it is all too easy to put a decimal point in the wrong place, paste data into the wrong cells in the Excel workbook, mix up male and female populations, or inadvertently select an unlikely assumption in a pull-down menu. Checking draft projections for obvious errors and plausibility forms an essential component in the process of generating any set of demographic projections.

Headline projection assumptions are shown in the POPACTS workbook alongside historical data, wherever possible. For example, Fig. 4.3 displays both past and assumed future life expectancy at birth by sex for NSW. Life expectancy tends to exhibit gradual, smooth changes over time. Any sudden changes of trend, or a discontinuity at the jump-off year, would indicate likely problems with input data or assumptions.

Similarly, age schedules of migration probabilities are shown graphically for State and sub-state geographical areas in the projections. As an example, Fig. 4.4 illustrates interstate in-migration probabilities by sex for NSW. The graph enables users to check for characteristics such as a plausible shape to the migration age profiles, an absence of excessive raggedness, and a high degree of correlation

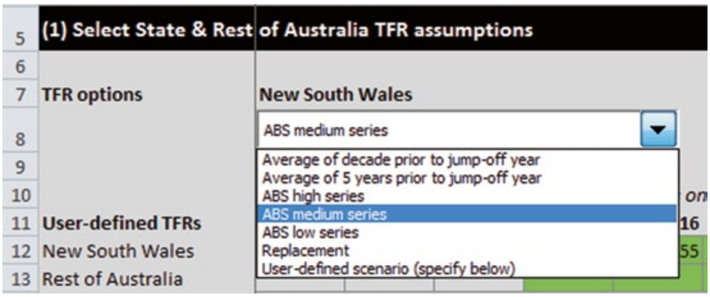

Fig. 4.2 State TFR assumption options in POPACTS

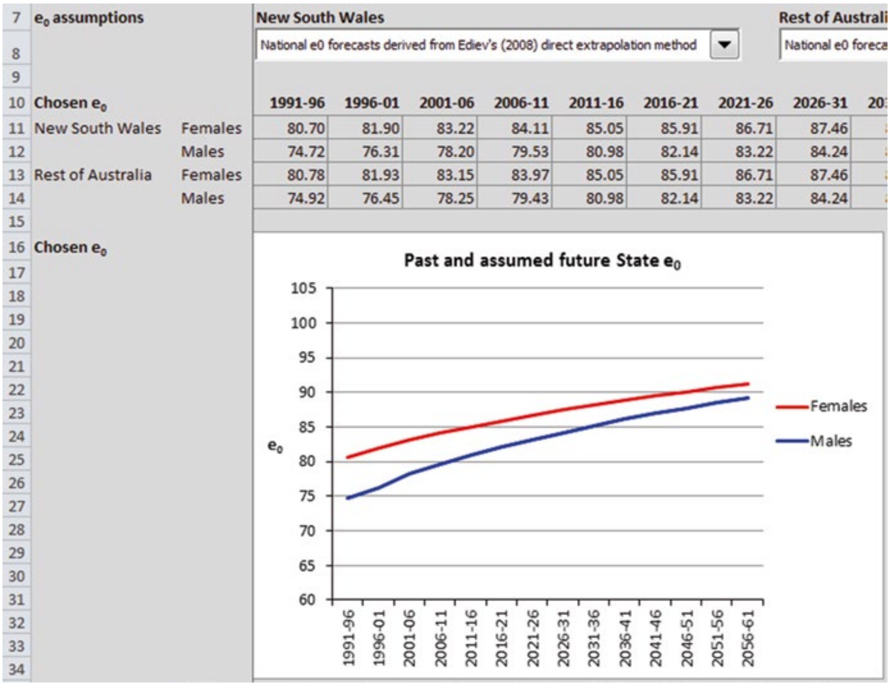

Fig. 4.3 Past and assumed future life expectancy at birth by sex for NSW

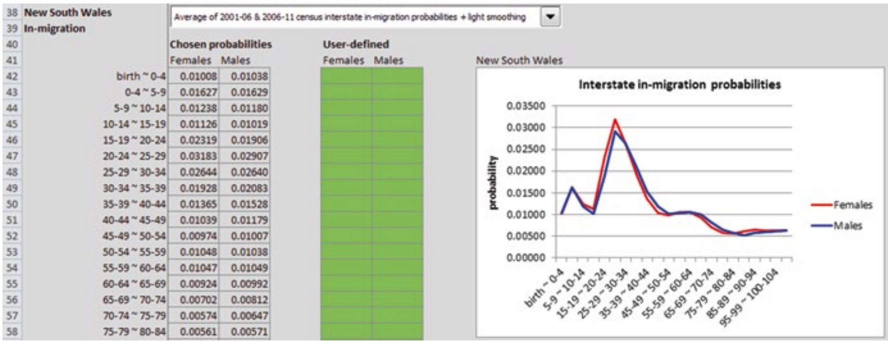

Fig. 4.4 Interstate in-migration probabilities by sex and period-cohort for NSW

between male and female age schedules (all of which exist in this case). The green cells in the Fig. 4.4 screen shot enable user-defined migration probabilities to be inserted if none of the pre-loaded options are judged suitable.

An example of final output presentation is shown in Fig. 4.5. Users select the local area of interest from the pull-down menu at the top of the sheet and the 2 years for which data are to be displayed in the population pyramid. The histogram at the top-right displays the percentage change by age group between the two selected

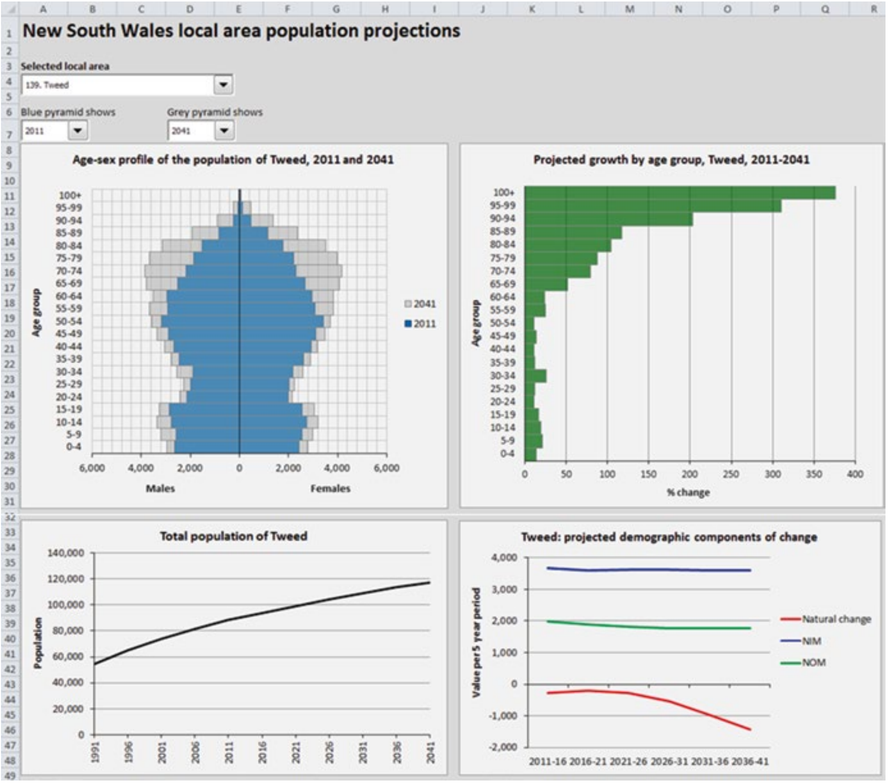

Fig. 4.5 Example output graphics for local area projections (Note: The projections shown in these graphs are illustrative of the POPACTS software and do not constitute official NSW Government projections)

years. The two lower graphs display total past and projected population numbers, and summary projected demographic components of change. In the case of Tweed, natural change becomes increasingly negative, an unsurprising result given the considerable amount of population ageing expected in this high amenity coastal region.

Aspects of the Future Demography of New South Wales

The POPACTS software was used by the NSW Department of Planning and Environment to produce 2011-based State, regional and local government area population projections (DPE 2014a). The Department's projections constitute the official NSW Government's population projections and are used throughout government for planning purposes. Selected highlights are presented in this section; details are available from the NSW Department of Planning and Environment's demographic projections web pages (DPE 2014a).

Population projections are, of course, the result of initial jump-off populations and assumed future trajectories of fertility, mortality and migration. For the state as a whole it was assumed that the recent level of fertility would continue, with the TFR remaining around 1.95 over the course of the projection horizon. The long-established trend of increasing life expectancy at birth was assumed to continue, with life expectancy by 2036–2041 reaching 89.3 years for females and 86.6 years for males. Net interstate migration was set at −20,000 per annum. Net overseas migration assumptions incorporated the Department of Immigration and Border Protection's short-term overseas migration forecasts out to 2016–2017 whilst long-term overseas migration was set to a net value of 65,400 per annum. Descriptions and justifications of the chosen assumptions can be found on the NSW Department of Planning and Environment's demographic projections website (DPE 2014b).

For NSW as a whole, the projections indicate considerable future population growth, with the State's 2011 population of 7.2 million rising to 10.2 million by 2041. Over time the growth rate is expected to decline marginally due to an increasing number of deaths, itself a result of large population increases in the elderly age groups where death rates are high. Just over half the growth over the 2011–2041 period is likely to be driven by natural increase, with remaining growth the result of net overseas migration gains (due to net interstate migration being negative).

In common with other States and Territories, the population of NSW will experience continued population ageing. The population aged 65 and over is projected to rise from just over 1.0 million in 2011 to 2.2 million by 2041, increasing from 14.5 to 21.9% of State's population over the period. Absolute growth of this age group is being generated by larger cohorts reaching age 65, in particular the large baby boom generation of 1946–1965 shifting into the 65+ age group during the second and third decades of this century, as well as declining mortality rates at the highest ages. The very elderly, defined here as those aged 85 and over, are projected to experience an even greater proportional increase, rising from about 140,000 to 440,000 between 2011 and 2041.

At the local government area scale, a variety of demographic futures are anticipated. Out of 152 LGAs in the state, 101 are projected to increase in population over the 2011–2031 period whilst 51 are expected to decline. This is not far off the experience of the 2001–2011 decade (in which 108 LGAs grew whilst 44 declined). As a broad generalisation, the larger and more densely populated the LGA, the greater the projected growth rate over the 2011–2031 period. Figure 4.6 displays projected percentage population change by 2011 population size for four categories of LGA. All Sydney metropolitan, peri-metropolitan areas (the Central Coast, Lower Hunter and Illawarra) and coastal LGAs are likely to increase in population by 2031. Inland LGAs will experience a wide range of demographic futures, with most containing fewer than 5000 residents likely to see a reduction in their populations over the next two decades. The outlier with very high growth at the top of Fig. 4.6 is Camden LGA in the Sydney metropolitan region. Being located within the NSW Government's South West Growth Centre it is an area designated for huge residential development in coming years.

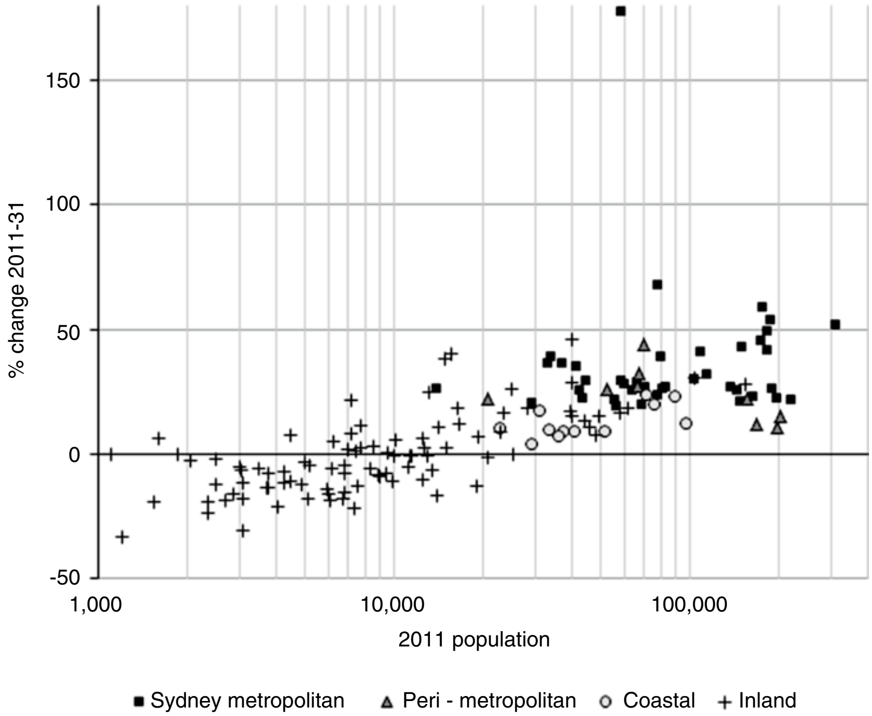

Fig. 4.6 Projected local government area population change in NSW, 2011–31, by initial population size (Notes: The x-axis is logarithmic. Sydney metropolitan LGAs are those within the Department of Planning and Environment's Sydney metropolitan region; peri-metropolitan LGAs are those in the Central Coast, Lower Hunter and Illawarra; coastal LGAs are all those on the east coast (excepting LGAs already classified as metropolitan or peri-metropolitan); all remaining LGAs are Inland)

All LGAs in NSW are expected to experience continued population ageing. Figure 4.7 shows the percentage of each LGA's population aged 65+ in 2011 against the projected percentage in 2031. The dashed diagonal line indicates a 10 percentage point increase in the proportion of the population aged 65+. LGAs in the Sydney metropolitan region are projected to undergo mostly quite moderate amounts of ageing, with an average increase in the proportion aged 65+ of 5 percentage points, whilst the equivalent increase in peri-metropolitan areas is 7 percentage points. Coastal and Inland LGAs will age more overall, with the average proportion of their populations above age 65 increasing 10 percentage points over the 2011–2031 period. Notice how the graph also demonstrates divergence in the proportion of the population aged 65+ over the 2011–2031 period.

These ageing trends are largely shaped by the combination of population age profiles at the start of the projections in 2011 and projected migration age profiles (Wilson 2015). Metropolitan areas tend to experience net inward migration in the young adult ages and net outward migration over the middle and older adult ages,

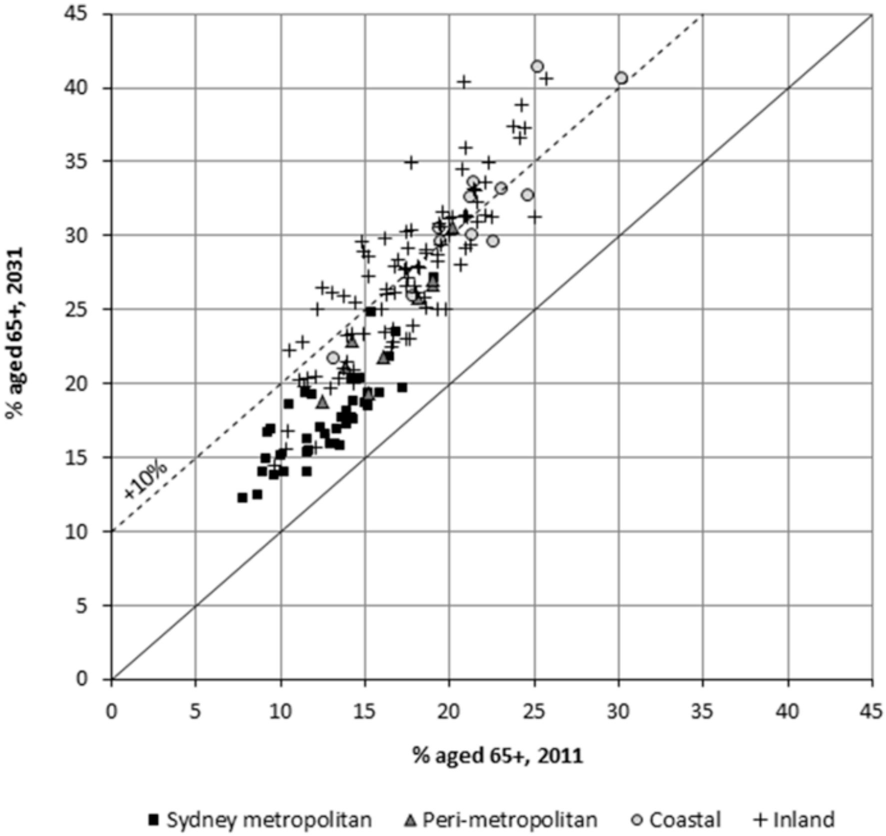

Fig. 4.7 Projected local government area population ageing in NSW, 2011–31 (Notes: The main diagonal represents no change in the percentage of the population age 65+ between 2011 and 2031. The dashed line indicates a 10 percentage point increase in the percentage of the population age 65+ over the period)

whilst coastal areas are often subject to the opposite. Inland areas tend to suffer considerable net out-migration of young adults and a mix of net migration gains and losses at other ages. The overall effect of migration is thus to augment the young adult populations but diminish numbers at some of the older ages in the more urbanised parts of NSW, whilst in coastal and remote regions migration often depletes the young adult age groups and, in coastal areas in particular, adds people at the older ages.

Conclusions

The use of multiregional models to produce regional and local population projections has long been hampered by their considerable input data requirements, the time-consuming data smoothing and indirect estimation needed, and the challenges of setting so many assumptions. It is not surprising that demographers have often opted for conceptually less satisfactory, but much less data-hungry and far simpler, single region net migration models. The POPACTS software introduced in this chapter has, to a fair degree, removed this traditional trade-off between conceptual sophistication and simplicity. The use of multi-bi-regional models, net migration adjustments of directional migration flows, a single mortality surface, and 5 year age groups significantly reduces input data and assumption-setting requirements. Regional and local area population projections can thus be produced more quickly, hopefully allowing in the words of Hajnal (1955), "less computation and more cogitation than has generally been applied". Those tasked with producing projections can dedicate more time to the crucial work of analysing past demographic trends, carefully formulating projection assumptions, and consulting with stakeholders.

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Chapter 5
Communicating Population Projections to Stakeholders: A Case Study from New South Wales

Kim Johnstone

Introduction

The key goal of population projections is to form an understanding of future population size and dynamics. Population projections make an important contribution to the activities of governments and represent a vital application of demography in planning and policy-making (Rowland 2003). Because people are ultimately at the heart of everything we do, population projections provide important evidence to inform all future planning. Population projections and the demographic processes that inform them are particularly important for informing government policy and strategic decision-making and are used by a diverse range of stakeholders. Most users of population projections are not demographers, nor do they understand the models that underpin them. Much of the public commentary about projected population futures, and the responses from government agencies that release data, are informed by local views of place and headline population numbers. In this context, communication of projection outputs by the demographers responsible for them needs to fall outside technical parameters with which they are most familiar. There is little information available to demographers on the best way to communicate, however, and no literature on how we communicate what we do to others.

This chapter uses the preliminary 2013 and final 2014 releases of population projections in New South Wales (NSW) as a case study to explore the diverse strategies needed to communicate population information from government. It highlights the significant time required to plan good communication and highlights the role of

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The views in this chapter reflect those of the author and do not necessarily reflect those of the Department of Planning & Environment. Any errors are the author's own.

K. Johnstone (✉)
Demography and Economics Branch, Department of Planning and Environment,
GPO Box 39, Sydney, NSW 2001, Australia
e-mail: kim.johnstone@planning.nsw.gov.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_5

communication in ensuring demographic evidence is used to inform policy and strategy across all levels of government.

Context for Population Projections in New South Wales

In Australia, national projections are the responsibility of the Australian Bureau of Statistics (ABS). Following each 5 yearly Census, national, state/territory, capital city, and balance of state population projections are released including variations of high, medium and low growth scenarios. Sub-state projections are the responsibility of each state/territory government.

The New South Wales government has required sub-state population projections for policy planning since the 1970s. A specialist demography unit has been in place in one form or another since that time. Current projections are the responsibility of demographers in the Centre for Demography and Economics Branch within the Department of Planning & Environment. Demographers prepare population projections for all 152 local government areas (LGA) within the state, 41 of which comprise metropolitan Sydney, the state's capital.

The population projections are prepared using cohort component methods. Different multi-regional models that constrain sub-state population projections to the state totals have been used for the NSW projections over time (Bell 2003; Wilson 2011). They are all based on cohort component methods with local level assumptions and projections constrained to the state total. Assumptions for population projections are based on the most up-to-date data available and reflect evidence of likely future births, deaths and migration trends (Johnstone et al. 2013; NSW Planning & Environment 2014a). The current model used for the projections discussed in this case study was purpose-built for New South Wales by Wilson (see Chap. 4 of this volume and Wilson 2013).

Population projections require approval by the Cabinet of the NSW Government for public release. This process necessitates preliminary approval by the Minister for Planning, who has portfolio responsibility for NSW population and household projections. The political approval needed to release the population projections means the projections are often linked to policy announcements. In this way, the projections themselves and the assumptions that underpin them are often viewed as state government policy rather than evidence to inform policy. This link with policy, and typically an announcement from the Minister for Planning about new releases means that population projections are often viewed as 'political arithmetic' (Donnelly 1998). Communication then must take account not only of the projections themselves but also the context in which they are used.

In the years preceding the release of the projections that are the focus of this case study, there had been significant negative publicity in relation to the NSW population projections for LGA geographies. Significant delays between completion of the projections in 2008 and approval to release the projections in 2010 meant differences between projections and subsequent population estimates released by the

ABS. ABS population estimates are based on historical data and are typically released for the year preceding release. Differences between estimates and projections were typically viewed as evidence of poor projection modelling, with both the method and professional credentials of the NSW government demographers called into question. This was particularly true in places were ABS estimates showed population growth but NSW projections indicated future stability or decline, and where growth rates based on historical population estimates were higher than projected growth. In addition to negative media, local governments petitioned the Department and lobbied state members of parliament about the validity of the demographic models used and questioned the population projections' reliability.

This negative profile of the NSW projections, alongside reforms to the NSW planning system to improve consultation with community members (NSW Government 2013) led to the Department's first ever face-to-face community engagement strategy in relation to the population projections. In 2012, the Demography Unit undertook 10 workshops throughout the state in partnership with the ABS. The aim was to meet with key stakeholders, explain the difference between population estimates and population projections, talk about the kind of evidence used to inform projection assumptions, and outline future projection reviews. Over 160 people took part, representing 85 different agencies.

Evaluation of these population workshops via a post-workshop survey showed how much community members valued meeting with the NSW Government demographers face-to-face (Planning & Infrastructure 2012). The open discussion between the demographers and participants was consistently rated as the best aspect of the workshops, as the following comments show:

> "[Enjoyed] the opportunity for dialogue both ways."
>
> "[Enjoyed] the ABS background data and the fact that the development and demographic analysis section of DP&I listened and took on board our concerns."
>
> "Very much enjoyed the collaborative tone that we're all working together on data collection – local, state and federal."

Many of the questions raised during discussions were about data sources, how projection methods could lead to outcomes that differed from historical trends, explanations of the difference between population projections and population estimates, and how to use the projections for planning decisions when outputs could change. Comments from participants showed how valuable it was to understand the work of the NSW Government demographers:

> "It opened my eyes to something that often perplexed me."
>
> "The relationship between Planning & Infrastructure projections and ABS data finally made sense!"

Comments such as these also highlighted the importance of communication between the demographers who 'make' the data, and those who use it. These workshops and feedback from participants laid the foundation for the communication strategies outlined in this case study.

Users and Stakeholders

The users of the NSW population projections are varied and include demographers, analysts, policy makers and planners who need an informed view of the future, non-government and private organisations, and politicians themselves. Most users are not demographers, nor do they understand demographic data or demographic methods. Many users do not have strong numeracy levels, indicated by an inability to collate data by regions, for example. At a basic level, good communication by the NSW Government demographers of the projection outputs, how they were developed and what they mean is needed to ensure their approval for release from the senior executive within the Department, the Minister's office, or Cabinet.

NSW Government agencies are primary stakeholders. These cover the breadth of planning, infrastructure and social service agencies. The NSW population and household projections are the common planning assumptions that must be used across all government agencies. NSW population and household projections are used to inform major policy developments (e.g. NSW Long Term Transport Master Plan (Transport for NSW 2012), A Plan for Growing Sydney (NSW Planning & Environment 2014b), The State Infrastructure Strategy 2012–2032 (Infrastructure NSW 2012)) as well as resource allocation planning.

Among the key stakeholders are the 152 local governments, or Councils, across New South Wales. Councils use the NSW projections to inform their own planning, and are viewed critically by Councils in relation to their role of informing the evidence base for NSW government policy and subsequently funding. Some of the Councils have independent population projections prepared by consultants, particularly where very small area projections are required below the LGA level. There are invariably differences between NSW Government and consultant projections, particularly when the jump-off year is different and different data are used to inform assumptions. In the past, differences between NSW Government and consultant projections has led to significant scrutiny of the methods used to prepare the NSW population projections, and the demographers who prepared them.

Social commentary on NSW Government projections often emerges in response to little or no projected growth, but also where high growth is projected in geographically constrained urban areas. Media headlines following each release of projections highlights typical negative views:

"Dubbo leaders deny city population will flounder", Daily Liberal, 10 April 2010.

"Fears infrastructure won't cope with extra 70,000 people", Northern Star, 7 April 2010.

"Fewer migrants and smaller families or it'll be high-rise hell", North Shore Times, 7 April 2010.

"Council slams projected population drop", Temora Independent, 22 October 2013.

"Council voices concerns about population forecasts", Tumut & Adelong Times, 7 January 2014.

"Figures 'over stated'", Walcha News, 5 June 2014.

"Bursting at Seams", Western Advocate, 21 July 2014.

The politics of population are apparent because local government stakeholders often lobby their local State Members of Parliament about projections that are seen as detrimental to a community. Media commentators will also ask politicians about population projections and what they will do to address the issues they portend, whether that is high growth or no growth. Moreover, social commentary often describes population projections as government targets, and the projection assumptions as a government policy position. Critical stakeholders then are NSW Members of Parliament, who respond to their communities and who have views about release of the data. While the role of the demographer is not to play politics, demographers do need to be aware of the political environment in which projections are used. This is true for demographers employed by government, and all those whose work is used in the public arena. In this context, good communication is essential to ensure debate is informed and that stakeholders understand the drivers of population change.

Preliminary and Final NSW Projections

Normal practice in New South Wales is to undertake a major review of state population projections following the release of data from each 5-yearly Census, alongside rebased population estimates that recalibrate inter-censal annual estimates. A major part of the review process is determining the assumptions for the projection models, which includes analysis of historical trends. Following the 2011 Census of Population and Housing, two key data issues affected planning for the usual review. Firstly, the ABS announced a 20-year revision of all estimated resident populations (ERPs).[1] The 20-year ERP revision included the normal 5-yearly rebase between the last two censuses (2006 and 2011) and a recast for the period 1992–2006.[2] The overall impact was mostly smaller populations than previously estimated. Secondly, ABS birth registration data systems were recognised as excluding just over 33,000 births in New South Wales for a 6-year period from 2005 to 2010 (ABS 2012a).[3] The 20-year revision of population estimates was announced by the ABS in December 2012 for release in August 2013. When the proposed 20-year revision to

[1] This revision was in response to results arising from the use of new data matching technology for the Census post-enumeration survey (PES). The new PES method showed lower levels of undercount compared to previous censuses and indicated that previous methods had over-estimated the undercount, with flow on effects to over-estimation of the ERPs.

[2] Rebasing is standard practice for the ABS. After every census, annual population estimates for the previous intercensal period are revised. In this instance, that was the period 2007–2011. The recast was a one-off event. It was a 15-year revision of all population estimates from 1992 to 2006 (ABS 2012c).

[3] The uncounted NSW births had been identified in 2012 due to ABS processing errors of late registrations (ABS 2012a, b). Late registrations are more common for young mothers, Indigenous mothers and those living in rural and remote areas of Australia (ABS 2006). This error was thus likely to disproportionately affect the fertility rates of those areas with large Indigenous populations and where there were greater proportions of younger mothers.

the ERPs was first announced, no date was available from the ABS for the release of updated births data that included the 33,000 unregistered births in NSW.

These announcements had a significant impact on the normal time frames for development and release of projections. The ERPs are the denominator population for all rates used to investigate historical trends – particularly births and deaths. They also provide an important check for validity of projected trends compared to historical ones.

A risk assessment was carried out internally on the impact of the data issues on the development of new projections. The biggest risk was the potential delays to the release of population projections for New South Wales using the most recent information. The projections in use at that time were modelled on 2006 Census data. Moreover, data released by the ABS and the Department of Immigration and Border Protection showed that levels of overseas migration and fertility were higher than previously assumed. This led to the decision to release preliminary projections using available data, followed by the development of new projections once final population estimates were released by the ABS.

2013 Preliminary NSW Population Projections

One of the impacts of the decision to release preliminary population projections was that original time frames for the development, testing and release of the projections were shortened. The most notable compromises affected planning for the release, with data input, model runs and validation taking priority.

A first step for improved communication of the 2013 preliminary NSW population projections was a 2013 Population Roadshow. This was both a follow-up to the successful workshops held the previous year and preliminary consultation on the assumptions being used for the 2013 revision. The aim was to establish early communication with users of the projections so they had early indicators of the population projection outputs and the reasons for them.

The Population Roadshow included a series of 12 face-to-face workshops with local stakeholders to talk through the population projection methodology, the data used to set the assumptions for each LGA, the proposed assumptions at the state and local level, and what those assumptions were likely to mean for the area. All participants were invited to provide information, data or other evidence that they thought would be useful in setting the assumptions. These workshops were also an opportunity to present the first results of the 2011 Census.

Evaluation of the workshops showed that the meeting of people face to face was again an important aspect of the discussions. While the main focus of the workshops was to discuss the projection assumptions, most participants talked about planning activities or observations of what was happening in relation to their local suburb or schools. These discussions did not necessarily lead to the provision of data that can be used to set demographic assumptions but were important to make sure users understood what projections were and how to use them. It also allowed the demographers to understand local issues and local developments that influence their work. One participant's feedback accurately identified the value of the workshops:

> "People might not understand about assumptions or be able to contribute but they appreciate being asked."

Following the 2013 Population Roadshow and building on the experience of the previous delayed projection release, which had generated such negative publicity, a detailed communication strategy was developed for the 2013 population projections' release. This was the first time a communication strategy broader than media releases and Ministerial announcements had been developed for the NSW projections' release. Such planning provide critical to ensure all users were recipients of communication outputs.

The communication strategy was developed by the demographers responsible for the projections' development. It included four key objectives:

- Increase awareness: all stakeholders know about the release
- Comprehension: stakeholders understand population change and the drivers of change
- Endorsement: recognition of demographic skill and robust methodology used for projections
- Action: feedback and suggestions from stakeholders are received.

There was a wide range of target audiences for the communication strategy. They included NSW Government Cabinet and Members of Parliament, State government agencies, local government, internal staff, non-government organisations, private enterprise and media. Despite the diversity among the audience, the objectives and messages were the same for all targets, particularly in terms of comprehension and endorsement.

The communication strategy included three key messages. These were the high level messages that would inform media releases, media interviews, and communication tools developed for the projections. These messages were developed initially by the demographers responsible for the population projections and subsequently refined in negotiation with the internal media and communications' unit. The resulting key messages were:

- New South Wales is growing, particularly Sydney
- Just over half the state's growth is being driven by natural increase
- The 2013 preliminary projections will be reviewed and finalised in 2014 once all data are available.

Two aspects of the projected population changes were not included in the key messages because of decisions from other parts of the agency. One of these was population ageing, one of the most significant demographic changes currently seen in Australia. The other was that population decline was projected for some parts of New South Wales. These decisions, essentially responses from non-demographers to fundamental demographic processes, highlighted the need to have robust internal communication to make sure internal stakeholders understand the work undertaken by the demographers. It also showed the need to test the language used to describe likely population futures to make sure important aspects of population change are not overlooked because of how they are described. As will be outlined in the next section, this process informed subsequent internal communication by the Demography and Economics Branch by ensuring the use of language which reflected a story linked to the strategic priorities of the Department. Of note is the fact that while ageing and population decline were not part of the communication strategy's messaging, these became the foci of discussion post-release, and managing future discussion on these issues also became part of subsequent communication strategies.

An important aspect of the communication strategy was the preparation of a range of release products for the 2013 preliminary population projections. A dedicated web address was created on the then Department of Planning & Infrastructure web page to make it easy to direct users to the population projections' data. A link was also created from the home page direct to the population projections page. While a seemingly simple structural change, the new web address was the first time users did not have to navigate a web structure that had no clear path between the home page and the NSW official projections.[4]

All release products were made available from the newly created web page. They included spreadsheets with data for the state and each LGA and a report to accompany the data. The report included summary information about factors driving historical population change and an explanation of how the assumptions were set, with more background information published than was the case for earlier releases. Graphic designers formatted the report for access as an electronic PDF file. For the first time, no hard copy run of the projections report was printed by the Department.

One of the inclusions in the report that became an important feature of the 2013 population projections' release was a series of icons showing the main reasons for projected population change over the 20-year projection horizon (Johnstone et al. 2013). These icons have subsequently been widely used and while simple, have received lots of praise from internal and external users of the population projection. As shown in the next section, the icons have subsequently formed an important part of the communication strategy for the 2014 NSW population, household and dwelling projections.

The concept for the icons was developed internally and were initially a by-product of trying to explain the reason for projected population decline in regional New South Wales, where population dynamics are largely the same across many small LGAs. This led to the identification of five summary indicators for the drivers of population change (Fig. 5.1). The aim was to have summary indicators that explained why particular growth patterns were seen in particular areas. The concept began based on images located on the web and were subsequently designed by a creative design team.

[4] Prior to the direct web link, users had six navigation options from the home page, none of which referred to demography, population, projections or forecasts. Population projections were listed under a link labelled, 'Housing Availability'.

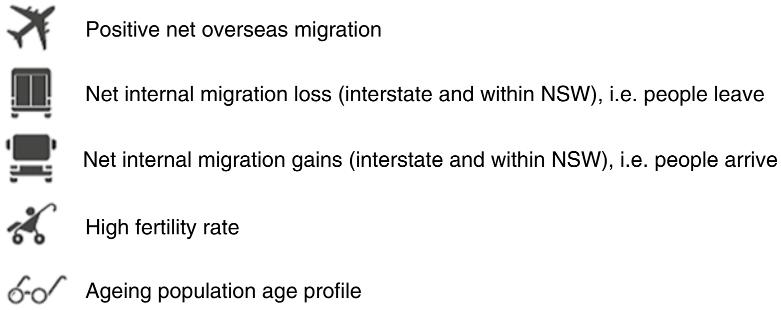

Fig. 5.1 Icons developed to show reasons for projected population change, 2013 NSW population projections (Source: Johnstone et al. 2013)

These icons enabled distinct patterns of population change in different parts of New South Wales to be described in a summary way. They also showed similarities across regions with similar profiles. For example, regional areas with small and older populations, and urban areas with younger populations at childbearing ages and which are also the point of arrival for internal and overseas migrants.

These icons were adapted by local media to explain the projected release. The images and summary information have been among the most requested information product from internal stakeholders for discussions with local councils.

An important innovation for the preliminary release was the creation of an interactive map, accessible via the web site (Fig. 5.2). The map enabled users to click on an LGA and a pop-up box would show summary information showing population size in 2011 and 2031, the numerical and per cent change between the two time periods, measures of age profile, and use of the icons indicating reasons for the projected population change.

The interactive maps were based on PDF maps. They provide a way of quickly creating information using simple technology to provide basic information. Despite their simplicity, they had a very positive response. Page views of the projections web pages increased from fewer than 100 to over 5000 views per month. Informal feedback on the site showed that users with technical skill found the site particularly useful to present summary information to people they worked with who did not have spreadsheet skills. For the Department, however, PDF maps were not a sustainable way of presenting data, because any changes or updates to the PDF required a return to the designer to have those changes made.

Other communications collateral included a Frequently Asked Question (FAQ) sheet, copies of the Department's media releases and an eight-page brochure, designed to be distributed in hard copy. The brochure was not identified as a communication priority by demography staff, but was identified as important by communication staff within the agency. Feedback from internal and external stakeholders was very positive in relation to the brochure. This small example shows how important it is to test communication messages as well as tools.

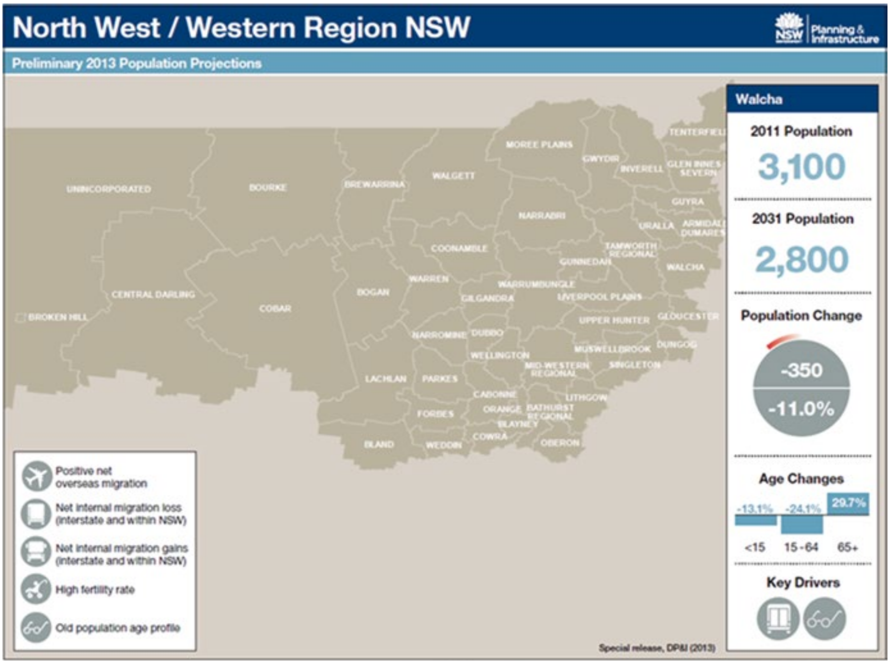

Fig. 5.2 Screenshot of PDF-based interactive maps for 2013 preliminary NSW population projections (Planning & Infrastructure 2013)

The preliminary projections were released in August 2013 via a media release. Media reporting fell into three broad categories – reporting of the projection outputs; social commentary on the implications for housing, infrastructure, and government services; and reporting of community and local council reactions to the projections. Much of the reported community response was in relation to projections that were lower or higher than expected.

Communication responses from the Department were twofold. The Department's media unit responded to media interactions, including radio and print interviews. There was also a significant amount of time spent responding to many phone calls from stakeholders. While some were congratulatory on the release of the data in a user-friendly way, many were complaints about the projections and requests for more information about the method, assumptions or data sources that had been used.

The release of the 2013 preliminary NSW projections and the need to respond to the many calls and requests for information provided an important mechanism for an ongoing dialogue to take place between the Department, other NSW government agencies, and local councils. The approach taken by the demography staff was twofold. First, to be responsive to requests for information about the projection assumptions, including the data the Department had used. Second, and more important, was ensuring users and stakeholders understood the demographic processes that underpin any population projection. In areas of population stability or decline, conversations generally centred around long-term internal migration patterns and the current older age structures. In growth areas, the focus was on the significant growth projected based on natural increase attributed to current younger age profiles and maintenance of high levels of immigration. This ongoing dialogue took place via (more) phone calls, presentations at meetings or specially-convened workshops. The importance of these meetings and conversations cannot be underestimated. The need to explain demographic processes is ongoing and much easier to do as part of a continuous dialogue than as a one-off announcement.

The level of detail published in the report was particularly useful as it provided a useful reference point to refer people to when they had questions. In conversations with stakeholders, the most referred to information related to the age profiles of each of the demographic processes that inform population change (births, deaths and migration). These were important for explaining how assumptions affect populations with different age profiles in different ways and subsequently projection outputs.

The launch of the preliminary projections was deemed a success because of a high level because of media coverage. Within the Department, the projections were used to support a range of communication in relation to planning reforms in New South Wales and to the development of new urban strategic plans. For the demography staff, the launch was seen as successful because it facilitated public discussion about population change now and into the future. It also enabled dissemination and discussion of new data from the 2011 Census and new migration data not previously used for NSW projections (experimental regional internal migration estimates (ABS 2012d) and international migration forecasts (DIAC 2012)).

2014 NSW Population Projections

The lead up to the release of the 2014 NSW population, household and dwelling projections (the projections) involved much longer lead times compared to the 2013 preliminary release and planning began almost immediately the 2013 preliminary projections were released. A practical reason for this was that all communication activity in response to the 2013 release took place within the context of the final review and release of the NSW population projections. Initial planning indicated at least 2 months for planning but this extended to 6 months by the time of release. Three other things also differed for this launch. First, a Centre for Demography, Research and Policy[5] (the Centre) had been established within the Department to bring together a multi-disciplinary team responsible for providing robust evidence to inform policy and planning in a systematic and efficient way. One of the benefits of the Centre's establishment was recruitment of a new Chief Demographer and

[5] As noted earlier, the Centre has been renamed the Demography and Economics Branch. Its functions and purpose remains the same.

support for two temporary part-time staff. This meant 50% more resources for release of the 2014 projections compared to the previous release. Second, weekly meetings were established with all Department staff with responsibility for aspects of the release of the projections. This included media managers, staff responsible for community engagement events management, and demography staff. Third, dedicated staff were given responsibility for helping with the development of information products and stakeholder events. The critical role for the demographers during this development phase was primarily ensuring that the population content was accurate and that proposed products and messages accorded with what the projections were showing.

A detailed communication strategy for the launch of the projections was developed in partnership between the Department's demography staff and the communication staff. The key audiences for the 2014 projection release remained unchanged from the 2013 release. These were media agencies, local governments, NSW state government agencies, internal staff within the Department, State members of parliament, not-for-profit organisations, industry groups and private enterprise.

The communication strategy for the 2014 NSW projections set a broad framework for ongoing communication about the projections with all stakeholders. It had three foci:

(i) internal stakeholders,
(ii) face-to-face interactions, and
(iii) on-line access to information and data.

These all had their genesis in the 2013 release. The explicit inclusion of internal stakeholders meant the underlying demographic processes that led to the projections were part of ongoing discussions and so key messages were understood across the Department. The importance of maintaining relationship with a broad range of stakeholders was also apparent from the ongoing request for participation in forums and seminars by the demography staff, as well as the ongoing one-on-one conversations with staff from local Councils and other government agencies. These requests were partly about stakeholders wanting to understand the methods and data that informed the NSW population and household projections. But in many cases it was because the outputs were about places that people had an emotional connection to, and it was only through face to face contact that demography staff were able to respond to concerns about places that were deeply personal. The need to ensure ready access to easily digestible information via an on-line forum had also been demonstrated by the success of the PDF maps used in the 2013 release of the projections. Easy to understand and easy to access information also facilitated responding to people's concerns because it showed a willingness to make data available to non-technical specialists.

The objectives for the release of the 2014 NSW projections were threefold:

- To ensure an ongoing discussion about the future population across New South Wales, the impact on future households and dwelling and implications for NSW communities

- To raise awareness of population and household changes that are coming (e.g. growth, decline, ageing), the drivers of those changes and their implications
- To disseminate information and data as widely as possible using on-line products.

While these objectives related to the 2014 release, they reflected the need for communication to be about more than the projected number of people. Rather, communication needed to relate to the drivers of population change so that the enduring importance of population to long-term planning was recognised.

A range of key messages were developed to accompany the release of the 2014 projections, again in partnership between the demography and communication teams. These were informed by experiences gathered following the release of the 2013 preliminary projections, and the key messages were:

- New South Wales is growing – particularly Sydney and the larger cities and towns
- New South Wales is changing
- New South Wales is ageing
- New South Wales projections are developed by skilled professionals
- Population projections provide the best evidence to frame future planning.

The development of the projection products was an iterative process. The starting point for the development was the need to use interactive mapping to make information available. As already noted, the PDF maps used for the 2013 preliminary release were not a sustainable vehicle to disseminate information because of the need to return to the designer to have changes or updates made. There was also a recognition of the need to repeat those things that had been successful with the previous release: the icons describing the main drivers of projected population change, plain language descriptions of the methods used, information about the data used to develop the assumptions and how those assumptions were set, and summary information available for each LGA.

The final suite of release products was designed around the Department's web site, with key design elements outsourced to a graphic design company. The icons developed in 2013 became a feature of the style guide developed for the 2014 NSW projections. Numerous icons were developed for all aspects of population change, including figures depicting different ages, household types and dwellings. A specialised projections' landing page was developed that gave access to the final range of information and data available (see Fig. 5.3). The projections' home page provided links to a range of collateral:

- 'NSW snapshot' was a simple link to a static overview in PDF format of key outputs
- Interactive maps accessed via a 'your area' link
- Excel spreadsheets of projection outputs
- Resource documents including brochures and technical documents
- A short, animated video highlighting the projection population changes for New South Wales.

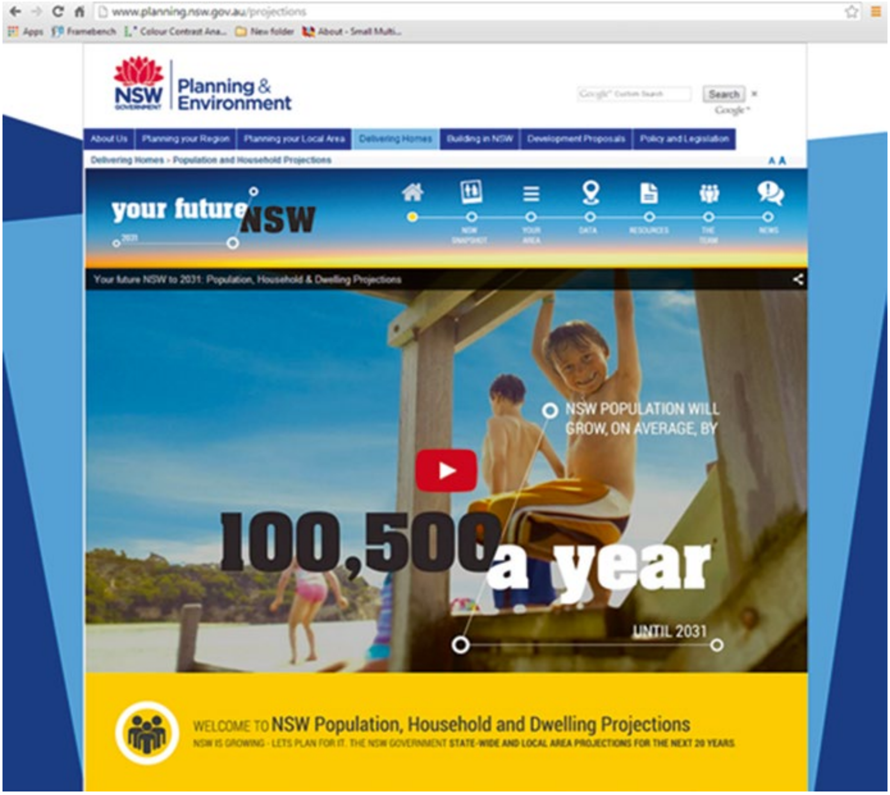

Fig. 5.3 2014 NSW population, household and dwelling projections home page (NSW Planning & Environment 2014c)

The interactive maps were designed using Google maps and were built so that they would automatically update if new data became available. They allowed selection of an LGA or a large region and selection of the following key indicators (see Fig. 5.4):

- Population numbers from 2001 to 2031 (graph),
- Annual average growth rates 2001–2006 to 2026–2031 (table),
- Drivers of population change (icons),
- Age profiles and dependencies 2011–2031 (table),
- Household counts by household type 2011–2031 (graph),
- Household size 2011–2031 (table), and
- Implied dwelling counts 2011–2031 (graph).

Excel spreadsheets were available via a 'Data' link, with data available in two formats. First, unformatted flat files, with labels provided for every row and column were available with data for New South Wales, large regions and all LGAs. This was in contrast to previous releases when data were presented for individual LGAs, for

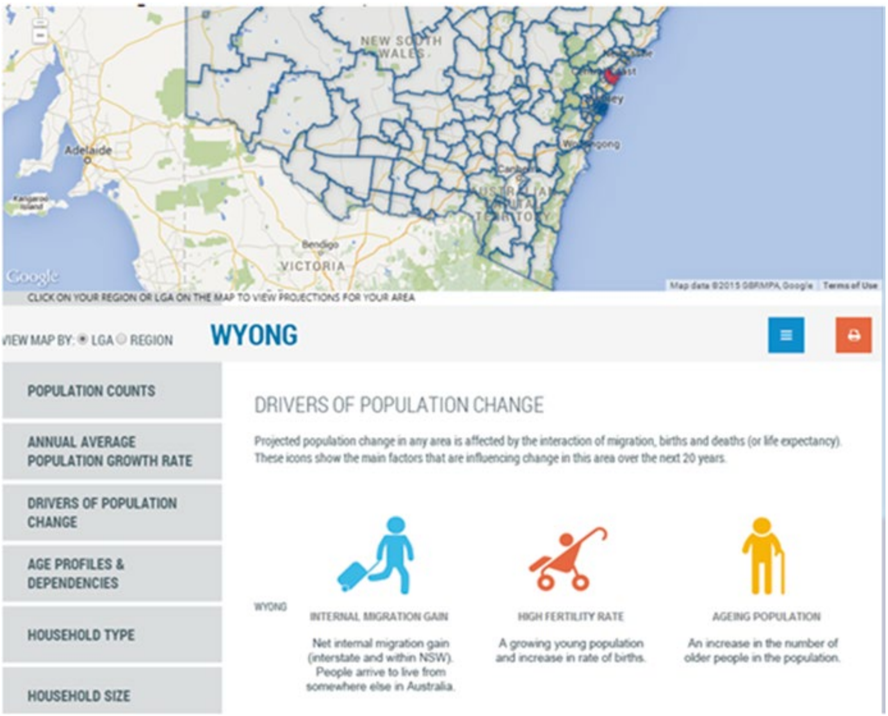

Fig. 5.4 Screen shot (cropped) of mapping function, 2014 NSW population, household and dwelling projections release (NSW Planning & Environment 2014d)

example, but to collate areas together simple sort or pivot table functions could not be used. The flat files enabled easy sorting and manipulation of data by LGA or age, for example. Second, data were also available for each LGA formatted in a way that a user could print one page with all relevant data for their area. Four files were available for four large regions (Metropolitan Sydney, Regional NSW and two regions representing the large peri metro regions to the north and south of Sydney). Each file contained a tab for each constituent LGA with population and household outputs for that LGA only. These were aimed particularly at users who only wanted data from one LGA or who were not comfortable manipulating data in flat file formats. While this may seem obvious and simple, making the data available in these two ways facilitated greater direct access to data tables by users rather than via a data request to the demography staff.

Two types of products were made available a 'Resources' link. The first were PDF copies of double-sided A4 size fact sheets that provided high level summary information on each of the four main regions in New South Wales. The second were a series of technical and methods papers providing plain language, summary information about the projection methods and process, assumptions (including historical trends that informed assumption setting), data used, and evaluation of previous projections. These were available as short, stand-alone papers rather than collated into one report. While the content that was successful for the 2013 release was again provided, the delivery mechanism was changed. This allowed those with specific questions to be directed to the relevant information paper.

In order to highlight the demographic credentials of those responsible for the NSW projection, for the first time, staff profiles were made available via a link to 'The Team'. This showed relevant qualifications, experience and areas of interest as well as any current study being undertaken by staff. As noted in the description of web content, hard copy products were also developed. The NSW snapshot used content from an A5 brochure in a folded card style opening out to an A4 size sheet. Regional A4 size double sided factsheets were also printed.

Projections were approved for release in May 2014 but a decision was made not to accompany this with a formal media announcement, social media activity led by the Department or promotion of the data. Despite no formal release, there was significant media coverage of the projections and they remain a regular media story at the time of writing over 6 months later. A key difference for the 2014 release media response compared to 2013 was that demography staff undertook all media interviews. This ensured a focus on population and appropriate expert commentary. Coverage of the projections was largely positive, with the outputs being discussed in relation to planning throughout the state, and particularly in relation to A Plan for Growing Sydney (NSW Planning & Environment 2014b). For some Council areas, however, the projections remain a source of contention, particularly where no growth is projected.

Immediately preceding the launch of the projections, representatives from all 152 local councils in New South Wales were invited to a teleconference to advise of the imminent release of the projections and the key outputs. A series of workshops throughout the state informed local councils of the projections' release and implications for their region alongside regional strategic planning initiatives underway by the Department. A large stakeholder event was also held in Sydney profiling the new projections and their implications. One-on-one meetings were held with individual local councils and other stakeholders who wanted to understand the projections in more detail and special presentations were made to diverse audiences, from government agencies to community action groups. All demography staff continue to be invited to present at a range of forums and seminars about the projections (for example, the author did 22 such presentations in 2014).

While the subject of these meetings and presentations has been the projections, for the demography staff a main theme continues to be communication of the fundamentals of demographic process that contribute to population change. As active participants in an ongoing dialogue about population change, the demography staff are able to promote a public policy debate that recognises basic demographic principals and ensure the complex interactions arising from age and migration flows in particular are recognised.

Lessons for Demographers

Population and demographic processes provide one of the most reliable long-term platforms for developing and implementing policy, and the most useful policy is developed for populations rather than individuals. Good communication then is essential if demographic evidence is to inform policy. The role of the demographer in this context is not simply to undertake the modelling, research and analysis but to ensure the outputs and their application are understood. This chapter has shown how communication strategies and tools have been developed to talk about population projections. The process used can be applied to all demographic output within government settings. For those providing evidence to government agencies, or wanting research to inform government policy, it is useful to consider that the processes outlined in this chapter are indicative of how government bureaucrats translate research findings for use internally and externally.

This chapter concludes with recommendations for successful communication about population issues arising from the experience in New South Wales. For communication specialists these may be self-evident, but they have not been common practice among government demographers in Australia. Nor has communication per se been a component of training for demographers. For demographers working in the policy arena communication is a critical skill in order to be effective ensuring population evidence is not only available, but also used.

Communication does not happen in a vacuum and it must be planned. At the very least planning must identify what needs to be communicated (e.g. a key finding, or where to get information), how it will be communicated (website, media release, word of mouth), and who needs to know (work colleagues, government agencies, media). As this case study has shown, the communication planning around the release of projections is significant and takes time. Having a plan means those things that demographers recognise as important become the communication priority. The best example is the importance demographers place on population age structures and the drivers of population change, critical factors when planning social policy and identifying priorities. Many users focus on projected population size in 20 or 30 years' time and overlook age structures, an oversight that could be detrimental for all services and infrastructure used by people differently at different ages (arguably, all services and infrastructure).

Using graphics, icons and colour are important. They help catch people's attention and make it easy to identify what is important. Demographers are (usually) not graphic designers and getting professional help is important. The design of key graphics or icons is also an important process in its own right. It forces thinking about what is the most important thing that people need to know from the information being provided. It requires testing of messages to make sure that what demographers are wanting to say is the same as what is understood by non-technical users of demographic modelling or research. Importantly in New South Wales, the use of colour and pictures engaged stakeholders with the projections in a way that prompted further discussion about what population change meant for the future – via social media, newspapers, and in person with demography staff.

The fundamental plank of all good communication, the use of plain language, is also true for demographers. The challenge is to convey complex ideas in a way that does not detract from that complexity (for example, explaining the difference between period and cohort effects). Demographers also use language in a way that is not always shared by non-demographers (e.g. fertility or cohort). It is therefore important that the language of demography is tested with people outside the discipline. For example, show non-demographers text or graphics and ask them what they think it means. If the material needs explanation then more work is needed on the messages. Testing messages with non-demographers can also highlight those aspects of work that are important but not recognised as such.

Communication can be greatly facilitated by identifying simple structural barriers to accessing information and addressing them. In retrospect these seem remarkably simple, but if not addressed inhibit communication. For the New South Wales' population projections the establishment of a dedicated web address for the 2013 release that was short and easy to remember increased access to data and information papers. Another structural barrier to access was having data available in a way that did not meet the numeracy levels among users, or the way they used the data in their day-to-day work. This was addressed by making data available in flat file format, with every row labelled to enable sorting, collation and further manipulation. Data were also provided with separate tabs for all LGAs within New South Wales so that all data for one LGA was in one place.

A final recommendation for communicating about population is the need to respond to people's emotions. Demography is about people and so the work of demographers reflects the lived experience of those making policy and those who are affected by policy implementation. This is particularly true for small areas where the focus is places that are communities, and which people have deep connections to. Recognising that stakeholders will not respond to the science but to their attachment to people and place enables communication that is more likely to be effective. Again, simple language and the use of simple graphics provides the starting point for a conversation about population change.

Communication about the population projections has highlighted that as demographers, if we are to ensure that population evidence will inform policy development, policy debate and policy implementation, then we are required to talk about demographic processes all the time. This means talking in a language that non-demographers understand – not only about the demography per se, but also its implications. While this may seem too simple or even simplistic, if demographers are part of an ongoing conversation about population change then they will also be an integral part of the response when more complex information and analysis is needed.

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Chapter 6
Not Just Ageing: Policy and Service Delivery Implications from Changing Population Compositions in the Northern Territory of Australia

Andrew Taylor

Introduction

High on the list of issues facing governments in developed nations, and with far reaching implications for policy and national finances, is population ageing. The phenomenon is usually discussed in terms of increasing life expectancies and shifts in age structures towards larger shares in post-retirement years. Ageing is also the result of significant reductions in fertility rates, such as the halving in the total fertility rate for OECD nations observed in the 45 years to 2008 (OECD 2008). Reflecting the importance of societal choice and changing social attitudes to family and fertility as a driver of population ageing, the OECD has couched this combination of factors in terms of 'ageing societies' (OECD 2008). In line with this, indicators of future population change for developed nations spotlight this global mega-trend and particularly the financial challenges for governments, which are associated with the progress towards a 'top heavy' age pyramid. In 2012, for example, women in OECD nations could expect to spend 22.5 years in retirement, a large gain from the 15 years in 1970, while men in 2011 could anticipate 18 years in retirement, up from 11 in 1970 (OECD 2014).

In line with global demographic trends, the population of Australia is also ageing. Population projections suggest dramatic future shifts in Australia's population composition and structure in coming decades. Median age, for example, is anticipated to rise from 37.3 in 2012 to 44.5 by 2061, and to reach as high as 46 years by 2101 (ABS 2013). Those aged 65 years and over are projected to comprise between 18 and 25% of the population by 2061, and as much as 27% by the year 2101. Meanwhile, the very old, those 85 years and over, are projected to more than double from 2012 to 2032 and continue to grow rapidly thereafter (ABS 2013).

A. Taylor (✉)
Northern Institute, Charles Darwin University, Darwin, NT 0909, Australia
e-mail: andrew.taylor@cdu.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_6

Population ageing is creating specific impacts and needs in societies as a result of the increasing incidence of age-related disabilities and complex care needs due to end of life morbidities. Burgeoning rates of dementia in Australia are perhaps emblematic of the matter with anticipated growth in cases from around three hundred thousand in 2011 to around nine hundred thousand in 2050 (AIHW 2012). Society and seniors themselves are voicing growing expectations about the quality and systems of aged care and increasing expectations, the onset of high rates of particular disabilities and conditions is creating significantly higher demand for specialised nurses, carers and those with skills in palliative care (Productivity Commission 2011).

The issue of population ageing is primarily broached in policy and public discourse for its fiscal impacts on governments. In particular, erosion of taxation revenues and the costs associated with providing services and income support for seniors. In Australia, ageing first reached primacy as a policy and economic issue during the early 1990s when the then Keating Government established a unit within the Treasury Department for modelling fiscal and economic futures. This led to the tabling of the first Intergenerational Report in 2002 (Australian Government 2002) with updates legislated for each 5 years from that point onwards (Australian National Audit Office 2014). The initial and subsequent reports have highlighted future challenges associated with meeting the health and other service costs associated with population ageing.

The counter-argument to the economic rationalism associated with the prevalent discourse on negative fiscal impacts and negative stereotyping of seniors focuses on the out-of-workforce social, community and economic contributions made by this rapidly growing cohort (Australian Association of Social Workers 2013). Improvements to life expectancies and general health in older age means that the onset of chronic illnesses has been progressively ‘compressed’ to later in life, such that more post-retirees are enjoying longer periods of healthy old-age (Bloom et al. 2010). Some argue that the health costs from ageing are over-estimated while benefits such as wealth transfers, willingness to volunteer, caring for and providing financial assistance to family, support for the arts and cultural sectors, desire to travel, law abiding influence and the generation of new consumer markets are not accounted for by economic rationalists (Healy 2004). Older people also face challenges including discrimination, ageism and social isolation. Those in rural and remote areas may have limited access to services and infrastructure, suffer from cultural sensitivity and be on the wrong side ofsocial justice issues (AASW 2013).

Not Just Ageing: The Policy Challenges for Service Provision across Population Lifecycles

In spite of the scale of and rapid transition towards population ageing that is confronting governments in developed nations, ageing is occurring unevenly between nations and across jurisdictions within these (Jackson and Felmingham 2002).

Drastically reduced fertility rates and increasing life expectancies in Japan from the 1970s onwards, for example, were a prelude to the significant effects on the Japanese economy in recent times (Jokisch 2006). By contrast, ageing is a rather distant population phenomenon for many developing nations where fertility rates remain very high and life expectancies low (United Nations 2013). Within developed nations, some jurisdictions, most notably sparsely population areas (SPAs), remain relatively unaffected to date by population ageing. This is the case in Australia where life expectancies vary greatly between States and Territories and between subpopulations, especially when comparing Indigenous Australians to others. Current estimates have at birth life expectancies in most states at close to 80 for men and 84 for women, but for the Northern Territory (NT), an SPA with a high Indigenous composition in the population, these are 75 years and 79 years.

Regardless of the extent of the advancement in population ageing for individual jurisdictions, the associated increases in demands for services are only one part of the complex and ongoing mandate for governmental provisioning of core services. Governments are increasingly confronted with fiscal pressures associated with long-term demographic change, and consequently seek policy solutions, efficiency dividends, savings measures and restructures to the delivery of core services like health, education, justice and public housing. The challenge is not only to plan to meet the needs of a growing seniors sector, but needs of residents across all life cycles, and to do so within the constraints of funding sources. Clearly, present and future population size and age-sex compositions are central to determining the aggregate costs associated with meeting such needs. For example, an ageing population implies, all else being equal, a smaller base of young people, which might also impact on incarceration rates and the demand for other services. Balancing the relative demands for services across sectors and into the future is thus a difficult policy task and necessitates research-based information. It is here that demographic research, and particularly scenarios based on population projections, can contribute significantly, even for jurisdictions where population ageing has not previously been part of the mix of major policy issues for incumbent governments.

Ageing and the Demography of Sparsely Populated Areas

Populations in the Sparsely Populated Areas of developed nations are characteristically different from those in urban, peri-urban or rural parts (Carson 2011). A small stock of comparative research on demographic change in Canada, Australia, Sweden, Norway, Russia, Finland, and Alaska has emerged to document the relationships between historical demography, contemporary population characteristics, and the economies of SPAs. The reasons span the gamut of social, economic, and political influences and were recently presented as a conceptual framework titled the “8Ds of remote demography” (Carson et al. 2011a), which lays out the key features of SPA populations differentiating them from others. An example is their “dynamic” nature, which makes them subject to fundamental structural changes (for example, large swings in sex ratios or substantially altered age structures) over short time periods. Sometimes change results from "black swan" causes, like extreme weather events, sometimes known factors are at play, such as major construction projects, but occasionally major demographic change cannot be traced to immediately identifiable causes. This makes accounting for and explaining observed data, as well as modelling the future for SPA populations a challenging assignment (Taylor 2014).

At the scale of individual settlements, SPA populations are highly diverse in their demographic characteristics. However, most exhibit a youthful composition, deriving in part from significant numbers of Indigenous residents, for whom low life expectancies and high birth rates combine to sustain a youthful age structure (ABS 2014a). Nevertheless, young populations in SPAs can be observed across most sub-populations including non-Indigenous, international migrants, temporary residents, non-resident workers and others. Migration age profiles too, both sub-national and international, feature youthful rate 'spikes', primarily attributable to the attractiveness of SPAs to young migrants as a 'stepping stone' early in their career. A long-term spike in those aged in their 20s for in-migration, and a downstream spike in those aged in their 30s for out-migration can be observed in most jurisdictions (Carson 2011; Martell et al. 2012). A further feature of SPA populations is the net outmigration of pre-retirees and recently retired residents (Martell et al. 2013). In combination, these features have meant that population ageing has been minimal in terms of size and the scope of impacts for these parts of developed natoins.

Population policies are largely absent for SPA jurisdictions in developed nations and instead are interwoven with policies relating to the 'frontier' or regional development, within which emphasis is given to specific aspects of national and economic interests; in particular defence, resource exploration and extraction (Carson et al. 2011b; Australian Government 2015). Youthful age structures and the absence of significant numbers of senior residents have diminished the immediacy of financial and other impacts from population ageing. Nevertheless, recognition of the need for greater demographic balance (in particular reductions in male biases and the retention of other cohorts) has been inherently recognised in various regional development and diversity strategies in such regions (for example, Alaska Department of Community and Economic Development 2002; Australian Government 2015).

The Northern Territory of Australia

As an SPA (with a population density just 0.2 persons per square kilometre), the NT has a small, transient and youthful population of around 240,000 residents, a third of whom are Indigenous. About half of the population lives in the regional city of Darwin (officially classified as "Outer Regional" under the national statistical system) and 12% live in Alice Springs. A further 12% reside in the small towns of Katherine, Nhulunbuy and Tennant Creek. Outside of these centres, the majority of the population are Indigenous Australians with most living in small and remote communities of between 200 and 3,000 residents. In recent years, only Darwin and Alice Springs have recorded population growth of note, particularly in Darwin where above 2% growth occurred from 2005 to 2010, while growth elsewhere was very low at less than 1% (ABS 2013). At any point in time, the NT, like most northern SPAs, is in receipt of relatively large numbers of non-residents in the form of fly-in-fly-out workers, temporary workers and tourists (Carson 2014).

As the Australian State or Territory with the lowest median age and lowest proportion of seniors in the population, the NT is only now seeing ageing manifest as an emerging population trend. Population projections from the Northern Territory Department of Treasury and Finance (2014) suggest a doubling in the proportion of the population aged 65 years and over by 2041. Unlike other jurisdictions, population ageing in the NT is and will be influenced significantly from demographic change amongst Indigenous residents. Growth rates for Indigenous people aged 65 and over, for example, are anticipated to average above 5% per annum from 2011 to 2041 as life expectancies continue to improve and as more Indigenous Territorians live into their 60s and 70s. Despite the impending growth in the seniors age groups, evidence to date suggests only a small proportion of retirees choose to remain in the Territory (Martell et al. 2013) and past research has noted that a lack of grandparents is one factor which has contributed to an 'unbalanced' population structure (Taylor and Carson 2014; Payer and Taylor 2015). Within this context, the Northern Territory Government (both current and future) will be required to account for the demands for increased aged care, health and other services associated with population ageing, as well as changing service demands across other service sectors.

In the NT, population projections, though generally poorly understood in method and application, are a useful tool for engaging with policy makers in discussions about population ageing and the anticipated effects of long-term population change more broadly. Such discussions are vital to informing processes around budgets, the development of infrastructure, negotiations between other governments (notably the Australian Government), and for understanding permutations from changing service demands across the population. Projections also help identify critical junctures in time where immediate policy actions might be required based on population changes. In this chapter I report on research using population projections for the NT as the basis for determining future shifts in service needs according to sector and based on anticipated changes in the demographic composition of the population.

Methods

In this study, I have developed a set of proxy indicators ('Service demand indicators') for mapping out future demands for individual services in the NT in the areas of aged care, health services, disability services, correctional services, education and housing demand. I also developed indicators of the future capacity of governments (NT and Australia as a whole) to provide services (labelled as 'Indicators of the future financial capacity to provide services') based on dependency ratios (age dependency and overall dependency), workforce growth and growth in the age groups contributing most to personal income tax revenue streams for governments. Definitions and data sources for each indicator are provided in Table 6.1.

Table 6.1 Summary indicators for projections of future service demands and capacity to provide them

Service or capacity type	Proxy indicators	Sources of data
Service demand indicators		
All	Projected median age (years).	NTDTF (2014)
All	Projected population 65 years and over.	NTDTF (2014)
Aged care	Projected Indigenous residents 50 years and over and non-Indigenous residents 70 years and over (%).	NTDTF (2014)
Health services	Projected hospital separations: Including renal patients. Excluding renal patients	Northern Territory Department of Health (2011) ABS (2011) ABS (2014b) ABS (2014c) NTDTF (2014)
Education	Projected numbers of children aged 5–17 years.	NTDTF (2014)
Housing demand	Projected dwelling demand based on a declining household occupancy ratio.	ABS (2012) ABS (2010) NTDTF (2014)
Correctional services	Projected number of prisoners (based on existing imprisonment rates).	ABS (2014d) NTDTF (2014)
Disability services	Projected number of residents needing help or assistance (because of a disability) in one or more of the core activity areas of self-care, mobility and communication.	ABS Table Builder NTDTF (2014)
Indicators of the future capacity to provide services		
Dependency indicators	Projected dependency ratios: Age dependency ratio – persons 65 years and over as a proportion of the working age population. Overall dependency ratio – persons 0–14 years and over 65 years as a proportion of the working age population.	NTDTF (2014)
Workforce entries and exits	Index of projected growth in residents aged 15–24 (entering) versus those aged 55–64 (departing) – 1986 to 2041	ABS (2014e) NTDTF (2014)
Future personal income tax revenues	Projected growth in peak ages for personal income tax contributions (males 35–49 years and females 40–54 years).	Australian Government (2014) NTDTF (2014)

I used NT population projections from the Northern Territory Population Projections model (NTPOP) as the denominator for the indicators. NTPOP is a collaboration between the Northern Territory Department of Treasury and Finance (NTDTF) and demographic researchers at Charles Darwin University (see Wilson 2009). The program is a cohort component model with the capacity to project for multiple geographies (or hierarchical 'states' – here the NT and rest of Australia). Importantly, NTPOP separately projects Indigenous and non-Indigenous populations and allows demographic interactions between them (by varying rates of Indigenous births to non-Indigenous parents and by changing rates of Indigenous identifications over time). Full details of the NTPOP model, its assumptions and its outputs are at NTDTF (2014). Where possible we separately model future Indigenous and non-Indigenous service demands as well as comparing and contrasting these changes in demand between the NT and Rest of Australia (ROA).

The underlying assumption for this study is that future changes in levels of service demand are determined by compositional population change alone, with other factors excepted. For example, the NT has the highest proportion of non-resident workers amongst Australia's States and Territories, at 5.2% of the workforce in 2011 (Brokensha et al. 2013). In this chapter we analyse changes in service demands based on projected resident populations and therefore exclude non-resident workers (and other 'service' populations like tourists) who may 'consume' services into the future. The benefit of this approach is to isolate, and deliver relatively clear messages about, population based impacts for future service demands in the NT. It also makes this study replicable for other jurisdictions.

The scope of the study precludes financial forecasting of future (aggregate) costs for providing individual services, nevertheless in conjunction with internally developed (by agencies responsible for individual services) unit costs data, the results here deliver policy makers and service providers the information necessary for these tasks. Finally, I do not attempt to delineate the responsibilities of the Northern Territory and Australian Governments in relation to funding services into the future. Instead, the results provide essential knowledge as an input to informed political negotiations.

Results

Indicators of Population Ageing

The median age for Indigenous residents in the NT is projected to increase from 23.7 years in 2011 to 28.4 years by 2041, a 4.7 year increase, compared to 2.3 years for non-Indigenous residents (from 34.7 years to 37.0 years). Dramatic differences in age-specific growth rates underpin these anticipated changes to median ages. In particular, while growth of between 30 and 50% is projected across most age groups, those aged 45 years and over may increase by substantially more (Fig. 6.1). For

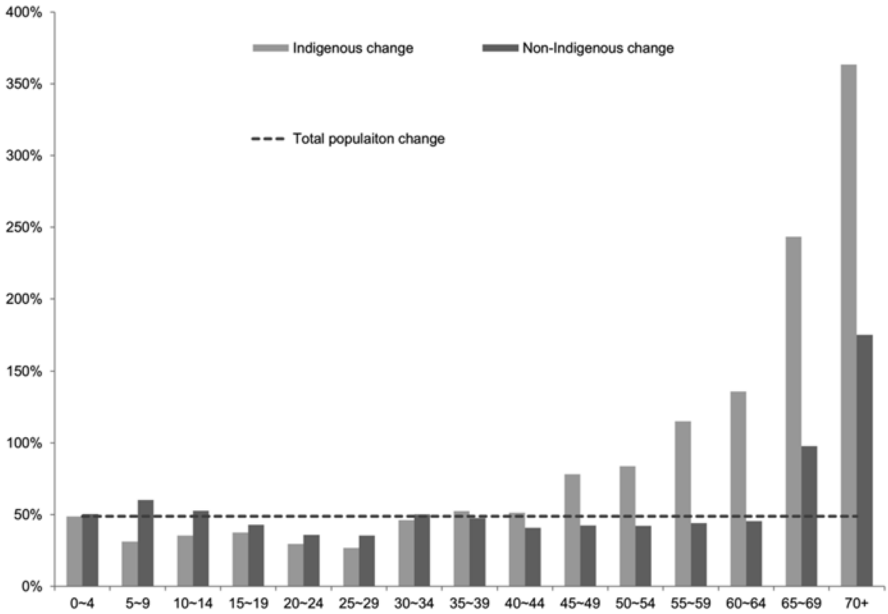

Fig. 6.1 Projected population change by age, sex and Indigenous status, 2011–2041

those aged 65 years and over, a 126% increase for non-Indigenous residents and a 290% change (albeit from a small base of 805 residents in 2011) for Indigenous residents are projected. Consequently, the population share in younger age groups, particularly for Indigenous residents aged 5–14 years and all residents aged 15–29 years, are projected to fall. This has implications for future workforce growth and taxation revenues since the latter group are new workforce entrants.

Changing Service Demand Indicators

Aged Care As an indication of the future demands for aged care services, the number of Indigenous residents aged 50 years or more is projected to increase by 163% from around 9,000 to more than 22,000 in the 30 years to 2041 (Fig. 6.2) and by 362% for non-Indigenous NT residents 70 years or more. This compares to a 134% increase for the projected ROA population aged 70 years or more.

Health Services In 2011, renal patients comprised 57% of hospital admissions for Indigenous residents in the NT compared to just 9% for others. Total hospital separations for both Indigenous and non-Indigenous residents in the NT are anticipated to increase by around 60% during 2011–2041, both including and excluding

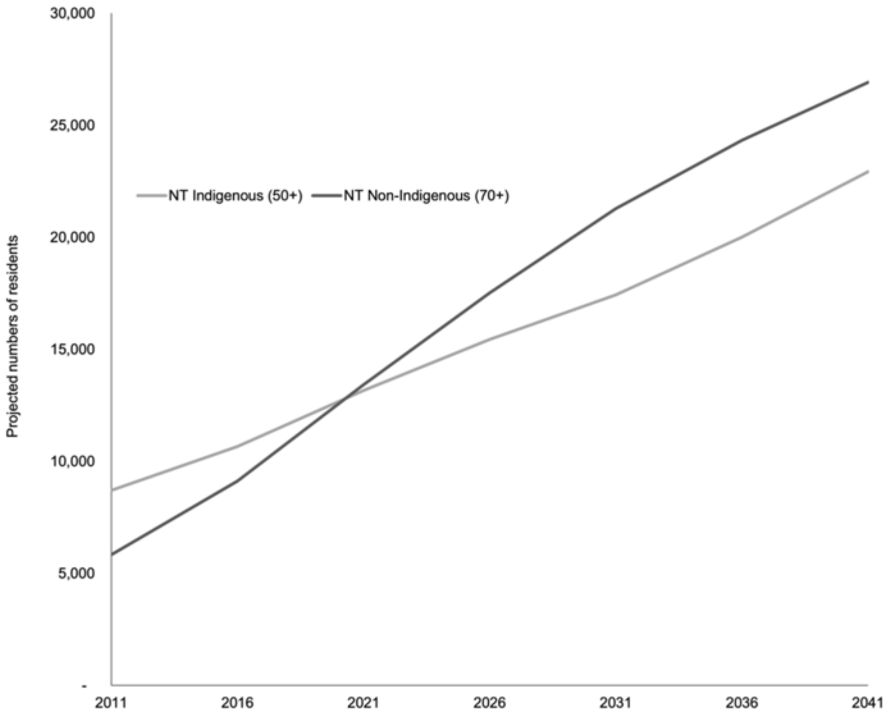

Fig. 6.2 Projected changing demand for aged care services in the NT, 2011–2041

separations for renal treatment. This compares to a 50% projected increase in separations for the ROA (for which data are only available including renal separations), signalling a relatively larger increase in health service costs for the NT.

Education In aggregate, the number of school-aged students (5–17 years of age) in the NT is projected to increase at a similar proportion to the ROA from 2011 to 2041 (45% and 43% respectively). However, a much larger increase is projected for non-Indigenous females (65%) in the NT (Fig. 6.3). Non-Indigenous school-aged residents are projected to comprise 59% of the share of the 5–17 years cohort by 2041 (up by 4% from 2011), while for Indigenous residents this is projected to be 41% (down 3% from 2011).

New Housing Demand Around 46,000 new dwellings are projected to be required in the NT by the year 2041 (an increase of 50%) based on no decline in average household size. This compares to a projected 50% increase in the ROA. However, projecting forward recent rates of decline in household size experienced across Australia (at a reduction of 0.1 persons each 5 years) would see new dwelling demand increase by 98% (78,000) in the Territory and by 95% in the ROA (Fig. 6.4).

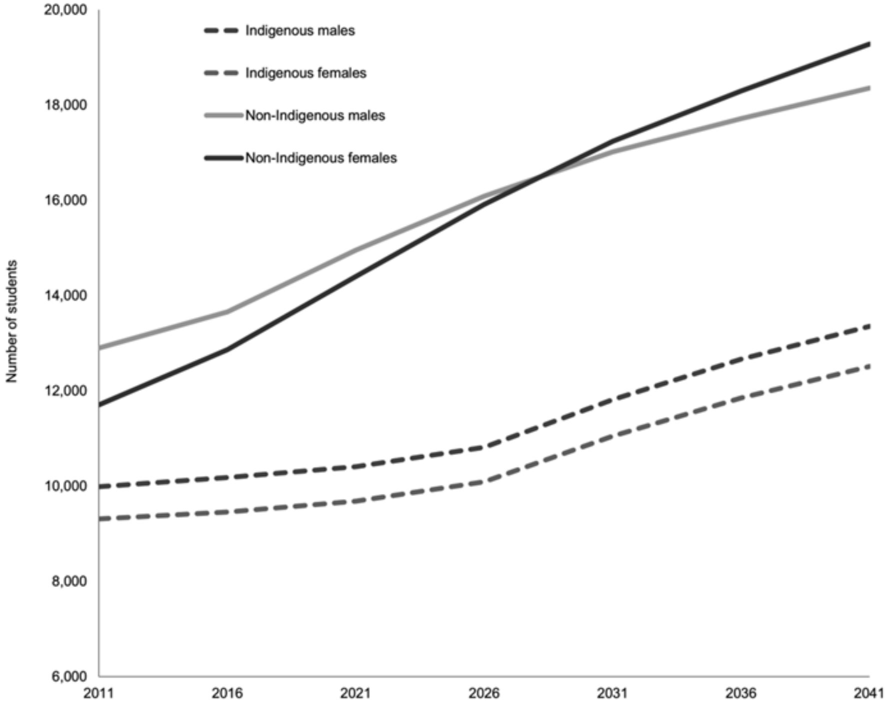

Fig. 6.3 Projected number of school-aged children in the NT, 2011–2041

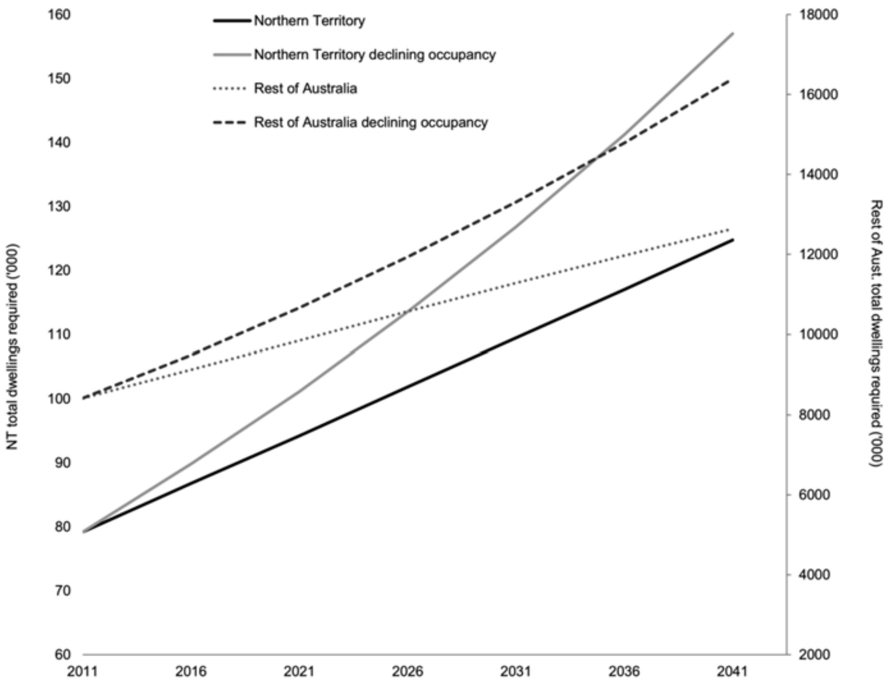

Fig. 6.4 Projected total dwelling demand, NT and ROA, 2011–2041

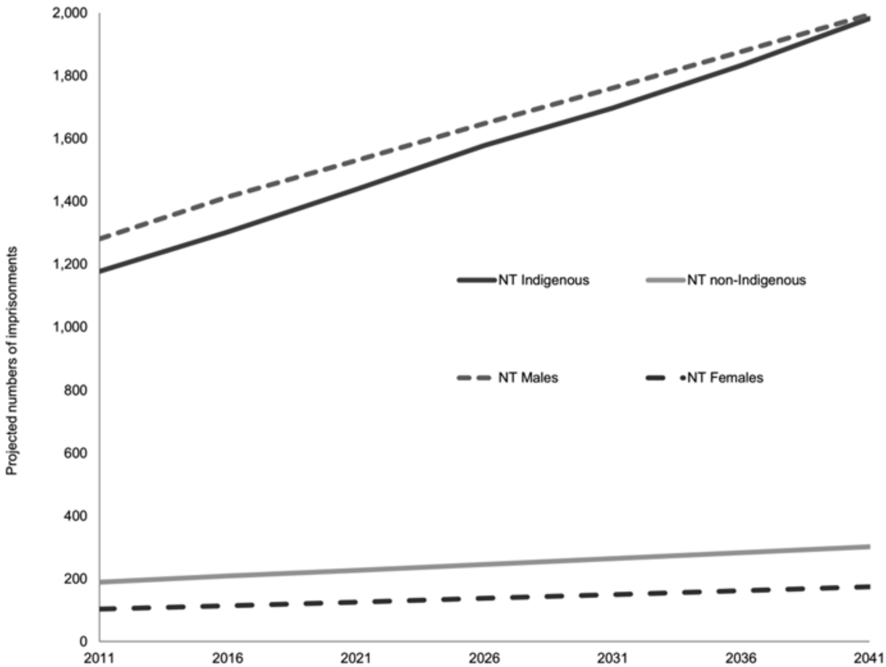

Fig. 6.5 Projected number of imprisonments in the NT, 2011–2041

Corrective Services Based on 2014 rates, projections suggest numbers of imprisonments in the NT will increase by 62% (to around 2,240) in the 30 years to 2041, and by 53% in the ROA (Fig. 6.5). Greater increases are projected for Indigenous people in the NT (68%) in comparison to others (59%).

Disability Services Based on the Census question about whether a person needs assistance with core activities due to a disability, projections suggest substantial increases in the numbers of seniors requiring assistance can be anticipated. For Indigenous residents a 340% increase (although from a small base) is projected compared to 242% for non-Indigenous residents 65 years and over. A small increase for late career aged residents and minor increases in the other lifecycle groups are anticipated (Fig. 6.6).

Indicators of the Future Capacity to Provide Services

Projected Dependency Ratios The child dependency ratio for Indigenous residents in the NT is projected to fall from 0.51 to 0.46 (by 9%) at the same time as the age dependency ratio is projected to grow by 189% (to 0.14). Consequently, the

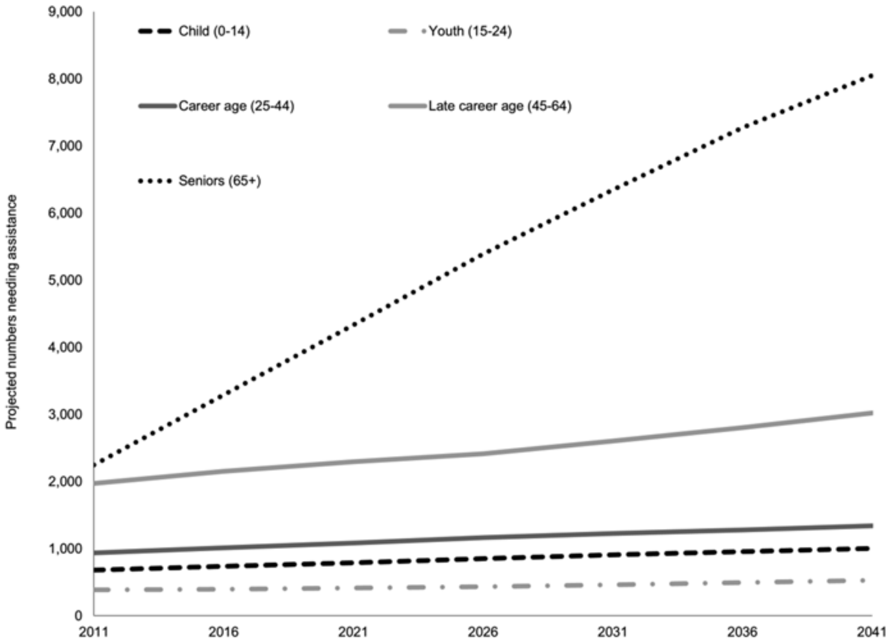

Fig. 6.6 Projected numbers of people needing assistance with core activities, 2011–2041

overall dependency ratio for Indigenous NT residents is projected to increase by 8%, much less than the projections for non-Indigenous residents at 43% (Fig. 6.7). Reflecting these anticipated changes to the Indigenous population composition in the NT, Indigenous dependency ratios (and consequently those for the NT as a whole) will trend towards the ROA. Nevertheless, the child dependency ratio for the NT will remain substantially above (0.43 compared to 0.29) while the age dependency ratio will continue to be much lower than for the ROA (0.14 compared to 0.32).

Workforce Entrances and Exits Based on an indexed rate of change with 1986 as the base year (of 100), Fig. 6.8 highlights the substantial growth anticipated in workforce exits for both Indigenous and non-Indigenous residents in the NT to 2041. Minimal growth in the non-Indigenous workforce entrants is anticipated to the year 2041, although a workforce 'dividend' is evident from Indigenous entrants on the assumption of increases from currently very low (circa 40%) participation rates.

Projected Growth in Peak Ages for Personal Income Tax Contributions Demonstrating the potential fiscal impacts from compositional population change for the NT, growth in the peak personal income tax age groups for both the NT and ROA are projected to increase to a much lesser extent than the overall population. For the NT projected growth in ages 35–49 years for males and 40–54 years for females is 7%, compared to an overall population increase of 49%.

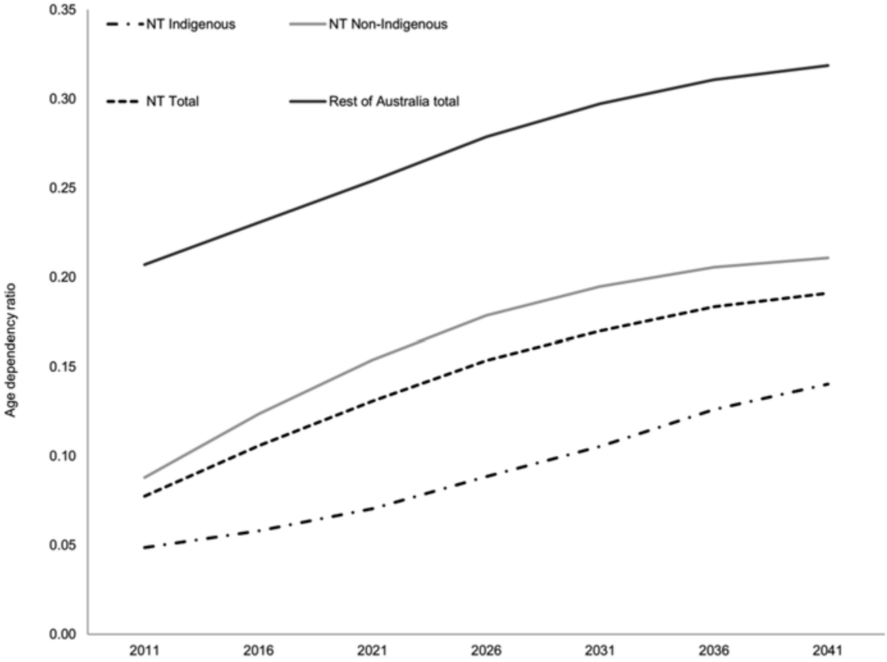

Fig. 6.7 Projected age dependency ratios, NT and ROA, 2011–2041

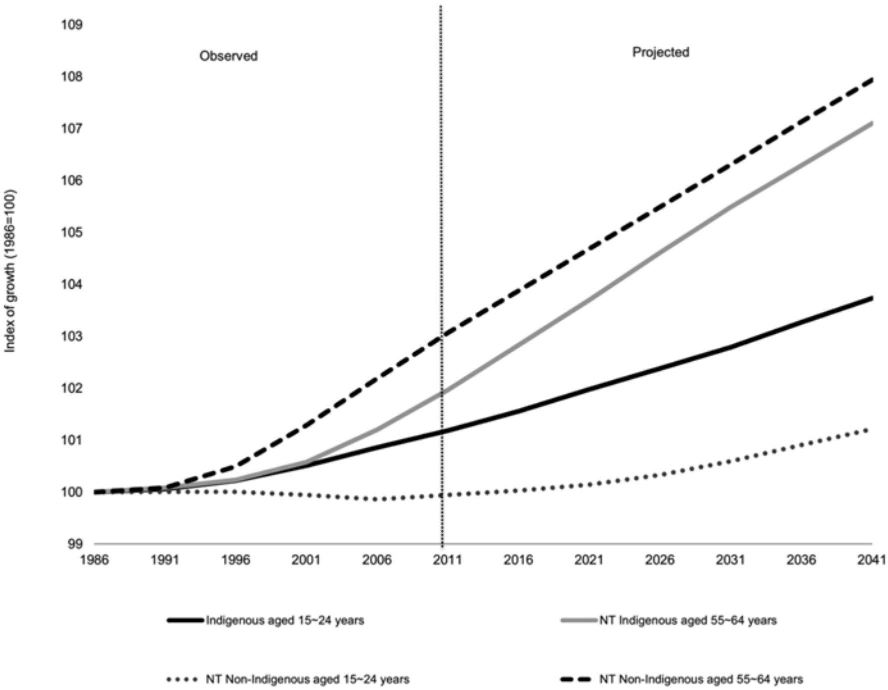

Fig. 6.8 Index of change for NT workforce entrants and exits, 2011–2041

For the ROA a 5% increase in peak tax ages is projected compared to overall population increases of 50%. These changes will further erode personal taxation income streams for both the Australian and State or Territory governments.

Conclusions

While population ageing is a global mega-trend, it has yet to surface as a major policy issue in some parts of developed nations. SPAs are one such example, where youthful age structures have to date shielded them from its onset. For SPAs this has been a function of both the pathways for economic development pursued, encouraging a young non-Indigenous resident profile, combined with relatively large proportions of Indigenous residents in the population, with ongoing relatively low life expectancies and high fertility rates. A further issue for many SPAs has been retaining seniors in the post-retirement years.

This set of conditions has certainly been evident for the NT of Australia in recent decades. However, there now exist 'demographic pre-cursors' which bring it to the precipice of the relatively rapid onset of population ageing. Not least are marked improvements to Indigenous (as well as Non-indigenous) life expectancies in recent decades (Wilson 2014). Other factors include the movement into retirement ages for long-term residents who may have moved to the Territory during its significant population expansion subsequent to self-government in 1978. This 'bubble' will leave a hole in the workforce and create significantly more seniors than has been observed in the past, even if past trends persist and many leave the Territory. For Indigenous residents, therefore, the dramatic anticipated proportional growth in ages 65 years and above is indicative that very small numbers previously lived to these ages and that some may have exited the Territory for the treatment of illnesses prior to death. By contrast, anticipated shifts in the age structure, dependency ratios, tax revenue streams and demand for aged care services for non-Indigenous residents demonstrates the scale of growth which is likely in numbers of seniors. The collective lesson is there is a present need for policies specifically to meet the needs of both cohorts.

The comparative analysis of future service demands utilising a population projections approach has demonstrated that population ageing is an issue that does not occur in isolation. For example, a reduction in the proportion of the Indigenous population aged 5–14 years in the NT, as indicated by a falling Indigenous child dependency ratio, is anticipated. In distributing finances to meet changing service demands, these relativities must be accounted for and, with all else being equal, a larger portion of revenues transferred from education to health, aged care and other related budgets into the future. While simplistic, such conclusions highlight the need for policy makers to be across long-term demographic changes and to act pre-emptively according to these. Unfortunately, the present approach sees the budgets of agencies producing the necessary data to facilitate this, notably the Australian Bureau of Statistics, and those of research organisations who create a 'picture' from the data, being cut. This is an awkward juxtaposition given the political mantra of 'evidence-based policy' and the routine political discourse of around 'governing for the future' commonly proffered by governments of all suasions.

This study has also demonstrated some of the practical applications for population projections outputs in shaping policies in relation to future service demands and needs. The focus has been the SPA of the NT, however the approach used in this study is replicable across other jurisdictions. Despite the inherent inaccuracy of population projections, where projected outcomes always deviate from the population which transpires (for example Wilson 2009; Taylor 2014) their application to policy-relevant scenarios where the focus is the differences in outcomes between scenarios has been demonstrated. It is unlikely that the major shifts in population composition highlighted in this study would be negated based on errors in the projections. In that respect, and despite potential errors in the assumptions for both the projections and proxy indicators developed here, the value of population projections in forewarning policy makers on the types and impacts of long-term demographic change is clear.

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Chapter 7
Forecasting Patterns of Metropolitan Growth Using an Optimised Allocation Procedure

David Pullar, Martin Bell, Jim Cooper, Robert Stimson, and Jonathan Corcoran

Introduction

The use of urban models to explore future growth scenarios for cities and examine the influence of urban policies has been of interest to planners for many years. Urban models may serve as a mechanism to coordinate community, industry and government interests to plan for a more certain future (Miller 2009). In practice, this has proven an elusive goal due to the inherent complexity and uncertainty of the way urban systems evolve (Batty 2013). Early models attempted to describe urban growth patterns by reference to broad structural forces – principally land use, transportation and demographic change – but did not have sufficient spatial resolution to capture underlying urban processes and socio-economic behaviour. A new class of models evolved to deal with urban dynamics and the way patterns of human activity shape urban processes, and a coherent framework is now emerging that provides a theoretical foundation for modelling these aspects of cities and their growth (Batty 2013; Heppenstall et al. 2012). However, there remains a need for classical models that link demographic data and physical land uses in order to predict the pattern of urban growth, anticipate pressures on the urban system and explore policy impacts.

D. Pullar (✉)
School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia
e-mail: d.pullar@uq.edu.au

M. Bell • J. Cooper • J. Corcoran
Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia
e-mail: martin.bell@uq.edu.au; j.cooper4@uq.edu.au

R. Stimson
Australian Urban Research Infrastructure Network (AURIN), The University of Melbourne, Level 2 West Wing, Alice Hoy Building, Parkville, VIC 3010, Australia
e-mail: rstimson@unimelb.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_7

The nature of the available data is a key consideration for these models. Most social and economic data are obtained in an aggregate form through census surveys and governments sources; this both enables and limits what may be done with urban models. Some of the earlier issues associated with classical models, particularly their use of coarse spatial scales, have since been overcome through the development of multi-level spatial approaches (Wegner 2011) which link regional socio-economic trends to local-level models of demographic and land use change. The use of optimisation techniques has enabled the coupling of these into multi-level spatial models, incorporating conditions which are honoured within its computational framework (Koomen and Borsboom-van Beurden 2011). In this chapter we adopt this approach through the use of a top-down allocation model to translate regional demographic forecasts to land use scales. The particular merit of this approach lies in providing a robust basis for generating spatial representations that make effective use of readily available land use and planning data collected at the local level.

The purpose of our work is to link urban models and demographic forecasting to policy-relevant issues. The modelling capability takes the form of a large scale urban model (LSUM) developed as part of an Australian Research Council-funded Linkage Project in collaboration with the Queensland Government. The structure of the model is laid out in Stimson et al. (2012). The context for the research is a large scale metropolitan region in Australia, namely the south-east region of the state of Queensland. The South-East Queensland (SEQ) region covers 22,244 km^2; approximately 13% is urbanised and includes the city of Brisbane together with the Gold and Sunshine coasts. Urban development is controlled by 22 local authorities with the Queensland State Government performing an overriding role through the broad policy framework of the SEQ Regional Plan (Queensland Government 2005). In 2011 the SEQ region had a population of three million people and is one of the most rapidly growing regions in Australia. Population projections for the SEQ region (Queensland Government 2014) forecast growth of almost two million people, an increase of 66%, over the period 2011–2036. Households will grow even more rapidly with a projected increase of 794,000 or 69% over the 25 year period to reach 1.95 million in 2036. The LSUM model forecasts the spatial pattern associated with this growth using annual increments to allocate projected growth in households across a fine lattice of grid squares covering the SEQ region. Crucial determinants guiding the allocation of growth are land availability determined by planning schemes set by the 18 local authorities that control urban densities, and the regional constraints imposed by the State Government which regulates the urban growth boundary. From a policy perspective it is important to know how well the existing regulations accommodate forecast growth and to assess the efficacy of alternative spatial planning strategies (Albrechts 2006).

The next section discusses the requirements for urban models. While there are fundamental differences between alternative approaches to urban modelling, there are also many assumptions common to both. Basic principles on how models satisfy conditions on allocated attributes, space utilisation and spatial behaviour are discussed. This is followed by a more detailed description of the problem and modelling requirements. It is argued that spatial allocation is an appropriate way to disaggregate demographic growth forecasts for new households and deal with dynamic aspects of the allocation. In particular, allocation models facilitate accounting for urban space utilisation based on land suitability, depletion of available land, and spatial constraints such as clustering in new developments. A link is also made to planning policy questions including the propensity for the uptake of available land over time, and the impact of directing new development to activity centres by modifying development capacities. The data and model underlying the allocation are then described. An interesting feature is that it models change based on land allocation classes in place of the conventional approach based on land use. The spatial framework takes the form of a multi-spatial resolution grid with mixed attributes. We describe how a variety of data, including planning constraints, land use and accessibility, are collected and synthesised to a grid representation. The next section describes the allocation algorithm and results. An optimisation procedure, namely simulated annealing, is used to disaggregate housing forecasts and satisfy the dynamic space utilisation constraints. Results of simulations for planning policy scenarios are given. The final section discusses the implications of the simulations and assesses the methods employed.

Model Background

Explicitly incorporating a spatial dimension in models is a challenging problem. According to Miller et al. (2004), the spatial aspects of urban economics and demography are the biggest challenge in urban model development and implementation. The processes captured by models are highly dependent upon spatial scales, time and organisational levels. We aggregate parcel-level data to a multi-spatial resolution grid so there is a sufficient level of detail to model cumulative growth effects (Irwin and Bockstael 2004). The spatial distribution of household growth is projected over a 20–25 year time period, in line with regional demographic forecasts. We propose a model suitable for disaggregating these regional forecasts in a way that handles the dynamics of the land development process. We assume that the transport network system is relatively stable over this period. Since our main focus is on the influence of land supply and planning constraints on the development of the urban fabric (Hunt et al. 2005). In the next section we review alternative approaches to modelling in order to understand their differences and commonalities.

Modelling Approaches

We broadly classify urban growth models as: (i) multi-level, (ii) empirical, (iii) cellular dynamics, or (iv) microsimulation. Multi-level models capture processes at a particular scale, holding larger scale effects constant and studying patterns of more detailed phenomena. The concepts of hierarchy and scale are well established principles in geography through central place theory and studies of urban structure (Anas et al. 1998). Modelling of urban systems may proceed from the national level down to regional and local scales. Higher levels dictate model behaviour at lower levels by setting parameters and allocation constraints. The lower levels combine new data in the detailed analysis while satisfying upper level constraints. Empirical models capture processes through analysis of trends. Observed data which have the best predictive relationship to urban growth variables are analysed statistically. Empirical models predict land use change by analysing past trends and maximising utility between alternative options. Typically either a logit (Landis and Zhang 1998) or a logistic regression (Verburg et al. 2004) is used to predict land use change. Cellular dynamics are based on a complex of areal units, or cells, which change state in response to transition rules. The state typically represents land characteristics such as land use and urban density. Transition rules analyse local characteristics (e.g. location preferences, growth along roads, expanding urban areas, development limitations from topography, etc.) within a neighbourhood to decide the probability that a cell will transition to another state. Models known as cellular automata simulate urban growth using explicit spatial rules for neighbourhood effects (White et al. 1997) and patterns of urban growth (Clarke et al. 1997). Microsimulation is another disaggregate approach that focuses on the interaction between urban processes and land use effects. Processes of demographic change, land development, housing choice and household activity patterns are simulated. Applications of microsimulation vary widely depending on what micro data are available and which urban processes are represented (Miller et al. 2004); they have a rich tradition in modelling land-use transportation interactions (Hunt et al. 2005) and more recently in modelling housing markets (Waddell 2000; Ettema 2011).

Despite the differences between these approaches, there is a lot of commonality in applied situations. Most allocation models attempt, at some level, to capture market forces determining land availability and residential preferences. Our approach was influenced by the requirement to assess the implications of alternative development policies using pertinent information and avoiding more complex micro-level urban analysis. A multi-level approach was highly desirable to integrate regional information, such as housing and population forecasts, with disaggregate modelling of land uses. The regional forecasts are provided as yearly totals for population, housing and employment (Queensland Government 2014). For the projection period of 25 years we could assume that major transport networks are stable or could be dealt with, along with other major changes in development areas, as discrete events. The problem was then to disaggregate forecasts in a way that dealt with the dynamics of land development. The spatial structure for the region may be characterised as a very weak polycentric hierarchy of mixed-use centres and residential locations around a major city centre, namely the City of Brisbane. The underlying fabric of land development for urban intensification and expansion is expected to change significantly from growth pressures, although many aspects of growth and land use change are controlled by zoning capacities and other land use regulations.

Urban Growth Objectives

A question of interest to planners is to what extent urban growth is shaped by human preferences and economic activity, as opposed to being regulated through planning processes. Over a long period the former has a significant effect, but in the short term the latter plays a dominant role in determining patterns of growth through planning controls. A 20 year forecast period is somewhere between long and short term. Policy makers are interested in the effectiveness of existing planning schemes, and the changes that can be made to best accommodate future growth. Thus, models have the dual purpose of: (i) evaluating existing policies, and (ii) developing future plans. Existing controls on growth are defined in planning schemes, in particular through prescribed residential densities. Planning schemes are set by local councils to provide infrastructure and services for the region. Although some variance from planning schemes is permitted, they do largely dictate growth patterns. From a regional policy perspective, the burning question is whether the growth capacity summed across local areas is sufficient to accommodate regional growth forecasts. If forecast growth exceeds planned capacity, this signifies impending shortages in the housing market and undesirable growth pressure in areas with inadequate services and infrastructure. Models that evaluate the efficiency of existing planning schemes are important for tactical planning and to inform negotiation between regional and local planning bodies. At the same time we want to evaluate if future plans support sustainable living principles (Commonwealth of Australia 2005). The impact of urban policy needs to assess interactions between land use and transport (Wegener 1994) and the environment (Landis 1995; Irwin and Bockstael 2004). One way to do this is with scenarios which play out future alternatives for urban policies (Couclelis 2005). Scenarios should be thought provoking, yet plausible. Planning can influence a number of variables; Wegener (1994) identifies factors associated with residential density, employment density, neighbourhood design, development location, city size, accessibility and transport as being related to land use policy.

The research reported here uses the LSUM model both to assess existing growth capacities and to generate and test potential future growth scenarios. It is important to recognise different levels of resolution in the urbanisation process. At a coarse level we recognise both urban expansion and intensification of development within existing urbanised areas. Land use transformation at the urban fringe is expansion, and land use transformation within metropolitan areas is referred to as intensification. At finer levels of resolution, expansion occurs into areas with existing rural residential or mixed uses, or onto greenfield land. Finer levels of intensification occur onto vacant land, urban residential, and brownfield sites. This discrete set of land classes provides a more meaningful representation of potential land use transitions (see Table 6.1 for allocation rates) than can be obtained by directly modelling land use changes. Our approach is to use the simplest representation of the problem while retaining information essential for modelling. We model household allocation to land classes at a regional scale based on capacity and accessibility. Capacity is the most crucial factor as it represents a planning constraint. As an area grows, available land stock is exhausted and densities get closer to regulated limits. Land scarcity is incorporated in other modelling approaches as a growth constraint (Hilferink and Rietveld 1999) or through land pricing via the marketplace (Wu and Webster 2000). We believe that space utilisation, as a function of urban capacity, is sufficient to model household growth. It is also an effective way to incorporate the influence of residential choice when combined with urban accessibility (Holm and Lundquist 1977). It captures the trade-off where land with high accessibility to urban services grows to its capacity quickly, whereas less accessible areas experience restricted growth but are ultimately settled to meet overflow demand.

The LSUM model combines these factors to allocate growth in a way that is shaped by the combined effects of urban accessibility, residential living preferences and planning capacities. Varying the relative influence of these factors enables us to evaluate scenarios. By raising capacities at strategic locations it is possible assess the impact of alternative densities on urban form and the pattern of urban growth. All the factors used to assess existing urban plans can be varied to evaluate alternative urban growth forms, such as a compact city, polycentric development or dispersed development (Wegener 1994). These scenarios are described in a later section, but first we explain the data model and allocation methodology.

Household Growth Data Model

This section describes the underlying data model and algorithm for allocating regional forecasts. The challenge was to find an appropriate scale and resolution for representing urban areas in models.

Spatial Representation Using a Multi-resolution Grid

Demographic and socioeconomic processes operate at specific scales, and the resolution of models needs to be relevant to these pattern-process relationships. Jantz and Goetz (2005) demonstrate the sensitivity of models to data resolution. In the SEQ study region there are over two million individual land parcels. This is an overwhelming number of objects to model computationally, and parcel scale is an inappropriate level of detail for understanding key urban processes. At the other extreme, administrative or statistical units such as suburbs are too coarse to capture the spatial nuances involved in urban processes. Their polymorphic spatial configuration also complicates spatial modelling. A common solution for dealing with multi-scale sensitivity is to use a multi-resolution procedure on gridded spatial data with variable sized neighbourhoods (Koomen and Borsboom-van Beurden 2011; Verburg et al. 2004).

As with most urban applications, the analysis utilises a range of socio-economic data each based on unique zonal boundaries. A gridded data representation facilitates analysis. Besides computational simplicity, a spatial grid provides a uniformly partitioned spatial structure to represent land classes. To overcome the shortcomings of a spatial grid we introduce two enhancements: (i) multiple attribution, and (ii) multi-scaled resolution (Wattelar 2006). Spatially-varying attributes are represented by a component value: for instance, the proportion of a cell made up by each land class (see Fig. 7.1). Dwelling counts and growth capacity are also represented on this basis for each land allocation class. The spatial resolution of the grid requires different scales between rural and urban areas. A two-level resolution is used to deal with multi-scale sensitivity. A one kilometre grid is used for most areas, but in areas with a larger population and higher housing density a 500 m grid resolution is used. A finer resolution grid reduces errors rates, but increases the number of grid cells used in analysis. A procedure was developed to test the variability of cells and to

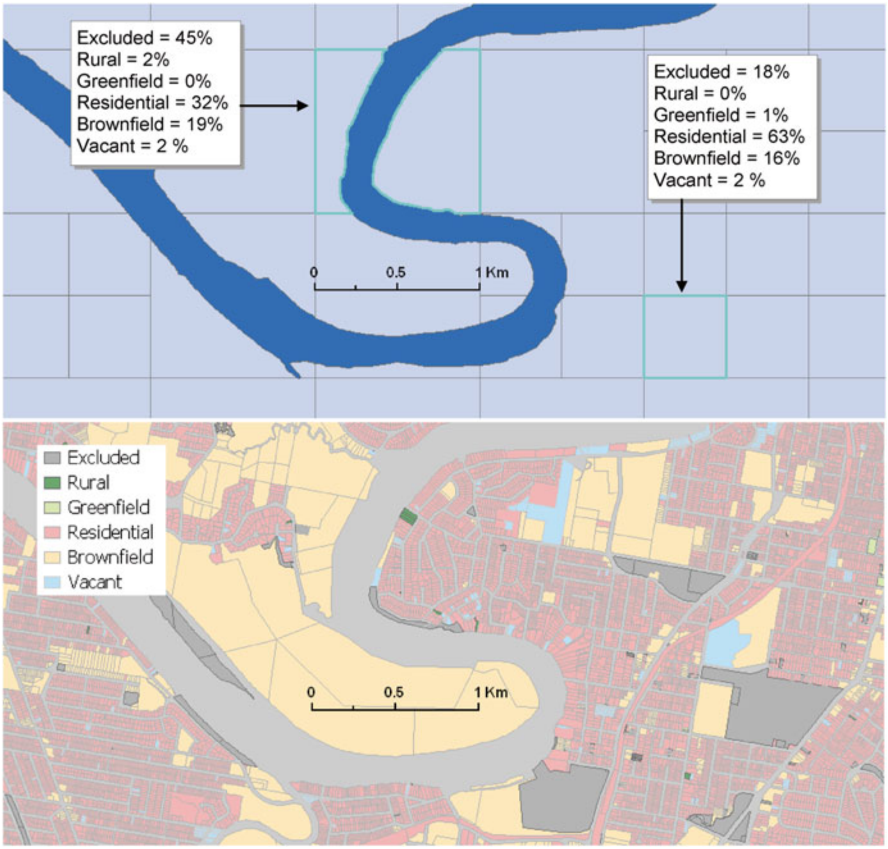

Fig. 7.1 Example of a spatial grid that represents the land data as component values for land allocation classes with a two-level spatial resolution

divide dense cells to a finer resolution. In general we found two levels (along with the multiple attribute description) provided a reasonable compromise for capturing spatial variability and for data processing.

Data Sources

The main factors considered in disaggregating household growth forecasts are land use classes, dwelling capacity and locational preferences.

Household Forecasts for the region were computed by the application of assumed living arrangement propensities, disaggregated by age and sex, to independently derived forecasts of population (ABS 2004; Wattelar 2006; Wilson 2013). The output comprises forecasts of total households classified by six broad categories of living arrangement, at 5 year intervals over a 25 year projection horizon. These were disaggregated to single years by interpolation but only growth in total households was utilised for our modelling. The population forecasts which underpin the household forecasting are delivered by a multi-regional cohort-component model that situates the SEQ region within the State and national context (Wilson and Cooper 2013; Wilson and Rees 2005).

Land Allocation Classes are derived from land use and zoning information to signify land conversion processes for urban expansion and intensification. The land tenure and primary land use activity is recorded for each land parcel. These were classified to the land allocation classes shown in Table 7.1. After classification, the land parcel data were aggregated to the spatial grid. For each cell we recorded an area-weighted proportion corresponding to the five land classes.

Urban Dwelling Capacities were obtained by compiling planning schemes for the 22 local government areas in the study region. A combination of planning regulations and zoning schemes were assessed to determine the dwelling capacities for individual parcels. These were then aggregated to the spatial grid with the dwelling capacity recorded for each land allocation class.

Table 7.1 Urban land classes

Expansion	
Rural residential	5%
Greenfield	20%
Intensification	
Vacant	50%
Urban residential	10%
Brownfield	15%

Residential Location Preferences and Accessibility Considerations were derived from a quality of life survey for the region. The methodology is described in Chhetri et al. (2007). In brief, a weighted score is assigned to cells in the spatial grid based on their perceived attractiveness and accessibility. This spatially derived weighted score is based on analysis of data for an urban quality of life survey involving a random sample of 776 households captured via telephone interviews. This was used to formulate a spatial indicator for location preferences and accessibility. For instance, questions on preferences for being located near natural areas (rivers, coast line, etc.), commercial areas, place of work, transit points (bus, rail or ferry stations) and the CBD were correlated to a factor for location preference. The survey data were geocoded so it was possible to compute physical accessibility of respondents to features such as parks, transport routes and job centres. A combined location preference and accessibility suitability score was developed and computed for each of the grid cells. For example, a high score is typically associated with being close to the CBD and aligned with transport networks.

Land Allocation Model

We applied a multi-level approach to urban growth modelling which disaggregates regional forecasts to the local level. Simple procedures may be developed to disaggregate regional data using multi-criteria analysis to represent residential location preferences (Koomen and Borsboom-van Beurden 2011), but realistic disaggregation procedures needs to reproduce key urban processes. The dynamics of space utilisation (Holm and Lundquist 1977) and spatial agglomeration are particularly problematic for allocation models using traditional multi-criteria analysis (Batty 2004). This section discusses the development of an allocation model using more advanced computational methods.

Optimisation Model

Land allocations that deal with complex objectives may be formulated as an optimisation problem. Optimisation is a procedure to find the best solution for a set of decision criteria. It has a generic form that seeks to minimise (or maximise) a set of decision objectives while also satisfying a set of constraints. Objectives have a degree of satisfaction determined by a cost-value function, whereas constraints are truth conditions determined by a predicate expression. The decision variables used in functions may represent spatial information, e.g. land uses, population, etc. From a spatial perspective we can distinguish global and local functions. For instance a global constraint may be that yearly population growth equals a given number, or a local constraint is that population in an area is less than a given capacity. Aerts et al. (2003) used optimisation to allocate land uses where there are development costs associated with each use, and the objective was to minimise this global aggregate cost. The optimisation we perform is different in that we are allocating a count variable, namely households, to areas.

We formulate the allocation procedure as an optimisation problem by specifying objective criteria and constraints. In our model, the constraint is a specified number of additional households to be allocated across the region within a year. There is an infinite number of ways to do the allocation, so we search for an optimal solution that maximises a set of cost measures over different objectives. To make comparisons between objectives compatible we standardise costs to a common scale, i.e. from 0 to 100%. The scheme allocates the projected number of households for a year to cells according to the following four objectives:

(i) allocate households among the five land classes based on historical trends;
(ii) assign households to cells with highest overall suitability;
(iii) progressively constrain new allocations in areas that reach dwelling capacity, and;
(iv) preferentially allocate households to growth locations, i.e. new development areas.

The suitability objectives are represented in the model as a combination of static and dynamic functions. Dynamic functions cater to changes in model variables within the allocation process, whereas static functions are constant within one allocation cycle. Static objectives include allocating households to cells based upon: (i) land classes, and (ii) location choice and accessibility preferences. For instance, an area of vacant land with high location preference and accessibility is rated as highly suitable for new households.

The first objective is to distribute the total number of households among the land allocation classes according to the rates specified in Table 7.1. Because these rates encompass the whole region, the allocation to cells evaluates a cost-value function which indicates the available land for the class and the extent to which the global allocation has been met. For instance, if a cell contains brownfield land and the global proportion for brownfield has not being met then households are likely to be assigned to this cell. The second objective is to assign households to areas based on residential location preferences and accessibility. This is expressed as an overall suitability measure as explained in Chhetri et al. (2007). Suitability is a natural way to express allocation in planning problems (Malczewski 2004).

Dynamic allocation functions include: (i) limiting the number of households to the capacity specified in the planning scheme, and (ii) spatial clustering of development. For instance, a cell with a small number of households relative to the planned capacity and close to other cells with high growth is rated with a high suitability for new households. Unlike the static criteria, these scores change within the optimisation process as households are progressively allocated to cells.

The third objective allocates households based on growth capacity modelled as a logistic function; this is the simplest form for a limited growth function and is commonly used in planning. A logistic function has an *s-shaped* curve which corresponds to a gradual take off, rapid growth in the intermediate stages, and a reducing rate of increase as it approaches carrying capacity (Fig. 7.2). This mimics real world processes where there is initially a modest market for new development, but subsequent uptake increases rapidly until capacity is met (Wu and Webster 2000).

The fourth suitability objective incorporates clustered growth patterns in of new residential development locations. Neighbourhood effects are incorporated in urban growth cell-space models (Engelen et al. 1997) to account for the attraction and repulsion effects from neighbouring land uses and landscape characteristics. This is essentially the phenomenon of spreading residential expansion in settlement patterns (Clarke et al. 1997) which in its simplest case is a diffusion term to spread the growth from a cell that undergoes growth (see central cell in Fig. 7.3) to its eight neighbourhood cells (numbered d_1–d_8 in Fig. 7.3).

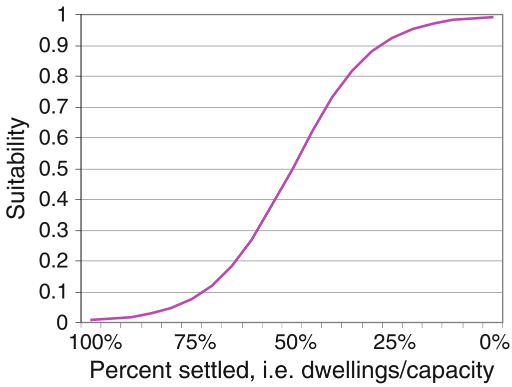

Fig. 7.2 Logistic curve as sigmoid function

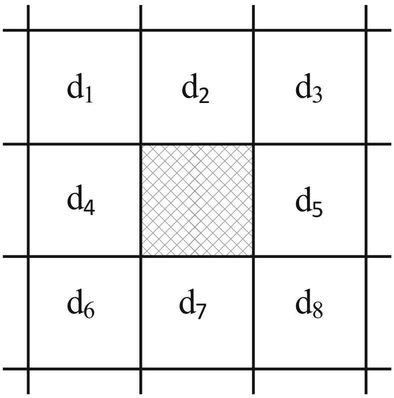

Fig. 7.3 The suitability score for neighbourhood development

Spatial Optimisation Algorithm

In multi-criteria optimisation we are given: (i) a decision problem in which we chose the 'best' among a set of 'alternatives', and (ii) criteria to assess the quality among the alternatives. The alternatives describe a continuous feasible set of options specified through the constraints. In most spatial problems the search space (i.e. set of variables to evaluate criteria) is not defined by real valued variables, but rather by an aggregate of local and neighbourhood spatial relationships for a candidate solution. Because there are a large number of feasible solutions, a strategy is needed to reduce the number of searches. The most common strategy for spatial problems is a *local search*. Local searches operate by making changes to a current spatial state to move to another feasible state. If the changes are applied in a way that leads to consecutive improvement in the overall aggregate criteria then this is called a *hill-climbing algorithm*. Hill climbing algorithms are computationally efficient, but are notorious for not finding the optimal global solution in spatial problems. Different strategies have been developed to avoid this problem; notably *simulated annealing* has been successfully applied to spatial optimisation problems. Simulated annealing allows for multiple search paths in the initial stages of iteration followed by hill-climbing to obtain a refined optimal solution in the later stages as it converges.

Simulated annealing uses a local search to identify changes to improve the solution; for spatial problems this involves repeatedly checking two cells at a time and swapping assigned quantities if it improves the overall allocation. On a yearly basis new households were assigned based on random sampling (guided by the suitability objectives) to cells, and the optimisation procedures swapped household assignments on this random basis to improve the overall allocation. This is a classical hill-climbing approach which may be trapped into a local minimum solution, so we use simulated annealing to find a better global optimisation. A more complete treatment on simulated annealing may be found in Kirkpatrick et al. (1983). The algorithm is analogously described by the physical process for the slow cooling of a liquid to achieve a crystalline state (i.e. as a local structure) with the minimum overall possible energy. A simulated annealing algorithm uses a variable analogous to temperature to control the sequence of changes in local searches. Simulated annealing uses two iterative loops. The pseudo code for the algorithm is presented in Fig. 7.4. An inner loop is similar to hill climbing where local changes are made between cells for the dwelling allocation. This is controlled by an outer loop which checks the aggregate criteria suitability for different solutions. If a solution produces a better overall suitability, it is accepted. If a solution produces a worse overall suitability, it is combined with the cooling variable as a coefficient and compared to a random value. If the coefficient is below the random value it is accepted; otherwise it is rejected. The cooling variable is reduced with each iteration of the outer loop so it is less likely to accept a solution with a lower aggregate suitability.

The simulated annealing algorithm is implemented in the visual basic language in ArcGIS. The performance for simulations is reasonable, usually converging to a solution in minutes for 24,000 grid cells. The user has the ability to weight objec-

```
Outer loop

current allocation ← initialise
repeat until stable solution
    new allocation ← local search allocation
    evaluate global change in objectives
    if change < 0 then
        current allocation ← new allocation
    else if change / cooling_coef < randon then
        current allocation ← new allocation
    reduce cooling_coefficient
end loop
```

```
Inner loop

repeat a large number of times
    cell1 = random selection
    cell2 = random selection
    score1 = criteria_suitability(cell1)
    score2 = criteria_suitability(cell2)
    if (score1 > score2)
        move household assignment 1→2
    else
        move household assignment 2→1
end loop
```

Fig. 7.4 Pseudo-code for simulated annealing algorithm

tives to change the solution. For instance, setting a lower weight for the third objective on dwelling capacities reduces its influence on the solution which is equivalent to relaxing the influence of planning schemes. This allows the model simulations to test 'what if?' scenarios by varying the weights or underlying data used in the allocation in line with policy decisions.

Results of Allocation

This section describes the versatility of the allocation procedure to address urban policy questions. An official legislated regional plan for the study area introduced growth boundaries in 2005 to promote compact growth and decentralised polycentric development (Queensland Government 2005). The growth boundaries aim to meet demand for future population growth while promoting a compact and efficient urban form. Higher density development was to be promoted particularly through transit-oriented development (TODs). At the time these policies and proposals were introduced, no sophisticated modelling had been undertaken to explore how forecast growth could be accommodated, nor to assess the quantitative impacts of TODs. To address these issues, we used the LSUM model to answer the two following questions:

1. How well do the specified urban growth boundaries accommodate forecast population for the next 20 years and what form does development take?
2. What difference does it make if policy shifts are made to encourage a compact urban form with higher density development around clearly defined centres?

While population growth in the SEQ region has accelerated rapidly over the subsequent decade, we report here the results of simulations run shortly after the urban growth boundary was announced.

To explore the first of the questions, an optimisation using the procedure described earlier was run for each year from 2005 to 2026. A summary of the variables is given in Table 7.2. We minimise the weighted sum of these variables and neighbourhood clustering for each year to test the influence of urban growth boundaries. Figure 7.5 shows spatial change in growth and density over the period.

The allocation represented in Fig. 7.6 shows results for areas within the urban growth boundaries in relative terms (with respect to capacity) and absolute terms for the modelled land classes. There only exist small pockets of land for urban expansion from rural and greenfield sites; these show a steady uptake as most sites are located in less preferred or less accessible locations. For urban intensification the existing land supply from vacant parcels shows rapid uptake. Intensification from brownfield developments and changes in residential areas increases steadily over the period. With regard to the first question above, from a planning point of view this indicates a high pressure on land and housing markets. As infill from vacant parcels is exhausted and levels off in 2020, there is a more rapid uptake of urban intensification around brownfield and residential areas.

Table 7.2 Variables re-sampled to multi-resolution grid

Variable	Role	Description
Cell Dwelling Count	Decision variable	Actual count given for 2005
Dwelling Capacity	Objective – growth capacity	Development capacity from planning schemes
Land Allocation Classes	Objective – heuristic distribution	Allocation land classes described in Table 1
Attraction Index	Objective – preference factor	Composite index of residential choice
Urban Boundary	Constraint	Flag for inclusion in urban growth boundary
Forecast dwelling growth	Constraint – yearly allocation	Yearly predicted growth in dwellings from 2005 to 2025

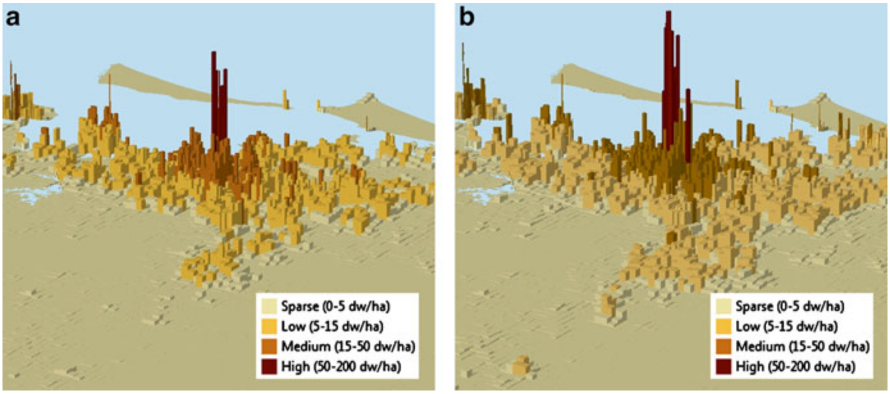

Fig. 7.5 Change in pattern of household density (dwellings per hectare) with an urban growth boundary. (**a**) Household density 2005. (**b**) Household density 2026

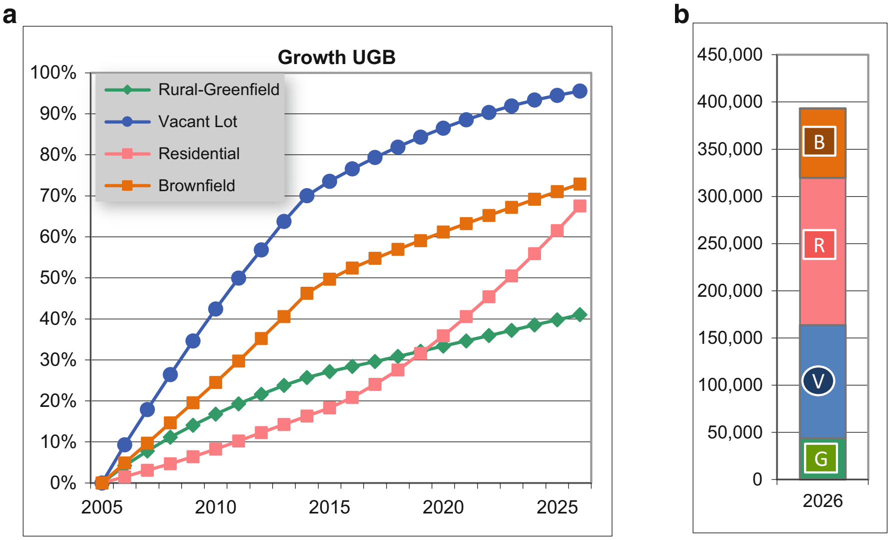

Fig. 7.6 Composition of growth for allocation classes with an urban growth boundary. (**a**) Growth as relative percentage of capacity. (**b**) Growth in household counts

What Impact Does the Growth Boundary Have on Urban Form? We use two spatial statistics to analyse the results of the allocation procedure. Galster et al. (2001) define spatial measures of sprawl and apply these to a number of US cities. We found that concentration and clustering, together with density, are good measures to identify the structure of urban form. Concentration describes the degree to which housing is disproportionately located in particular areas. It may be measured as the variation in housing density; Galster et al. (2001) define high density as two standard deviations or more above the mean for a subset of populated areas. We chose the mean density for all areas within the urban growth boundary as the benchmark. Clustering is the degree to which statistically high values are located close to each other. The local Moran statistic which measures spatial autocorrelation (Anselin 1995) is a popular method of identifying spatial clusters, and is more effective than arbitrary density thresholds for detecting patterns within cities (Riguelle et al. 2007). Measures for both concentration and clustering are shown in Fig. 7.7. Visual inspection of Fig. 7.7 shows only minor differences in urban form between 2005 and 2026, with some increase in concentration and clustering around the central business district located in the centre of the maps.

A separate optimisation procedure was run to address the second policy question identified above – namely to test the effect of allowing increased dwelling capacity around selected activity centres. These are distinguished in urban areas as a cluster of economic land uses with integrated shopping and public transit facilities (Anas et al. 1998). The policy objective is to promote compact development, reduce urban expansion at the metropolitan fringe and facilitate access to public transport by allowing higher density development in and adjacent to TODs. In line with current

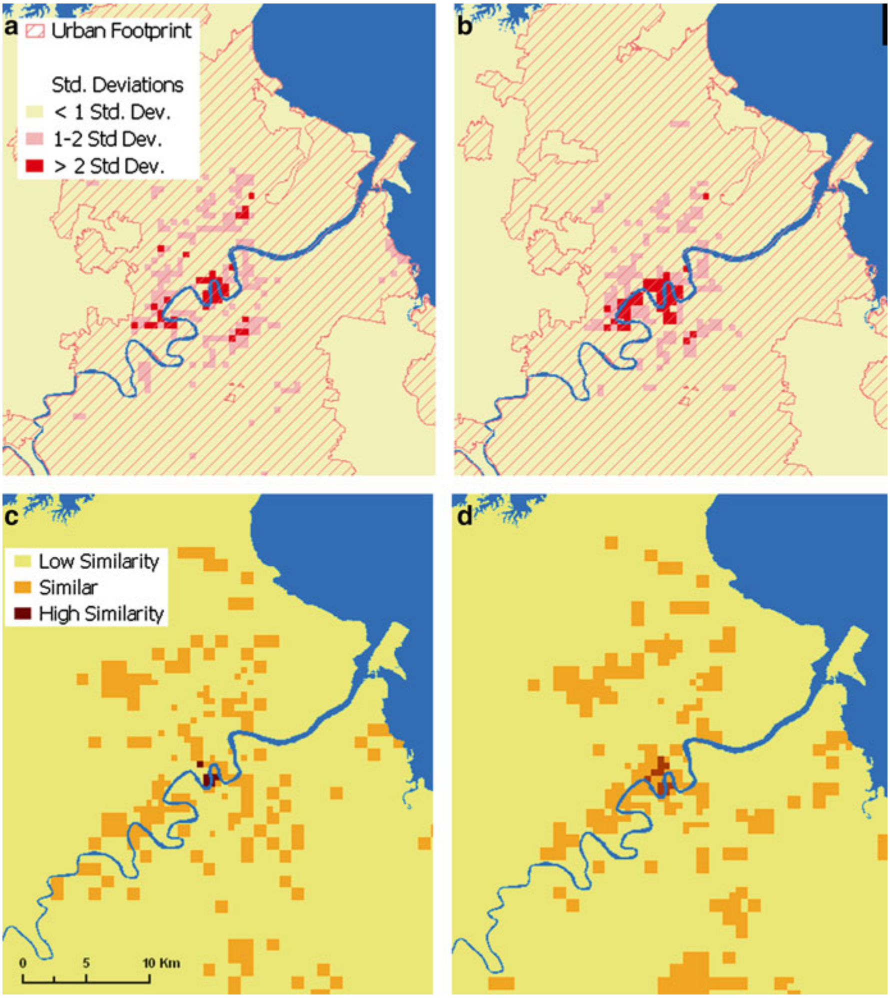

Fig. 7.7 Concentration and clustering pattern of household density with an urban growth boundary. (**a**) Concentration of households in 2005. (**b**) Concentration of households in 2026. (**c**) Clustering in household density 2005. (**d**) Clustering in household density 2026

density profiles of Australian cities, we chose a capacity of 100 dwellings per hectare within 750 m of large activity centres and 50 dwellings per hectare within 750 m of small activity centres. Figure 7.8 summarises results for the various land classes (i) relative to growth capacity, and (ii) by absolute value. There is still good uptake of vacant land as the preferred focus of new housing development, slightly less pressure on urban greenfield sites, and a significant drop in the intensification on residential and brownfield areas. Overall, there is a decline of around 25% in the utilisation of land within the urban growth boundary which translates to significantly less pressure on land and housing markets, and greater conservation of land.

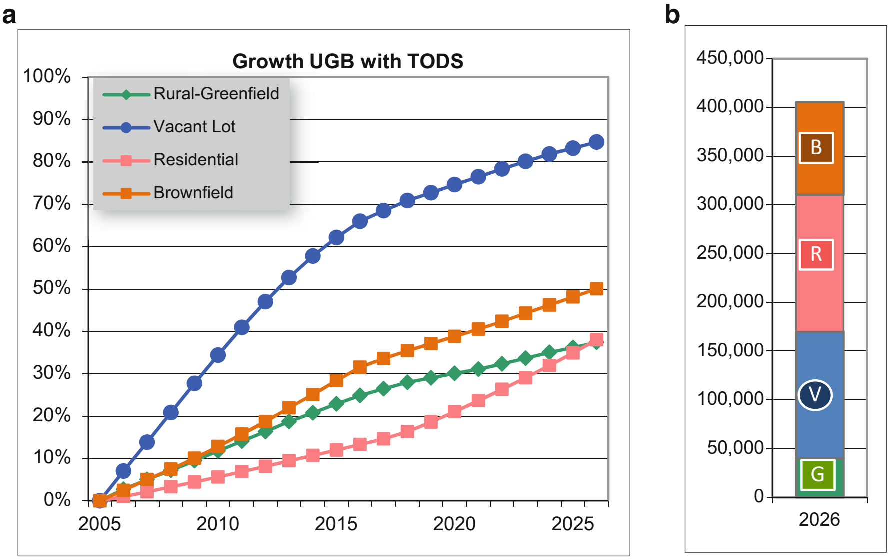

Fig. 7.8 Composition of growth for allocation classes with increased capacity at urban centres. (**a**) Growth as relative percentage of capacity. (**b**) Growth in household counts

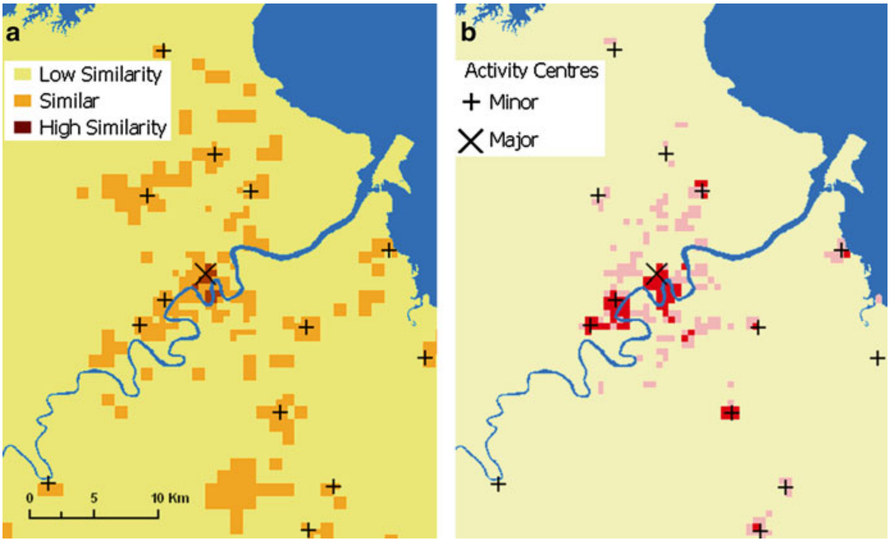

Fig. 7.9 Concentration and clustering pattern of household density with increased capacity at urban centres. (**a**) Concentration of households in 2026. (**b**) Clustering in household density 2026

Also, Figs. 7.8 and 7.9 show measures for concentration and clustering respectively. The main observation is that growth clearly occurs around the desired areas for activity centres.

Conclusion

The chapter has described the application of a classical top-down allocation model to disaggregate regional demographic forecasts to small areas within the rapidly growing SEQ region. Our approach offers a number of innovations. It adopts a multi-level and multi-state representation of the urban area and surrounding region (Wattelar 2006) that matches well with the way development occurs. It uses an optimisation framework to integrate components of the model and address computational issues. It also provides a framework that facilitates development of scenarios to address policy-relevant urban growth issues. Together, these innovations address some of the pressing issues in contemporary urban modelling (Timmermans 2003; Miller 2009).

Our approach departs from other urban models in differentiating various classes of urban land for the allocation of urban growth, in place of the more common approach which simply differentiates types of land uses. This classification provides a finer guide to the propensity for urban development. Allied to this, the LSUM model explicitly treats urban intensification as well as expansion along the urban fringe. Only a small number of land classes are required to accommodate the allocations for urban intensification and expansion. These classes are deliberately framed to be consistent with planning terminology and represent a meaningful basis for allocating new housing development over a moderate forecast horizon. Limiting the number of classes also facilitates data representation using a spatial grid. Grid cells have a multiple-attribute structure to record component values for the proportion occupied by each allocation class and associated values for household count and capacity. Maintaining this representation allows us to track changes to the allocation of households to cells over time.

The model is fully specified with the framework of an optimisation problem with objective functions and constraints. It applies multi-level concepts whereby the regional demographic forecasts constrain the overall number of new households allocated across the spatial grid. The objective functions modulate the propensity to assign new households to grid cells based on historical trends, changes in the capacity of each land class, and land suitability according to accessibility and residential preferences, while also respecting growth constraints expressed in terms of urban densities and policy goals aimed at a spatial clustering of growth. Using optimisation to allocate new households addresses concerns by Wegner (2011) in regard to data requirements, efficient computation and stochastic variation. Model constraints and objectives provide a means to handle locational choices (Miller 2009); in the LSUM model this is expressed in relation to residential preferences but other aspects such as commuting fields and housing market factors could also be accommodated.

Our aim was to develop a planning model that could test policy options for a large metropolitan region. We investigated how forecast population growth could be accommodated under existing planning schemes, and examined the implications of recent and possible planning interventions. Over a medium forecast period of

20 years we showed that forecast growth could be accommodated to available land within current housing density ceilings, but with significant resulting pressure on the urban housing market. This pressure could be partly attributed to the introduction of urban growth boundaries. Planning agencies are promoting higher density development around urban activity centres (TODs) as one mechanism to ease fringe growth expansion. We found that lifting the capacities around desired growth centres is effective in relieving growth pressures and concentrate development around activity centres. The allocation procedure and optimisation algorithm proved to be very flexible for modelling these changes. However, there are some limitations. For instance, the model does not currently allow growth capacities to change over the forecast period. In practice, we might expect changes to land classes and staged increases to allowable densities over time. Future work will focus on these shortcomings.

The mathematical specification of optimisation problems using constraints and objectives offers a conceptually simple and flexible way to define urban development scenarios. Beyond the two scenarios described in this paper we have investigated others based around the imposition of comprehensive planning proposals, the impacts of major extensions to the transportation system, and the attraction of development to different expansion areas and newly defined centres (see Stimson et al. 2012). The LSUM model has also been used to assess impacts on the natural environment and the pressure of urban expansion on conservation areas. Development and maintenance of large scale urban models such as LSUM requires substantial investment, particularly in the derivation and assembly of up-to-date data on land availability and planning constraints. Once in place, however, such models provide a powerful framework for simulating the development of urban form, assessing the adequacy of land availability and exploring policy options.

Acknowledgments This chapter is based on research funded by Australian Research Council Linkage grant. LP0453563 with additional support from the industry partner, the Office of Economic and Statistical research in the Queensland Treasury. The views expressed in the paper do not necessarily reflect Queensland government policy.

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Part III
Understanding Demographic Change for Planning and Policy

Chapter 8
Migration and Ageing Processes in Non-metropolitan Australia: An Analysis of 30 Years of Dramatic Change

Neil Argent, Trevor Griffin, and Peter Smailes

Introduction

While the ageing of post-industrialised nation populations is an established fact, the incidence and rate of demographic ageing is almost always severest in non-metropolitan parts of the settlement system (Australian Institute of Health and Welfare (AIHW) 2007; Kirschner et al. 2006; Davis and Bartlett 2008; Stockdale 2011). In the Australian context, the relative concentration of ageing in rural regions results from the complex interactions of a small number of migration currents, all set within broader secular trends of increased longevity and declining fertility. In particular, structural ageing across rural Australia is being substantially driven, or at least heavily reinforced, by two key internal migration processes: the out-migration of the young working-aged (chiefly 20–29 year olds); and the in-migration of two contrasting post-retirement streams – local farm retirees and amenity-seeking 'tree change' and 'sea change' retiree migrants from farther flung regions, including metropolitan areas. In the first case, the net loss of younger people greatly accelerates, and accentuates, structural ageing (Davies and James 2011) while the latter migration current increases both numerical and structural ageing processes (see Han and Corcoran 2013; Smailes et al. 2014). For the bulk of non-metropolitan Australia the weaker compensatory migration currents are inadequate to replenish the loss of youth. International migration, running at historically high levels since the mid-2000s (McGuirk and Argent 2011), is a key source of demographic rejuvenation at

N. Argent (✉)
Division of Geography and Planning, University of New England,
Armidale, NSW 2351, Australia
e-mail: nargent@une.edu.au

T. Griffin • P. Smailes
Department of Geography, Environment and Population, University of Adelaide,
Adelaide, SA 5005, Australia
e-mail: tlcandmc@bigpond.com

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_8

the national level but, as has been well-documented (Hugo 2008) the vast majority of these migrants arrive and remain in the major capitals, Sydney and Melbourne. Although a number of migration programmes exist to deliver international migrants to regional areas – chiefly those on skilled temporary work visas (see Hugo 2008; Argent and Tonts 2014) – these do little to ameliorate the net loss of 'home-grown' young people.

The cumulative outcome of these processes is demographic ageing, expressed differentially at regional and local scales. The highest levels of demographic ageing – measured by the elderly's (65+) share of the population – are usually found in traditional, inland, broadacre farming-dependent regions (Davis and Bartlett 2008; Horton et al. 2010). When coupled with the chronic decline of total population numbers and associated loss of public and private services since the mid-1980s, the accelerated ageing of increasingly locationally-disadvantaged populations is creating 'hot spots' of entrenched and multiply-determined disadvantage, poverty and poor physical and mental health (Davis and Bartlett 2008).

This chapter focuses on the lower reaches of the Murray-Darling Basin (MDB hereafter) of south-eastern Australia (Fig. 8.1). Widely regarded as one of the nation's most important 'food bowls', the MDB incorporates a number of distinctive regions – the Riverland (SA), Sunraysia (Vic), and Murrumbidgee Irrigation Area (NSW) amongst others – whose agricultural bases are highly dependent on irrigation. As a contribution to the ongoing discussion of the optimal set of local and regional population planning strategies for rural Australia (Hogan et al. 2012;

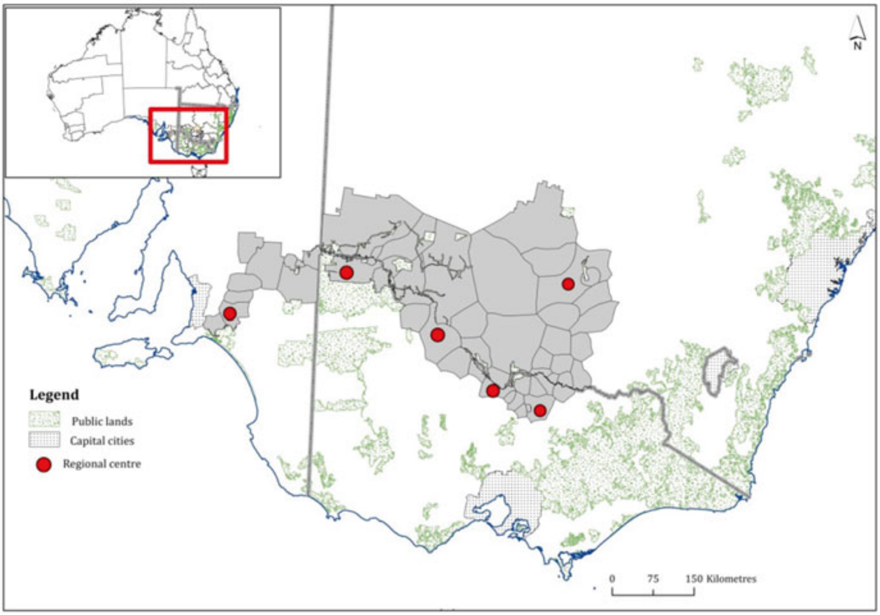

Fig. 8.1 The lower Murray-Darling Basin study area

Smailes et al. 2014), this chapter, after setting the historical context, has four central aims. First, it traces numerical population changes within the MDB study area through three decades of tumultuous climatic, regulatory, economic and social change (1981–2011). Second, two simple indices of relative ageing are introduced, applicable at a variety of scales, and designed to measure the degree to which ageing in a regional or sectoral sub-population diverges from that of the national population. Third, using these measures, the chapter seeks to demonstrate the substantial differences in the rate, nature, extent and significance of ageing within the study area at three scales of resolution within the regional settlement system. Finally, it seeks to draw out the relevance of the findings for local and regional aged care service planning. The chapter is structured in accordance with these aims.

Blooming Deserts, Blossoming Communities? The Lower MDB Case Study Area

The inland irrigation-dependent regions at the core of this study form part of a much larger study area (and socio-economic and demographic database) used by the authors to analyse social, economic and population change across south-eastern Australia since the early 1980s (Argent et al. 2005). The spatial units used are approximations of the social catchments of country towns, based on a gravity model calibrated from extensive empirical research in South Australia (Hugo et al. 2001; Smailes 2000, 2002, 2006) and then applied to the rest of the study area. Areas of overlap between social catchments have been split along median lines to give mutually exclusive and exhaustive spatial units, to which Census data at the CCD (Census Collectors' District) level were fitted, using a concordance.[1] The restricted data available for CCDs in the first censuses of the study period necessitates combination of the oldest age groups to a single 75+ bloc. The boundaries of these spatial units have been held constant over the study period; they are preferred to the census Statistical Local Areas (SLAs) which have been subject to much change over time and in many cases fail to match empirically observed social catchments. For each social catchment, for convenience frequently referred to as "communities", separate data are available for the central town itself, the dispersed rural settlement, and any subsidiary clustered settlements identifiable as separate CCDs.

All communities in which irrigated agriculture (including intensive viticulture, orcharding, horticulture as well as rice, cotton etc.) accounts for at least 25% of the value of agricultural production, and/or accounts for at least 0.5% of the total irrigation water volume used in the three study area states (2010–2011) were included, plus three small non-irrigated communities added to consolidate the shape of the study area. All are located in low rainfall areas (median 375 mm. annually) and

[1] For the 2011 Census, where CCDs were no longer used, where necessary the equivalent SA1 units were partitioned between catchments as accurately as possible, using meshblock data.

many have a nucleus of dense irrigation-based settlement surrounded by extensive areas of dry farming or pastoral country (Fig. 8.1).

Many communities owe their existence to colonial and later State Governments' ongoing experimentation with 'closer settlement' policies during the late nineteenth and early twentieth centuries. With the exception of the Chaffey Brothers' schemes around Mildura and Renmark, these were public sector initiatives, with colonial and later State governments assuming the vast majority of the financial and legal responsibility for establishing and maintaining irrigation and urban infrastructure (Williams 1975). Later, the national duty of honouring First World War servicemen formed a third strand in this policy/ideology complex, with Soldier Settlement used to populate the newly productive landscapes (Williams 1975; Powell 1988). Not surprisingly, then, many case study towns and communities are less than a century old, and date from the establishment of schemes such as the Murrumbidgee Irrigation Area.

Within a few short decades the heavy public investment in such schemes was scrutinised from increasingly critical economic and environmental perspectives, with analysts like Davidson (1969), for example, arguing that publicly-funded irrigation developments were an uneconomic use of scarce capital, given both the schemes' large sunk costs, and the substantial direct and indirect subsidies applying to many farm commodities at that time (Pigram 1988; Powell 1988). Later, as salinity – both the dryland and irrigation forms – spread its deadly tentacles across large swathes of the MDB the full environmental costs of 'watering the desert' began to be realised (Powell 1988; Lawrence and Vanclay 1992). The long-term ecological toll exacted by upstream impoundments on the downstream river ecology further strengthened policymakers' belief that wholesale changes to inland riverine management were urgently required.

Since the late 1980s, then, the study area communities' access to irrigation water has come under increasingly stringent scrutiny and control. Following the 1987 Murray-Darling Basin Agreement, genuine cross-state and Federal co-operation in water regulation led to the 2004 Council of Australian Government (COAG) framework on national water regulation: the National Water Initiative and the 2007 Water Act. The latter saw the creation of the MDB Authority and the preparation of the controversial Basin Plan, which recommended reduced extraction limits for each major irrigation region. Simultaneously, irrigation water has been permitted to be freely traded, within prescribed volume limits, across the MDB (Henderson 2015). The first Basin Plan, released in 2010, was vigorously resisted across the MDB, though it is important to note that Basin communities did not necessarily present a united front against the plan. For South Australian irrigators and their communities, forced to endure declining quantities and quality of water as the 'Millennium drought' and upstream use reduced availability, any scheme that forced more water down the Murray and into the State's suffering river systems and wetlands – including the Coorong – was welcome. Upstream of South Australia, though, concerns focused on the potentially dire consequences that proposed irrigation water cutbacks would have on farm incomes and rural communities.

Population Change Within the Lower MDB

The 54 communities in the present study area are treated as a single hierarchical level in terms of the standard daily to weekly social interactions with their respective immediate social catchments. However, they include a number of regional cities which *also* provide service functions at a higher level in the urban hierarchy, over a much wider area. Two major findings of earlier research (Smailes et al. 2014) were: (a) the very different demographic trajectories of these major communities, compared with those of the surrounding country towns; and (b) striking differences in trends in the rural as compared with the urban population elements, irrespective of community population size. This chapter tests these differential findings and their implications at the regional level. All six regional cities – Murray Bridge, Mildura, Swan Hill, Griffith, Shepparton and Echuca – anchor communities whose total populations exceeded 16,000 in 2011, while in the 48 surrounding smaller communities the median total population was just 2900. Their interquartile range was 1650 to 5900, in round figures.

In addition to their *central towns*, a number of communities possess one or more subsidiary townships, 31 of which are identifiable at every census during the 30-year period. The *rural* population consists of dispersed rural settlement and any small clusters of dwellings not separately identified by the census in 1981. Thereafter, any small cluster that by 2001 had grown to a point where it was identifiable in the census geography is still included as Rural, to maintain comparability of the four population segments (central towns and rural remainders of the 6 largest and 48 smaller communities respectively) over time.

The total population of the study area reached a value close to 360,000 by 2011, after growing 17.2% over the previous 30 years (Table 8.1), compared with a national growth of 47.6%. However, this overall increase conceals a major contrast between the urban and rural components of the communities: the 54 central towns grew by 33.6% during the 30 years, while the rural remainder declined by 7.6%. Thus, between 1981 and 2011 the central towns increased their share of the study area population from 58 to 67%, or about two thirds. Additionally, the rural decline of −7.6% (Table 8.1) certainly understates the extent of urbanisation in the study

Table 8.1 Population change in MDB case study area over the period 1981–2011 (n = 54 communities)

	Central towns			Rural remainder			Study area total		
	Population ('000)		% Change	Population ('000)		% Change	Population ('000)		% Change
Communities	1981	2011	1981–2011	1981	2011	1981–2011	1981	2011	1981–2011
6 Largest	80.3	120.1	+49.6	34.9	35.4	+1.3	118.5	159.3	+34.4
48 Smaller	98.5	118.9	+20.6	81.4	72.1	−11.4	187.8	199.8	+6.4
Study Area	178.8	239.0	+33.6	116.4	107.5	−7.6	306.3	359.2	+17.2

area, because the 2011 "rural" population still includes 16 subsidiary townships that had become identifiable by that time, of which eight were functional outliers of the regional cities. Meanwhile, the 31 subsidiary settlements identifiable over the whole period (not separately shown on Table 8.1) increased their aggregate population by some 13% to reach a total of 12,600 – still only 3.5% of the study area total.

Table 8.1 also illustrates the dominant role of the 6 largest communities, based on the regional centres. These increased in size at twice the rate of the whole study area, though still slower than the national average. In fact, this value relied upon four of the six (Echuca, Mildura, Murray Bridge and Shepparton), while the other two (Griffith and Swan Hill) showed little growth. Nevertheless, in aggregate the group generated 77% of the 30-year net growth. Among the other 48 communities, although two more than doubled in size (Moama and Strathalbyn), 27 actually declined over the period. Thus the aggregate growth of the smaller communities was relatively small, held back by a substantial decline in their rural remainder.

A further characteristic of the change in population over the 30-year period was its variation over time (Table 8.2). The rate of increase for the study area as a whole declined markedly after the first 10 years, particularly across the smaller 48 communities.

The 1980s, then, were a decade of relatively robust growth, while the early 1990s to the present have been marked by fluctuating population increases. Dominating the overall growth are the regional centres, which have occasionally experienced annual average rates of growth double that of the national average. The most radical and widespread deterioration occurred in the "rural remainder" of the smaller communities, after 1991. Interestingly, the most recent intercensal period has seen substantial growth in the regional centres' hinterlands, perhaps indicating the development of some 'spillover' effects.

Spatially, aggregate population declines appear to be associated with the more broad-acre irrigation farming dependent communities, while communities that experienced net growth tend to be adjacent to the Murray, with more varied economic and employment bases that include intensive horticulture and/or tourism, retirement and lifestyle functions (Fig. 8.2).

Table 8.2 Population change in community central towns and rural components, 1981–2011 intercensal periods (percent)

	1981–1986	1986–1991	1991–1996	1996–2001	2001–2006	2006–2011
6 largest (central towns)	10.65	5.84	3.03	9.68	6.86	5.77
6 largest (rural remainder)	–4.01	2.42	3.59	–0.35	–5.30	5.40
48 smaller (central towns)	3.42	5.30	2.21	2.63	3.27	2.27
48 smaller (rural remainder)	1.19	1.72	–2.25	–1.17	–6.62	–4.20
Total study area	3.83	4.23	1.41	3.46	1.10	2.13

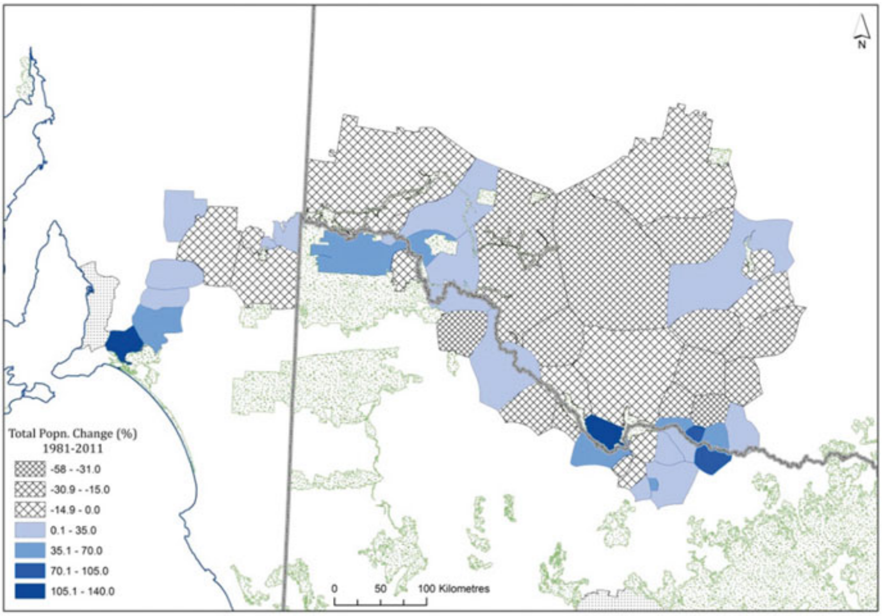

Fig. 8.2 Total population change, lower Murray-Darling Basin study area, 1981–2011

Measuring the Ageing Process

Conceptually, measures of the ageing process fall into three main categories: those that (a) compare the ageing status of two or more populations at a given point in time; (b) measure the amount or rate of ageing in a single population over time; or (c) measure the relative rates of ageing of two or more populations, where one is used as the basis for comparison. For the purposes of this chapter, a measure of type (c) is required and, accordingly, we apply a recently developed measure termed the "Relative Ageing Index" (RAI), along with a closely related measure of type (a), the Comparative Age Profile (CAP) (Smailes et al. 2014).

The RAI is a measure of the extent to which the *rate* of ageing of a region over a given period exceeds or falls short of the rate for the whole national population. The CAP on the other hand measures the extent to which the age structure of a given sub-population is "older" or "younger" than a comparator (in this case the total Australian population), at a single point in time. The rationale for these measures and their relation to other indices of ageing in use in the literature is outlined in detail elsewhere (Smailes et al. 2014). Briefly, though, the two indices have several key advantages compared with more commonly used measures (such as the proportion of the population aged 65+, or the number of persons aged 65+ per 100 aged 0-14). Most importantly, the CAP and the RAI take account (respectively) of the age status/ageing process throughout the entire age/sex pyramid, rather than just focussing on the two extremes. Secondly, as we demonstrate below, they each combine an easily calculated overall *numerical* value for (respectively) the ageing process/ agedness with the option of *graphical* depiction of the ageing (or age status) profiles throughout the age structure. Thirdly, they can take either positive values indicating relative youthfulness/ rejuvenation, or negative values for agedness or ageing. These (and other) advantages make them powerful tools for description, visualisation and analysis of the ageing process in its spatial context.

Both measures take full account of the twofold nature of the structural ageing process, in which the depletion of the younger age groups at the base of the age/sex pyramid is generally accompanied by a parallel expansion of the older age groups at the top. In the former case the main mechanism is a reduction in fertility in the female members of the child-bearing age groups, and in the latter the increased longevity of both sexes, though both of these primary mechanisms may be strongly affected (either mitigated or reinforced) by age-specific net migration flows to/from the relevant age-groups. The two processes normally act in concert, and the RAI and CAP seek first to measure, and then add together, their separate contributions in order to provide indices of ageing that apply to the entire age/sex structure. To achieve this, the age structure of the studied population(s) is first divided into two parts, separating those cohorts whose female members are in or below the reproductive age groups, from those in the post-reproductive ages. The dividing line is not immutable, but here it is set between the age groups from 0 to 44, and those of 45 and above, in line with the conventional upper limit of female fertility used in measurement of fertility rates. Ageing of a population over time is then measured by the degree of *shrinkage* in the age groups potentially capable of reproduction, plus the degree of *expansion* of the post-reproductive cohorts. In this additive approach the RAI and the CAP differ from existing ratio-based indices.

The conceptualisation and construction of the Relative Ageing Index is illustrated in Figs. 8.3 and 8.4. Initially, Fig. 8.3 compares the 1981 and 2011 age/sex pyramids for (a) Australia (left), and (b) the present study area (right). The horizontal line above the 40–44 age-group separates the cohorts whose female components are conventionally taken as potentially capable/not capable of reproduction, as outlined above. Visual comparison of the two diagrams shows that, while ageing has clearly affected both cases quite strongly, the study area has experienced a substantially greater shrinkage of the younger cohorts and a relatively greater expansion of the older ones over the 30 years, as compared to the national norm.

However, to quantify what can at best be an imprecise visual comparison of these differences, the RAI provides a numerical index through which the ageing of a target sub-population (in this case the study area) is more precisely measured against that of the comparator population (in this case Australia as a whole) over the given time period.

In constructing the index it is only the extremities of the bars representing the 5-year cohorts in Fig. 8.3a, b that are of interest, where the non-overlap of the 1981 and 2011 bars indicates change in each cohort's share of the total population over the time period. The 1986–2011 *differences* in these gains or losses as between Fig. 8.3a (the national norm) and Fig. 8.3b (the study area) are represented graphically in Fig. 8.4a, using the same horizontal scale and showing, for each cohort, the extent

Fig. 8.3 Change from 1981 (*shaded*) to 2011 (*blank*) in the age/sex structure of: (**a**) Australia as a whole; and (**b**) the lower MDB study area

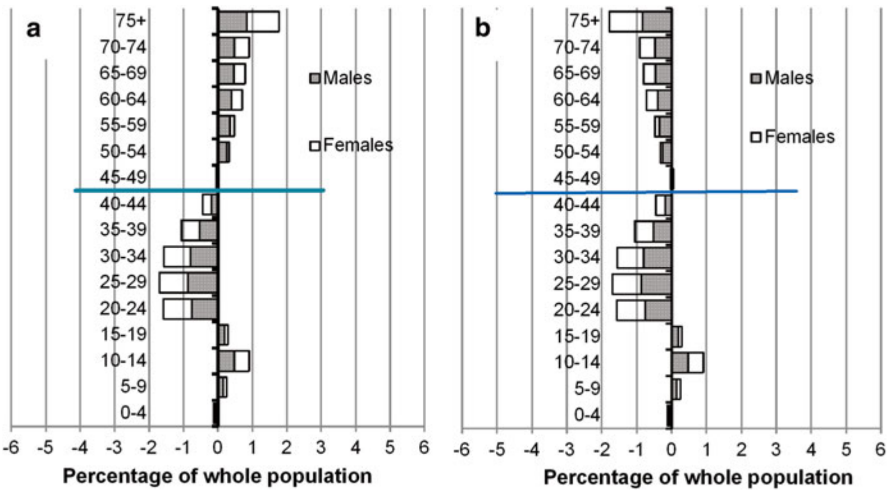

Fig. 8.4 The ageing of the lower MDB study area in comparison with that of Australia's population as a whole: (**a**) before, and (**b**) after inversion of sign for the post-reproductive age groups (Australian Bureau of Statistics (ABS) and Space-Time Research Pty. Ltd. 1990; Australian Bureau of Statistics 2012)

to which change in the study area exceeds or falls short of the equivalent change in the national population. The data and method of calculation for Fig. 8.4a, b are shown in Table 8.3. For example, the top line in the Table shows that the 75+ age groups increased nationally by 2.94% over the 30 years, whereas in the study area they increased by 4.84%, a difference of +1.9 percentage points (Table 8.3, column g; top bar, Fig. 8.4a).

Figure 8.4a, then, plots the results from column g, showing the combined male and female components of the change. For all but the first cohort from age 45 upwards, the study area has aged faster (increased more) than the national comparator. Likewise, all but one of the cohorts below the age of 45 shrank more rapidly than the national equivalents. The plot in Fig. 8.4a resembles an inverted S-shape, whose pronounced divergence from the vertical axis and very small incidence of cohorts ageing less than the national equivalents indicates a substantial relative ageing, extending almost throughout the age structure.

One further step is needed to produce the Relative Ageing Index. In Fig. 8.4a, the positive and negative deviations of each cohort from their national equivalent by definition cancel each other out, and sum to zero (see Table 8.3, column g). Therefore in Fig. 8.4b the sign of the deviations is *inverted* for all age groups above the 40–44 age cohort, such that the seven oldest age groups switch to the opposite side of the vertical axis (Table 8.3, column h). All cohorts in which ageing exceeds that of the national population, whether by shrinkage of the potentially reproductive age groups or expansion of the post-reproductive ones, now appear in Fig. 8.4b on the *same* (left, or negative) side of the vertical axis. Likewise, any cohorts which have aged less than the national comparator appear on the right, and produce a partially offsetting positive score. After this sign inversion, the ageing values for all the cohorts (+ and -) can be summed to produce a non-zero value which we have termed the RAI – in this case −10.96, where 0.00 would indicate ageing exactly keeping

Table 8.3 Calculation of the difference in rates of ageing between the study area and the entire Australian population, 1981–2011, by age group

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
	Australia			Study area				
Age group	1981 (%)	2011 (%)	Diff 81 − 11 [(b) − (a)]	1981 (%)	2011 (%)	Diff 81 − 11 [(e) − (d)]	Excess or deficit cf. to Australia (f) – (c)	After sign inversion, ages ≥ 45
75+	3.50	6.44	2.94	3.38	8.22	4.84	1.90	−1.90
70–74	2.71	3.29	0.58	2.63	4.20	1.57	0.99	−0.99
65–69	3.60	4.27	0.67	3.50	5.07	1.57	0.90	−0.90
60–64	4.11	5.61	1.50	3.92	6.32	2.40	0.90	−0.90
55–59	4.98	6.03	1.05	4.92	6.52	1.60	0.55	−0.55
50–54	5.20	6.73	1.53	5.19	7.05	1.86	0.33	−0.33
45–49	4.96	6.99	2.03	5.03	6.97	1.94	−0.09	0.09
40–44	5.64	7.17	1.53	5.68	6.73	1.05	−0.48	−0.48
35–39	6.70	7.07	0.37	6.22	6.02	−0.20	−0.57	−0.57
30–34	8.18	6.76	−1.42	7.38	5.20	−2.18	−0.76	−0.76
25–29	8.12	7.04	−1.08	7.56	5.34	−2.22	−1.14	−1.14
20–24	8.56	6.79	−1.77	7.91	5.22	−2.69	−0.92	−0.92
15–19	8.64	6.54	−2.10	8.89	6.84	−2.05	0.05	0.05
10–14	8.88	6.37	−2.51	10.18	7.29	−2.89	−0.38	−0.38
5–9	8.58	6.29	−2.29	9.43	6.54	−2.89	−0.60	−0.60
0–4	7.63	6.61	−1.02	8.18	6.49	−1.69	−0.67	−0.67
Total	100.00	100.00	0	100.00	100.00	0	0	−10.95

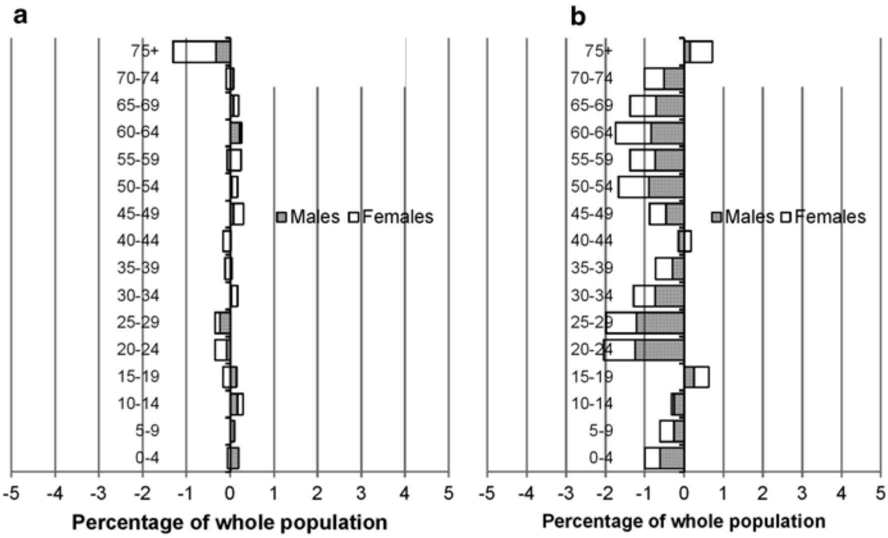

Fig. 8.5 Relative ageing profiles, six largest communities cf. to Australia as a whole, 1981–2011; (**a**) Central towns; (**b**) Rural remainder (Australian Bureau of Statistics (ABS) and Space-Time Research Pty. Ltd. 1990; Australian Bureau of Statistics 2012)

pace with that of the national population. Figure 8.5b, then, represents the study area's *relative ageing profile* for the period. Ageing is strongly consistent throughout the age structure of the study area, for almost 99% of the deviations plotted in Fig. 8.5b are negative, with very small positives in just two age groups.

To assist in interpreting the RAI value of −10.96, the units are percentage points by which net change in the age structure of the target subpopulation differs from that of Australia as a whole. The index has no fixed upper limit, but in real populations it is unlikely to ever approach ±100. Values for individual communities in the present study area range between −34.5 (very strong relative ageing) and + 0.5 (very weak relative rejuvenation).

The Comparative Age Profile (CAP) is constructed in the same way as that described above for the RAI, with inversion of the sign of the differences for the 45+ age groups to produce a numerical index. In this case, however, it compares just two age profiles (the target subpopulation against Australia) at a single point in time, rather than measuring the rate of change over time. Thus the CAP gives a measure of relative age status at each census year, while the RAI measures change in relative ageing between any two censuses. For example, the CAP value for the entire study area was +1.00 in 1981, and −9.96 in 2011. The difference of −10.96 between the two equates exactly to the RAI index for the period.

Differential Ageing Across Space and Time

Central to this chapter's focus are the dynamic processes of population ageing in the lower MDB since the early 1980s, interpreted through the CAP and RAI measures outlined above. As noted, the RAI for the whole study area for the 30-year period was −10.96, and its ageing profile is shown in Fig. 8.4b. A major feature to be investigated, however, is how far the urban and rural population components differ in their contribution to the overall picture. Starting with the six communities based on regional cities, the rural and urban ageing profiles appear in Fig. 8.5.

The massive rural/urban contrast in these major communities is striking, with the regional cities themselves ageing only marginally more than the national norm, and that due only to a greater ageing in the top (75+) age groups. Even in the immediate social catchments of these regional cities, however, rural ageing exceeds the national norm almost (but not quite) throughout the age structure, with an RAI of −14.7. In the 48 communities on the next rung down in the settlement hierarchy, the urban/rural contrasts are still observable, but somewhat different (Fig. 8.6).

In these lower order communities the *rural* ageing profile is very similar to that of the six regional cities, though even more intense, with the RAI dropping to −19.4. The urban profiles for the 48 communities and the regional cities are vastly different, however, exposing far stronger evidence of ageing, almost throughout the age structure. Particularly striking is the very strong concentration in the oldest age groups in the 48 country towns, relative to Australia as a whole.[2] By contrast, in both Figs. 8.5 and 8.6 ageing among the dispersed rural population aged 75 years and more has been *less* than the national average, forming an opposing "mirror image" of trends in the towns, implying a strong sign of rural-urban retirement migration. A further common feature of the rural populations is a positive ageing in the 15–19 age group, with increasingly negative trends moving down the age structure to the 0–4 group. We return later to the impact of falling fertility on this trend.

Table 8.4 reveals a number of salient features of the lower MDB's population ageing since 1981. Firstly, ageing has been a temporally discontinuous process. The 1980s ushered in a phase of particularly rapid ageing across the study area, though least so for the six regional centres. The 1990s saw a marked slackening in the ageing process, with the regional cities producing signs of a slight rejuvenation. The final decade saw a return to more rapid ageing, with the final inter-censal period producing the highest aggregate RAI values in the entire series. Over the study period the number of communities ageing faster than the national mean also followed a similar pattern, rising to 51 of the 54 communities in the final inter-censal period. By 2011 the number of communities exhibiting age structures younger than the national standard, measured by the CAP, had declined to four: Griffith, Robinvale, Shepparton and Leeton.

[2] The compression of the oldest 5-year age groups into one, (75+), makes no difference to the RAI score, as the RAI is insensitive to the number of age groups. It will give the same value whether 1, 5, 10 or irregular age groups are used.

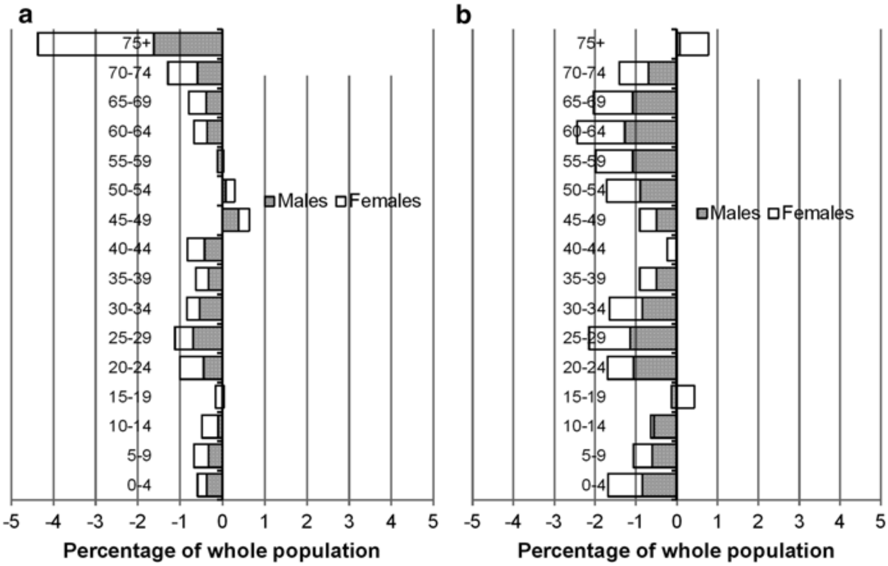

Fig. 8.6 Relative ageing profile, 48 smaller communities cf. to Australia as a whole, 1981–2011; (**a**) Central towns; (**b**) Rural remainder

Table 8.4 Relative ageing the study area, as compared with the entire Australian population, 1981–2011, by community type

	CAP	RAI						CAP
	1981	1981–1986	1986–1991	1991–1996	1996–2001	2001–2006	2006–2011	2011
6 regional centres	1.46	−1.67	−1.35	0.40	1.87	−1.47	−2.16	−2.92
48 smaller communities	0.71	−3.35	−3.23	−0.75	−1.06	−3.60	−4.29	−15.57
All 54 communities	1.00	−2.68	−2.48	−0.25	0.25	−2.59	−3.20	−9.96
Communities ageing>Aus.		45	43	36	32	48	51	

Simultaneously, the relationship between the youthfulness/elderliness and the large/small size of the community population gradually increased. As well as ageing much more slowly than the smaller communities, the aggregate population of the six regional cities experienced continuous growth over the 30 years, while that of the other 48 communities remained essentially static in aggregate over the final two decades (Tables 8.1 and 8.2). In this latter period 31 of the 48 smaller communities aged more rapidly than the Australian average. This combination of a static population and an increased rate of ageing suggests that the process involved was essentially one of intra-community 'ageing-in-situ' extending almost throughout the lower level of the settlement hierarchy. Over the study period, however, a weak

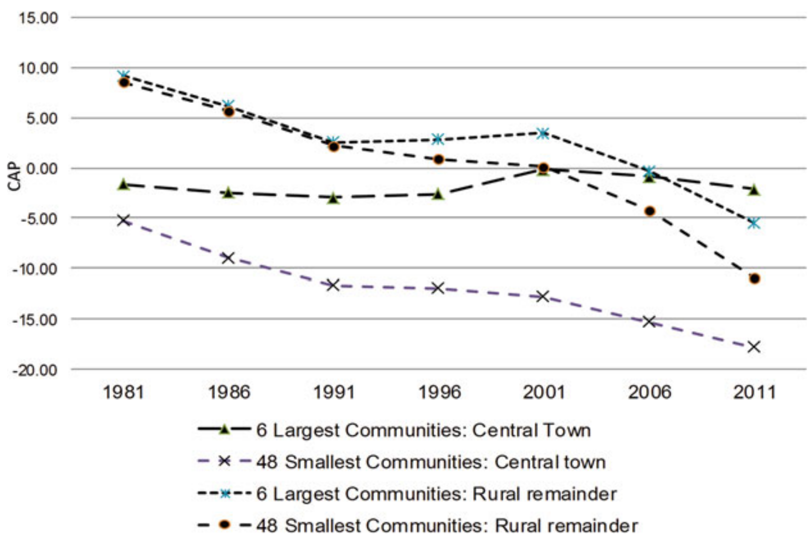

Fig. 8.7 CAP scores and RAI trends for 6 largest and 48 smallest urban and rural population components, MDB study area, 1981–2011

relationship between the CAP values and absolute population size did gradually develop among the 48 smaller communities, starting practically at zero in 1981 (Pearson's $r=.03$) and rising to $r=.30$ by 2011 – a result just significant at the .05 level of probability.

Figure 8.7 provides a graphical summary of the RAI and CAP movements for the two hierarchical levels of community, and their rural and urban components, for each intercensal period from 1981 onwards. The zero line represents the national rate of ageing. Data points indicate CAP value at each census; change between data points equates to intercensal RAI value. This figure shows that while both levels of the settlement hierarchy started the period in 1981 with a younger age structure than Australia (Table 8.4, column 1), this was due to very youthful rural age structures more than compensating for the substantially older central towns. Thereafter, by far the most dramatic ageing has been in this dispersed (essentially farm) segment of the case study population, particularly after 2001. It is notable that ageing of the rural element in the regional centre catchments, initially almost identical to that of the smaller communities, diverged after 1991 and aged more slowly than the national mean, suggesting the possibility of some rejuvenation by urban overspill. After 2001, however, the RAI of the dispersed segment of the six regional city communities deteriorated very sharply, giving the regional cities a *younger* age profile than their rural surroundings by 2011– a novel situation in rural Australia.

The second main feature of Fig. 8.7 is the increasing divergence in the *urban* ageing trends as between the regional centres and the smaller communities. Starting relatively close in 1981 with negative but very similar CAP values, by 2011 the regional centres remained close to the national norm, with a 1981–2011 RAI of only

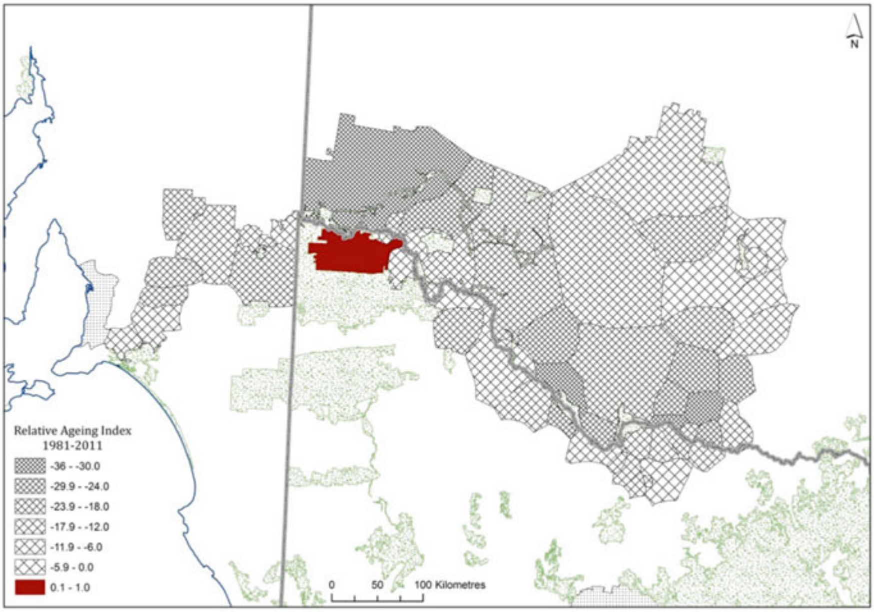

Fig. 8.8 Relative Ageing Index scores, lower Murray-Darling Basin study area, 1981–2011

–0.04, while the main towns of the 48 smallest communities fell consistently further behind with an equivalent RAI as low as –12.6. The rural component of the 48 communities aged even faster with an overall RAI of –19.4, falling rapidly behind the Australian norm after 2001, with an age structure apparently converging towards its urban counterpart. Despite our focus here on structural ageing, it should be noted that substantial numerical ageing has also occurred. Between 1981 and 2011 the study area population aged 65 and over more than doubled (from 29,000 to 63,000), while that aged 75 and over almost trebled (from 10,300 to 29,500, despite net migration losses).

To close this section, Fig. 8.8 illustrates the spatial variability of ageing within the study area at the individual community level. It shows the cumulative RAI change for each of the 54 communities over the 30 year study period. While random factors combined with small populations as well as space limitations restrict our options at this detailed level, Fig. 8.8 highlights some key points. Only one community – Mildura (with a value of +0.5) – aged more slowly than the national average. However, the six regional centres were all in the group of ten with the least relative ageing over the 30 year period. At the other end of the scale, 14 communities experienced a negative RAI value for every one of the six intercensal periods, while a further 15 communities had five negative values, and none had less than three. Overall, the ageing of the population in the study area, although extremely variable, was very much greater than the Australian average.

In summary, then, the lower MDB's regional centres and their hinterlands underwent a relatively gradual process of ageing from 1981 to 2011, though the rate of increase has been felt most acutely in the rural areas. By the 2011 Census, the six regional centres and their communities exhibited the youngest age structures across the study area, with their dispersed populations not too far behind. For the 48 communities further down the regional urban hierarchy, and despite commencing the study period with marginally younger populations than the nation as a whole, the subsequent 30 years brought rapid and sustained increases in ageing. The 48 smaller community central towns in aggregate have aged only slightly less than their rural catchments, registering an RAI score of -12.58 for the three decades. While undergoing dramatic ageing over the study period, the rural hinterlands of these 48 communities still ended the period with younger populations than their central towns. Nevertheless it appears that the farm sector's long-held position as an incubator of regional populations and net donor to the remainder of the national settlement system is under serious threat. The chapter now considers the possible causal factors underlying these processes.

Drivers of Ageing Processes in the Lower MDB

Critical to the future demographic, economic and social vitality and viability of the study area communities is their capacities for regeneration via local births and/or in-migration of young families. In seeking explanation for the acute ageing described above, we commence with fertility changes since any sustained secular downturn in fertility must needs lead to structural ageing as successively smaller cohorts move up the age pyramid. Figure 8.9 demonstrates trends in the General Fertility Rate (children aged 0–4 per 100 women aged 15–44) in the study area.

Although higher than the national rate for the whole period, the general fertility rate reached a peak in 1996. After 1996, however, the fertility rate fell sharply for 10 years, especially for the rural population, with a slight recovery by the 2011 census in line with the national trend. Children aged 0–4 in 1996 were aged 15–19 by 2011. If the timing of this fertility decline is compared with the ageing profiles in Figs. 8.5 and 8.6, it will be seen that the 15–19 age cohort was the last one with a positive RAI, with the successively younger cohorts becoming more and more negative. It appears highly likely that structural ageing at this end of the age pyramid is at least partly impacted by fertility decline, especially for the rural population. In 1981 the dispersed population's general fertility rate was over five percentage points higher than that of the community centres; by 2011 this relationship had become inverted with the regional cities and smaller towns exhibiting slightly higher fertility than the farming areas.

However, in most Australian rural communities, structural ageing is also strongly driven by net youth migration loss, supplemented by aged net migration gain and 'ageing-in-situ'. Of course, where heavy net youth migration loss is sustained the capacity of a community to replenish itself via natural increase (i.e. excess of fertility over mortality) can be undermined. To test this contention, Figs. 8.10 and 8.11

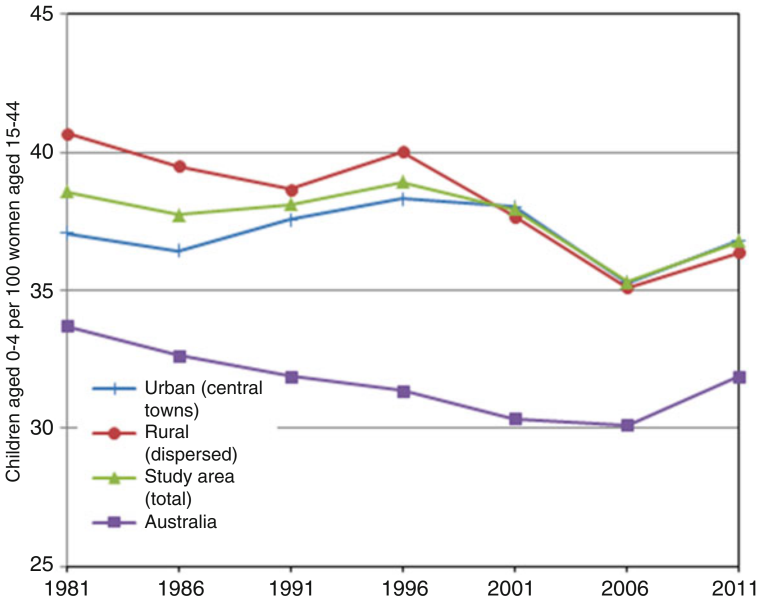

Fig. 8.9 Change in the General Fertility Rate, 1981–2011, total study area and Australia

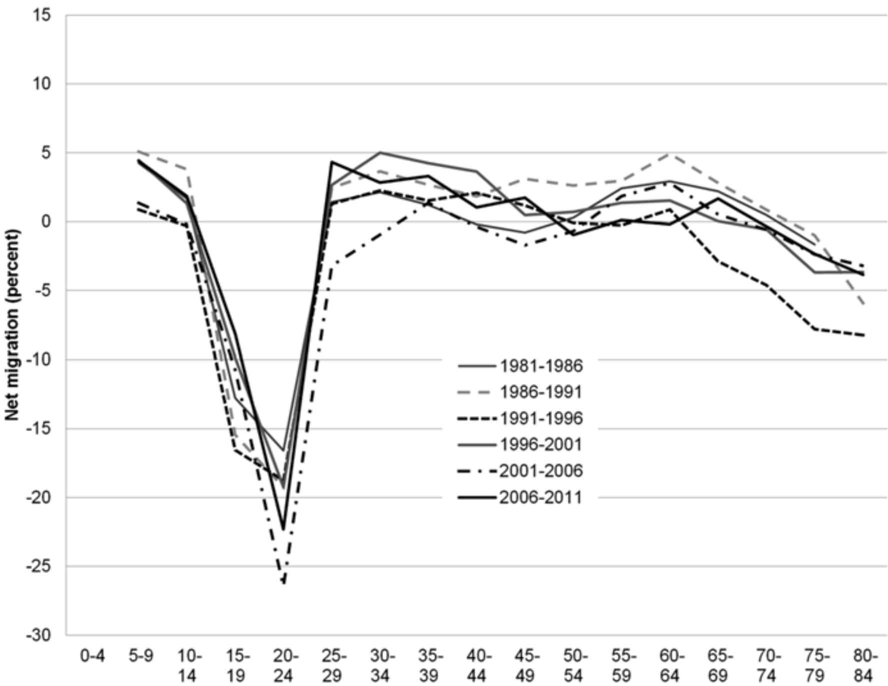

Fig. 8.10 Age-specific net migration profile, 1981–2011, total study area, males

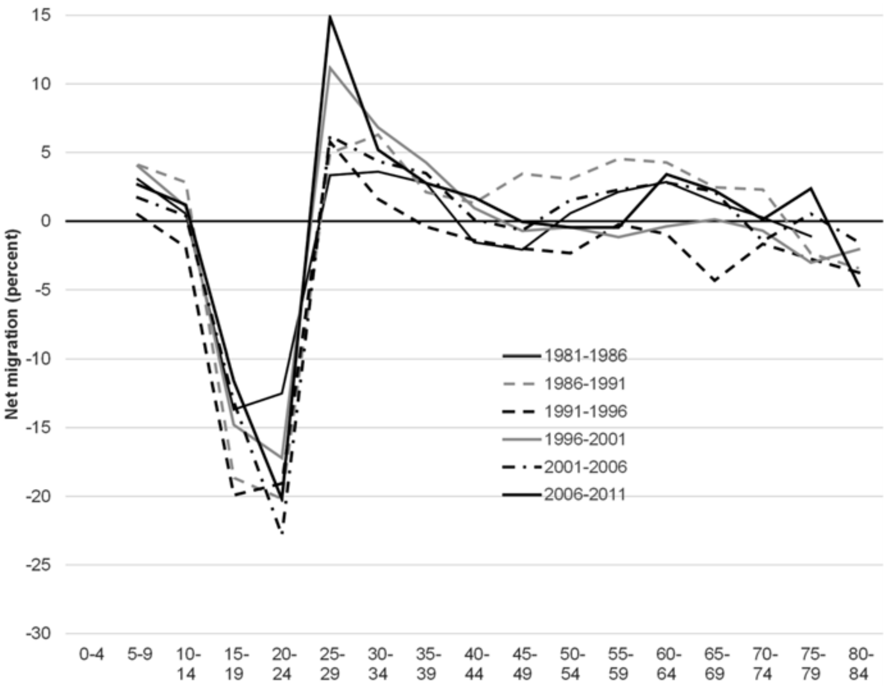

Fig. 8.11 Age-specific net migration profile, 1981–2011, total study area, females

show net migration rates for males and females, respectively, within the MDB study area from 1981 to 2011. The peaks and troughs of the age-specific estimated net migration profiles show heavy losses in the school leaver, higher education and first job seeker 15–19 and 20–24 cohorts, and net in-migration in the middle to older working age of families with young children, as are typically found in rural Australia (Argent and Walmsley 2008; Davies 2008). Here however, the trough in the 15–19 and 20–24 age groups is extremely deep, the impact reaching its nadir in 2001–2006 with a net loss of over 9000 persons, or almost a quarter of the 2001 total. Male net out-migration in the 25–29 and middle working age groups also increased in the same period, which witnessed the severe and protracted 'Millennium drought', associated cuts in irrigation outtakes, and ongoing cost/price pressures in key horticulture sectors such as viticulture and citrus. This decade also saw large numbers of men – and to a lesser extent, women – leave farming regions across the nation to take up highly remunerative work in the booming Queensland and Western Australian mineral and energy extraction sectors.

Beyond the youth and young adult cohorts, meagre net migration gains were indicated for most cohorts and for most intercensal periods. However, two further trends stand out: (1) the somewhat predictable net migration loss of the elderly (70+); and (2) a pronounced net migration gain in the 25–29 age group. Importantly, this 'rebound' is especially marked for women and, although fluctuating, appears to have increased over time. This would appear to be evidence of a return migration current; one that, if sustained, could provide a valuable counter to the chronic ageing processes outlined in this chapter (Jarvie and McKay 1993).

Policy and Planning Implications and Conclusions

The foregoing analysis reveals that one of Australia's most important 'food bowls' is rapidly ageing, simultaneous with increasing urbanisation of the regional settlement system and the ongoing re-interpretation of the MDB's resources. However, this has been a temporally and spatially uneven process: the major regional centres have generally experienced relatively rapid population growth and, relative to the broader study area, below average ageing. Smaller communities, characterised by smaller service centres and their farming hinterlands, on the other hand, have generally experienced very rapid ageing, particularly over the last decade. Our previously cited research over a broader area of south eastern Australia advocated a twofold strategy: the first constructive, to ensure an integrated, cooperative economic future for both levels of the settlement hierarchy, and the second ameliorative, to confront the social costs of an ageing process already substantially ahead of the national norm. We focus here on the latter aspect.

The CAP and RAI used in this chapter provide a simple means by which the ageing trajectories of sub-regional populations may be measured over time and space. Also, because changing age-sex structures are central to the CAP and RAI's calculation, proximal causes (and possible solutions) for the specific ageing process under investigation can be suggested. Structural ageing, driven primarily by net youth migration loss but also augmented by fertility decline, ongoing age-selective 'amenity-led' pre- and early post retiree in-migration and ageing-in-place, appear as the chief drivers. In relation to appropriate policy and planning measures, based on our analyses we advocate a socio-spatially nuanced strategy which recognises that the needs of the rural aged and those of the (essentially place–based) communities in which they choose (or are forced by circumstance) to live, are inextricably intertwined (Feist et al. 2011; Hugo et al. 2012). As demonstrated above, the 48 smaller rural communities and their main centres experienced some of the fastest rates of ageing in the study area, and many contain highly concentrated aged populations. The severe ageing of the rural population revealed by this chapter also highlights a potential threat to the family farming sector once at the centre of the 'closer settlement' policies that originally brought regions like the MIA into being. In regions and localities hard-hit by long-running restructuring processes, involving, *inter alia*, chronic and severe population decline, public and private service and industry closures, life for the elderly can be difficult (e.g. Halseth and Hanlon 2005; Stockdale 2011; Milbourne 2012) . By contrast, for the aged living in the six regional centres of the lower MDB, access to vital health and related services is unlikely to constitute a major problem given State and Federal Governments' concerns to regionalise a host of key public services, including health and aged care. Complementing this strategic approach at the local scale is a combination of private mobility and public community transport agencies seeking, to encourage individual and/or community mobility for hinterland residents.

However, the ageing residents of towns and rural areas outside the regional centres potentially face more problematic futures in the absence of remedial planning action for this order of the settlement hierarchy, as advocated above. Following decades of population decline and public and private sector service withdrawal, many now lack anything but the most basic health and aged care services. For some of the smaller centres even General Practitioner services are provided only on a part-time, visiting basis. The capacity of elderly residents of these lower tier centres to move to access better quality care – either in the metropolitan areas or more nearby regional centres – can be checked by the near dormant state of local real estate markets, hampering the ability of residents to liquidate local housing assets. Yet the current level and nature of aged care provision across much of rural Australia is predicated on the elderly's mobility. Local and regional development strategies to help revitalise the economies of this tier are vitally needed to bolster local populations, services and their vital socio-cultural functions.

Notwithstanding the rather generic manner in which we have discussed the 'aged' in this chapter, it is vital to appreciate that the current and future elderly cohorts are not homogenous, in terms of socio-economic status, health, current and preferred place of residence, etc. (Davis and Bartlett 2008; Milbourne 2012). There can be no 'one-size-fits-all' approach to planning for the rural aged. The 'baby boomers' – the first wave of whom has joined the ranks of the 'young-old' – enjoyed the prosperity of the 'Long Boom' and a series of major advances in public health care. They and subsequent waves have benefited substantially from ongoing improvements in longevity, and it can be expected that a high proportion will enjoy good health well into their post-retirement years. This may mean that current and future generations of the rural elderly will continue to maintain some connection to the workforce and require comparatively little health care support. The rural aged also frequently play fundamental roles in sustaining the economic, social and cultural lives of rural communities (Chalmers and Joseph 1998; Winterton and Warburton 2012). In part, this is due to many rural aged people's strong attachment to place; a bond that for some has been forged over a lifetime (Stockdale 2011; Milbourne 2012; Winterton and Warburton 2012). Therefore, 'ageing-in-place' can provide fulfilling experiences, both for the individual and the broader place-based social unit to which he/she belongs.

There is also a growing anxiety that, with the increasing incidence of chronic poor health conditions, such as arthritis, dementia and Alzheimer's disease, in the Australian population, increased longevity may be outpacing healthy life expectancy (Stockdale 2011). As should be obvious from the above, managing the chronic conditions of ageing will likely be much more difficult outside the regional centres due mainly to the thin spread of relevant services in non-metropolitan Australia. The roll-out of the national broadband network (NBN) offers some hope of state-of-the-art telemedicine and chronic illness support but, again, the network's patchy coverage throughout rural Australia means that this is a hope largely unfulfilled.

In these circumstances there is genuine concern that existing spatial inequality suffered by residents of the small towns and rural hinterlands of the lower MDB could be further compounded by a complete lack, or only intermittent provision of, key services for the elderly.

Dedication This chapter is dedicated to the memory of Graeme Hugo, a dear friend and colleague.

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Chapter 9
Measuring Spatial Variations in Wellness Among Australia's Rural Aged

Martin Bell and Jim Cooper

Introduction

Among the most significant demographic changes confronting Australia, like much of the developed world, is the ageing of its population. Over the past 20 years, the proportion of the nation's population aged 65 or over has risen from 11.3 to 13.8%, and is forecast to reach 18.7% in 2031. This represents almost a doubling in the absolute number of older Australians over a 20 year period. The rate of increase in the old-old, those aged 85 and over, is even more dramatic, with numbers projected to reach 805,000 by 2031 (ABS 2013a). Demographic ageing is primarily a consequence of falling fertility, fuelled in Australia by the post-war baby boom and supplemented by massive post-war immigration, but it has also been shaped by steadily increasing longevity (McDonald 2014). With life expectancies around 80 years (ABS 2014), older Australians, on average, can now expect to have two to three decades of life beyond the traditional age of retirement (Sanderson and Scherbov 2008; Kendig 2014).

Population ageing has far-reaching implications – social, economic and political – and has triggered extensive policy debate, particularly in regard to health, income support, housing and labour supply (see Productivity Commission 2013; United Nations 2012). Budget, financial and macro-economic considerations remain at the forefront of public discourse, but there is rising recognition that the aged are a diverse and heterogeneous population, with widely varying experiences, circumstances and needs (Keating et al. 2011; Winter and Warburton 2011). Kendig (2014) argues in favour of a life-course perspective that views ageing as a variable social process in place of uniform assumptions as to age-based capacities. Equally important

M. Bell (✉) • J. Cooper
Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia
e-mail: martin.bell@uq.edu.au; j.cooper4@uq.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_9

is recognition of the role of geography in the life chances and wellbeing of older people. Places differ, both in the composition of communities, in their inherent fit to the needs of older people, and in their locational attributes, particularly the accessibility they provide to essential services and support.

Older people in Australia's rural communities merit attention from both these perspectives. On the one hand, they have distinctive lifetime experiences, particularly in regard to family, educational and occupational trajectories that often differ markedly from the majority urban population. On the other hand, they reside in a diverse array of communities including farming areas, rural service centres, mining towns, regional hubs and retirement destinations. At the same time we know that rural communities make up a large proportion of Australia's most disadvantaged areas (Alston 2007; Winter and Warburton 2011) and that older people are over-represented in rural areas. In 2011, rural Australia housed just 16% of Australia's population, but was home to 19% of those aged 65 and over.[1] At the 2011 Census, there were 332,500 people aged 65 and over living outside Australia's urban areas,[2] up from 277,100 in 2006.

Planning for the needs of older people in rural communities needs to be shaped by an understanding of diversity in both the people and the places in which they live. We aim to address this need by developing a general classification of rural communities based on the key features that affect the wellness of older people, defined broadly here to encompass overall physical, social, emotional and spiritual wellbeing (Alston 2007; Davis and Bartlett 2008). The work reported here forms part of the ASPIRE project (Ageing Services and suPports In Rural Environments), an international program of collaborative research, which aims to identify the systems and services that best support the wellness of older people living in rural communities. The overall goal of the work is to help identify the systems and services that best support the wellness of older people living in Australia's rural communities. The classification presented here aims to provide a framework to guide the selection of case study sites for in-depth analysis and field work, and also represents the first stage in developing an aged wellness index for Australian rural communities. For the purposes of this chapter, we focus on the rationale for choice of wellness indicators, and confine attention to just two Australian States: Victoria and Queensland; the former representing a relatively closely settled rural environment, the latter encompassing much more extensive territory including a sparsely settled and remote interior, very distant from the main locus of settlement.

In the section entitled "Indexes and Area Classifications" we examine existing indexes of wellness among the aged and briefly review prior approaches to mapping ageing and socio-economic status across rural Australia. The section entitled "Measuring Wellness Among the Aged" set outs the key determinants of wellness identified in prior studies, as revealed in the comprehensive review of literature

[1] Rural Australia here defined as those SA2s with no part in an urban agglomeration of 10,000 persons or more.

[2] ABS definition of Major Urban and Other Urban comprises all centres which contain 1000 people or more (ABS Census Dictionary 2011 Catalogue 2901.0, ABS Canberra).

undertaken for the ASPIRE project. In the section entitled "The Spatial Framework" we set these determinants against the much more limited range of information available at the local level and identify a series of variables that can be used to capture key dimensions of wellness. The section entitled "Self-Reported Wellness" discusses the geography for which the data are available and outlines our approach to area classification. In the sections entitled "Comparing indicators" and "Identifying Areas of Need" we report the results, focusing first on selected indicators and bivariate relationships, and subsequently using data reduction techniques to establish clusters of areas characterised by high and low wellness. The concluding section identifies avenues for further work.

Indexes and Area Classifications

A number of indexes can be found which endeavour to capture the level of wellbeing among older people, generally by combining selected variables across a series of domains. Some, such as the *Seniors Sentiment Index*, which seeks to encompass social, financial and health aspects are based on questionnaire surveys and confined to the national level.[3] The *Australian Unity Wellbeing Index* uses a similar approach to measure Australians' satisfaction with quality of life and extends to economic and environmental dimensions, but is not focussed exclusively on older people.[4] Indexes have also been developed to make comparisons among countries. The *Global Agewatch Index* draws on numerous international datasets to compare countries with respect to the income security, health status, employment, education and social environment of people aged 60 and over.[5] In a similar way, the *SCL/PRB Index of Wellbeing in Older Populations* summarises 12 key indicators across 4 domains of material, physical, social and emotional wellbeing, and is unusual in distinguishing among different age groups of older people.[6] Underpinning these global indexes is an assortment of objective, generally quantitative measures including household income, poverty, disability, healthy life expectancy, employment, family contact, suicide and depression, access to public transport and civic freedom.

Within Australia a range of social indicators have been developed, foremost among which is the family of SEIFA indexes (*Socio-Economic Indexes for Areas*), developed by the Australian Bureau of Statistics (ABS 2013b). SEIFA consists of four indexes constructed using data from the population census that rank areas of Australia according to relative advantage and disadvantage. SEIFA indexes are specifically designed to facilitate socio-economic research and help identify areas that require funding and services, and are provided down to very fine levels of

[3] See http://nationalseniors.com.au/sites/default/files/140213-NationalSeniorsAustralia-Challenger-SeniorsSentimentIndex2.pdf

[4] See http://www.australianunity.com.au/about-us/Wellbeing/AUWBI

[5] See http://www.helpage.org/global-agewatch/

[6] See http://longevity3.stanford.edu/wp-content/uploads/2012/10/SCL-PRB-Index-of-Well-Being-in-Older-Populations.pdf

spatial scale. However, SEIFA are generalisedindexes which do not focus directly on the aged; indeed, none of the indexes include variables which relate specifically to older people.

Some researchers have focussed on specific subgroups of the population in the endeavour to develop more targeted indexes. For example, Biddle (2009) constructed an *Index of Relative Indigenous Socioeconomic Outcomes* based on 2001 and 2006 Census data, and examined spatial variations across 37 Indigenous Regions and 531 Indigenous Areas. This was subsequently refined to create a suite of indexes summarising different aspects of indigenous wellbeing (Biddle 2013). Like SEIFA, the indigenous indexes are based exclusively on Census variables, although a separate strand of work has attempted to link individual and community level measures of wellbeing using survey data (Biddle 2014a, b).

While social indicators provide a simple summary index on which to compare geographic areas, they tend to mask the underlying basis on which comparisons are being made: it is important to understand the key dimensions on which places differ. An alternative approach which addresses this is through area classifications which use selected data to group together areas with similar characteristics. In the UK, the Office of National Statistics produces a number of general purpose area classifications which identify clusters of areas with similar socio-economic profiles (see Vickers and Rees 2006, 2007). Area classifications can also be constructed around specific themes. For example, Dennett and Stillwell (2011) derived a classification for understanding internal migration in Britain which divided the country's 408 districts into eight area types based on analysis of 44 migration-related variables. In Australia, Baum and Stimson (2005) used labour force, education, income and housing characteristics to classify 118 nonmetropolitan urban regions into a six-fold typology of socio-economic advantage and disadvantage. Area classifications commonly adopt simple rubrics to describe each class in a typology.

While social indexes and area classifications differ in regard to forms of output, both aim to capture key aspects that differentiate and help to characterise geographic areas at a range of spatial scales. Methods of analysis vary, but generally involve some degree of data reduction through factor or principal components analysis, and/or grouping of areas using clustering techniques. What is essential to the efficacy of either approach is the selection of variables that faithfully reflect the phenomenon of interest.

Measuring Wellness Among the Aged

Despite burgeoning interest in health, wellness, wellbeing and quality of life, there is remarkably little consensus as to how these concepts should be measured, or the factors that determine them. Rachele et al. (2013) note subtle distinctions between these notions and characterise wellness as focusing on lifestyle behaviours which enable individuals to live to their fullest potential. Wellbeing, on the other hand, is seen as a broader concept, being defined by reference to the adequacy of an individual's social, psychological and physical resources. Health is more tightly conceived as set against illness, while quality of life extends to encompass cultural norms, goals, values and expectations. Our focus here is broadly defined, encompassing elements of all these concepts, but we retain the term wellness for the sake of consistency.

The diversity of constructs in this field of research is exacerbated by a plethora of measures. Villanueva et al. (2013) distinguish between subjective assessments and objective indicators of health, while Rachele et al. (2013) identify an array of principally psychometric indicators of wellness among adolescents. Scholarly attention has focused particular interest in the way urban environments influence health, but a recent review of the literature (Badland et al. 2014) identified a massive 233 discrete indicators of urban liveability, with major inconsistencies in measurement and few attempts at validation.

For the analysis presented here, we draw on an extensive review of the literature conducted as part of the ASPIRE project, which sought to identify factors found in prior research to have an influence on wellness among the aged in general, and the rural aged in particular (Winterton et al. forthcoming). That work classified key factors into seven discrete domains as set out in Table 9.1. While many factors are common across both rural and urban settings, it is notable that the review identified some which were not commonly identified as significant in rural areas. Factors such as traffic noise, graffiti, and the availability of green space appear less significant to wellness among rural residents. At the same time, it is clear that some factors, accessibility for example, contribute to more than one domain.

A major issue for empirical analysis is that data are lacking, sparse or difficult to obtain for many of the factors identified in Table 9.1, especially in the domains of social capital and neighbourhood quality. In some cases, relevance to wellness has been established from small scale case studies in specific regional settings and the significance of these factors remains untested at a broader spatial level. Other factors thought to be relevant to wellness are difficult to quantify, while for some (e.g. accessibility) the task of measurement is technically feasible but would involve substantial work. In many cases (e.g. availability of key facilities such as a health clinic) there is no readily accessible, centralised source of data. Problems also arise in harmonising data drawn from different collections onto a common spatial framework. In light of these issues, it is no surprise that the majority of spatial indexes and areal classifications have been derived from comprehensive sources such as the Population Census, and therefore tend to focus on the domain of socio-demographic characteristics.

The analysis presented here follows in the same tradition, focusing primarily on the cluster of socio-demographic characteristics identified in the literature review.[7] Within the socio-demographic domain, it is useful to distinguish between three types of variable that we employ in the analysis. We identify these as *outcome*

[7] In separate work we introduce a number of measures drawn from other domains in Table 9.1 including: (1) SEIFA scores, (2) crime rates (3) population density (4) distance to nearest medical facility and (5) a relative remoteness index

Table 9.1 Factors influencing wellness among older people

Key domains	Factors relevant in rural areas	Factors identified in other studies
Social capital/ cohesion/inclusiveness	Formal/informal social ties	Reciprocity
	Level of community interaction	
	Trust	
	Norms of collective action	Attraction to neighbourhood
	Collective efficacy	
	Shared community values;	
	Sense of belonging	
Neighbourhood safety	Perceived safety	Levels of traffic
		Antisocial behaviour
	Crime rates – incidence of murder, rape, robbery, aggravated assault, burglary, larceny, theft, and motor vehicle theft	Perceived neighbourhood problems
		Neighbourhood violence
Neighbourhood quality	Air quality/pollution	Water, soil quality
	Attractiveness of built/natural environment	Green space
	Traffic congestion/speed	Litter, graffiti, environmental deprivation
Services and amenities	Accessibility, quality, age, appropriateness and affordability of key amenities, services, transport and ICT	
Built/physical environment	Housing – suitability and availability	Housing: – zoning for senior housing
	Pedestrian/traffic controls (condition of roads/footpaths)	
	Land use mix/urban design	Accessible public buildings,
	Proximity to business and amenities	
	Street density	Transport
	Residential density	
Socio-demographic characteristics	Neighbourhood social mix – age, ethnicity, SE status	Rate of urban development
	Residential turnover	
	Socio-economic status,	Households living alone or with unrelated individuals
	Economic health	
	Neighbourhood deprivation	Households without a phone
	Education level (high school/college)	
	Income and poverty	Households without access to a car
	Levels of unemployment	
	Levels of home ownership	Family structure
	Disability levels	
	Source of income	Recent immigrants
	Housing value	
Geographical location	Distance from service centres	Households receiving public assistance
	Urban/rural status	

Modified after Winterton et al. (forthcoming)

Table 9.2 Community, individual and outcome variables associated with the wellness of older people in rural areas

Wellness-related variables	Anticipated effect
Outcome variable	
Older persons need for assistance with daily living	Indicator of wellness
Individual variables	
Education level of older persons	Lower levels of education reflect less human capital
Marital status of older persons	Widowhood increases isolation and vulnerability
Access to private transport for older persons	Accessibility to services increases independence
Community variables	
Education level	Lower levels of education reflect less human capital
Marital status	Widowhood increases vulnerability, reduced feelings of security
White collar occupation	Higher occupation levels linked to greater community affluence
Employment level	Higher employment levels associated with more prosperous environment
Poverty level	Greater poverty reduces lifestyle and recreation options in community
Living arrangements	Home ownership increases security and community interaction
Residential stability	Short residency in community reduces social networking
Socioeconomic level	Community affluence enhances lifestyle options

variables, *individual* indicators, and *community* characteristics. The first of these, the outcome variable, is a direct measure of wellness among the aged population, as collected at the 2011 Australian Census by each individual's subjective assessment of their need for assistance with aspects of daily living. The second group, individual variables, represent characteristics of the aged populations themselves which are believed to influence their wellness. These are essentially surrogate indicators of wellness. These are complemented by the third group of community variables which aim to capture key facets of the community as a whole, and as such describe the socio-demographic context within which aged persons reside. Table 9.2 sets out the census variables employed under each of these headings and indicates their expected relationship with wellness among older people. Distinguishing census variables in this way effectively enables us to triangulate three independent approaches to measuring spatial variations in wellness between rural areas.

The Spatial Framework

Any form of spatial analysis is ultimately constrained by the zonal framework on which the data are made available. In the case of the 2011 Population Census, the native format is defined by the newly created Australian Statistical Geography Standard (ASGS), developed by the ABS, which defines a multi-level geographic framework (ABS 2010). SA2s form the second level in the hierarchy and are broadly equivalent to Statistical Local Areas which were part of the superseded Australian Standard Geographical Classification (ASGC), but the basis for their definition is quite different. Unlike SLAs, SA2s do not necessarily aggregate to Local Government Areas (LGAs). They are intended to be broadly uniform in population size, with an average of 10,000 persons, although the design range is 3,000–25,000 persons. Consequently, densely populated areas have a large number of SA2s while in sparsely populated areas SA2s can be very large in terms of area. Despite this, they are the smallest geographical areas for which many other statistical collections are made available, including annual population estimates, health, crime and vital statistics data.

There is a total of 2214 SA2s across Australia as a whole. Of these, around 60% lie within urban areas of 100,000 persons or more, while a further 10% are in population clusters above 10,000. Since the ABS defines urban centre boundaries at SA1 level, the lowest level in the ASGS hierarchy, some SA2s on the urban fringe encompass both urban and rural components. For the purposes of this analysis we defined as 'urban' any SA2 which is partly located in a population cluster of 10,000 persons or more. For most areas this threshold provides a distinctive boundary between urban and rural areas but there is a small number of excluded SA2s that encompass significant rural populations. Nevertheless, we exclude any SA2 in which any part is within a population cluster of 10,000 persons or more in order to mitigate against contaminating the analysis with urban characteristics. This leaves a total of 597 rural SA2s with a 2011 Census population of 3.5 million persons.

For the analysis presented here we focus on two Australian states which provide contrasting physical settings and a diversity of social and environmental contexts. In Victoria, rural areas are closely settled compared with the Australian average and offer good access to the state capital, Melbourne, and a network of regional centres. In contrast Queensland is larger and more sparsely settled and has a clear divide between coast and inland, the former undergoing rapid growth while the latter is characterised largely by population stasis or decline across a thinly connected network of rural centres. These differences will almost certainly resonate in the lives and wellness of older residents. In Victoria, 116 SA2s meet our criteria for designation as rural, together housing a total of 751,000 persons, 138,000 of whom were aged 65 or over. In Queensland, there were 126 SA2s, with 116,000 older residents in a population of 806,000.

Self-Reported Wellness

By international standards the Australian Census collects a wide range of information, but the 2006 enumeration was the first to collect data pertaining to health and wellness. This contrasts with countries such as the UK which has a much shorter census questionnaire but seeks information both on general health and long term limiting illness, the latter question dating back to the Census of 1991. In Australia, the information is collected through a series of four questions which together measure the number of people with a profound or severe disability. These are defined as those people needing help or assistance in one or more of the three core activity areas of self-care, mobility and communication, because of a disability, long term health condition (lasting 6 months or more) or old age (ABS 2011).

In 2011, 5% of Australians indicated a need for assistance with core activities, but this figure rose to 19% for those aged 65 and over. It is interesting to note that these figures are substantially below the comparable data for England and Wales where 8% of the total population and 25% of those aged 65 and over reported that their day to day activities were 'limited a lot' by a long-term illness. Moreover, these figures more than double if account is taken of those whose day to day activities were 'limited a little' and fully 15% of those aged 65 and over reported being in bad or very bad health (Office for National Statistics 2013). These differentials may reflect differences in the nature of the questions but could also be affected by the older age composition of the British population, since rates of disability rise rapidly with increasing age.

Across rural Victoria and Queensland, an average of 16.4% of SA2 populations aged 65 and over, equivalent to one person in six, needed assistance with core activities. With a standard deviation of just 4.7%, most SA2s recorded values in the range of 12–25%, but a small number of areas in both States registered figures exceeding 30%. As shown in Figs. 9.1 and 9.2, there is no clear evidence of spatial patterning in the incidence of need for assistance. Areas of high and low need for assistance appear to be widely scattered, though the outliers are more prevalent in Victoria.

Comparing Indicators

How well do the individual and community variables reflect the subjective assessments of wellness? Table 9.3 sets out simple correlation coefficients (Pearson r) across the 242 SA2s which demonstrate a broad level of consistency across the suite of variables. Recall that the individual variables are measured for people aged 65 and over and are expected to serve as indicators of likely levels of wellness. The results show that widowhood and living alone without independent transport display moderate positive associations with the need for assistance in daily living, while education is negatively correlated, although the coefficients are low. Thus, SA2s recording low subjective measures of wellness tend to have high proportions of widows, older people living alone without private transport, and older people with relatively low educational achievements.

The community level variables measure the characteristics of the broader population, and aim to capture the overall status of the community within which older people are situated. Table 9.3 reveals only modest correlations with the proportion of older persons requiring assistance with daily living, but the coefficients are all in the expected direction. Thus, SA2s recording low subjective measures of wellness tend to have lower overall levels of educational attainment, occupational status and

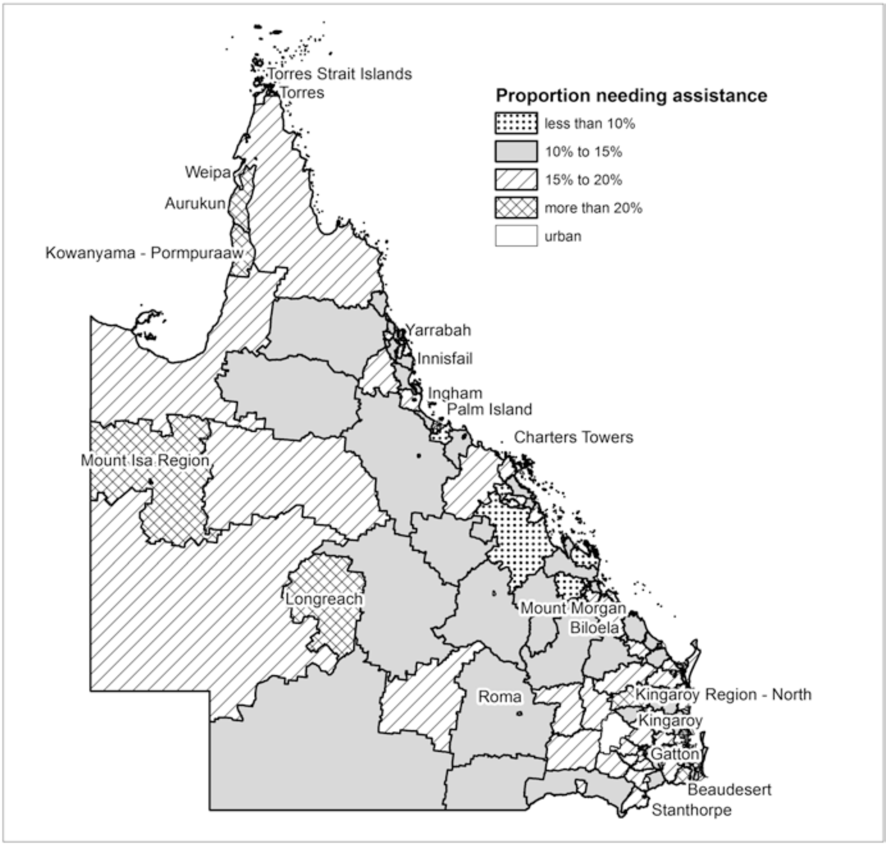

Fig. 9.1 Percentage of population in need of assistance with daily living, rural SA2s in Queensland

home ownership, more widows and low income households, and higher residential turnover.

To further assess the strength of these associations and the consistency of the subjective, individual and community variables we examine SA2s at opposite ends of the distribution: those in which older people's need for assistance is more than 25% above or below the mean across all rural areas. We designate these as the HIGH and LOW groups respectively. Table 9.4 records the average value of each variable for the group relative to the mean for all rural SA2s. Values above 1.0 indicate that the group average for that variable is higher than the overall rural mean while values less than 1.0 indicate the reverse.

The table confirms a consistent association between the individual and community variables on the one hand and the outcome variable on the other. In that group of SA2s where the need for assistance with daily living among older persons is high, the individual and community variables also point to a high likelihood of poor

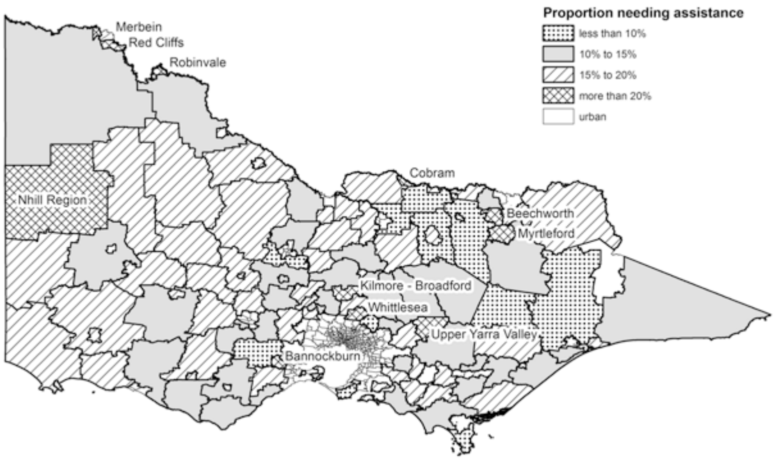

Fig. 9.2 Percentage of population in need of assistance with daily living, rural SA2s in Victoria

Table 9.3 Association between proportion of older persons requiring assistance with daily living and individual and community level variables, rural SA2s in Victoria and Queensland

Description	Pearson r
Individual variables	
Year 12 completed %	–0.3281
Degree or diploma %	–0.1960
Widowed %	0.4421
Live alone with no car %	0.5540
Community variables	
Year 12 completed %	–0.2668
Degree or diploma %	–0.3085
Widowed %	0.4604
Executive/professional occupations %	–0.2876
% employed	–0.2665
Low income HH	0.2458
Home ownership	–0.2282
Residential Stability	–0.1837

wellness. For example, SA2s in the HIGH need group exhibit below average education among older people and above average proportions who are widowed and lack access to private transport. For SA2s in the LOW need group, where the need for assistance with daily living for older persons is low, the individual and community

Table 9.4 Subjective, individual and community wellness indicators for SA2s with high and low need

Type	Variable	Mean across all rural SA2s	SA2s where need for assistance is LOW	SA2s where need for assistance is HIGH
		Per cent	Ratio relative to Mean	Ratio relative to mean
Individual variables				
Year 12 completed %		21%	1.39	0.84
Degree or diploma %		60%	1.10	0.89
Widowed %[a]		21%	0.81	1.14
Living alone & no car[a]		7%	0.49	1.34
Community variables				
Has need for assistance with core activities %[a]		5%	0.65	1.24
Year 12 completed %		37%	1.23	0.95
Degree or diploma %		38%	1.19	0.92
Widowed %[a]		6%	0.75	1.17
Executive/professional occupations %		33%	1.16	0.83
% employed		59%	1.10	0.99
Low income HH[a]		40%	0.86	1.06
Home ownership		73%	1.08	0.93
Residential Stability		63%	1.03	0.92
Socioeconomic level (SEIFA)		967	1.06	0.98

[a]On these variables higher scores indicate greater relative disadvantage
LOW denotes areas where need for assistance is more than 25% below rural mean
HIGH denotes areas where need for assistance is more than 25% above rural mean

variables also point to a lower likelihood of poor wellness. Thus, SA2s in the LOW need group display above average levels of education in the community and below average proportions of widows and low income households.

For comparative purposes, we include in Table 9.4 the ABS SEIFA Index of Relative Socioeconomic Disadvantage (IRSD) for the two groups alongside the rural mean. High values of this index (above 1000) are generally associated with relatively advantaged status, while lower values are associated with disadvantage (ABS 2013b). It is interesting to note that the IRSD provides little evidence to discriminate between the two groups. In particular SA2s with high need for assistance among older people register little difference in terms of the SEIFA index, underlining the case for more targeted indexes to capture the needs of particular population groups.

Identifying Areas of Need

Simple associations of the type discussed in the previous section suggest that Census variables can provide useful indicators of the spatial distribution of older people in need of assistance but these area-based, ecological associations do not establish a causative link. Moreover, there is likely to be considerable auto-correlation among the groups of individual and community variables examined. More rigorous statistical analysis is needed to establish a reliable basis for selection of field study sites, and for subsequent planning and policy intervention.

Data reduction aims to distil the essential dimensions of a multivariate dataset and eliminate redundancy. We approach the task by applying factor analysis separately to the individual and community variables. In each case, we then sum factor scores which meet the Kaiser criterion of eigenvalues exceeding unity, and rank the 226 SA2s on the combined total. Treating each group of variables separately in this way maintains the integrity of the two sets of forces thought to influence aged wellness. Next, we combine the ranks, applying equal weights to each, to derive a summary rank and sort the results into deciles to indicate areas with the highest and lowest levels of expected wellness. Subjective wellness is measured by the single outcome variable so no data reduction is needed. We simply rank SA2s in terms of the proportion of older people in need of assistance with core activities of daily living and sort the results into deciles. Comparing ranks on measured wellness with the combined rank on the indicator variables identifies those areas which have consistently high or low wellness. It also serves to highlight areas in which the subjective assessments of older people are at odds with the independent indicators.

Tables 9.5 and 9.6 set out factor loadings on the individual and community variables respectively. In each case we extract two factors. For the individual variables,

Table 9.5 Factor loadings, individual variables

Variable	Factor 1	Factor 2
Year 12 completed %	0.51	0.68
Degree or diploma %	–0.14	0.89
Widowed %	–0.88	–0.22
Live alone with no car %	–0.86	0.14

Table 9.6 Factor loadings, community variables

Variable	Factor 1	Factor 2
Has need for assistance with core activities %	0.93	0.02
Year 12 completed %	–0.73	–0.20
Degree or diploma %	–0.23	–0.81
Widowed %	0.75	–0.17
Executive/professional occupations %	–0.02	–0.82
% employed	–0.85	0.01
% low income HH	0.88	–0.20
Home ownership %	0.09	–0.69
Residential Stability %	0.25	–0.72

Table 9.7 Wellness cluster types

Cluster	Wellness indicators	Wellness measure
high + high	ranked in top 20%	ranked in top 20%
low + low	ranked in bottom 20%	ranked in bottom 20%
high-low	ranked in top 20%	ranked in bottom 20%
low-high	ranked in bottom 20%	ranked in top 20%

Factor 1 might be described as 'not isolated' as it is represented most strongly by the variables 'not widowed' and 'not living alone without a car'. Factor 2 may be described as 'well educated' since it is represented most strongly by the variables 'completed year 12' and 'completed degree or diploma'. Together these two factors account for 78% of the variance across rural SA2s. Analysis of the community variables delivers rather different dimensions. Factor 1 loads positively on the need for assistance with daily living, widowhood and low income and negatively with employment and educational attainment. It tends to characterise older, disadvantaged communities. Factor 2 captures further aspects of these communities that again appear inimical to wellness among the aged, loading negatively on further education, occupational status, home ownership and residential stability. Together these two factors account for two thirds (67%) of total variance across the 226 SA2s.

Individual SA2 scores on each factor were summed separately for the individual variables and for the community indicator components, then ranked such that a low rank represented a low expected level of wellness. In order to give them equal weight, the ranks for each SA2 on the individual and community factors were then summed and that result used to group the SA2s into deciles. The 10% of SA2s in the first decile have the 'worst' scores on the aggregate individual and community factors, indicative of an expected low level of wellness, while those in the tenth decile have the highest expected level of wellness. Corresponding ranks were then computed based on the wellness outcome variable (the proportion of older persons needing assistance with core activities of daily living). A low value on this variable equates to a relatively high level of wellness so SA2s were ranked in reverse order before being grouped into deciles.

Comparison of the deciles into which each SA2 falls on the combined ranking of the wellness indicators and on the ranking of the subjectively-based outcome variable provided a basis for deriving a series of four area-based clusters, as shown in Table 9.7 and in Figs. 9.3 and 9.4. The low wellness cluster is labelled 'low + low'. The SA2s in this cluster are in the bottom 20% of SA2s on both the wellness indicators and on the outcome variable. In Victoria, this cluster includes a group of SA2s in the far west of the State, Nhill and Yarriambiack, and a scattering along the River Murray which forms the northern border with New South Wales – Merbein and Red Cliffs in the Riverland region, and Cobram further east. There are isolated SA2s in the low cluster closer to Melbourne, at Maryborough near Castlemaine, Seymour, Myrtleford and the Upper Yarra Valley. In Queensland the low wellness cluster includes a crescent of SA2s in the far hinterland of metropolitan Brisbane, sweeping down from Kingaroy through Nanango, Jondaryan and Gatton to the Lockyer

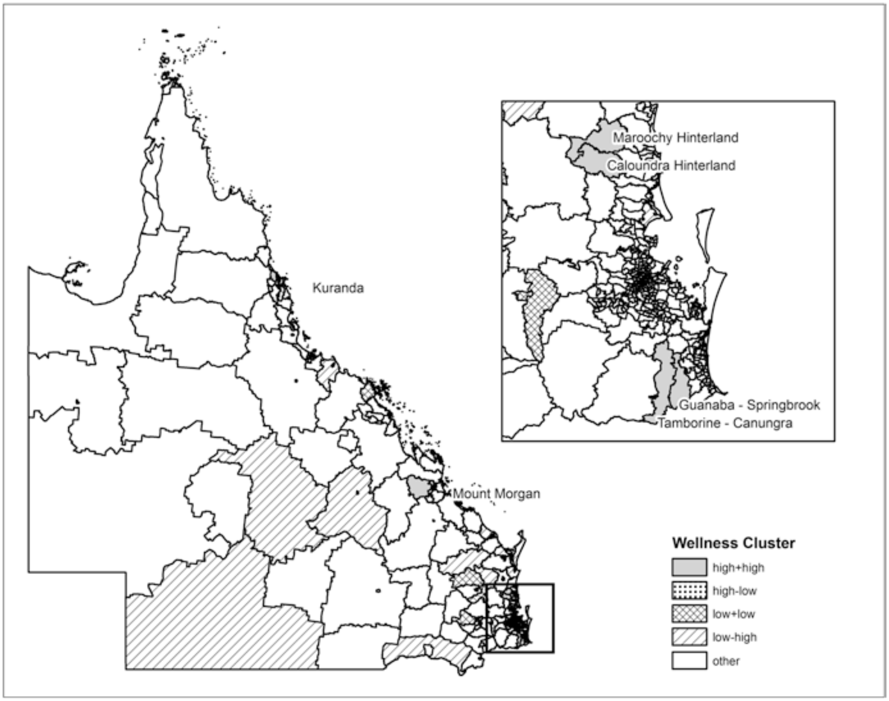

Fig. 9.3 Clusters of aged wellness, rural SA2s in Queensland

Fig. 9.4 Clusters of aged wellness, rural SA2s in Victoria

Valley. There is also a second group, dotted along the coast from Ingham and Innisfail in the Far North through Charters Towers, Ayr and Proserpine to Mount Morgan at the southern end of the central coast.

At the opposite end of the scale, SA2s which are ranked in the top two deciles on both the wellness indicators and the outcome variable are labelled 'high + high'. In Victoria these describe a broad band at a distance from metropolitan Melbourne, from Otway on the central west coast through Golden Plains to Bendigo and across to Romsey, Yea, St Andrews and Mount Baw Baw. A second cluster is apparent around Beechworth, Wangaratta and Bright in the Victoria Alps, with outliers in Ararat and Bendigo. In Queensland, areas of consistently high aged wellness are confined to parts of the Gold and Sunshine Coast hinterlands and isolated communities on the coast, in the Whitsundays and at Rockhampton and Kuranda.

There are some areas whose level of expected wellness (based on the individual and community variables) differs markedly from their measured wellness (based on reported need for assistance). In other words, the indicator variables are poor predictors of subjective wellness. These can be identified in two clusters. On the one hand is the cluster labelled 'high-low' which contains areas with an expected high level of wellness but which register a high reported need for assistance. In Queensland three isolated SA2s conform to this pattern – Roma, Weipa and Port Douglas while in Victoria the cluster includes a loose chain from Winchelsea to Whittlesea with outliers in Yackandandah and French Island. The final cluster, labelled 'low-high', contains SA2s which perform poorly on wellness indicators, indicating an expected low level of wellness, but have a low reported need for assistance. In Victoria the sole rural SA2 in this cluster is Yarram, while in Queensland there are several SA2s that fit this pattern, including a large swathe of Southwestern Queensland, but extending also to the outer periphery of the more closely settled southeastern corner of the State.

When these four clusters are combined on the same maps as in Figs. 9.3 and 9.4, the dominant impression to emerge is of a patchwork mixture of high and low wellness across both States, but some clear patterns can nevertheless be discerned. Predominant among these is a nucleus of high wellness areas in the immediate hinterland of the larger urban centres. This is most readily apparent in Victoria and in the hinterland of the Gold and Sunshine coasts. Areas of low wellness appear to be located at a further remove from the major centres, and often in relatively isolated settings. The western districts of Victoria are the most prominent example but this is also characteristic of many smaller communities along parts of the Queensland coast. At the same time, it is notable that many of the most remote parts of each state – western Queensland and eastern Victoria – do not emerge as areas of low wellness or high need. It appears that absolute distance from the metropolitan centre and low population density alone do not account for local differences in wellness.

Also notable is that there are few instances in which SA2s from opposing clusters are physically adjacent. Only Myrtleford in north-eastern Victoria, a low wellness area surrounded by a phalanx of high wellness areas in Bright, Wangaratta and Beechworth, stands as an exception. More striking is that areas which form part of the two clusters with opposing indicators are closely juxtaposed in space with the groups that show either consistently high or consistently low wellness. Thus, in Victoria areas with high wellness on the indicators but low wellness on the outcome variable fill out a ring around Melbourne that has consistently high objective indicators of aged wellness, but is interspersed with some patches in which subjective reports indicate low wellness. Conversely, in Queensland, the indicators suggest that low wellness is likely to extend widely across the State, but the subjective measure shows a more positive result. Both outcomes invite further investigation.

Conclusions

Population ageing will present significant challenges for Australian society, particularly in rural areas where health services are sparse and isolation can be high. Physical and mental wellbeing are at increasing risk as age rises but individuals and communities vary widely in their capacity to maintain health and wellness. A clear understanding of the factors that shape wellbeing among older people is essential to guide effective policy, planning and delivery of services where they are needed most. The research reported here aimed to enhance that understanding by establishing the extent of spatial variation in wellness among Australia's aged population, and identifying the factors that shape it. We focused on two Australian states, Victoria and Queensland, which exemplify different ends of the spectrum of rural settlement.

Attempts to capture spatial differentiation in multivariate phenomena commonly adopt one of two pathways: either subjecting a battery of variables to data reduction to generate a single summary index, or applying cluster analysis to generate a spatial typology. Attempts to develop bespoke measures for particular subgroups of the population using either approach are rare. The research reported here adopted elements of both approaches, but is distinctive in focusing on one particular characteristic – wellness among the rural aged – and adopting three different means of measuring the phenomenon. Giving separate consideration to subjective assessments and independent indicators of wellness, and further differentiating between individual (surrogate) and community (contextual) variables, recognised that contemporary understanding of aged wellness is as yet poorly developed. It also facilitated triangulation among different pathways to explanation.

We used the composite Census measure of 'need for assistance with daily living' as a subjective measure of aged wellness (termed the outcome variable), coupled with a suite of variables hypothesised to serve as symptomatic indicators, based on a comprehensive review of the literature (Winterton et al. forthcoming). The spatial framework was provided by 226 SA2s across the two States, the second smallest spatial units available in the Australian statistical geography. We found moderate associations between need for assistance (the complement of wellness) and some of the indicators, particularly widowhood, low income and living alone without access to private transport, and more modest inverse links to educational attainment, employment, occupational status, home ownership and residential stability. Application of factor analysis distilled the latent content of this suite of individual and community variables, which we then ranked and combined. Setting these results alongside a separate ranking of the subjective measure of wellness enabled us to identify areas which consistently displayed low or high wellness, and to also identify areas in which the subjective assessment was at variance with the objective indicators.

The patchwork of results is complex and varies between the two States, but there appears to be a consistent pattern of high wellness in the hinterland of major urban areas, with some evidence of lower levels of wellness at a greater distance, particularly in Queensland. Areas of high and low wellness also tend to be spatially distinctive but with numerous outliers in both states. Notably, the more remote and sparsely settled areas – western Queensland and eastern Victoria – do not register as areas of low wellness. An intriguing difference, however, is found in the relationship between measures. In Queensland, subjective assessments appear to be generally positive across SA2s, even where the indicators point to low wellness, whereas in Victoria the case is reversed with negative assessments sometimes occurring even where the indicators are positive.

The results presented here represent a first attempt to identify the spatial patterning of aged wellness in rural Australia and should be interpreted as suggestive, rather than conclusive. They aimed to provide a framework for survey-based fieldwork but in meeting this objective also identify a number of avenues for further investigation, one of which is the difference in subjective and objective measures of wellness revealed by the methodology adopted for this study. Further work is needed to establish the extent to which the findings reported here are replicated in other parts of Australia. Equally important is to extend the analysis to incorporate variables capturing the other dimensions of wellness identified in the literature review, but which could not be encompassed here. Central among these are factors such as accessibility to service and facilities, particularly those pertaining to health and welfare, and to contact with family and friends, since these are forces inextricably tied to all aspects of human wellbeing.

Acknowledgments The work reported in this paper forms part of the ASPIRE (Ageing Services and suPports In Rural Environments) project. We gratefully acknowledge funding support from the Australian Research Council under ARC Linkage Project LP120200226 and from our project partners the Victorian Department of Health, UnitingCare Queensland and South West Hospital and Health Service Queensland. We also wish to acknowledge with thanks the support of other members of the ASPIRE team: Professor Jeni Warburton (lead CI), Dr Rachel Winterton, Dr Maree Petersen, Dr Suzanne Hodgkin, Professor Norah Keating, Professor Jill Wilson, Jacquie Eales and Turi Berg. The views and findings reported here do not necessarily represent the views of the Industry Partners or of other members of the research team.

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Chapter 10
Spatial Mobility Patterns of Overseas Graduates in Australia

Angelina Zhi Rou Tang, Francisco Rowe, Jonathan Corcoran, and Thomas Sigler

Introduction

Labour and skill shortages have been a persistent theme in the historical development of Australia, wherein attracting adequate numbers of working-age migrants has been linked with the country's economic progress. Since the late twentieth century, however, the country has experienced the same suite of demographic pressures as many other industrialised nations: life expectancies rising gradually, fertility rates falling below replacement level and rapid population ageing (DIAC 2012). Collectively, these processes have led to a reduction in the share of the working-age population and presented serious challenges to maintaining an adequate stock of human capital to meet labour demand (Birrell et al. 2006, 2011; BTRE 2006; Hugo 2006, 2008; DIAC 2012). This challenge is expected to persist in the coming decades as the fertility rate remains below replacement level, and the largest cohorts of the working-age population begin to transition into retirement, foreshadowing the possibility of an even more acute human resource gap (Cully 2011; DIAC 2012).

In the last 25 years, the Australian government has narrowed the country's labour and skill shortages by attracting and retaining skilled overseas individuals (Birrell et al. 2006; Hugo 2008; DIAC 2012) through a series of immigration policy programs. These include the Skilled Independent visa, Skilled Sponsored visa, Skilled Nominated visa, Employer Nomination Scheme, Temporary Work (Skilled) visa, Temporary Work (Long Stay) visa, Temporary Work (Short Stay) visa and

A.Z.R. Tang (✉) • F. Rowe • J. Corcoran • T. Sigler
Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia
e-mail: z.tang@uq.edu.au; f.rowegonzalez@uq.edu.au; jj.corcoran@uq.edu.au; t.sigler@uq.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_10

Regional Sponsored Migration Scheme visa. Each of these visa programs aims to recruit skilled overseas individuals to sustain the pool of human capital within the country, and each is backed by development plans and policies that target the revival of non-metropolitan locations in which labour and skill shortages have been most acute as a result of a continuing outflow of young people to major urban centres (Bell 1994; Bell and Hugo 2000; Stimson et al. 2004; Hugo and Harris 2011).

In addition to the evolving visa schemes available to prospective migrants, new policies have sought to move beyond a reliance on offshore applicants. More specifically, since 1998, the scope of these policies has been broadened to target overseas graduates who studied at local Higher Education Institutions (HEIs) (Arkoudis et al. 2009). Three key reasons motivate this policy shift (Hawthorne 2005, 2008; Ziguras and Law 2006; Suter and Jandl 2008). First, these graduates are considered to be more readily employable than their offshore counterparts as less training is needed. Second, locally acquired skills and qualifications are perceived to be more compatible with the local labour market than those acquired overseas. Third, since domestically educated overseas graduates have been immersed within the local culture during their studies, they are considered to be more familiar with local customs, legislation and language. A major outcome of these policies has been an increase in the number of locally educated tertiary students from overseas remaining and working in Australia following graduation (Birrell et al. 2006, 2011). However, little is known about this component of the Australian labour force, as few studies have examined their employment outcomes and spatial choices. These students are referred to as ‘overseas graduates’ within this chapter in order to distinguish them from ‘domestic graduates’ and from skilled migrants who gained tertiary educational qualifications before migrating to Australia.

This chapter explores the migration patterns and spatial redistribution of overseas graduates across Australia. Emphasis is placed on the spatial impact of these movements on non-metropolitan regions given the labour and skill shortages experienced in these areas. The chapter is structured as follows: the next section establishes the contextual framework through discussion of the labour and skill shortages in non-metropolitan Australia, followed by an examination of the role of overseas graduates as a source of human capital to help address this deficit. Next, we review the policies and plans introduced to redirect skilled labour, including overseas graduates, to non-metropolitan locations. Section “Data Sources” describes the data sources utilised in the study and we then examine the spatial choices and migration patterns of overseas graduates. We conclude by summarising the main findings, offer some recommendations for policy development and identify avenues for future research.

Labour and Skill Shortages in Non-metropolitan Australia: The Role of Overseas Graduates

The significance of understanding the spatial choices of overseas graduates is underscored by the pronounced and persistent labour and skill shortages in Australia’s regional and remote areas. As in many other developed countries, a large share of young Australians relocate from non-metropolitan areas to major urban centres in pursuit of better educational and employment opportunities along with a more vibrant lifestyle (Bell 1994; Bell and Hugo 2000; Stimson et al. 2004; Hugo and Harris 2011). As a consequence of this movement, urban centres and coastal regions have experienced large net migration gains of young people, whereas non-metropolitan locations, especially remote inland regions, have consistently recorded marked net migration losses (Bell and Hugo 2000; Hugo and Harris 2011; Argent and Tonts 2015).

This out-migration of young people has exacerbated the effects of ageing in non-metropolitan locales (see Chap. 8 by Griffin et al. in this volume), as well as eroded the pool of skilled labour. The effects are further underpinned by the loss of young leaders in many rural communities, restraining the growth of local economic activity and social development (Hogan and Young 2013). At the same time, the flow of skills, knowledge and labour from these non-metropolitan locations into major cities has reinforced the concentration of economic development and young highly skilled human capital in metropolitan areas of the country (Bradley and Gans 1998; BTRE 2004; Hugo and Harris 2011).

As these processes take effect on rural communities, the depletion of human capital outside the urban centres of Australia has gained substantial attention in policy debates. Federal and state governments have examined the extent and reasons for the loss of young skilled individuals from regional and remote Australia (RRSDC 2006; DPC 2008; DPMC 2008). The issue was highlighted as a key discussion topic and ranked as a national priority in the 2007 National Youth Roundtable (cited in Corcoran et al. 2010) and in the Australia 2020 Summit (DPMC 2008). To help enhance the social fabric and economic development of non-metropolitan areas, domestically educated overseas graduates have been considered a potential source of labour supply, skills and knowledge (Hugo 2008; Massey and Parr 2012).

Previous studies have identified certain factors as highly relevant to the locational and vocational choices of overseas graduates. Profession-specific skills, communication ability and personal attributes were found to play a more important role than English language competence in determining employment outcomes (Arkoudis et al. 2009; Birrell et al. 2011; Birrell and Healy 2013). Related studies have shown that non-metropolitan regions appeal to a select group of overseas graduates, in particular, people who have studied and lived in non-metropolitan areas and those who are qualified in health or education (Rowe et al. 2013; Tang et al. 2014). Faggian et al. (forthcoming) and Corcoran et al. (2015) have also highlighted that overseas graduates have a greater propensity for employment in lower-skilled occupations, experience greater misalignment to their educational qualifications and are at a considerable salary disadvantage in comparison to their domestic counterparts.

Notwithstanding these findings, overseas graduates represent part of a potential solution to labour and skill shortages in Australia for at least two reasons. First, as global competition for skilled labour heightens, the retention of overseas graduates already in the country offers a practical alternative to the recruitment of offshore migrants (Hawthorne 2008). Second, Australia has a relatively abundant supply of locally educated overseas graduates compared to other developed countries, recording

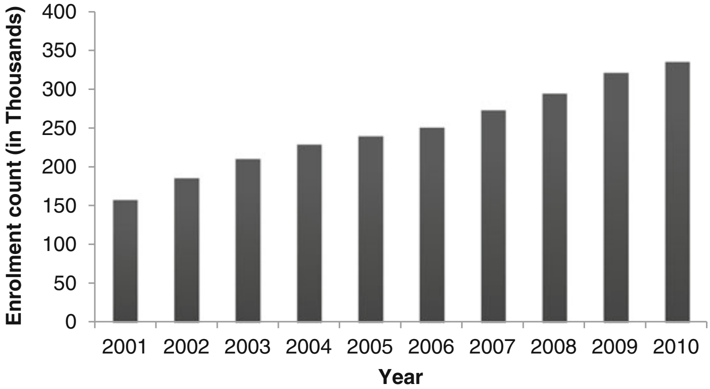

Fig. 10.1 Enrolment count of international students in Australian higher education institutions, 2001–2010 (Authors' elaboration using data from Department of Education 2013)

the highest proportion of overseas students in tertiary education institutions of all member countries of the Organisation for Economic Co-operation and Development (OECD 2011). In 2009, overseas students constituted 21.5% of total tertiary enrolments in Australia (OECD 2011). Other international education suppliers recorded substantially smaller figures. For example, the United Kingdom and United States, which were also categorised as 'major players' in international educational services, had foreign enrolment rates of 15.3 and 4% respectively (Hawthorne 2008; OECD 2011). Since 1982, Australia's export of educational services has expanded significantly with an average annual growth rate of approximately 14% (Hall and Hooper 2008). During the last decade, this figure has more than doubled from 157,643 in 2001 to 335,506 in 2010 (Fig. 10.1). As such, Australia has the potential to draw upon this relatively large and growing pool of overseas graduates to address the depletion of young skilled human capital in its non-metropolitan areas.

Despite their potential for filling regional labour shortages, there is evidence that overseas graduates prefer major urban centres to non-metropolitan locations (Geddie 2013; Mosneaga and Winther 2013; Rowe et al. 2013; Tang et al. 2014). Five reasons appear to underlie this preference. First, compared to the seemingly pastoral lifestyle of non-metropolitan Australia, cities are more appealing to overseas graduates who are typically from middle-class families residing in major urban centres of the sending countries (Ziguras and Law 2006). Second, major cities offer better employment opportunities in terms of the number of vacancies and the variety of occupations (Geddie 2013). Third, overseas graduates commonly take up degrees such as business and information technology studies, which tend to match jobs clustered in metropolitan areas (Faggian et al. forthcoming). Fourth, overseas graduates tend to have developed contacts in well-established migrant communities concentrated in major urban areas (Rowe et al. 2013). Such social networks provide assistance, advice and information concerning job opportunities (MacDonald and MacDonald 1964; Portes and Sensenbrenner 1993). Fifth, this preference may be explained by path dependence whereby overseas graduates mirror the settlement patterns of long-standing migrant communities and the migration flows of recent migrants, sometimes termed herd effects (Bauer et al. 2002; Epstein 2008). To counter these forces and promote settlement of overseas graduates in non-metropolitan regions, some form of governmental policy intervention appears necessary.

Plans and Policies to Attract Population to Non-metropolitan Areas

Given the relatively small population in non-metropolitan Australia, a modest injection of highly skilled human capital is likely to play a significant role in the social and economic development of local communities. Skilled individuals support the functioning and growth of the local economy (Mathur 1999) and constitute a major source of labour supply for critical services in fields such as health care and education (Vias 1999; Corcoran et al. 2010; O'Sullivan 2013; Rowe et al. 2013). Furthermore, the in-migration of skilled individuals expands rural communities and helps to justify the provision of new public infrastructure and social services in locations where populations would otherwise fall below critical thresholds for service provision (Vias 1999; BTRE 2006; O'Sullivan 2013).

In view of these benefits, federal and state governments have made efforts to attract skilled individuals to non-metropolitan areas as well as metropolitan areas with low rates of population growth, such as Adelaide (DIBP 2013). The key federal policy initiative that targets overseas graduates is a bonus point system, which intends to influence their choice of study location and thus settlement patterns upon arrival. This policy awards overseas graduates five additional points when applying for permanent residency if they studied in the designated areas (for example, Sunshine Coast in regional Queensland), representing a significant boost towards the 65 points required (Ziguras and Law 2006; Hugo 2008). This policy principally aims to "raise international students' awareness of opportunities and increase their choices [of destination when settling in Australia]" (Nelson 2003, p. 18). It also seeks to disperse overseas students from metropolitan HEIs that are already at full capacity in terms of infrastructure and resources (Ziguras and Law 2006).

State governments, on the other hand, focus on improving the attractiveness and competitiveness of their non-metropolitan areas as potential employment destinations (Becker et al. 2013). A number of development plans have been introduced to enhance employment opportunities and quality of life in regional and remote regions. For example, the Victorian Government initiated the Regional Infrastructure Development Fund (RIDF) in 2000 and the Moving Forward project in 2005 with a view to boosting the number of businesses and jobs in non-metropolitan areas, and providing better transport, housing, social and cultural infrastructure (RDV 2014). In particular, RIDF supported the Bendigo Chinese Precinct Project, which recognised the existing Chinese heritage and enhanced cultural facilities (RDV 2014).

Some of the enhancements included the revitalisation of Dai Gum San square as the major outdoor event space, the opening of Bamboo Garden and the integration of Chinese cultural symbols such as lotus and chrysanthemum flowers, Chinese calligraphy and lanterns as part of the urban design (RDV 2013). While the project principally aims to create more employment in the construction and hospitality fields (RDV 2013), this initiative has the potential to attract more immigrants, especially those with a Chinese background, to settle in Bendigo and consequently replenish the pool of labour, skills and knowledge in this area. In Queensland, a development plan, entitled 'Blueprint for the Bush', was launched by the State government in 2006 to promote rural investment and settlement (Department of Communities 2006). In addition to a focus on infrastructure development and job creation, the plan also included a homestay pilot program to assist relocation of both domestic and overseas students to regional and remote localities (Department of Communities 2006). This initiative has the capacity to enhance enrolments in the non-metropolitan HEIs and increase young skilled labour in these areas.

State governments have also implemented a number of *ad hoc* incentive schemes, offering a range of financial and non-financial rewards to attract labour with key skills and qualifications to work in non-metropolitan regions (Connell and McManus 2011; McGrail et al. 2011; Rowe et al. 2013). Such incentives commonly include annual cash bonuses, housing assistance, travel allowances, professional development courses and a supply of electronic devices, such as computers. These schemes are offered to the whole working population and are designed to redirect health practitioners, teachers and lawyers to non-metropolitan areas, with the objective of addressing shortages in these professions outside Australia's urban centres.

Taken together, each of the various initiatives is likely to have attracted overseas graduates to non-metropolitan locations. As yet, however, there has been little research exploring the migration patterns and spatial redistribution of overseas graduates in the context of these policy initiatives. Key questions remain as to whether the aforementioned plans and policies have been effective in attracting and retaining overseas graduates, and in particular whether non-metropolitan migration schemes have been successful. While a comprehensive evaluation of the effects of these initiatives is beyond the scope of this chapter, we examine the geographic origins (i.e. study location) and destinations (employment location) of overseas graduates, paying particular attention to the influence of policies and plans in redirecting labour, skills and knowledge to non-metropolitan Australia.

Data Sources

This chapter draws on data from the Australian Graduate Survey (AGS) administered by Graduate Careers Australia (GCA). This project consists of the Graduate Destination Survey (GDS), the Course Experience Questionnaire and the Postgraduate Research Experience Questionnaire. These annual surveys collect information on personal characteristics (sex, age and citizenship), course studied (study location, subject studied and study experience) and employment characteristics (employment location, wage and occupation) to capture graduate outcomes from Australian HEIs between 6 and 18 months after graduation. Our analysis uses micro data from the 2007 GDS, which provides information on the career and migration trajectories of the 2006 graduating cohort of students.[1]

The 2007 dataset presents a good case study given the sustained policy attention focused on skilled labour shortages in non-metropolitan areas originated during the early 2000s and has resulted in the implementation of a series of development plans and polices, such as the aforementioned RIDF in Victoria, around this period. At the same time, a raft of visa changes was announced in late 2005 with a view to retain more overseas graduates (Vanstone 2005). One of the key changes was the introduction of a new Occupational Trainee Visa that allowed overseas graduates to undertake apprenticeships in Australia for a maximum of 12 months following graduation (Phillips and Spinks 2012). The visa expansion is likely to have increased the number of overseas graduates remaining in the country and enhanced the pool of human capital available to meet labour demand.

This chapter focuses on those overseas graduates remaining in Australia and draws on the definition used by GCA (Guthrie 2008) that describes an overseas graduate as a self-identified international fee-paying student. The analysis focuses on overseas graduates who were employed (in a full- or part-time job) in Australia and provides information on study and employment locations. The dataset comprises 9,675 individual records of overseas graduates. Of these, 94% had studied on-campus (required to attend classes at the HEI regularly) while 6% had undertaken studies off-campus (accessing learning materials online).

For comparison, we also explore the spatial choices and migration patterns of domestic graduates. Domestic graduates are those who self-identify as domestic fee-paying students, are working full- or part-time in Australia, and have reported their study and employment locations. For domestic graduates, this comprises 60,330 individual records. On-campus students constitute 81.2% of the sample while the remaining 18.8% studied off-campus.

To identify metropolitan and non-metropolitan areas in Australia, data are classified using the Australian Standard Geographical Classification Remoteness Structure (ABS 2011). This framework divides Australia into five settlement zones, derived from an Accessibility/Remoteness Index for Australia: major cities, inner regional areas, outer regional areas, remote areas and very remote areas. In contrast to the conventional binary urban-rural categorisation, this structure better captures the variation in population distribution across the country (Searston 1995; Corcoran et al. 2010). HEI and employment postcodes reported by respondents were assigned to one of the five settlement zones. Non-metropolitan zones are defined to include inner regional, outer regional, remote and very remote areas. HEIs located in remote and very remote areas were not invited to participate in the 2007 GDS. However, the number of HEIs and tertiary students in these regions is negligible (Fig. 10.2).

[1] The 2007 GDS captured approximately 40.8% of the 2006 overseas graduating cohort compared to 62.3% for domestic graduates.

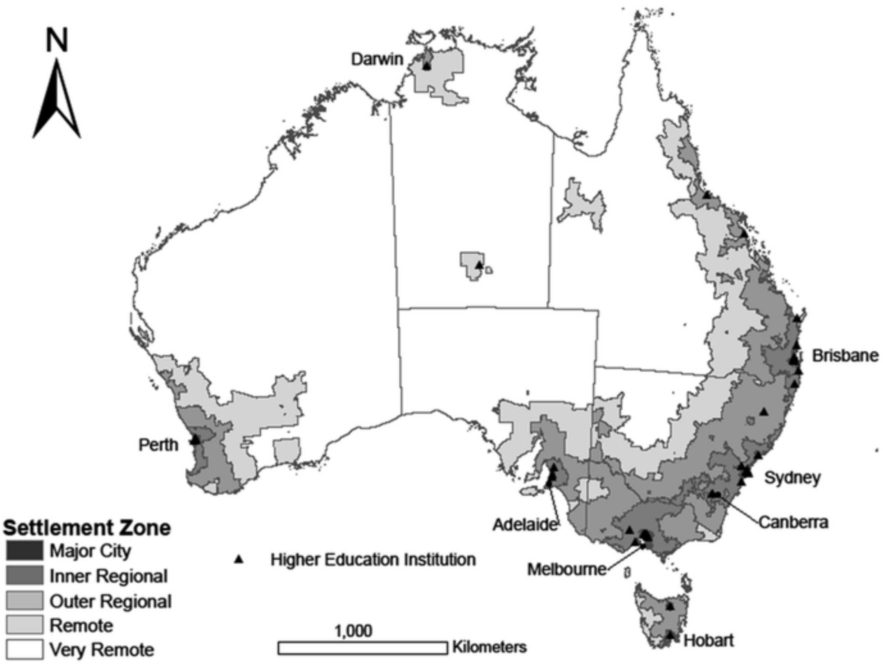

Fig. 10.2 Distribution of universities by settlement zone (Authors' elaboration using the Australian Standard Geographical Classification Remoteness Structure and data from Corcoran et al. 2010). At this scale, the area that delimits the major city category is difficult to differentiate due to their relatively small spatial coverage

Overseas Graduate Migration in Australia

For overseas students graduating from Australian HEIs, the Australian labour market offered a stronger labour market and more robust social and financial prospects compared to their countries of origin (Gao and Liu 1998; Khoo et al. 2008). Following graduation in 2006, 63.5% of overseas graduates remained in Australia for employment, while a little over one-third (36.5%) moved abroad. Of the latter, most (92.8%) returned to their home countries. As might be expected, compared to their overseas counterparts, only a small percentage of domestic graduates (3.2%) migrated to another country for work. The vast majority (96.8%) remained in Australia.

Origins of Overseas Graduates: Study Locations

During their studies, both domestic and overseas students were overwhelmingly concentrated within Australia's metropolitan areas. The major cities of New South Wales, Victoria and Queensland accounted for the bulk of both domestic and overseas students in Australia. Together, these areas were the study locations for 79.2% of the 2006 overseas graduating cohort and 77.5% of their domestic counterparts (Table 10.1). This pattern largely reflects the spatial distribution of universities in Australia (Fig. 10.2).

Although the distribution of overseas students roughly corresponds with the general settlement patterns of their domestic counterparts, there are some points of difference. Overseas students (23.5%) were less likely than their domestic counterparts (28.2%) to study in New South Wales despite the concentration of the long-standing migrant communities in that State. In contrast, compared to domestic students (21.4%), overseas students (27.6%) showed a greater tendency to undertake tertiary education in Queensland. The preference for Queensland among overseas students mirrors the tendency of both internal migrants and recent immigrants to settle in this State over recent decades (Bell and Hugo 2000; Hugo 2008). This migration inflow has been attributed in part to economic constraints in other states and territories in comparison to better employment prospects across Queensland (Hugo and Harris 2011).

Table 10.1 also shows that non-metropolitan HEIs appeared more attractive to overseas students than to their domestic counterparts. In 2006, 21.3% of overseas students studied in a non-metropolitan area, compared to 16.3% of domestic students. A large share of the overseas group (14.7%) studied in inner regional areas of Queensland, which include several medium-sized coastal conurbations such as the Sunshine Coast and Rockhampton. This was significantly more than the proportion of domestic students in the same areas (3.7%) or that of overseas students in the major cities of Queensland (11.8%). The aforementioned bonus point system is likely to have promoted this pattern through improving the opportunity of overseas

Table 10.1 Spatial distributions of domestic and overseas students according to study location, by state and territory and settlement zone (Authors' elaboration using data from the 2007 Graduate Destination Survey)

Overseas students					Domestic students				
State and Territory	Settlement zone				State and Territory	Settlement zone			
	MC	IR	OR	Total		MC	IR	OR	Total
ACT	2.0	0.0	0.0	2.0	ACT	3.1	0.0	0.0	3.1
NSW	21.7	1.8	0.0	23.5	NSW	20.4	7.8	0.0	28.2
NT	0.0	0.0	0.3	0.3	NT	0.0	0.0	0.4	0.4
QLD	11.8	14.7	1.1	27.6	QLD	15.8	3.7	1.9	21.4
SA	9.7	0.0	0.0	9.7	SA	8.0	0.0	0.0	8.0
TAS	0.0	0.9	0.0	0.9	TAS	0.0	1.6	0.0	1.6
VIC	25.7	0.0	2.4	28.1	VIC	27.0	0.0	0.9	27.9
WA	7.8	0.0	0.0	7.8	WA	9.3	0.0	0.0	9.3
Overall	78.7	17.4	3.9	100.0	Overall	83.7	13.1	3.2	100.0

NSW New South Wales, *VIC* Victoria, *QLD* Queensland, *SA* South Australia, *WA* Western Australia, *TAS* Tasmania, *NT* Northern Territory, *ACT* Australian Capital Territory, *MC* Major Cities of Australia, *IR* Inner Regional Australia, *OR* Outer Regional Australia
Percentages based on the total number of graduates in the specific group

graduates to qualify and apply for permanent residency (Ziguras and Law 2006). Willis et al. (2000) and Hugo (2008) argue that lower living costs in regional areas also motivate the decision of overseas students to undertake studies in these localities.

Migration Patterns and Redistribution of Overseas Graduates

We explore the migration patterns and redistribution of overseas graduates using two spatial frameworks: states and territories, and settlement zones.

States and Territories

Following graduation, the majority of overseas graduates found employment in the state or territory of study. Table 10.2 shows that most states and territories retained at least three-quarters of their overseas graduates. The exception was Queensland, which lost a significant proportion, recording the lowest graduate retention rate in the country (50.0%). Retention rates for other states and territories ranged from 76.4% in Tasmania to 95.0% in New South Wales.

Like their overseas counterparts, domestic graduates (71.5–91.2%) showed a strong tendency to remain in the same state or territory for work. However, Table 10.2 reveals prominent differences in the retention rates of domestic and overseas graduates. First, although Queensland retained the majority of domestic graduates (90.0%), it retained only half its overseas graduates. Second, in comparison to overseas graduates (95.0%), New South Wales retained a significantly lower share of domestic graduates (83.2%). These patterns can be partly explained by differences in the study choices of domestic and overseas graduates. In comparison to their domestic counterparts (22%), 45.5% of overseas graduates were qualified in management and commerce qualifications. Since jobs matching these qualifications

Table 10.2 Retention rates of domestic and overseas graduates at study location, by state and territory (Authors' elaboration using data from the 2007 Graduate Destination Survey)

States and Territories	Overseas graduates (%)	Domestic graduates (%)
Australian Capital Territory	89.7	76.4
New South Wales	95.0	83.2
Northern Territory	90.0	71.5
Queensland	50.0	90.0
South Australia	86.6	83.6
Tasmania	76.4	79.2
Victoria	86.2	85.7
Western Australia	94.4	91.2

Percentages based on the total number of graduates in each group who studied in each state or territory tend to concentrate in Sydney (Rolfe 2013; Thrift 2013), which is the commercial and administrative capital of New South Wales and Australia's pre-eminent Global City, overseas graduates are more likely to remain in New South Wales for employment. On the other hand, overseas graduates (3.7%) were less likely than domestic graduates (6.6%) to major in natural sciences. As a result, overseas graduates have a lower likelihood to take up employment in the mining and agricultural sectors that represent key economic activities in Queensland (ABS 2008a, b, 2013a; Rowe et al. 2015).

While most overseas graduates remained in the state or territory where they studied, a significant proportion (13.4%) of overseas graduates relocated to a different state or territory for employment. As proposed by Sander et al. (2014), we employed circular plots to capture the migration patterns of overseas graduates, and to depict differences in these patterns relative to their domestic counterparts. Additionally, we calculated the coefficient of variation (CV) and Gini coefficient to measure the dispersion of flows. The Gini coefficient ranges between 0 and 1, while CV has no upper limit. A Gini coefficient close to 0 and low values of CV indicate high spatial dispersion of migration flows in the regional system (i.e. flows of relatively equal size), whereas a Gini coefficient close to one and high values of CV denote high spatial focusing of migration flows (i.e. flows from and to a small number of origins and destinations).

Figure 10.3 shows circular plots for domestic and overseas graduates. The eight circle segments represent the states and territories in Australia. Each major tick on the segments in Fig. 10.3a indicates 100 overseas graduates, while it represents 1000 domestic graduates in Fig. 10.3b. The ribbons linking the segments represent migration flows within and between states and territories. Each ribbon has a direction: where the ribbon touches a segment indicates the origin of flow and the other end denotes the destination. So, for instance, the dark ribbon linking the Victoria and New South Wales segments in Fig. 10.3a indicates that approximately 200 overseas graduates (2 major ticks) moved from Victoria (an origin as the ribbon touches the Victoria segment) to New South Wales (a destination since there is a gap between the ribbon and the New South Wales segment).

Figure 10.3a reveals that three dominant flows explained the majority (78.2%) of overseas graduate migration between the states and territories. A large proportion of overseas graduates moved from Queensland to New South Wales following graduation, constituting the largest migration flow in the system (45.5% of all interstate moves). The next largest flows from Queensland to Victoria and Victoria to New South Wales accounted for 18.7 and 14% of total moves respectively. In contrast, the major flows of domestic graduates were more balanced in terms of volume: from Victoria to New South Wales (13% of the total) and from New South Wales to Queensland (10.4%), Victoria (9.9%) and the Australian Capital Territory (6.6%).

The circular plots show that migration flows of overseas graduates tended to focus on three states: New South Wales, Queensland and Victoria. In contrast, migration flows of domestic graduates appeared to be more spatially dispersed. This finding is supported by a combination of higher CV and Gini coefficients for overseas graduates, indicating that their movements were more spatially concentrated.

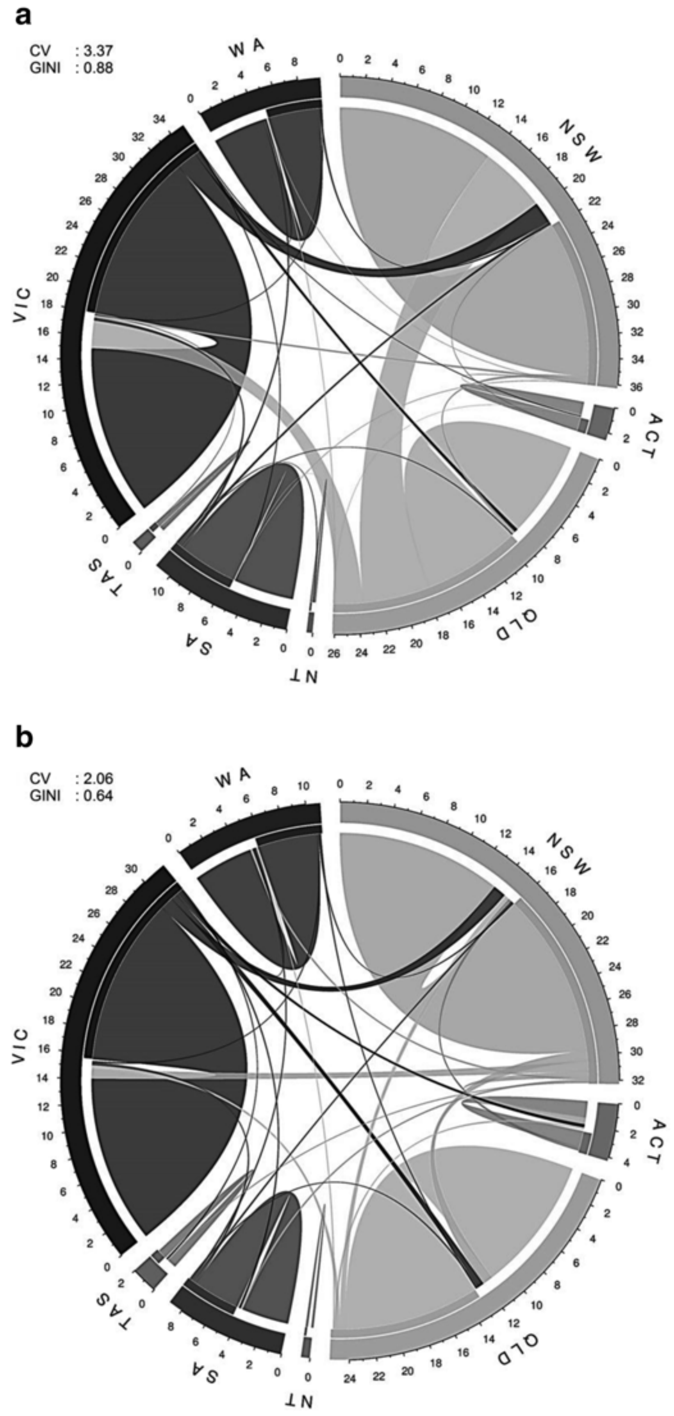

Fig. 10.3 Top 50% of interstate migration flows of domestic and overseas graduates (Authors' elaboration using data from the 2007 Graduate Destination Survey). (**a**) Overseas graduates. (**b**) Domestic graduates. *NSW* New South Wales, *VIC* Victoria, *QLD* Queensland, *SA* South Australia, *WA* Western Australia, *TAS* Tasmania, *NT* Northern Territory, *ACT* Australian Capital Territory, *CV* Coefficient of Variation, *GINI* Gini Coefficient

The results also reveal that New South Wales was the main employment destination for overseas graduates who moved after graduation. It attracted the majority (62.9%) of the overseas graduates who relocated for employment purposes following graduation, resulting in the largest growth of overseas graduates with a net migration rate of 51.5% (Table 10.3). In addition to suitable employment opportunities, these graduates appear to have been attracted by established migrant communities, particularly within Greater Sydney (Rowe et al. 2013). These communities have been shown to attract overseas graduates by providing them with information about job opportunities, and in doing so assisting them in the transition to the local labour market (MacDonald and MacDonald 1964; Portes and Sensenbrenner 1993). This preference of overseas graduates for New South Wales contrasts with that of domestic graduates, who registered a net outflow of 4% from this State. Labour substitution effects may partly explain this pattern, as a large number of overseas graduates moving into New South Wales generate escalating competition in the local labour market, crowding out domestic graduates who then relocate to locations with more abundant employment opportunities such as Queensland, Victoria and the Australian Capital Territory.

While overseas students showed a higher tendency than their domestic counterparts to study in Queensland, they were less likely to take up employment in that State. Figure 10.3a shows that migration flows to Queensland were relatively small, constituting only 5.4% of total interstate moves. This was markedly less than flows of domestic graduates to Queensland (20.3%) or the migration outflows of overseas graduates from the State. As a result, Queensland was the main net loser of overseas graduates with a net migration loss of 45.9%.

Table 10.3 also highlights two interesting patterns. First, the domestic graduate population in the Australian Capital Territory grew by 39.5% compared to a 7.9% increase for overseas graduates. Second, the Northern Territory registered a net migration rate of 110.4 and 50% for domestic and overseas graduates respectively,

Table 10.3 Net migration rates of domestic and overseas graduates, by state and territory (Authors' elaboration using data from the 2007 Graduate Destination Survey)

States and Territories	Overseas graduates (%)	Domestic graduates (%)
Australian Capital Territory	7.9	39.5
New South Wales	51.5	–4.0
Northern Territory	50.0	110.4
Queensland	–45.9	3.5
South Australia	–10.0	–6.4
Tasmania	–12.7	13.6
Victoria	3.9	–4.5
Western Australia	3.5	3.2

The percentage shows the difference between the number of persons entering and leaving the particular state or territory per 100 graduates who studied in the particular state or territory in the specific group partly due to the small population of domestic and overseas students in the Territory. The influx of domestic graduates to both territories may be due to a higher rate of public service appointments in the Australian Capital Territory, the public service capital of Australia, and in the Northern Territory where the key industry is government administration and defence (ABS 2013b).

Settlement Zones

The use of settlement zones permits further insight into the geography of overseas graduate migration within Australia at a spatial scale more appropriate to examining the outcomes of policy initiatives with their objective of relocating labour, skills and knowledge to non-metropolitan localities. Table 10.4 presents the migration choices of domestic and overseas graduates by settlement zone. The key point that emerges from the table is that major cities were the main employment destination for overseas graduates, a finding consistent with previous work (Rowe et al. 2013; Tang et al. 2014). Compared to their domestic counterparts (89%), overseas graduates who studied at an urban HEI (96.9%) were more likely to remain in this type of region for employment. Additionally, metropolitan areas attracted large inflows of overseas graduates from regional areas with between 71.4 and 89.4% of overseas graduates relocating from inner and outer regional areas to major cities for employment. As a result, the overseas graduate population in major cities experienced a net gain of 20.2% (Table 10.5).

In contrast, non-metropolitan areas appeared less successful in attracting and retaining overseas graduates. Although overseas graduates showed a higher propensity to undertake their tertiary studies at a regional HEI, they were less likely to remain in such localities, with just 9.1% (inner regional areas) and 23.5% (outer regional areas) staying on for employment. Of the overseas graduates who moved,

Table 10.4 Migration intensity and flows of domestic and overseas graduates, by settlement zone (Authors' elaboration using data from the 2007 Graduate Destination Survey)

Study location	Workplace location					Out-migration
	Major cities	Inner regions	Outer regions	Remote areas	Very remote areas	
(**a**) Overseas graduates						
Major cities	(96.9)	1.7	1.0	0.3	0.1	3.1
Inner regions	89.4	(9.1)	1.1	0.3	0.2	90.9
Outer regions	71.4	5.0	(23.5)	0.0	0.0	76.5
(**b**) Domestic graduates						
Major cities	(89.0)	6.7	3.1	0.9	0.4	11.0
Inner regions	47.8	(39.2)	10.6	1.6	0.7	60.8
Outer regions	20.1	20.8	(55.8)	2.5	0.8	44.2

The percentages were based on the total number of graduates who studied in a particular settlement zone in the specific group. Out-migration rate for a particular settlement zone is the sum of total outflows. Percentages may not sum to 100% due to rounding

Table 10.5 Net migration rates of domestic and overseas graduates, by settlement zone (Authors' elaboration using data from the 2007 Graduate Destination Survey)

Settlement zones	Overseas graduates (%)	Domestic graduates (%)
Major cities	20.2	−2.8
Inner regional areas	−82.3	−12.9
Outer regional areas	−50.4	81.7

The percentage shows the difference between the number of persons entering and leaving a particular settlement zone per 100 graduates who studied in the particular settlement zone in the specific group

most (between 71.4 and 89.4%) relocated to major cities while only a small number (between 0.1 and 5%) migrated to another non-metropolitan region. The inflows into inner and outer regional areas were significantly smaller than the outflows, contributing to net losses of 82.3 and 50.4% respectively from these regions.

While a significant share of domestic graduates remained in or relocated to major cities, they were more likely than their overseas counterparts to work in a non-metropolitan area. As Table 10.4 shows, inner and outer regional areas retained higher percentages of the domestic graduate population, in addition to attracting larger inflows from major cities than of overseas graduates. Domestic graduates from inner and outer regional areas were also more likely to settle in another metropolitan area for employment. Faggian et al. (forthcoming) propose that the stronger preference for major cities among overseas graduates reflects their tendency for undertaking studies that match the jobs available in the cities. This settlement pattern may also be partly attributed to the fact that overseas graduates tend to have less or no well-developed social contacts outside major urban centres and are hence less likely to relocate to non-metropolitan areas for employment (Rowe et al. 2013).

Destinations of Overseas Graduates: Employment Location

While post-graduation migration redistributes a proportion of domestic and overseas graduates to a different state, territory or settlement zone, the general settlement pattern following employment corresponds to some degree with the pattern of distribution during tertiary studies. Following graduation, both domestic and overseas graduates clustered in the major cities of New South Wales, Victoria and Queensland (Table 10.6), predominately within the state capitals of Sydney, Melbourne and Brisbane, respectively. A small percentage of domestic and overseas graduates settled and worked in the metropolitan areas of South Australia, Western Australia and the Australian Capital Territory. This spatial distribution largely reflects the population distribution and economic landscape of Australia.

Despite broad similarities, Table 10.6 shows two interesting differences between domestic and overseas graduates in terms of workplace locations. First, in comparison

Table 10.6 Spatial distributions of domestic and overseas graduates according to employment location, by state and territory and settlement zone (Authors' elaboration using data from the 2007 Graduate Destination Survey)

	Remoteness area					
State	MC	IR	OR	R	VR	Total
(**a**) Overseas graduates						
ACT	2.2	0.0	0.0	0.0	0.0	2.2
NSW	34.8	0.7	0.1	0.0	0.0	35.6
NT	0.0	0.0	0.4	0.1	0.0	0.5
QLD	13.1	0.8	0.9	0.1	0.1	15.0
SA	8.4	0.1	0.2	0.0	0.0	8.7
TAS	0.0	0.7	0.1	0.0	0.0	0.8
VIC	28.3	0.7	0.1	0.0	0.0	29.1
WA	7.8	0.1	0.1	0.1	0.0	8.1
Overall	94.6	3.1	1.9	0.3	0.1	100.0
(**b**) Domestic graduates						
ACT	4.2	0.1	0.0	0.0	0.0	4.3
NSW	23.1	3.2	0.8	0.1	0.0	27.1
NT	0.0	0.0	0.5	0.2	0.1	0.8
QLD	16.3	2.7	2.7	0.3	0.2	22.2
SA	6.6	0.2	0.5	0.1	0.0	7.4
TAS	0.0	1.5	0.3	0.0	0.0	1.8
VIC	22.8	3.3	0.5	0.0	0.0	26.6
WA	8.4	0.4	0.4	0.3	0.2	9.7
Overall	81.4	11.4	5.8	1.0	0.4	100.0

NSW New South Wales, *VIC* Victoria, *QLD* Queensland, *SA* South Australia, *WA* Western Australia, *TAS* Tasmania, *NT* Northern Territory, *ACT* Australian Capital Territory, *MC* Major Cities of Australia, *IR* Inner Regional Australia, *OR* Outer Regional Australia, *R* Remote Australia, *VR* Very Remote Australia

The percentages were based on the total number of graduates in the specific group. The percentages may not add up due to rounding

with their domestic counterparts, overseas graduates were more likely to settle and work in New South Wales (35.6%) and Victoria (29.1%), mirroring the congregation of existing migrant communities in these States (Hugo 2008). In addition to assistance in assimilating into the local labour market, overseas graduates may be attracted to the familiar cultural environment in these communities (Hugo 1995). Second, most overseas graduates (94.6%) were employed in major cities, though these appeared less attractive to their domestic counterparts (81.4%). In contrast, larger domestic graduate populations were employed outside metropolitan areas, particularly in the regional areas of New South Wales, Victoria and Queensland. Remote and very remote areas of Western Australia also attracted higher shares of domestic graduates, attributable in this case to their greater tendency to work in the mining industry that is concentrated in such regions. In comparison to their overseas counterparts (0.5%), domestic graduates (1.3%) were more than twice as likely to be employed in the mining industry, though the numbers in both cases are small.

Conclusion

The spatial choices and migration patterns identified in the 2007 GDS data illuminate contemporary debates in relation to Australian educational, migration and labour policies. Australia has historically been heavily reliant on foreign labour and the current era is no exception against a backdrop of below replacement-level fertility and population ageing. As global competition for skilled labour has stiffened, novel approaches to the attraction and retention of skilled individuals are needed. Recent immigration policy programs have targeted locally educated overseas graduates who are generally deemed more employable than prospective immigrants recruited offshore. The abundant supply of overseas graduates from local HEIs makes these individuals a potentially practical and reliable source of human capital to redress labour and skill shortages. As such, the Australian government has been proactive in attracting and retaining overseas graduates after graduation by introducing a series of plans and policies in the attempt to redirect skills and labour to non-metropolitan areas where the shortages have been most acute.

To develop an understanding of the post-graduation pathways of locally educated overseas graduates in Australia, this chapter has explored the spatial patterns and redistribution of the 2006 graduating cohort after graduation. It compared the migration patterns of overseas graduates against those of their domestic counterparts. The results showed that the majority of overseas graduates (63.5%) remained in Australia for employment, with most settling in the metropolitan areas of New South Wales, Victoria and Queensland (Sydney, Melbourne and Brisbane). Despite the concentration of overseas students in Queensland for higher education, the State lost almost half its overseas students after graduation. Reflecting the settlement patterns of long-standing immigrants, most of Queensland's overseas graduates relocated to New South Wales. Accordingly, New South Wales experienced the greatest gain in the number of overseas graduates following graduation.

Despite government plans and policies aimed at redirecting skilled labour to regional and remote areas of Australia, these areas were less successful in attracting and retaining overseas graduates compared to major cities. While overseas graduates were more likely to undertake tertiary studies at a non-metropolitan HEI than their domestic counterparts, non-metropolitan areas struggled to retain these graduates, losing around four-fifths of its overseas student population following graduation. At the same time, only a small number of overseas graduates from urban HEIs relocated to non-metropolitan regions, resulting in the majority of the 2006 overseas graduating cohort (94.6%) settling in a metropolitan location for employment. The results of this chapter are consistent with recent studies (Rowe et al. 2013; Tang et al. 2014), providing strong evidence that overseas graduates have a high tendency to settle and work in the major urban centres of Australia.

While this chapter does not directly measure and evaluate the effectiveness of government policies and plans, the findings provide some insight into the potential capacity of such plans and policies in influencing the decisions of graduates to settle and work outside metropolitan areas. The evidence suggests that existing plans and policies have been less successful in redirecting overseas graduates to non-metropolitan locations compared with their domestic counterparts. In order to strengthen overseas employment in non-metropolitan locations, a better understanding of the forces underlying the choice of employment destination is necessary. There is some evidence that having previously lived in a rural community and developed a sense of attachment is an important determinant underlying the decisions of overseas graduates to take up jobs in non-metropolitan areas (Tang et al. 2014), suggesting that one approach might be to provide further financial and non-financial incentives for overseas graduates to settle and undertake study or education-based placements in regional and remote locales during their studies. Further research could extend the current analysis by means assessing the efficacy of existing policies and plans. Such work would shed light on the specific characteristics of policy and plans that have been the most persuasive in promoting settlement in non-metropolitan areas, along with the specific policy components that might be refined to achieve the desired mobility outcomes.

Acknowledgements We wish to acknowledge Graduate Careers Australia for their co-operation and the supply of the data on which this paper is based. Graduate Careers Australia cannot accept responsibility for any inferences or conclusions derived from the data by third parties.

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Chapter 11
Relationships Between Population Change, Deprivation Change and Health Change at Small Area Level: Australia 2001–2011

Paul Norman, Elin Charles-Edwards, and Tom Wilson

Introduction

Effective planning and provision of services in small areas needs to respond to both population dynamics and the relative level of deprivation of residents. For small area planning, information is needed on whether the population is growing or shrinking and whether the population is youthful or ageing. Small area measures of deprivation are also important for resource allocation since they can be used to highlight areas which require intervention through policies or programmes (Simpson 1996; Beale et al. 2006). Population dynamics and deprivation are linked. For example, areas with shrinking populations are often seen to be in economic decline (Reher 2007; Hollander et al. 2009; Johansson 2014), becoming more deprived over time (Norman 2010a). This is driven both by migrant selection, with different types of people moving into or away from different kinds of places (Walters 2000; Champion and Fisher 2003; Clark 2008) as well as changes in the attributes of non-migrants (e.g. employment status). More generally, migration away from more deprived towards less deprived areas (Norman 2010a) has the potential to increase inequalities across the deprivation gradient for a range of outcomes. Conversely, improvements in the relative deprivation of areas have been shown to positively

P. Norman (✉)
School of Geography, University of Leeds, Leeds, LS2 9JT, UK
e-mail: p.d.norman@leeds.ac.uk

E. Charles-Edwards
Queensland Centre for Population Research, School of Geography, Planning and Environmental Management, The University of Queensland, Brisbane, QLD 4072, Australia
e-mail: e.charles-edwards@uq.edu.au

T. Wilson
Northern Institute, Charles Darwin University, Darwin, NT 0909, Australia
e-mail: tom.wilson@cdu.edu.au

T. Wilson et al. (eds.), *Demography for Planning and Policy: Australian Case Studies*, Applied Demography Series 7, DOI 10.1007/978-3-319-22135-9_11

affect mortality (Norman et al. 2011; Exeter et al. 2011; Norman et al. 2008a; Basta et al. 2014; McNally et al. 2014), a key component of demographic change.

Untangling the relationship between population size and structure, and deprivation and how these vary over time presents a number of analytical challenges. Changes in population size are driven by natural change and migration (Norman 2010a). Since rates of births, deaths and migration vary by age (Wilson 2010; Norman et al. 2012), these affect the age structure of the population (Norman et al. 2008b). Capturing demographic change at the small area level requires time series data for consistent geographical boundaries; often unavailable for small areas. Capturing shifts in relative deprivation, presents more serious analytic challenges. Conventional measures of deprivation (e.g. Townsend 1987; Carstairs 1981; Noble et al. 2006; Bell et al. 2007; Havard et al. 2008; Salmond and Crampton 2012; Saunders et al. 2008) combine a set of indicator variables on population attributes into a single composite index and these are invariably cross-sectional (Morelli and Seaman 2007). The development of temporally comparable measures requires population data with the same variable definitions over time, aggregated to the same geographical boundaries (Norman et al. 2003; Exeter et al. 2005). In addition, definitions of what constitutes deprivation over the study period need to be established. Recently, time comparable measures have been developed and applied in the United Kingdom (Norman 2010b; Exeter et al. 2011).

This chapter explores the relationship between small area population change and deprivation in Australia. It seeks to articulate the links between population growth and decline across the deprivation gradient, the components of this population change, links between deprivation and population age structure, and the association between mortality and deprivation across Australian regions. Given Australia's unique geography and settlement system, population and deprivation are examined with respect to Statistical Areas Level 2 as well as the ABS Remoteness Structure (ABS 2011). Section "Measuring Change in Locational Deprivation Over Time" describes the data and methods used for the calculation of a time series deprivation measure used in this study. Section "Measuring Population Change" reports measures of demographic patterns and trends. Section "Results: Deprivation Change in Australia" explores changes in relative deprivation across the Australian settlement system for the period 2001–2011. Section "Overall Population Change" then examines the links between deprivation and population change over this period including population change, natural increase, migration, age structure and mortality. It concludes with a discussion of the policy implications of observed patterns and trends.

Measuring Change in Locational Deprivation Over Time

The measurement of the spatial dimensions of deprivation has been a concern of social scientists for decades, leading to the development of a range of indexes drawing on different dimensions of deprivation. Most prominent in Australia are the four Socio-Economic Indexes for Australia (SEIFA) which capture relative disadvantage and advantage across small areas (SA1 areas) based on different subsets of census variables.[1] Whilst the SEIFA indices are useful for cross-sectional analysis, their utility in time series analysis is more limited. This is due to changes in the input variables between censuses, shifts in the spatial framework of analysis, and the method used in construction of the Indexes (Principal Component Analysis), which generates different results from census to census. Comparisons based on changes in the relative ranks and percentiles of small areas using SEIFA are possible, but must be treated with extreme caution (ABS 2013a). The same situation occurs with the Indexes of Multiple Deprivation (IMDs) used in the UK (Morelli and Seaman 2007). Other measures of locational disadvantage in Australia, such as the Child Social Exclusion index (Tanton et al. 2010) and Indigenous Index of Socioeconomic Outcomes (Biddle 2009), suffer from similar constraints.

To develop a temporally consistent measure of deprivation we follow the approach of Norman (2010b) to construct a Townsend-like measure of deprivation for small areas for the period 2001–2011. This approach requires a stable set of indicator variables and consistent geographical framework over the period. The choice of inputs for the deprivation measure has been guided by existing deprivation indices (see e.g. Townsend, SEIFA) as well as practical considerations with respect to data availability and the comparability of definitions over time. There is a wide and ongoing debate on which variables should be included in a deprivation scheme but commonly used indicators include unemployment, not being a home owner, living in overcrowded conditions, lacking education, not having access to a car and low social class (Senior 2002). The input variables chosen for identifying change in deprivation at SA2 level in Australia are listed in Table 11.1.

To construct the index, the variables in Table 11.1 were calculated for 2011 SA2 areas in 2001 and in 2011. The most recent data from the 2011 Census were downloaded from the Australian Bureau of Statistics online Tablebuilder tool, while 2001 data were custom ordered from the ABS based on 2011 SA2 boundaries. To avoid small number problems and bias we restricted the study to SA2s which had more than 200 people in both time periods. This leaves 2,078 out of 2,214 SA2s for analysis, with an average population of 9,025 in 2001 and 10,431 in 2011.

To construct the time series deprivation index, input variables were first transformed to near-normal distributions where necessary. Variables were then standardised using z-scores, calculated from observations in both 2001 and 2011. This entailed taking the six input variables for all 2,078 SA2s in both 2001 and 2011 and stacking the files so that the observation for each area appears twice. To standardise the variables, z-scores were then calculated as:

$$\frac{(\text{Each observation} - \text{Average of } 4156 \text{ observations})}{\text{Standard deviation across } 4156 \text{ observations}}$$

[1] The Index of Relative Socio-Economic Disadvantage (IRSD); The Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD); The Index of Education and Occupation (IEO); The Index of Economic Resources (IER).

Table 11.1 Variables included in the deprivation index, 2001 and 2011

Dimension	Census variable	Derived variable
Labour force	Labour Force Status (LFSP)	% Unemployed
Housing	Tenure and Landlord Type (TENLLD)	% Living in Public housing
Family	Household Composition (HHCD)	% Persons in Lone parent households
Social	Proficiency in Spoken English/Language (ENGLP)	% Persons who do not speak English well
Education	Non-School Qualification: Level of Education (QALLP)	% Persons without a degree
Income	Total Personal Income (weekly) (INCP)	Median individual income

In doing this calculation, each area was placed relative to the average of 2001 and 2011 for Australia at national level. For example (and ignoring the log transformation applied to this variable), unemployment across SA2s was 7.75% in 2001 and was 5.67% in 2011. The average unemployment rate for all areas in both years was 6.71% and the standard deviation 3.32. An SA2's unemployment rate in 2001 and 2011 was then compared with 6.71 to determine whether its level of unemployment has improved or worsened over the decade. The final deprivation scores were the unweighted sum of the z-scores in both 2001 and 2011. More negative scores relate to less deprived areas and more positive scores to those which are more deprived. If a score for an area has risen then the area has become more deprived and vice versa. The 2011 deprivation scores calculated using the above method are highly correlated with the 2011 SEIFA IRSD index (r=0.86), suggesting that the six inputs combined here yield outputs comparable to the official ABS measure of deprivation.

To aid interpretation, deprivation scores for the 4,156 SA2s are categorised into population weighted quintiles. SA2s in 2001 and 2011 are first ordered based on their deprivation score, before being divided into five groups of equal population size. The population sizes, number of SA2s and range of deprivation values in each quintile are shown in Table 11.2. Having comparable deprivation scores and quintiles across the decade allows population shifts between different levels of deprivation to be identified and relationships with natural increase, migration, age structure and mortality to be investigated.

Measuring Population Change

There is a growing body of evidence that change in small area deprivation is both a product of and driver of demographic change (Lupton and Power 2002; Clark 2008; Norman 2010a). In Australia there is evidence of links between migration and the deprivation gradient across small areas, with migration to large cities selective of high income Australians, and migration to rural areas selective of low income

Table 11.2 Summary of deprivation quintiles

Population weighted quintile	2001 population	2011 population	Number of SA2s in 2001	Number of SA2s in 2011	Deprivation range
Q1 Least deprived	3,164,072 (17%)	4,918,760 (23%)	359	483	−17.90 to −3.33
Q2	3,560,482 (19%)	4,518,388 (21%)	431	464	−3.34 to −0.87
Q3	3,397,675 (18%)	4,699,018 (22%)	409	474	−0.88 to +1.27
Q4	4,078,052 (22%)	4,005,173 (18%)	448	360	+1.28 to +3.66
Q5 Most deprived	4,554,140 (24%)	3,534,399 (16%)	431	297	+3.67 to +14.11
Total	18,754,421 (100%)	21,675,738 (100%)	2078	2078	

Note: Negative deprivation scores represent relatively less deprived areas and positive scores are more deprived areas. Zero is national average for the two census years

migrants (Hugo and Bell 1998). Similarly, links have been established between fertility and socio-economic disadvantage, with more deprived areas demonstrating a higher level of fertility than the least deprived (de Vaus 2002; Norman 2011), as well as with mortality which is positively associated with disadvantage (i.e. the more disadvantaged an area, the higher the mortality) (Wilkinson et al. 2001). Overlying these associations are factors driven by population composition, with Indigenous Australians more likely to live in disadvantaged circumstances than non-Indigenous Australians (Biddle 2014), and accessibility with the population of non-metropolitan areas more likely to live in deprived areas than residents of metropolitan areas (Hugo et al. 2001). To further investigate the links between demographic processes and change in small area derivation we examine the association between population change, age structure and mortality. We further examine these relationships by remoteness area to gain a comprehensive picture of the links between deprivation change and population processes across the Australian settlement system. SA2s are grouped according to the ABS Remoteness Structure categories: Major Cities; Inner Regional; Outer Regional; Remote; and Very Remote. These regions are shown in Fig. 11.1.

Population Change

To describe changes in population size and age structure, and to act as denominators in rates, we use population by 5-year age groups in both 2001 and 2011. We do not disaggregate by sex. Population estimates, births and deaths by SA2 for each year during the decade were obtained from the ABS to inform both the components of

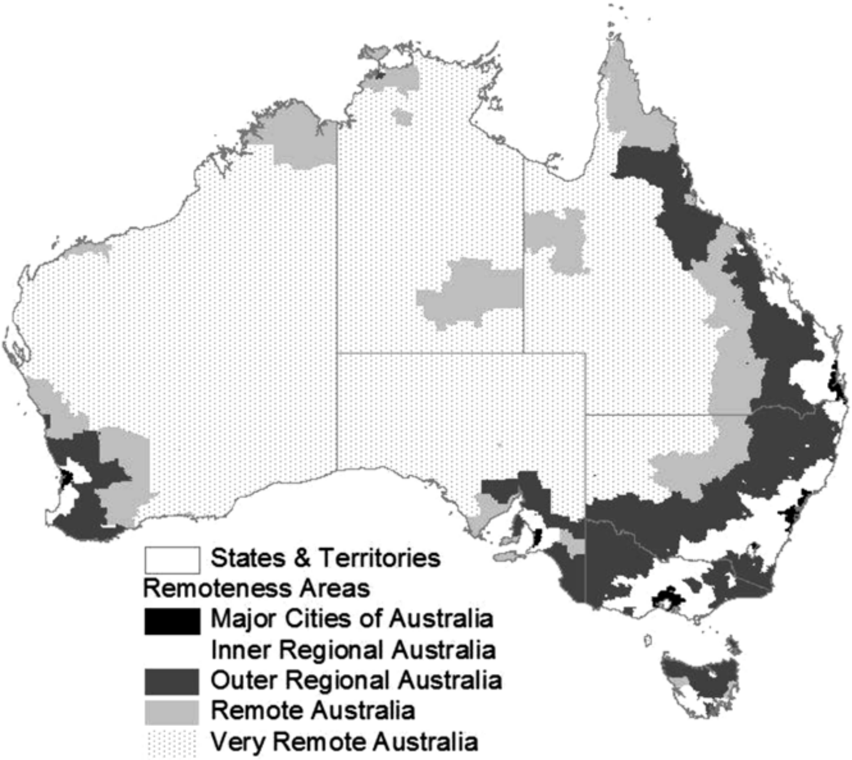

Fig. 11.1 Map of remoteness classification

population change and mortality in both 2001 and 2011. For each SA2, the components of demographic change were calculated using the population accounting equation so that:

- Population change = (2011 Population – 2001 Population)
- Natural change = (Births during mid-year 2001 to mid-year 2011) – (Deaths during mid-year 2001 to mid-year 2011)
- Net migration = (Population change – Natural Change)

Calculating Dependency Ratios

Dependency ratios are a straightforward way of revealing differences in population structure by expressing the ratio of the young and the elderly to the working age population. Following Holdsworth et al. (2013) we take the size of the 0–19 age-group relative to those aged 20–64 to calculate youth dependency ratios and the size of the 65 and over age-group relative to those aged 20–64 to calculate elderly dependency ratios. Any changes in dependencies will show whether populations are becoming more youthful or are aging.

Calculating Mortality Change

The available data do not allow mortality measures to be used which are comparable over time. Indirect Standardised Mortality Ratios (SMRs) are often used at small area level because the inputs are usually available but are calculated relative the national level at a fixed point in time. Taking an average of national age-specific rates for the 2000s for 5 year age groups gives a level to which the mortality at either end of the decade can be compared. To control for the small area age structure, these national rates are disaggregated by 5 year age groups to calculate the 'expected' number of deaths for each SA2. The 'observed' number of deaths is pooled for 2001–2003 and for 2010–2012 to avoid small numbers and smooth annual fluctuations. The indirect SMRs are calculated as:

$$\frac{\text{Observed deaths}}{\text{Expected deaths}} \times 100$$

whereby an SMR of above 100 indicates higher mortality than the national level and below 100 lower mortality, and 100 is the national average for the 2000s.

Results: Deprivation Change in Australia

Over the period 2001–2011 the average deprivation score across Australian SA2s declined from 0.44 to −0.43, suggesting that deprivation eased overall. This overall improvement followed a decade of GDP growth, suggesting that, at least when measured at the SA2 level, a majority of Australians has benefitted from this growth. Across all areas, there is a correlation of 0.89 ($p<0.001$) between 2001 and 2011 indicating that, in the main, areas remained similarly deprived over the decade. This aggregate picture masks changes in the level of deprivation of individual SA2s. A cross-tabulation of the count of SA2s in the 2001 and 2011 quintiles (Table 11.3) shows that, whilst the majority (57%) of areas remained in the same category (on the diagonal), over one third (34%) of SA2s fell below the diagonal, so were classified as less deprived in 2011 than in 2001, while 9% fall into a more deprived category in 2011 than in 2001 (above the diagonal).

There was a clear spatial dimension to shifts in relative deprivation between 2001 and 2011. Improvements in the relative level of deprivation were concentrated among SA2s in the inner core of Australian capital cities, high amenity coastal regions and resource regions of Western Australia. By contrast, SA2s experiencing a worsening of relative deprivation were concentrated in the peri-urban fringe of capital cities, the dryland farming belt of southern Australia and remote northern Australia. Classification by remoteness area provided further insights (Fig. 11.2). The average level of deprivation in Major Cities, Inner Regional Australia and Outer Regional Australia were similar in 2001 and 2011, with slight improvements across

Table 11.3 Cross-tabulation of deprivation quintiles: Australia 2001 and 2011

		2011					
		Q1	Q2	Q3	Q4	Q5	Total
2001	Q1 Least deprived	310	45	4	0	0	359
	Q2	140	233	54	4	0	431
	Q3	29	142	195	43	0	409
	Q4	4	40	192	183	29	448
	Q5 Most deprived	0	4	29	130	268	431
	Total	483	464	474	360	297	2078

Note: Quintile 1 = Least deprived; Quintile 5 = Most deprived

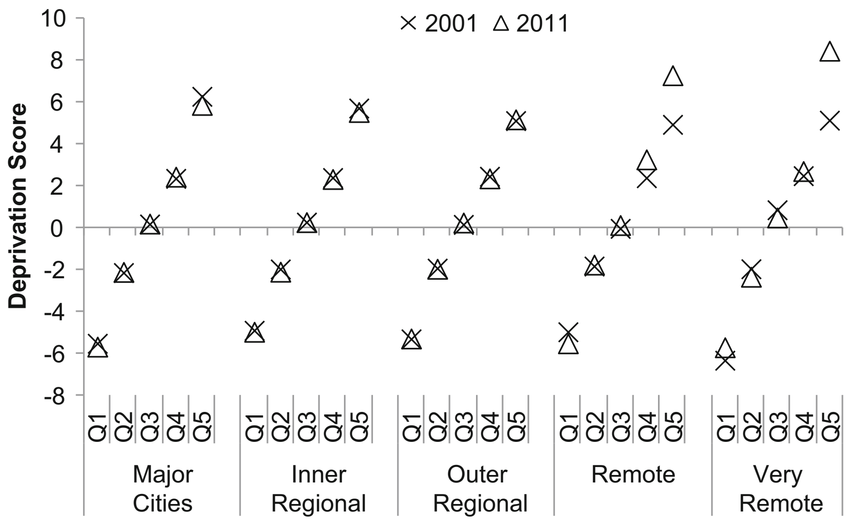

Fig. 11.2 Average deprivation by 2001 and 2011 deprivation quintiles and remoteness: Australia 2001–2011 (Note: Negative deprivation scores represent relatively less deprived areas and positive scores are more deprived areas. Zero is national average for the two census years. Quintiles 1–5 are ranked least to most deprived)

all deprivation bands. By contrast, in Remote and Very Remote Australia the most deprived SA2s (Quintile 5) had higher means in 2011 compared with 2001, indicating that these locations became more deprived over time. Interestingly, some less deprived SA2s in Remote and Very Remote Australia experienced improvements in relative deprivation. This was likely the result of the mining boom.

Differences in deprivation by remoteness band have policy implications, particularly as they relate to Indigenous populations. Moving along the deprivation quintiles from least to most deprived SA2s corresponds to a steady increase in the percentage of Indigenous Australians in the population, from 1.5% in Q1 to 10.1% in Q5. This gradient becomes even more marked when examined by Remoteness Area (Fig. 11.3). In 2011, the most deprived SA2s in both Remote and Very Remote

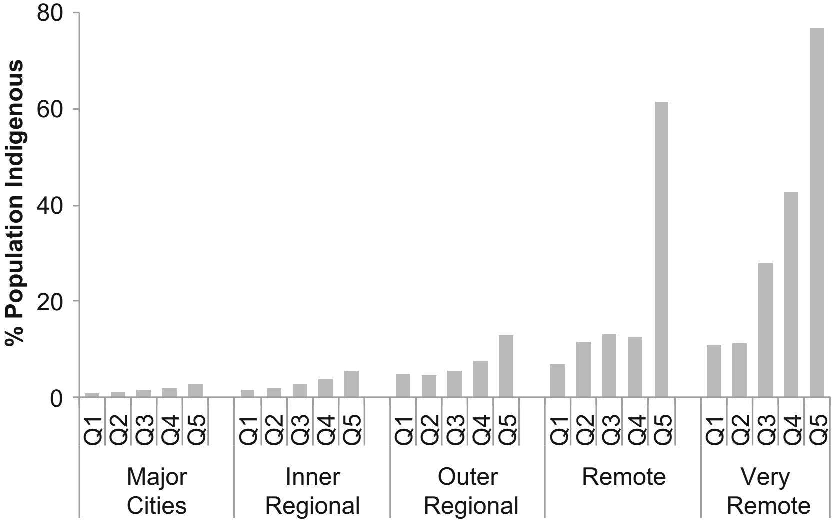

Fig. 11.3 Percentage Indigenous Australians in the population by 2001 and 2011 deprivation quintiles and remoteness: Australia 2001–2011

Australia had, on average, more than 50% Indigenous residents. These include many of the same SA2s that experienced a relative worsening of deprivation between 2001 and 2011.

Overall Population Change

Between 2001 and 2011 the population of Australia grew by around 3.3 million. This growth was underpinned by high net overseas migration, which accounted for just over half of total population growth, together with a substantial contribution from natural increase (ABS 2013b). At the SA2 level, net migration (international and internal) was strongly correlated with population growth ($r=0.97$). Natural increase was less variable across Australian SA2s, and demonstrated a weaker correlation with population change ($r=0.35$). Alongside this growth in population was a shift in the distribution of people by deprivation quintile. Table 11.2 shows there were more people in relatively deprived circumstances in 2001 than in 2011. The share of the population in the most deprived quintile declined from 24% in 2001 to 16% in 2011, and increased in the least deprived quintile from 17 to 23%.

Figure 11.4 shows that levels of natural increase were similar across the deprivation quintiles. However, with decreasing deprivation, there was a progressive increase in net migration gains (which comprises both internal migration from differently deprived quintiles and immigration). Almost all the growth in the most deprived areas was through natural increase.

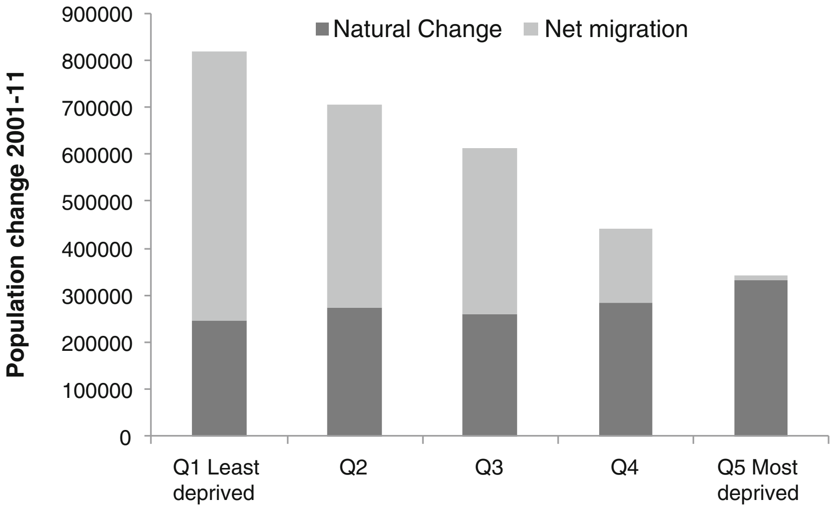

Fig. 11.4 Components of demographic change by 2011 deprivation quintiles: Australia 2001–2011

The same components of change can be cross-classified by remoteness area. Figure 11.5 reveals that the growth was mainly in 'Major Cities' and it was net migration gain in less deprived areas which accounted for the growth. For 'Inner Regional' SA2s it was the middle deprived areas which experienced more growth. In 'Outer Regional', 'Remote' and 'Very Remote' areas (Fig. 11.6 with a different y axis due to the smaller population sizes) a more mixed picture was found. However, there was consistency in the gain in the least deprived areas through positive net migration coupled with net migration loss in more deprived areas. Whilst only a clear gradient with deprivation is seen in the Major Cities, there was a strong tendency for net migration loss in the more deprived areas in Outer Regional and Remote areas.

Changes in Population Structure

Over the decade, the population growth noted above was not evenly distributed across age-groups. Population aged 0–19 grew by just over 7%, population aged 20–64 by over 17% and those aged 65 years and older by nearly 28%. Across all area types, the youth dependency ratios (aged 0–19 relative to ages 20–64) fell during this period (Fig. 11.7). In general, youth ratios were lower in less deprived than more deprived areas but the gradient was flatter in Inner Regional areas. Across remoteness areas, the relationships between youth dependency ratios and deprivation were similar in 2001 and 2011, but overall there was a decline in youth dependency.

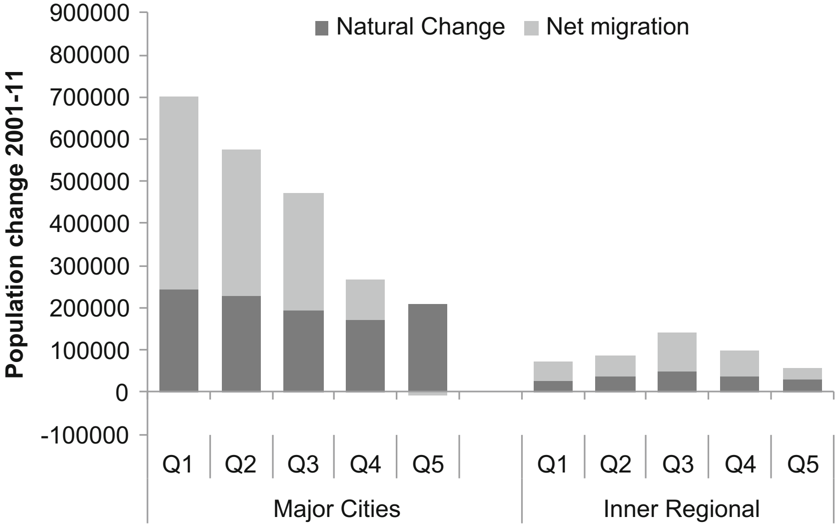

Fig. 11.5 Components of demographic change by 2011 deprivation quintiles in Major Cities and Inner Regional Australia: Australia 2001–2011

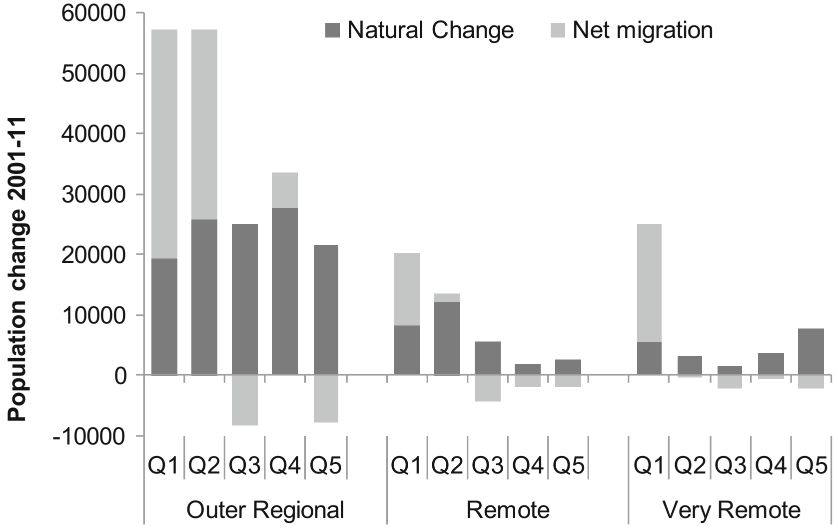

Fig. 11.6 Components of demographic change by 2011 deprivation quintiles in Outer Regional, Remote and Very Remote Australia: Australia 2001–2011

Turning to elderly dependency ratios, Fig. 11.8 shows that for Major Cities, Inner Region and Outer Regional Australia, elderly dependency ratios increased with rising deprivation. In Remote and Very Remote Australia there were large rises in elderly dependency ratios in the middle deprivation quintiles. These changes in dependencies do not imply absolute changes in numbers of young or elderly but are

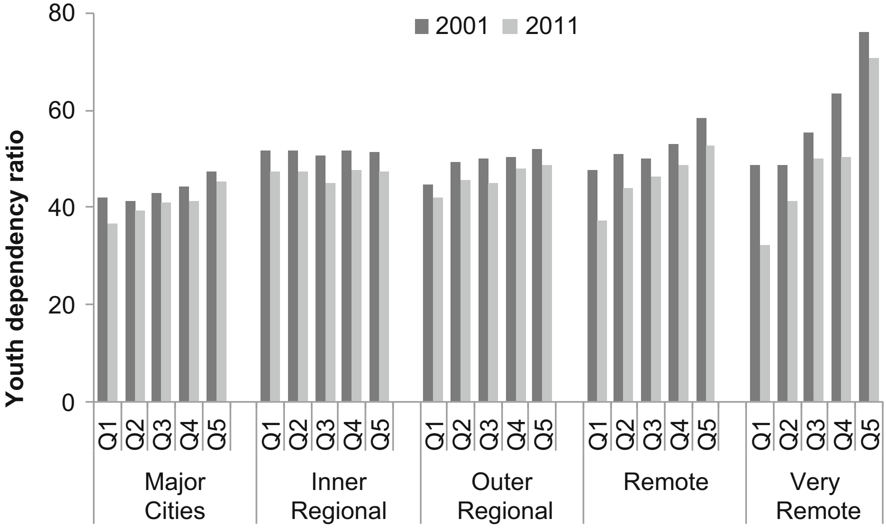

Fig. 11.7 Youth dependency ratios by 2001 and 2011 deprivation quintiles and remoteness: Australia 2001–2011

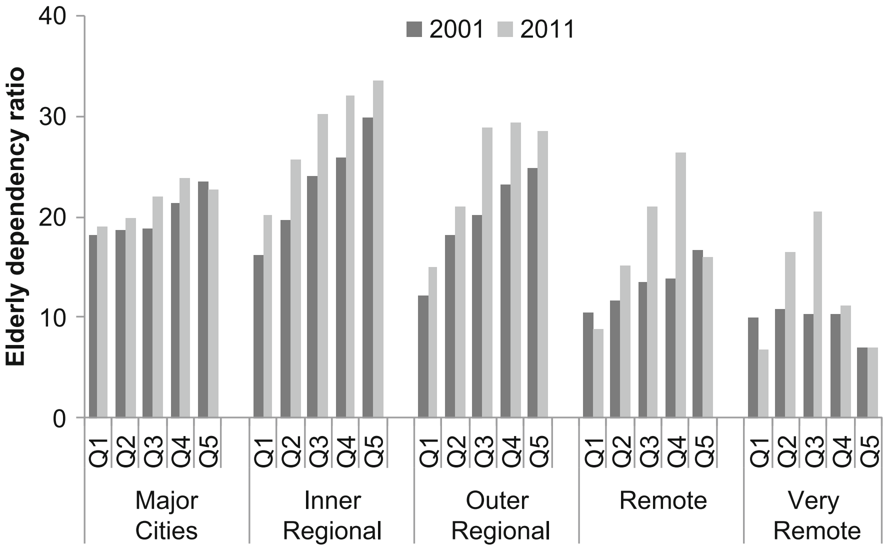

Fig. 11.8 Elderly dependency ratios by 2001 and 2011 deprivation quintiles and remoteness: Australia 2001–2011

relative to changes in the size of the working age population. The usefulness of dependency ratios, particularly in relation to the elderly, is that a high ratio might place local populations under pressure in terms of formal (relevant jobs and services) or informal (e.g. family caring) support.

Changing Mortality

National age-specific mortality rates reduced through the decade and, as shown in Fig. 11.9, standardised mortality ratios in the deprivation-remoteness categories almost all fell as well. In Major Cities, SMRs were positively associated with deprivation (i.e. the more deprived the higher the SMR) but showed the most improvement in less deprived areas over time. In Inner and Outer Regional Australia, the deprivation gradient in 2001 was the opposite of what would be expected but by 2011 had aligned with deprivation. In Remote and Very Remote areas, the patterns were not so clear. There was a large reduction in mortality over the decade for SA2s in the top four quintiles. SA2s in the bottom (i.e. most deprived) quintile experienced an increase in SMRs over the decade, suggesting that mortality worsened. There are possible links with Indigenous status, with Indigenous Australians constituting the majority of the population in the most deprived SA2s.

Two inter-related processes could be associated with the changing deprivation and mortality patterns observed here. First, areas may have changed their level of deprivation. We have found that areas in the main are either similar or have improved

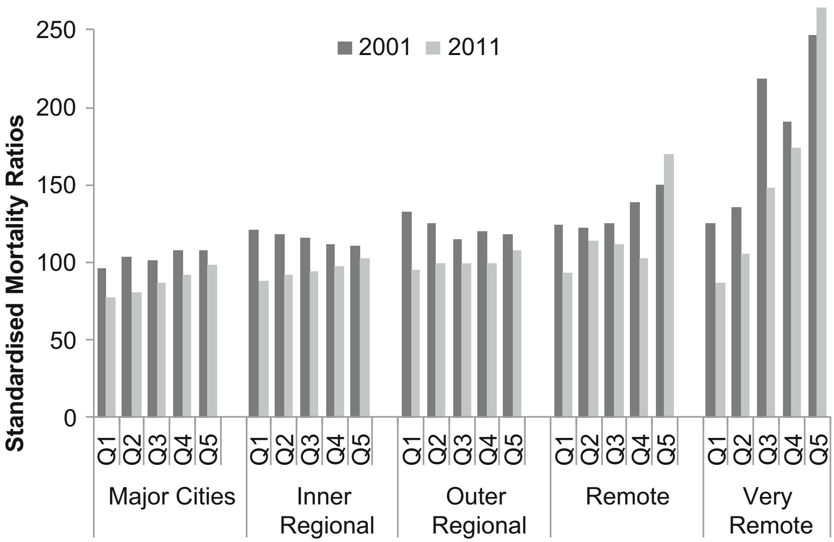

Fig. 11.9 Standardised Mortality Ratios by deprivation quintiles and remoteness: Australia 2001–2011

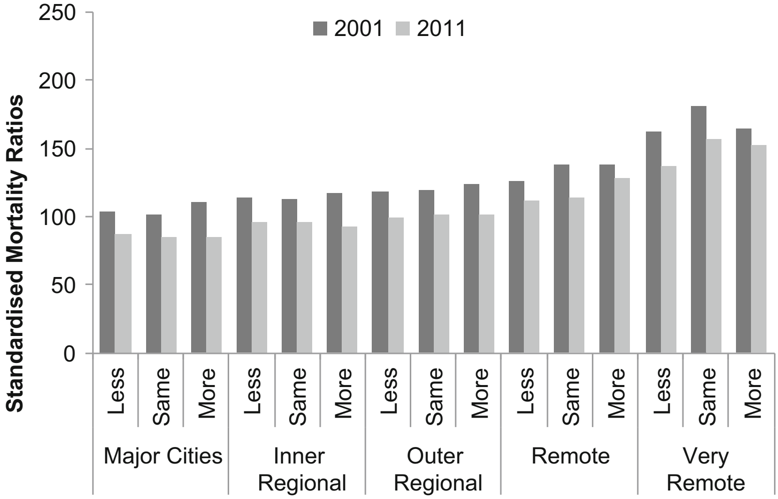

Fig. 11.10 Standardised Mortality Ratios by changing deprivation and remoteness: Australia 2001–2011

their deprivation characteristics, though for some locations deprivation has worsened. Secondly, areas have changed in population size, largely due to net migration. Elsewhere both changing deprivation levels and population gain through net migration have been associated with improving mortality experiences.

Figure 11.10 illustrates SMRs for SA2s which remained in the same deprivation quintile and those areas which were in less or more deprived quintiles. The broad pattern of lower to higher mortality from Major Cities through to Very Remote persisted, but there was no evidence of greater or lesser mortality improvements in areas which changed deprivation quintiles levels over the period.

Figure 11.11 shows SMRs for SA2s which experienced either a gain or a loss of population between 2001 and 2011. As with the deprivation change, the gradient across the Remoteness classification is apparent but there is no difference in mortality for areas which gained or lost population.

Conclusions

The decade 2001 through 2011 saw average deprivation decline across Australian SA2s. Improvements were not uniform across the settlement system, however, with almost 10% of SA2s becoming more deprived over this period. There was a clear spatial dimension to this inequality with regions in the inner city, high amenity coastal regions and resource rich districts showing marked improvements in deprivation, and SA2s on the peri-urban fringe of cities, dryland agricultural zones and northern Australia experiencing a worsening of deprivation. These patterns mirror

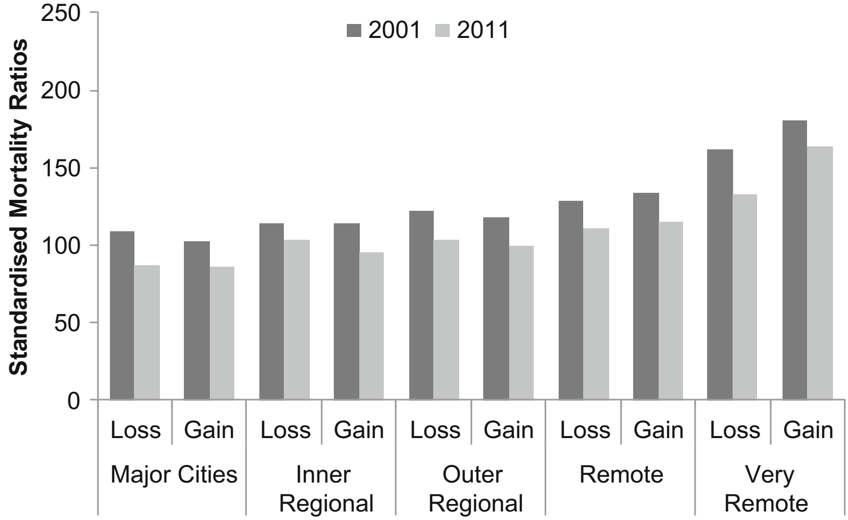

Fig. 11.11 Standardised Mortality Ratios by changing population size and remoteness: Australia 2001–2011

wider transformations in the Australian space economy such as the increased tertiarisation of central city areas and high amenity coastal fringe, the prolonged mining boom, the progressive disappearance of manufacturing from the outer suburbs of major cities (Stimson 2011) and the impact of the millennium drought on agricultural regions. When examined through the lens of the Remoteness Area Classification, a slightly different picture emerges, with deprivation worsening in the most deprived SA2s in Remote and Very Remote Australia; areas with very large Indigenous populations. There is clearly a need for targeted policy interventions in lagging regions as well as an assessment of the efficacy of past policy in lessening social disadvantage. Despite continued division across Australia, the gap between the most and least deprived SA2s did narrow between 2001 and 2011.

For the decade 2001–2011, small area population change was mostly accounted for by net migration, with the contribution of natural increase relatively uniform across the settlement system. A clear gradient was observed across deprivation quintiles, with the least disadvantaged SA2s (in 2011) experiencing the largest net migration gains. This gradient was strongest in Major City regions, although net migration gains were experienced by the least deprived quintiles in all remoteness areas. This broad pattern suggests a link between migration and deprivation in Australia. Given that migration is known to be selective of the young, healthy and educated, this has the potential to worsen deprivation at places of origin and lessen deprivation of destination areas over time. Without individual level data linked to areas at the beginning and end of the decade and an appropriate analysis framework (Norman and Boyle 2014), it is difficult to determine whether migrants are attracted to less deprived areas and/or whether migrant characteristics contribute to locations becoming less derived over time.

Age structure was shown to vary by remoteness type and deprivation quintile. Youth dependency ratios were quite uniform with the exception of Very Remote Australia, which recorded markedly higher youth dependency ratios in the most deprived areas. Youth dependency ratios did decline over the period 2001–2011, reflecting broader trends in population ageing in Australia. The strong decline in youth dependency in Remote and Very Remote locations raises the prospect of a demographic dividend in these communities. Harnessing this demographic windfall, particularly for Indigenous Australians, demands significant policy intervention with respect to both education and employment (Biddle and Taylor 2012). Echoing the work of Argent et al. (Chap. 8) and of Bell and Cooper (Chap. 9), there is a clear spatial dimension to population ageing in Australia. This in part reflects the numerical growth in elderly across Australian regions, but also the impact of youth out-migration from many rural and regional communities. There is a clear association between the level of deprivation and population ageing across the settlement system, with the highest dependency ratios observed in the most deprived quintiles. This is particularly marked in Inner and Outer regional areas, which, as discussed in Argent et al. (Chap. 8), presents particular challenges to policy makers with respect to service provision.

Turning to the link between deprivation and mortality, no strong relationships are evident, however data from 2011 suggest increasing mortality with increasing deprivation and increasing remoteness. There is, however, little evidence to suggest that changing population or deprivation is influencing mortality across Australian regions, implying that other factors are at play.

The changing relationship between small area deprivation and demography over time has not previously been explored in Australia. The results presented here represent a first attempt to untangle these relationships over space and time. They show a clear link between the demographic process of migration and small area deprivation, which further impacts on population age structure across deprivation quintiles. At the same time, there is evidence of persistent disadvantage in locations with high proportions of Indigenous Australians which appears to further entrench disadvantage in remote parts of Australia. Further exploration of these patterns and processes over time is needed to inform policy and planning, and thereby assist in reducing disadvantage and addressing spatial divides.

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