

SPATIAL DATA ACCESS AND INTEGRATION TO SUPPORT LIVABILITY

A CASE STUDY IN NORTH WEST MELBOURNE



ABBAS RAJABIFARD & SERRYN EAGLESON



SPATIAL DATA ACCESS AND INTEGRATION TO SUPPORT LIVEABILITY:

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IN NORTH AND WEST MELBOURNE**

Editors

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Foreword

This publication ‘Spatial Data Access and Integration to Support Liveability: a Case Study in North and West Melbourne’ is the result of a collaborative initiative of the University of Melbourne, School of Engineering, Department of Infrastructure Engineering, Centre for Spatial Data Infrastructures and Land Administration (CSDILA), the Australian Urban Research Infrastructure Network (AURIN), the Australian National Data Service (ANDS), the North West Melbourne Regional Management Forum, the Victorian Government and the McCaughey VicHealth Centre for Community Wellbeing for initiating the groundwork for the project.

The research reported here is about how we can understand the liveability of Melbourne, and cities more generally, in a quantitative manner, integrating multiple data sets. To do this, the researchers have partnered with approximately twenty agencies to establish the Victorian Datahub; laying the foundation for researchers across Australia. Through this network one hundred datasets have been joined and made available via the AURIN portal.

The four demonstrator projects reported in here provide a holistic view of planning. This is achieved by recognising the interrelations between multiple datasets, such as population, transport, land use and health care. These are then considered within an integrated system and explored across four demonstration projects: walkability, employment housing, and health. Importantly they provide decision makers with robust, relevant and interdisciplinary information to support fundamental planning decisions which affect the liveability at both the regional and neighbourhood scale.

I congratulate all involved, AURIN and ANDS, members of the Regional Management Forum for North West Melbourne, all the contributors, champions, researchers, co-authors, and particularly the Centre for Spatial Data Infrastructures and Land Administration for its leadership and coordination. The superb efforts of all participants over the past year have delivered a significant advancement in evidence-based planning.

Professor Iven Mareels

Dean

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The editors and project leaders have been privileged to work with, and enjoy the support of a vast number of researchers, policy makers and software engineers throughout this project. The project has been successful in working with over 100 people and over 20 organisations and is a testament to what can be achieved through collaboration.

Deserving special mention are the Australian Urban Research Infrastructure Network (AURIN) and the Australian National Data Service (ANDS) who are both supported by the National Collaborative Research Infrastructure Strategy Program and the Education Investment Fund (EIF) Super Science Initiative, the McCaughey VicHealth Centre for Community Wellbeing as well as the Centre for Spatial Data Infrastructures for Land Administration for leading and executing the project

We would like acknowledge the contribution of Jim Betts (former Secretary, Department of Transport) and Iain Butterworth (Manager, Public Health, NWMR) who chaired the Regional Management Forum and Regional Management Forum Data Integration Working Groups respectively, and Billie Giles-Corti, from McCaughey Centre and her team for establishing the foundations for the project; all of whom have played an integral part in the success of the project.

We would also like to thank the project champions who have provided guidance and support to the research teams. They are: Sandy Austin, Jane Gunn, Austin Ley, Mick Carroll, Christine Kilmartin, Jim Betts, Billie Giles-Corti and Bob Stimson.

The editors would like to extend their special thanks to the demonstrator leaders and team members who have worked on delivering world-class research. They are: Ian Bishop, Hannah Badland, Marcus White, Sophie Sturup, Jennifer Day, Mohsen Kalantari, and John Furler. Special thanks also go to Ian Bishop for his contribution and continuing support as an advisor to the project. Further to this the support of the technical team who have been responsible for developing innovative technical solutions are Gus McCauley, Amir Nasr, Ghazal Nogoarani, Yiqun Chen, Muiyiwa Agunbiade, Rebecca Roberts, Azadeh Esfahani and Alireza Jamshidi.

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We hope the outcomes of this project can contribute to the future planning of our societies and cities.

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Abbreviations

ANDS	Australian and National Data Service
ANZLIC	Australia and New Zealand Spatial Information Council
AURIN	Australian Urban Research Infrastructure Network
CBD	Central Business District
CSDILA	Centre for Spatial Data Infrastructures and Land Administration
CSRIO	Commonwealth Scientific and Industrial Research Organisation
EIF	Education Infrastructure Fund
EPA	Environment Protection Authority
DEPI	Department of Environment and Primary Industries
DHS	Department of Human Services
DPCD	Department of Planning and Community Development
DPI	Development Potential Index
DZN	Destination Zone
GIS	Geographic Information Systems
JTW	Journey to Work
LGA	Local Government Area
ML	Medicare Locals
MMA	Melbourne Metropolitan Area
NCRIS	National Collaborative Research Infrastructure Strategy
NWMR	North and West Melbourne Region
NWMR-MF	North and West Metropolitan Regional Management Forum
OAI-PMH	Open Archives Initiative - Protocol for Metadata Harvesting
OGC	Open Geospatial Consortium
PCP	Primary Care Partnerships
PDF	Polygon Dissimilarity Function
PHIDU	Public Health Information and Development Unit
PPARS	Planning Permit Activity Reporting System
PTV	Public Transport Victoria
RIF-CS	Registry Interchange Format - Collections and Services

RMF	Regional Management Forum
SLA	Statistical Local Area
UDP	Urban Development Program
UI	User Interface
WFS	Web Features Service
XSD	XML Schema Definition

Chapter 1

Spatial Enablement from an International Context – A Vision for the North and West Melbourne Corridor

Abbas Rajabifard and Serryn Eagleson

Introduction

Problems of space, place and liveability are identified issues facing societies of today. There is an expectation that addressing these identified needs of society would help to build cities that are suitable places to live in; places that in turn will improve our health and wellbeing and the way we contribute to society.

This book is intended to provide an introduction to spatial enablement for health, place and liveability within the North and West Melbourne Region. Its readership is therefore aimed at planners, researchers and decision makers who have a particular interest in the application of spatial data for addressing the issues related to liveability. In the following chapters, applications are detailed specific to the themes of walkability, employment clustering, housing supply and health. The unique issues raised by these demonstrators form the specific focus of this book and demonstrate the value of location-based information and integrated data to provide new insights into the way we plan and forecast for liveable communities.

This chapter outlines the importance of spatial information for researchers and policy makers whose work it is to make a difference to liveability. In doing so the chapter also provides the international and local context for spatial enablement. This includes an understanding of the initiatives being undertaken to empower governments and society to contribute to planning for liveability.

Liveability and Spatial Information

Defining liveability is a complex task as the concept is highly subjective. However the common elements in which liveable communities share are that they are healthy, safe and walkable. They offer choices for timely transportation to schools, housing, jobs, services and basic needs. They are cost effective for individuals and local governments. To plan for liveability requires wise decisions about land use and housing, coupled with the ability to realise the potential impacts of seemingly small decisions at various scales and across time (Chicago Metropolitan Agency for Planning 2013).

It is now well understood that spatial information can support researchers and decision makers concerned with liveability. This is by providing an evidence base to understand the use of space, enabling analysis of connections and change based scenarios. Spatial information in its simplest form is information that relates to a specific location. Figures 1.1 and 1.2 illustrate six different types of spatial information relating to a typical urban environment. Government departments typically collect data on the physical environment represented by data on the buildings and streets. Information is also collected on land use, value of property information, provision of services and number of people. In addition, there is information on the socioeconomic environment such as the age distribution of residents, gender of workers and origin of visitors. This data cannot be observed physically but are geographic in nature and are aggregated to geographic units (Martin 1996). Events occurring at the location also have space and time coordinates attached to them, they can be integrated to understand the use of the place throughout different temporal scales for example: hour, day and week.

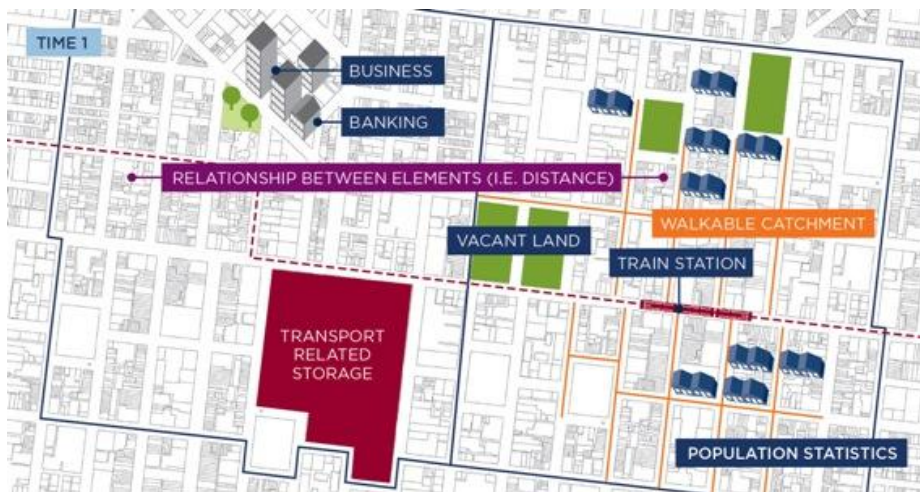


Figure 1.1 Example of changing place-based activities across space and time 1



Figure 1.2 Example of changing place-based activities across space and time 2

The problem

Despite continuing to witness extraordinary technological advancements and progress in the collection and collation of data, the collection activities between departments and tiers of government and wider industry and society is fragmented. As a result it is often difficult for decision makers to discover and access the information they require to make informed decisions that are critical to the future of our cities.

International context

Cities around the world face a complex array of interrelated challenges that threaten their liveability. Examples of these challenges include the increasing rates of urbanisation and population growth, climate change and the impacts of operating in a global economy. As a result city planners are required to draw on limited resources when seeking to create, improve, or ensure, a quality living environment for people. To do so they require access to information that, when analysed, accurately measures and monitors the liveability of a place. It is well known that the process of measuring and monitoring liveability between and within cities is a complex task. This is because there are no well-established frameworks or uniform definitions of liveability. At the city or country level there are numerous studies that rank the liveability of cities or countries according to a specific definition. For instance the *Economic Intelligence Unit - Liveability Rankings* are created to assess 'hardship.' It is designed for employers to apply when assigning hardship allowances as part of job relocation. Others focus on the general quality of life of a country or city from the perspective of the existing citizens. Overall, due to the scale and subjective

nature of the indicators collected, the existing systems lack locally relevant data required for public policy analysis (VCEC 2008).

In an effort to address the local issues government, industry and societies around the world are increasingly acknowledging the benefits of spatial enablement. This is particularly to improve their understanding of cities and therefore make decisions about them. At the same time, location is emerging as a key enabler to decision making and is now commonly regarded as the fourth driver in the decision-making process, complementing the more traditional triple bottom line approach, social, economic and environmental drivers (Rajabifard 2012).

To address the challenges facing cities around the world requires information systems that support planners in their development for the benefit of the people who live within them. As described by (Thurstan and Ball):

“The city of tomorrow will be built upon a foundation of sustainable processes that will generate cleaner air, water and higher energy efficiency while delivering revolutionary transportation systems and quantifiable numbers to prove quality living exists” .

To create these liveable cities requires access to up-to-data that is relevant to the questions at hand. For example, transport decisions depend upon information about population growth, existence of travel routes, stops, accessibility and demand. Housing decisions require information on land use, planning zones, supply and demand. These are only a few examples of areas that depend upon spatial information due to the nature of the services they require and deliver, for liveable cities.

With advancing maturity in the use of spatial information resources, together with the recognition of the importance of spatial information, there is also a significant increase in the amount of data and information available through new and emerging technologies. Examples include ‘cloud’ computing, the use of mobile tracking devices and volunteered geospatial information and crowd sourcing. Although of benefit, this increase also presents challenges that warrant attention. An enabling platform addresses these challenges by facilitating accessibility standards and providing opportunities for collaboration and partnering.

Melbourne – the most liveable city

Melbourne is internationally renowned for being one of the most liveable cities in the world. The city continues however to face unprecedented challenges to plan for population increases that are occurring at a rapid rate. Within Melbourne the current population of 4.1 million is expected to increase by an additional 2 million in less than 40 years. To cope with this increase will require

an extraordinary amount of infrastructure. A planning report 'Planning for Community Infrastructure in Growth Areas', has revealed that Melbourne will require 8 new hospitals, 67 secondary schools, 125 new maternal and child health centres and 222 kindergartens by 2050 to cater for the booming population (Yardney 2012). Positioning each of these will require high-quality spatial information, research and the transfer of knowledge between researchers and policy makers. In this context and in an attempt to showcase the value of integrated data this project was developed.

The North and West Melbourne Data Integration project

This project is about the collaboration from two perspectives: researchers and policy makers. For the researcher developing rigorous techniques are a means to an end – the development of scientific knowledge. For the policy maker however the strategic and tactical deployment of resources informed by the application of scientific method and understanding can improve the decisions related to place through a process of spatial enablement. Within this environment the latest data is available on request in a variety of formats. An enabling platform provides the benefits of both perspectives to achieve the common purpose – an improved evidence base for decisions concerning liveability. To achieve this purpose, the information is embedded within an enabling platform that support the various research and planning activities at a neighbourhood, local and regional scale (Rajabifard and Coleman 2012). Importantly this approach highlights a new paradigm of data management that focuses on spatially enabled infrastructure to integrate urban data from varying sources.

This project illustrates how data can be mapped, modelled and analysed at a level of detail and extent not possible in the past. The value of the framework is exemplified in four policy-relevant demonstrator projects. The demonstrators (on walkability, employment, housing affordability and health service) enable multi-disciplinary research teams to provide an evidence-based approach to decision making. They are supported by an integrated web-based framework giving access to the data sets in their custodial institutions, and sets of open-source analysis tools. Importantly, the framework provides a governance structure that facilitates access to resources and licensing agreements, as well as dissemination channels directly to policy makers.

Governance

The transition from a series of silos across government, to a fully integrated data environment requires a governance framework with appropriate seniority to allow access to data between various departments. This project has been facilitated by the North West Melbourne Regional Management Forum (NWM-

RMF) which was established in 2007 as a resource to strengthen advocacy platforms. The RMF has a mandate to share data with the intention to guide policy decisions and collaborate in integrated planning activities.

The functions of a RMF include strategic priority setting, regional planning, implementation of strategic initiatives and projects, information sharing, consultation on major whole-of-government initiatives and projects. By doing so the forum builds an evidence base of effective practice. The RMF program has established a collaborative relationship between state and local governments and provides a mechanism for constructive, regular dialogue.

Relevant to this project, the NWM-RMF identified four critical areas where better data integration was needed – transport access, education opportunities across the life course, housing affordability, health and employment opportunities. Researchers from the University of Melbourne, in collaboration with the NWM-RMF, AURIN and ANDS, then devised a series of demonstrator projects to respond to these areas of concern (Figure 1.3).

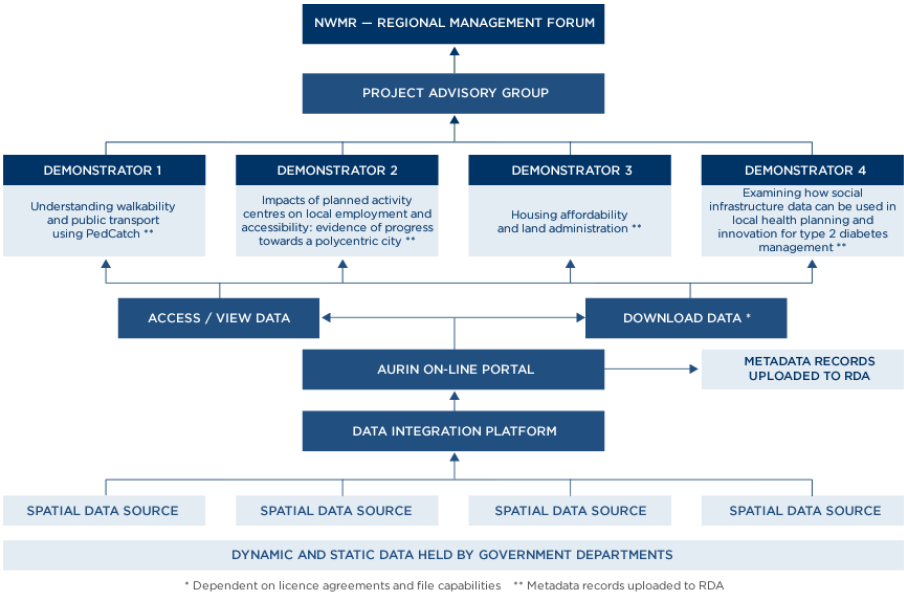


Figure 1.3 NWMR Governance and Project Structure

Champions from within the NWM-RMF and a working group were assigned to each demonstrator project. In this way the demonstrator projects align with current policy directions and priorities across government, thereby encouraging dissemination and end-user ownership of the framework.

This work is ground breaking in the system design and scale at which the demonstrator projects operate. It has enabled researchers to work with policy makers in constructing new views of old problems and provide new understanding and insights.

Communication

To communicate the progress of the project a blog site was created and can be found at: <http://blogs.unimelb.edu.au/aurinands/>. The blog includes project updates, descriptions of each of the demonstrators and their core team members, as well as providing a means to house the quarterly newsletters and videos of the seminars and workshops.

Over one hundred workshops were held during this last year in relation to the project.

The limitations and challenges

This project set out with a vision to integrate data from disparate sources to form a datahub on which researchers could develop tools to support decision making. At the conclusion of this phase, the project had delivered over 60 integrated datasets and four software tools for the purpose of research and planning more liveable cities in the North and West Melbourne Region.

The project is not without its challenges. In particular the project was developed over the period of one year, which is relatively short for the development of partnerships and implementation of data feeds. In terms of technical issues, a lack of services for the delivery of data and clear standards limits the ability of organisations to collaborate. The issues relating to the lack of metadata and descriptive information about datasets is also common, as it is often not systematically addressed.

We note the pressing demands for further innovations, to make better use of the available spatial information, and the drive to create new, smart applications to harness, integrate and interpret spatial data. To move forward, there is a need for greater collaboration, strengthening the existing partnerships and forging new ones, and bringing together communities of practice.

Book Structure

The first two chapters of this book sets the scene for identifying the needs of the North and West Regions of Melbourne to improve liveability and illustrates the importance of data integration and collaboration (AURIN, ANDS, The University of Melbourne) to inform decision making, planning and sustainability.

The first of the demonstrator projects (walkability) is highlighted in chapter three. The authors demonstrate their open-source GIS tool that allows built

environments to be manipulated and evaluated for walkability using an animated agent-based simulation within a web interface.

Chapter four addresses a housing platform that provides opportunities to critically and effectively combine factors important for the efficient and effective delivery of land for housing production.

Chapter five considers the rising prevalence of diabetes and other chronic illnesses and the understanding that disease prevalence is not randomly distributed but rather clustered with social disadvantage is a critical issue for planning services.

Chapter six demonstrates a tool to provide an analytical process to identify spatial clusters of industry in the Melbourne Metropolitan Region and that these clusters can then be used to address issues of concern to urban policy making.

This leads us to the Datahub and the processes behind access and the ability to describe spatial data using metadata in chapter one. Technical specifications of a series of tools that integrate data with a spatial reference to retrieve, process, analyse and visualise data from multiple agencies simultaneously is described.

Lastly, Chapter eight closes with a case study: Footscray. Here the four data integration tools are applied to the suburb of Footscray and demonstrate the potential for spatial data integration to inform policy, planning and therefore liveability to increase health and wellbeing for local communities.

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Chapter 2

Perspective 1: Setting the Scene for the North and West Melbourne Data Integration and Demonstrator Projects

Iain Butterworth, Billie Giles-Corti and Carolyn Whitzman

This chapter provides the background to the project from three perspectives, Perspective 1: the Victorian Government – North and West Metropolitan, Perspective 2: the Australian National Data Service and Perspective 3: The Australian Urban Research Infrastructure Network. Together these perspectives provide the framework and guidance for the project.

There is increasing concern about rising rates of serious physical and psychological conditions in the urban populations of developed nations. These conditions include obesity, heart disease, diabetes, asthma, depression and emotional stress. Research shows that urban planning and health patterns are closely related. Urban growth with low residential densities, car dependency and separation of home and work are linked to behaviour patterns that contribute to poor physical and mental health (Gebel, King et al. 2005).

Most of the factors and the resources that promote people's health and wellbeing are determined by policy and activity outside the health sector. These include infrastructure planning, urban design and development, architecture, employment and investment, education, art, culture and the environment (Wilkinson and Marmot 2003). Health is therefore everyone's business, and not just the role of the health sector. These complex inter-relationships are presented in Figure 2.1.

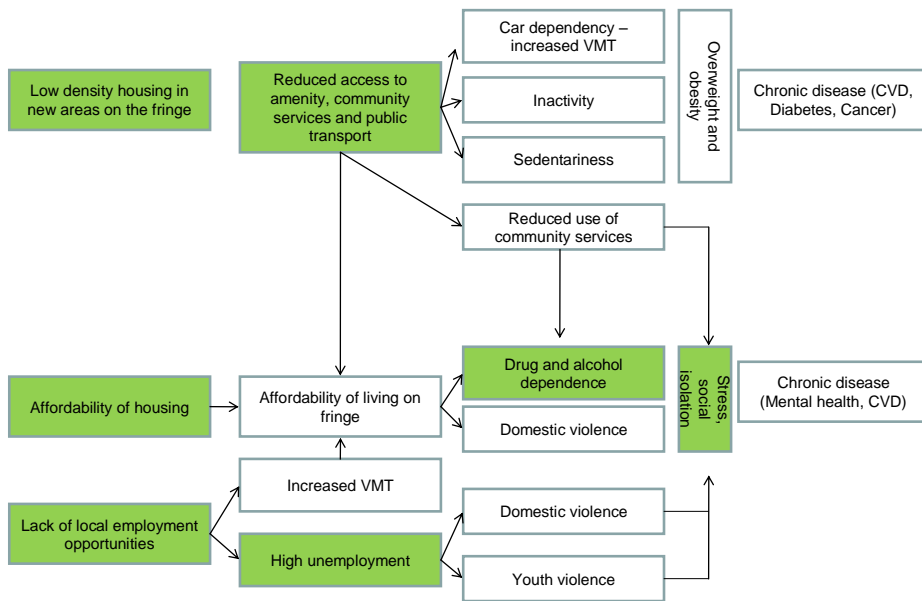


Figure 2.1 Potential pathways of the social determinants of health (Whitzman and Giles-Corti 2011)

The North and West Metropolitan Region of Victoria (NWMR) covers the northern and western suburbs of Melbourne. It is the most populous and diverse region spanning from the Melbourne Central Business District (CBD) to the outer northern and western suburbs. It covers an area of 2,981 square kilometres and includes 14 local government areas. NWMR also has four of the six designated Growth Areas in Melbourne. The region currently has a population of 1.68 million, which is expected to grow by over twenty percent to 2.04 million by 2020 (Department of Planning and Community Development 2008).

Challenges for NWMR include high levels of disadvantage affecting particular groups from low socioeconomic status, culturally and linguistically diverse communities including Aboriginal and Torres Strait Islanders, homelessness and people experiencing disability and mental health issues. In the NWMR there are significant groups and places in which disadvantage is concentrated; generating a heightened need for community infrastructure and service delivery, owing to either lack of access or knowledge, or multiple/complex needs.

The Department of Health (NWMR) is working to: (i) improve health and wellbeing of all people within our region; (ii) improve health equity for those most vulnerable and/or disadvantaged; (iii) strengthen and coordinate an integrated health system so it responds to future needs; and (iv) build our regional workforce and system capacity to influence. We cannot do this work alone. We need to involve all sectors and policy making areas. Because of its strategic importance and influence, the Department of Health has worked

closely with the North and West Metropolitan Regional Management Forum (NWM RMF), of which it is a member.

RMFs aim to identify and address critical social, economic and environmental issues facing each region, and consider the strategic priorities for the region. They also aim to encourage cooperation between state government departments and councils, and work with statutory authorities, businesses and local communities to set and deliver key priorities. Functions of RMFs include strategic priority setting; regional planning; implementation of strategic initiatives and projects; information sharing; networking consultation on major whole-of-government initiatives and projects; sharing lessons and building an evidence base of effective practice. Chaired by a Departmental Secretary, membership comprises of Regional Directors of relevant state government departments, CEOs of local councils, and senior personnel from uniformed services and agencies such as Vic Roads (OECD 2009).

Integrated planning approaches that consider the wellbeing of the whole person and the whole community are vital to NWMR. Furthermore, integrated planning requires good integrated data. Often different parts of government (including state government) have access to different sets of data. RMF members agreed that sharing access to integrate data could potentially help all members to make more informed decisions and collaborate in integrated planning activity. This is particularly relevant for the NWMR, given its growing and changing population.

The RMF Integrated Data Working Group was established in March 2011 at the behest of the RMF. The Working Group created a setting for members to explore some of the issues, and solutions, on how RMF members could share data. In doing so the working group also developed a platform for integrating data across the NWMR.

A number of developments took place throughout 2011 that ultimately led to the successful funding submission to AURIN and ANDS in early 2012. Firstly, early in the life of the RMF Integrated Data Working Group, members realised that the group could also act as a 'data advisory group' to the University of Melbourne's Place, Health and Liveability research program. This program was part of the formal Partnership between the University of Melbourne, Department of Health NWMR and Department of Human Services NWMR. Prof Billie Giles-Corti, Director of the McCaughey Centre at Melbourne University, joined the Integrated Data Working Group.

Secondly, at the behest of the Department of Health NWMR, Prof Billie Giles-Corti led strategic conversations with selected RMF members about their ideas for practical initiatives that the RMF could adopt to address the social determinants of health. The following priorities were identified that could help

make it easier for people to live healthier lives across the North and West Metropolitan Region:

- affordable living and secure housing tenure
- access to public transport and healthy walkable communities
- local employment – particularly for youth
- access to lifelong education to up-skill residents.

The findings complemented and supported the results of consultations on the determinants of crime prevention (conducted by the Department of Justice in 2011). Furthermore, these four key themes were emblematic of the kinds of interrelated ‘wicked problems’ for which access to geospatially integrated data is critical to their resolution. (Housing, employment, transport/walkability, access to health services and access to amenities are currently addressed in the AURIN/ANDS project.)

A third development during 2011 was a clear opportunity for the RMF Integrated Data Working Group to be linked to the Australian Urban Research Infrastructure Network (AURIN). Prof Giles-Corti and her team enabled the RMF Integrated Data Group members to make contact with Prof Bob Stimson, AURIN Director, and his colleagues, who then joined the RMF Integrated Data Working Group.

As a result of these strategic conversations and the shared purpose, the Department of Health was able to fund the University to lead the development of the AURIN/ANDS submission in collaboration with the RMF Integrated Data Working Group. The RMF Chair, Jim Betts (former Secretary of the Department of Transport) also secured the engagement of five other government departments to share their data.

The Integrated Data Platform and Portal has the potential to be of immense benefit, not only to planners, policy makers and researchers in NMWR, but across Melbourne and Victoria. In addition to informing the Place, Health and Liveability research program and supporting best practice municipal public health planning, these resources could be utilised in the implementation and evaluation of the Melbourne Metropolitan Planning Strategy.

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Perspective 2

Australian National Data Service (ANDS)

Stefanie Kethers and Andrew Treloar

The Australian National Data Service (ANDS) is funded, like AURIN, by the Australian Government through the National Collaborative Research Infrastructure Strategy (NCRIS) and the Education Investment Fund Super Science Initiative. Monash University leads the ANDS partnership together with the Australian National University and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). With the development of ICT technologies and advances in data collection methods and sensors, researchers are producing larger and more complex datasets than ever before, and so it is a ‘critical’ task to effectively manage and share these data.

ANDS focuses on addressing these issues by leading the creation of a cohesive national collection of research resources and a richer data environment that will:

- make better use of Australia’s research outputs
- enable Australian researchers to easily publish, discover, access and re-use data
- enable new and more efficient research.

ANDS is also working with other capabilities to create the Australian Research Data Commons – a meeting place for researchers and data that provides descriptions of data collections that are shareable; an infrastructure that enables populating and exploiting the commons; and the connections between the data, researchers, research, instruments and institutions. Research Data Australia (<http://researchdata.ands.org.au>) is the key web-based ‘discovery’ service developed by ANDS. This aims to provide rich connections between data, projects, researchers, institutions, and promote visibility of Australian research data collections in search engines (e.g. Google and Bing).

The general ANDS vision is to encourage more Australian researchers to re-use research data more often. Specifically, ANDS is working to enable the following four transformations:

- to transform data that are *unmanaged* to well-*managed* collections
- to transform data that are *disconnected* to collections that are widely *connected*
- to transform data that is *invisible* to easily *findable* collections
- to transform data that is *single use* to *re-useable* collections.

It is this last transformation that is particularly relevant to the ANDS funding for the North West Melbourne Metropolitan Region of Melbourne Data Access, Integration and Interrogation and Demonstrator Projects. ANDS has funded a suite of projects, of which this is one, that demonstrate the value of bringing data together for re-use to answer new problems.

The resulting demonstrations of value are required to:

- lead to data being transformed or integrated across multiple sources to produce new forms of information that enable innovative, high-quality research outcomes
- deliver value to a high-profile research champion
- be relevant to a range of government portfolios
- engage with national research capabilities.

The ANDS/AURIN demonstrator project fulfils all these criteria:

1. **The project has facilitated access to a myriad of data sets for the Melbourne North and West corridor via the AURIN portal.** This data access is enabling world-class research that will be focused toward addressing the key policy issues in the NWMR in the areas of built environment and health, housing affordability, economic productivity, and transport and sustainability.
2. **The outputs of the project are demonstrating the benefit of providing open access to government datasets to researchers, planners and policy makers.** The research champions include Professor Jane Gunn (Health Demonstrator Champion), Professor Abbas Rajabifard (Housing Demonstrator Champion), Professor Bob Stimson (Employment Demonstrator Champion), and Professor Billie Giles-Corti (Walkability Demonstrator Champion).
3. **The outputs are also relevant to Victorian Government departments that are dealing with problems of space, place, and liveability.** This is evidenced by the leadership provided to the project through the Regional Management Forum.
4. **The project has been a true partnership between ANDS and AURIN that has provided tangible results.** On completion of the project the datasets collected will be made available to both AURIN and ANDS through Research Data Australia and the AURIN portal.

ANDS is proud to have been able to support this joint activity, and looks forward to seeing the ongoing benefits from continuing to use the data and tools made available through this project.

Perspective 3

The Australian Urban Research Infrastructure Network (AURIN)

Christopher J. Pettit

The Australian Urban Research Infrastructure Network (AURIN) is building an e-infrastructure to primarily support urban research and the built environment community. This will deliver benefits to policy and decision making across Australia. AURIN has been initially funded for \$20 million up until mid-2015 through the Australian Government's Super Science Initiative, specifically the Education Infrastructure Fund (EIF). AURIN has established a number of strategic implementation streams known as 'Lenses', which address areas of national significance. There were initially 10 'aspirational' lenses established: (i) Population and demographic futures and benchmarked social indicators; (ii) Economic activity and urban labour markets; (iii) Urban health, wellbeing and quality of life; (iv) Urban housing; (v) Urban transport; (vi) Energy and water supply and consumption; (vii) City logistics; (viii) Urban vulnerability and risks; (ix) Urban governance, and policy and management; and (x) Innovative urban design. It is through these lenses, and the expert groups that are responsible for their governance, that the priorities for e-infrastructure investment are made (Pettit, Tomko et al. 2013).

The NWMR project was initially supported through Lens 3, urban health, wellbeing and quality of life. However, through the North West Regional Management Forum there was an opportunity to look at unlocking a number of government datasets that could benefit urban researchers across a number of disciplines. These related to other AURIN lenses such as urban transport and housing and therefore enabling a multidisciplinary approach to urban research. At the same time the AURIN lens expert groups identified better access to data assets as a key priority. Therefore, AURIN agreed to co-fund the NWMR project to provide better access to a multitude of data assets via the AURIN Portal Beta Version 2 (<https://apps.aurin.org.au/gate/index.html>).

The AURIN portal is an open-source federated e-infrastructure that is essentially a lab in the browser to urban research across Australia. As of the Beta Release 2 of the AURIN portal (May 2013), there are approximately 300 datasets available for researchers. These datasets are kept as close as possible to the data custodians and the AURIN portal provides a direct link to this data through its federated data architecture (Sinnott, Bayliss et al. 2012). There are more than 20 agencies/data custodians providing data in the AURIN portal

through dedicated data services being set up across Government, university and the private sector. Current custodians include: The Australian Bureau of Statistics; The Public Mapping Sector Agency; Landgate; Department of Planning, Western Australia Government; Population Health Information Development Unit (PHIDU) University of Adelaide; Centre of Full Employment and Equity (CofFEE); University of Newcastle; The National Centre for Social and Economic Modelling (NATSEM); the University of Canberra; and the eResearch Lab, the University of Queensland.

Specific to the NWMR project a number of contributing government departments and local council include: Department of Environment and Primary Industries (DEPI), Department of Planning and Community Development (DPCD), Department of Human Services, VicHealth, Melbourne City Council and the Shire of Melton. Over a 12 month period the NWMR project team have made a significant contribution to AURIN through the provision of over one hundred datasets that have been registered using the AURIN metadata tool and now can be discovered, analysed, visualised and where permitted downloaded to support evidence-based research and decision making – see Appendix.

A number of these datasets are required to support the demonstrator projects described later in the book. These demonstrators have built different spatial and statistical e-Tools that are available through different levels of integration within the AURIN portal. For example, the clustering routine developed through the Employment demonstrator is a tightly coupled algorithm integrated within the AURIN portal architecture as a workflow component. Whereas the Agent Based Walkability Tool developed from the Walkability demonstrator project is a stand-alone web tool, which has been developed in open source but is not integrated within the AURIN technical architecture. Nevertheless each of the e-Tools developed as part of this project are most useful in supporting urban research and ultimately policy and decision making in Victoria.

The NWMR project makes a valuable contribution to a joined up government approach to support decision making in Victoria. It provides a systems approach where a number of datasets and innovative e-Tools can be used to plan and design Melbourne's urban form now and into the future.

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Chapter 3

Using Agent-Based Modelling to Inform Neighbourhood Walkability

Hannah Badland, Marcus White and Gus MacAulay

Introduction

Physical inactivity is the fourth leading contributor to the burden of disease globally (Beaglehole, Bonita et al. 2011) and increasing physical activity is therefore a priority, in Australia (National Prevention Health Taskforce 2009) and elsewhere (World Health Organization 2009). In the last decade, an emerging and growing body of evidence confirms that pedestrian-friendly neighbourhoods encourage walking for both recreation and transport (Department of Health Physical Activity Health Improvement and Promotion 2004; Transportation Research Board and Institute of Medicine of the National Academies 2005). In particular, specific built environment attributes, such as residential density, street connectivity, and land-use mix, either considered separately or combined in a walkability index (Frank, Sallis et al. 2010), are related to walking for transport and recreation in the local environment. These measures have been derived using Geographical Information Systems (GIS) drawn from existing spatial datasets. Used extensively by public health researchers, this index enables: neighbourhoods of ‘high’ and ‘low’ walkability to be identified (Badland, Schofield et al. 2009); provides information on the walkability characteristics of a given region (Leslie, Coffee et al. 2007); and provides a standardised benchmark to compare different settings, both nationally and internationally (Frank, Sallis et al. 2010).

The development and application of the walkability index has yielded many insights into the relationship between urban form and walking behaviours (Owen, Cerin et al. 2007; Van Dyck, Deforche et al. 2009; Witten, Blakely et al. 2012). However, the relative inflexibility of the index means that it has been primarily limited to assessing the ‘walkability’ of existing environments with the connectivity measurements being more suited to regional-scaled analysis.

Another factor that impacts on walking, particular walking for transport is proximity to services or features of interest. Methods for assessing proximity of these, such as distance to railway stations and schools, have also been limited

(Sander, Ghosh et al. 2010) with one of the simplest and most frequently used methods being a Euclidian 'circular catchment' or 'circular buffer approach' (Andersen and Landex 2009). This method is rapid to apply but does not take into account street network connectivity or barriers to walkability such as major roads, rivers or railway lines with few crossing points, and tends to overestimate catchment areas. This method is also very limited when it comes to assessing 'what if' scenarios.

A more accurate approach to catchment analysis is the Service Area Approach, sometimes called 'isochrone mapping', or a 'pedshed', which can be calculated in contemporary GIS software such as Esri's ArcGIS™ with the Network Analyst™ extension. This method has far greater accuracy (Andersen and Landex 2009) than the circular catchment method as it takes into consideration street network permeability, barriers such as creeks, rivers or railway lines, and allows for 'what if' scenario testing. These software suites (e.g. Esri's ArcGIS™) can however be prohibitively expensive, as they require high-end GIS software and require specialist staff, as it is too complex for non-expert users.

Although useful, both the walkability index and the circular catchment tools have restricted utility for modelling the impact different built environment scenarios might have on localised walkability, prior to developing or retrofitting communities. For example, modifying the street network, changing light phasing, or access points to features of interest will likely affect the permeability and accessibility of neighbourhoods; and there are substantial advantages to testing different built environment layouts prior to constructing any interventions. As such, we sought to develop an open-source agent-based modelling tool that could respond to these limitations noted above, while building on the existing walkability knowledge to advance the built environment and health-based agenda.

Agent-based modelling is an approach to modelling complex systems of autonomous individual 'agents'. They are programmed with simple rule-based behaviours to interact with each other and their environment over time (Macal and North 2010) to analyse a system as a whole. Though agent-based modelling is not new (Langton 1989), it has become increasingly popular in modelling human movement in the past decade due to both software and hardware development (Macal and North 2010).

High-end proprietary agent-based modelling software such as Legion™ has been used to model complex human behaviours in crowded railway stations and large sports stadiums to predict effectiveness of egress in the event of an emergency, such as a building fire. This kind of agent-based model is highly detailed and involves programming complex agents' behaviours; it is well suited to building-scaled analysis, but is perhaps overly detailed for precinct-scaled analysis. For this reason, our work sought to develop a simplified open source agent-based modelling tool that combined the benefits of Service Area

Approach mapping with some of the other dynamic factors within precinct catchment areas, such as agents (pedestrians) having to cross busy roads or wait times at traffic lights and crossings.

The purpose of this work was therefore to yield a more accurate understanding of how neighbourhood walkability is associated with access and permeability, and to develop an interactive online tool for researchers and planners to modify neighbourhood walkability to enhance access to features of interest. As such, this work will provide not only innovative tools to investigate how neighbourhood walkability is related to amenity access, but enables different planning scenarios to be tested prior to developing new or retrofitting older areas. It is anticipated that planners will apply these tools to diverse areas in Melbourne's North and West metropolitan region and beyond, prior to building infrastructure or when seeking to modify existing sites.

Method

Stakeholder working group and project champions

As per the remit of the overall project, a stakeholder working group and industry and research-based project champions were established prior to commencing this work. The stakeholder working group comprised of representatives of federal, state, and local government agencies drawn from transport, planning, and health sectors. This group met three times with the research team over the course of the project to: inform the content of the agent-based model (workshop 1); provide interim feedback on the alpha version of the model (workshop 2); and review the final assumptions, interface, and model capability. Industry- and research-based project champions communicated the development and utility of the tool to a wide network, including government, academia, and industry.

The initial development of the agent-based model was informed by the health and place-based literature, and earlier walkability research undertaken by the investigators (Badland, Schofield et al. 2009; Badland, Keam et al. 2010), along with a working prototype of the 'Ped-Catch' tool (White 2007; White 2010). The earlier prototype was developed for pedestrian catchment analysis that utilised Autodesk's Maxscript™ and PFlow™ within 3ds Max™ animation software. This method involved agents being programmed with simple behaviours to calculate catchments. The agents could be programmed to move at various walking speeds seeking to travel as far as they could away from a node within an allocated time; navigate a street or footpath network; be hindered by barriers such as major roads or rivers; avoid interacting with buildings and each other; and could be slowed down by steep topography. Ped-Catch has proved to be effective in the design decision-making processes and is also beneficial for design decision advocacy (White 2008). However, this approach requires a high

degree of skill to operate the tool, proprietary animation software is used, and each site must be manually modelled specifically for the analysis.

Refinement of the initial Ped-Catch tool was supplemented with information provided by the stakeholder working group. Considerations raised by this group included the need to be able to utilise and upload a coarser to finer-grained hierarchy of spatial data at various administrative scales, as well as the provision of editing and customisation interface features to model different scenarios. Bearing in mind other complexities in using the earlier walkability tools, including the technical expertise required to manipulate the data; the agent-based modelling tool was designed to be used with open-source spatial data drawn from the AURIN data repository, and had pre-specified user functionality built into the interface.

Datasets

A strength of this tool is its spatial data flexibility; that is, different users have the ability to upload different data sources at different scales. In order to do this the tool has been developed with a spatial data hierarchy in mind. Fine-grained data are optimal, but inputs extend to coarser-scale (e.g. SA2-level or suburb-level) and open-access (e.g. Walk Score, refer: www.walkscore.com) data sources. In this way, a variety of different end-users are able to utilise the tool either using their own data, or those supplied through the AURIN portal or other open-access sources.

Currently, standard datasets used for the tool include the road network, features of interest (e.g. schools, public transport nodes), and traffic lights. Depending on end-user access to other spatial data, additional spatial layers can also be incorporated into the tool. These include footpaths, traffic volume, and topography. Including such additional spatial data layers enhances the accuracy of the tool. There is also scope to add in more subjective features of the environment, such as shade, crime and incivilities, and aesthetics.

Model development

User-specified functionality

This was conceptualised as being a flexible tool that allows users to test different scenarios based on features of interest (e.g. public access nodes, school locations), street connectivity, and population of interest (e.g. vulnerable populations, such as children or older adults). In order to achieve this, a series of user-specified functionalities were designed into the interface.

These included sliding bars to manipulate the: maximum walking time (up to 20 minutes), maximum walking speed (up to 2 m.s^{-1}), and intersection wait time (up to 60 seconds). Vector editing tools were also provided in the interface, allowing the user to: add or remove street networks to modify street

connectivity; and manipulate the agents' starting point to reflect potential features of interest (e.g. public transport egress, location of a school). These attributes are theoretically linked to walking behaviours (Owen, Cerin et al. 2007). For example, walking speeds vary greatly with different ages and levels of mobility (Tran-Safety ; Aspelin 2005; Fitzpatrick, Brewer et al. 2006), and having the ability to alter pedestrian speeds was important for investigating potential for different nodes of interest (e.g. primary schools, senior citizen organisations). It was hypothesised such destinations would have smaller catchments than others due to the different expected walking speeds.

Vector-editing functionality

Together, the limitations of earlier walkability tools and feedback from stakeholders showed a need to include vector-editing functionality. This would enable the user to modify the street network and test different scenarios prior to retrofitting an environment. This was regarded by the stakeholder working group as being a valuable extension to the tool, and was created by snapping vectors to the existing street networks. Multiple vectors can be added or removed within a given scenario. An example of this is shown in Figure 3.1, where additional connections have been snapped to the periphery of the oval in the left hand image; Figure 3.2 shows the agents travelling the new connection.

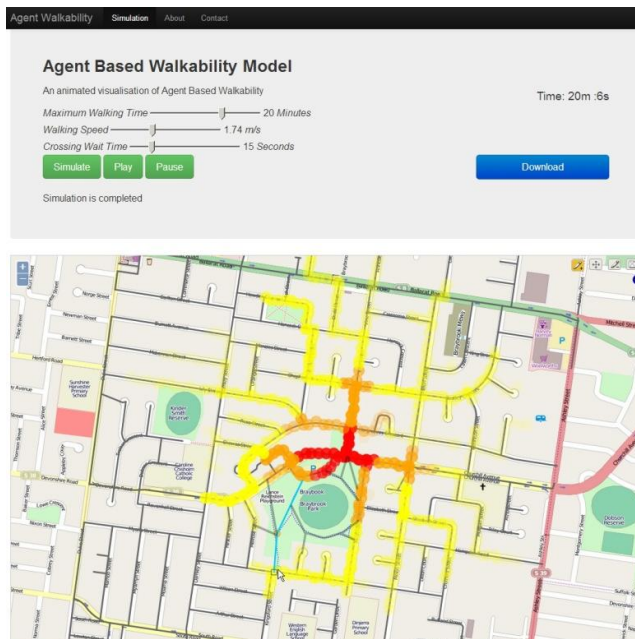


Figure 3.1 Screen grab showing the existing street network and 20 minute catchment area (shown in red, orange and yellow) being modified using vector editing tools to potentially increase connectivity thus increasing catchment area.

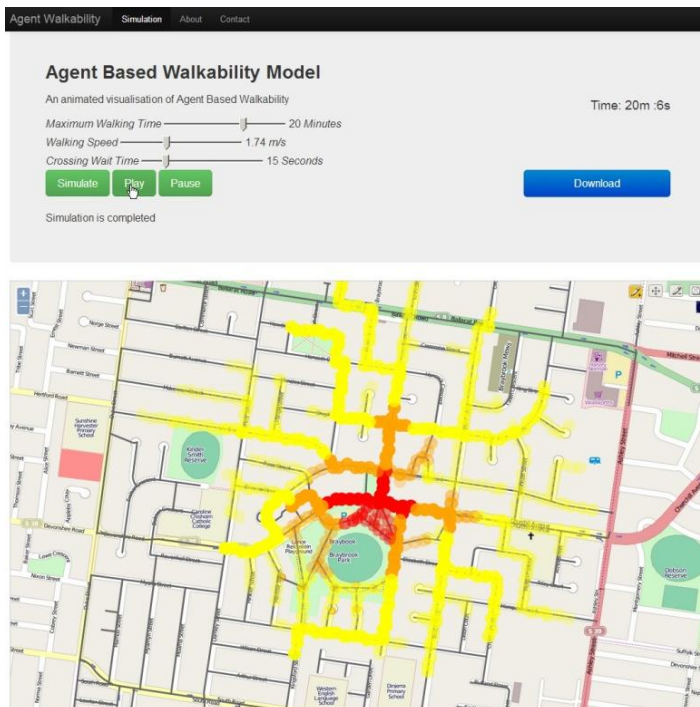


Figure 3.2 Screen grab showing the simulation being re-run over the modified street network. The resulting catchment area is dramatically increased due to the network modifications.

Simulating and visualising the data

The simulation was written in Java and Geotools, and in particular the Geotools Graph library. The Graph library was read in a footpath network dataset in a vector format, and then it performed graph traversal operations, and critically, provided an A-Star navigation algorithm. In addition, using JTS (the core geometry library used by Geotools), the footpath network dataset for the simulation was prepared by creating nodes at intersections and snapping the origin and destination points to the footpath network (so that the agents could traverse to and from destinations that are near but not on a footpath). Using this enhanced footpath network and the A-Star algorithm the paths' agents followed from a starting point to a destination that then was calculated. The paths were then converted into a series of equally spaced points with a timestamp attribute, taking into account time spent waiting at intersections. The final step was to write this out in a geo-referenced file format (GeoJSON or ESRI Shapefile).

Once a time-stamped point dataset was generated, visualising in OpenLayers was quite simple, using an OpenLayers time filter animation. In short, this filtered the dataset to show slices of time incrementally, as demonstrated in the Figure 3.3 (a-d) screen shots.

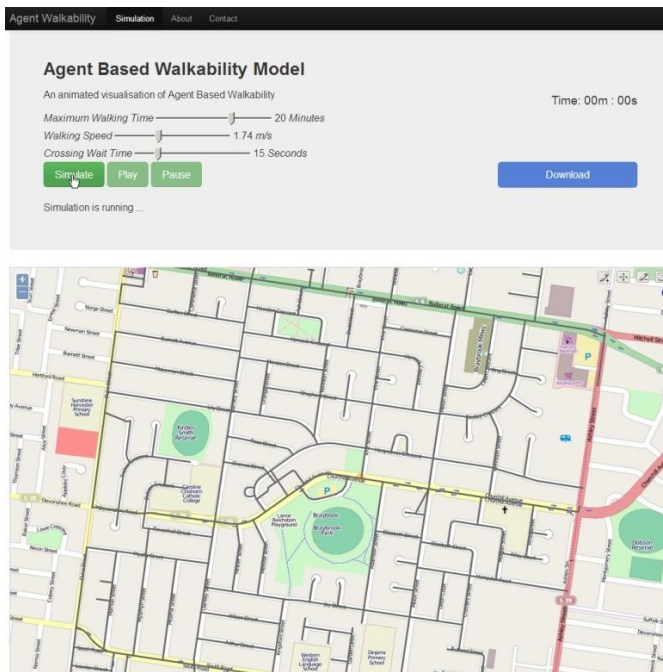


Figure 3.3(a) Screenshots of agent-based modelling tool interface and agent movement 00m:00s.

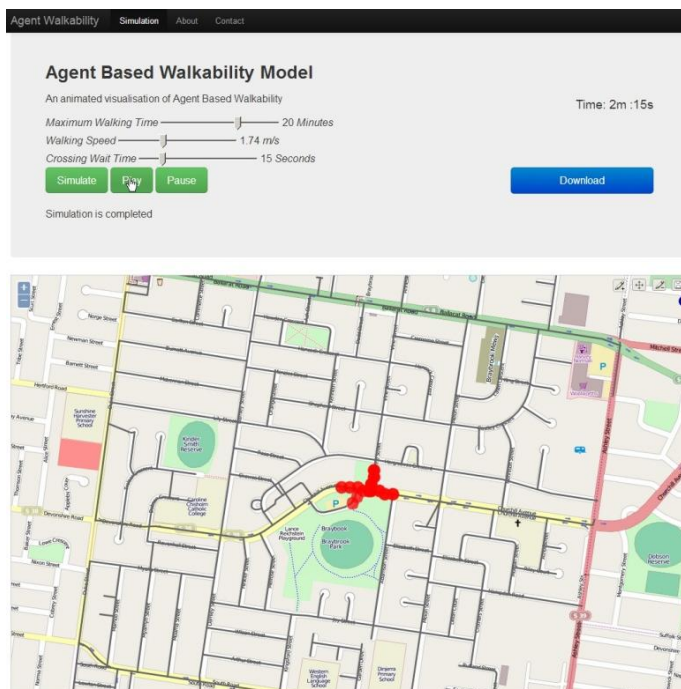


Figure 3.3(b) Screenshots of agent-based modelling tool interface and agent movement 2m:15s.

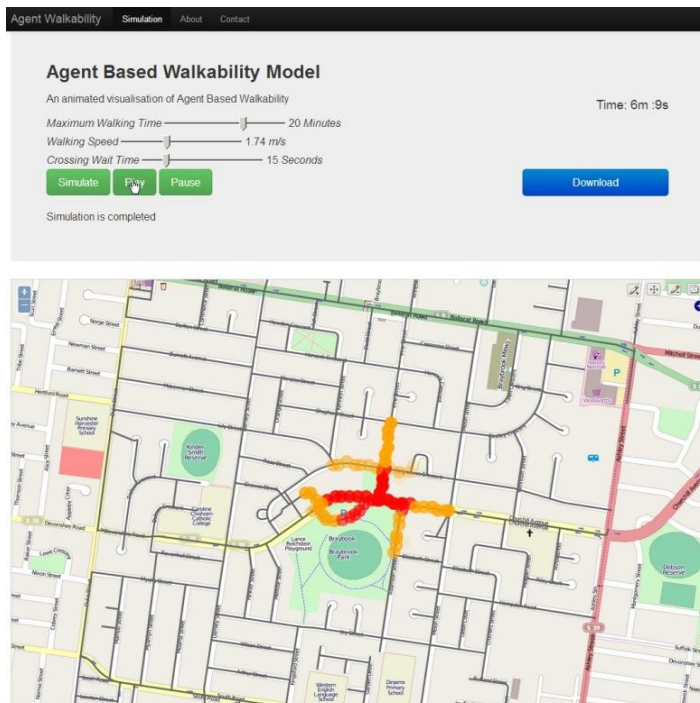


Figure 3.3(c) Screenshots of agent-based modelling tool interface and agent movement 6m:9s.

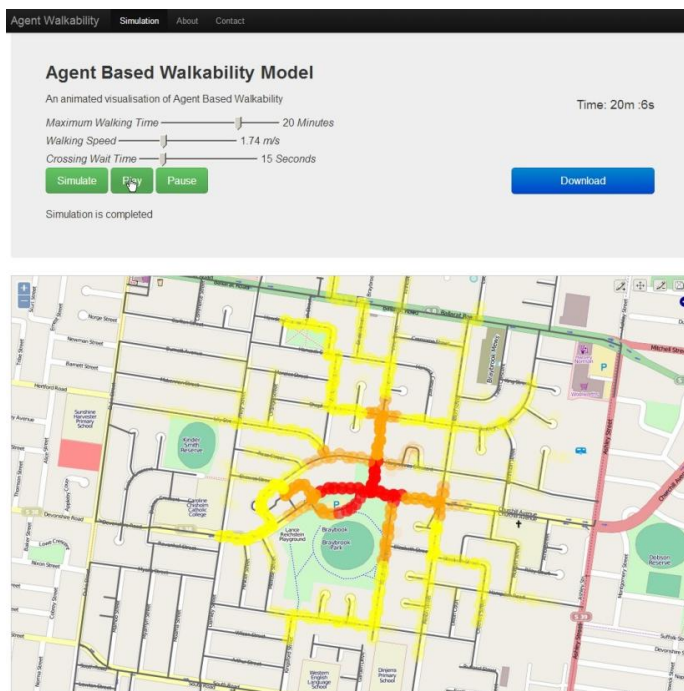


Figure 3.3(d) Screenshots of agent-based modelling tool interface and agent movement 20m:6s.

Broader model considerations

As well as providing end-user and vector editing functionalities, broader considerations for model development included having to: operate within an open-source environment and within the AURIN portal requirements and architecture; be flexible enough to include a range and hierarchy of spatial data and scales provided by the end-user; function in hardware with basic computational power; and provide an interface that was easy to navigate. In order to do this, the tool was developed using basic agents with a limited level of artificial intelligence. Agents left from a user-specified node and travelled to a randomly distributed points snapped to the street network within the parameters set by the user (e.g. walking speed, time, intersection wait time). This allows different 'what if' scenarios to be rapidly tested; the stakeholder group regarded this as being an important feature.

Testing

Given limited development resources it was critical to use lightweight and agile testing methods. We took a behaviour driven development approach in which stakeholder requirements could be translated into simple statements of features against which we could write and run automated tests. These behaviour driven tests were written using common open-source libraries (jBehave and junit). Using this approach we were able to ensure that key features were implemented and were sufficiently robust. In addition we used an automated code quality analysis tool (Sonar). This helped to identify potential issues as code was developed, reducing code complexity, which is beneficial for future integration and re-use in other projects.

Using an iterative approach to development, we demonstrated prototypes and key functionality to stakeholders early in the process. This allowed us to identify bugs and other issues as early as possible, and prioritise critical requirements and functionality.

Outcomes

The agent-based modelling tool was designed as a flexible, open-source tool, where a variety of spatial data could be uploaded and built environment attributes could be manipulated. Furthermore, based on potential future research applications and stakeholder feedback, a series of metrics were also generated after each model's simulation was run. These outputs include: a visual, graded representation of agents throughout the network; area coverage comparison between the agent-based model and circular catchment (expressed as a ratio); and mean data on the number of intersections crossed. All of these variables are recognised as being important attributes of walkability, and

catchment ratios have been used previously to benchmark and monitor planning policy (Owen, Cerin et al. 2007).

These outputs are generated as a .csv file after running each model, thereby allowing comparisons of walkability to be made across different hypothetical built environments. Together these outputs enable the user to understand how walkability is influenced by built environmental and behavioural modifications, or test specific environments to reflect the population of interest (e.g. children, older adults).

Discussion

Leveraging off the substantial body of earlier walkability and agent-based modelling work, to our knowledge, this is the first open-source GIS tool that allows built environments to be manipulated and evaluated for walkability with an animated agent-based simulation within a web interface. Providing a tool such as this to translate research into practice is a substantial contribution to the health- and place-based research agenda. Built environment interventions are costly to implement, however, the longevity and ability to influence a large population make these cost-effective developments in the long-term if done correctly from the outset (Sallis, Floyd et al. 2012), and this tool provides the opportunity to trial and evaluate different scenarios prior to building infrastructure. Furthermore, this tool can be used in conjunction with the 'walkability index tool'. The walkability index tool was developed by researchers in 2012 at the Place, Health, and Liveability Program (University of Melbourne) and is available through the AURIN portal. These tools were designed to be used by people with limited technical expertise to firstly, identify the existing walkability of a given area, and secondly, to examine how these areas can be manipulated to modify the walkability of the built environment. Depending on the data layers used, models take between 5 and 10 minutes to generate.

This work has close links with the other demonstrator projects, being: housing, health, employment, and access to community services. The ability of being able to design environments that facilitate walking from home to local employment and education, shops, services, and public transport has important far-reaching implications. Globally, physical inactivity accounts for approximately eight per cent of deaths per year (approximately three million people) attributed to non-communicable diseases (Beaglehole, Bonita et al. 2011), therefore increasing walking at the population-level will generate substantial health benefits (Hallal, Andersen et al. 2012). Furthermore, increasing walking will generate additional benefits, including increases in social cohesion (important predictor of mental health) (Sugiyama, Leslie et al. 2008), and reduced reliance on motor vehicles, minimising fuel vulnerabilities (Giles-Corti, Foster et al. 2010). These issues are of importance to the NWMR of

Melbourne, particularly in developments located within the urban fringes (Modelling GIS and Planning Products Unit 2010). Furthermore, this tool can be used in conjunction with the other demonstrator tools to test for the suitability of settings prior to building facilities, and to examine the pedestrian accessibility around a node of interest.

Developing a tool such as this has many challenges. These include: being able to develop a tool that can utilise a wide range of spatial data, which may differ between users; having a tool that can be operationalised by users with limited spatial or software engineering expertise; and ensuring the outputs are meaningful. As such, the tool has been designed to accommodate a range of data and has been developed as an interdisciplinary effort to ensure that the tool is useable and informative. The uptake of the tool will be dependent on the spatial data available; however, there is potential for the user to upload the open-source 'Walk Score' data layer (www.walkscore.com). This reduces the risk of street network data being unavailable. Notably there have been substantial challenges in accessing data layers, and at the time of writing footpath data across the NWMR of Melbourne were still unavailable. This has prompted the Municipal Association of Victoria to develop a working group to standardise footpath data collection across the region.

Having the ability to import more detailed spatial data, such as footpaths, into the tool if available provides greater accuracy in modelling. The ability for a user to modify the network layout with vector editing tools can also improve accuracy, especially where detailed local knowledge of a precinct can be included. Examples may include mapping 'known' pedestrian connections through parkland.

The vector editing capabilities also allow for the rapid testing of 'what if' scenarios such as the introduction of a pedestrian linkage, or a new pedestrian crossing, with data generated allowing quantifiable comparisons in addition to animated simulation, which can be used in the advocacy of such interventions.

There is potential to extend the tool to: identify optimal street networks for developing walking interventions (e.g. walking school bus route); locate appropriate sites for amenity upgrades; monitoring amenity of the area over time overlaid with pedestrian volume change; and develop a smartphone application for planning walking journeys based on specified parameters. There is also opportunity to extend the spatial datasets to include the sensitivity of the tool, and these layers may include: safety, crime, incivilities; footpaths, aesthetic features, traffic volume, and topography.

To conclude, the agent-based modelling tool has the capacity to be not only a powerful urban design tool that builds on existing walkability measures, but also an influential advocacy tool. The open-access nature of the tool means that it is available to all, and it demonstrates the benefits of bringing together

multiple data sources and disciplines to respond to challenges faced in the NWMR of Melbourne. Furthermore, there is much scope to extend this tool, including incorporating diverse spatial and non-spatial data and integration with other tools developed through this project and the more commonly used walkability index. As such, this is an effective tool for supporting the development of more walkable and accessible communities for populations across the lifespan.

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Chapter 4

Housing Affordability – Data Platform and Analysis Tool

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Overview

Already, more than half of the world population, at over 7 billion people, live in urban areas (UN 2010). Specifically to our local context, more than 80 per cent of Australian residents live and work in the major cities (ABS 2011). This level of urbanisation brings the associated challenges of housing affordability, liveability, sustainability and productivity. Of particular interest is that a substantial proportion of Australian urban residents are experiencing housing stress due to insufficient income to secure adequate housing (Hulchanski 1995; Yates 2007) at a desired location (Kelly, Weidmann et al. 2011; Mulliner, Smallbone et al. 2013).

Previous studies have attempted to determine this level of stress through the assessment of housing affordability. However, most of these (Hulchanski 1995; Kutty N. K and A. 2005; Whitehead, Monk et al. 2009) have adopted the 30:40 rule, which is the most widely used indicator of housing stress internationally. This refers to situations where household housing costs exceed 30 per cent of income for a household in the bottom 40 per cent of the income distribution (Yates 2007). This is a commonly used measure due to the ease of access to data and its computation. It measures and compares the ratio of housing repayments, or the percentage spent on rent relative to income. However, this approach is a simplistic view of housing affordability assessment (Hulchanski 1995; Gabriel, Jacobs et al. 2005). Some of the major limitations are its arbitrary and normative nature (Bogdon and Can 1997; Seelig and Phibbs 2006; Stone 2006) and its inability to account for access to services and location quality (Bogdon and Can 1997; Mulliner, Smallbone et al. 2013).

Stone et al. (2011), however, set housing affordability against residual income in order to provide sufficient meaning to the different conceptual understandings of housing affordability, along with addressing some definitional issues. As described by Stone et al. (2011), the residual income approach 'looks at what different household types can afford to spend on

housing after taking into account the other necessary expenditures of living'. However, like the previous ratio approach, the residual approach is limited by the criteria of assessment. In particular, it fails to include the quality of housing or the environment in which the housing is situated (Mulliner, Smallbone et al. 2013).

With this consideration it is important to include location, within the context of the relationship between housing demand and housing supply.

There are opposing views as to the causes of a housing affordability crisis. The questions often asked are: Were rising prices the result of a demand-induced bubble or a consequence of government supply-side policies? Are restricted housing supplies a function of excessive control of land supply, taxes/charges and onerous regulatory requirements? To provide any convincing answer, considering the interactions among all the players on both the supply and demand sides are important, especially within the context of how this is influenced by land management.

As observed through previous studies (Barker 2004; OECD 2005; Barker 2006; Cheshire 2009), land as a resource is not currently managed efficiently or effectively and this creates an imbalance between the demand and supply of housing. On the supply side, the strategies of determining land use and land development rights are considered a major determinant, as is the time it takes to complete development assessment processes. Slow approvals have been observed to impact housing market flexibility. This has the potential to disrupt housing prices, dynamics and affordability. On the demand side are issues of income, relative to house prices and interest rates that impact housing affordability. To gain better insights into the interactions of demand and supply requires the interrogation of datasets from different agencies and departments.

To assist in resolving these challenges, this project explores some of the current issues and challenges in the North and West corridor of Melbourne Metropolitan area. It develops a new framework and suggests a new strategy to identify land that has the potential for residential development. This is with a view to increase the housing stock, and therefore supply, in locations close to existing infrastructure.

This work builds on previous approaches to assessing both land availability and housing affordability by extending the variable measurements. As this work includes environmental, social and institutional considerations, this work is consistent with that of (Mulliner, Smallbone et al. 2013). Housing affordability is a measure of the ability to pay for a house that meets one's needs in a place one wants to live. The objective assessment of housing affordability can be extended by not only considering economic variables but also the environmental and social sustainability of housing, such as environmental

quality and access to employment opportunities. Our assessment process also considers the implications of planning controls and activities for timely land delivery, as a component of housing supply. Within this approach, it is recognised that housing affordability is a complex interaction between household income, housing costs (rent and mortgage repayments) and the cost of living (Stone, Burke et al. 2011). It also recognises the significance of urban land development land management policies and land administration processes as major contributions to land supply. These also have wider implications on housing stock, housing price and consequently housing affordability. The premise is that adequate and sustainably affordable housing will be achieved, only when an interactive link is established between available information, different layers of regulatory processes and involved stakeholders. This will then translate to consistent and evidence-informed decisions. As a result, this chapter discusses the capability of data integration to enhance housing research, analysis and decision making. The area of focus is the housing affordability of the North and West corridor of Melbourne. To do so this work developed an integrated data infrastructure platform as a platform to inform housing affordability.

The platform has three modules:

- Residential Development Potential Index
- Development Assessment Analysis
- Demand Assessment Analysis for Affordability.

Current housing situation in North and West Melbourne

North and West Melbourne is one of the fastest growing areas in Melbourne, and indeed Australia. The *Victoria In Future* population forecasts report that the population is projected to increase from 1,662,500 in 2011 to 2,183,700 in 2021 (31%). Such an increase would require approximately 260,000 new dwellings (DPCD, 2012). Therefore unless housing supply in the region is able to match the increased demand, prices will inevitably increase. It is important to also mention that other costs associated with housing such as interest rates, stamp duty and schemes such as developer contributions also impact the price of housing. This in turn affects the ability for people to rent and purchase property in the area as well as meet their other needs.

Using the standard inputs for metropolitan Melbourne provides a useful example of this causal relationship. The average house price in Melbourne is \$550,000 (REIV 2012). Calculating the repayments of this average home at the current interest rate of approximately 6.1% (and assuming a 5% stamp duty and 5% deposit) the repayments required for a 30-year loan are approximately \$770.00 per week (Your Mortgage, 2012). At the same time the median household income is \$1,333 (ABS, 2011). Therefore, based on the median

scenario, the proportion of costs required to purchase a home would be 58% of the household income. Although this is a simplistic representation it does highlight that home ownership comprises a high proportion of the household income. In turn if households are forced to commit a greater proportion of income to housing they have less disposable income for other necessities such as food, education and utilities (AHURI, 2012), which in turn can lead to housing stress.

The groups of people most impacted by stress as a result of housing being too expensive are likely to be those who are most vulnerable such as single parents, lower income home purchasers and private renters (AHURI 2012). In turn this can have detrimental effects on local labour markets as key service workers seek more affordable locations and renters are forced to change homes more frequently. A number of housing groups are researching the impacts of housing stress on society and social cohesion (AHURI 2007).

Developing a data integration platform and analysis platform

We took a four-stage approach to deliver the platform. The stages were:

1. conceptualising functions and data
2. data integration
3. system implementation
4. system evaluation.

The purpose of this platform was to provide better insights into the variables important for the assessment of housing affordability. An outline of each stage is set out below.

Conceptualisation

This stage included designing the types of analyses in the platform together while identifying the data needed to support the analyses. The platform is intended to analyse aspects of housing affordability. More specifically they were to identify developable land parcels/properties that have potentials for residential development; to analyse land administration processes that impact approval of development right; and to understand demand factors (income, household size, mortgage repayment etc.) that influence housing affordability.

Given the number of variables affecting housing affordability, the variability of decision applications, and the contextual issues peculiar to different geographies, the platform was designed to be flexible and able to accommodate different scenarios such as: determining the potential use of properties, accessibility to facilities, planning controls and efficiencies of

development assessment. To be able to accommodate the above analysis, the following datasets were identified:

- Vicmap Property
- Valuer General Data on Property information
- Public Transport route network through the Department of Environment and Primary Industries
- Facilities data extracted from VICMAP – Features of Interest
- Planning Permit Activity Reporting System, Department of Planning And Community Development
- Overlay Controls data from VICMAP – Planning Scheme Overlay.

Data integration

This stage involved preparing and integrating data from multiple sources. From the outset significant issues were identified in integrating data across agencies. Spatially enabling the datasets (i.e. geo-reference) was the most challenging part of the data preparation. The data was provided in different formats that were prepared in line with the objectives of the custodian organisation. Therefore, there were semantic and descriptive inconsistencies when integrating data from multiple sources. For instance, the property view in the Vicmap property was different from the property view in the valuation dataset. This, in particular, is challenging in high-density built areas such as the City of Melbourne where there are multiple uses within a property. Another example of the integration issue was the geocoding process for the PPARS dataset as a non-spatial spreadsheet. The integration process was undertaken through an automated platform developed in-house using Vicmap address datasets as a reference geocoder database. The other development effort in this process was making the coordinate system of the input layers consistent, along with performing the required analysis on the new updated layers.

Implementation

We then developed a web-based geospatial analysis platform. The platform was developed in its current form to focus on the analysis of housing in the North and West corridor of Melbourne. It does however have the capacity to be extended and applied in any jurisdiction, provided the necessary data integration component is adequately implemented.

The platform was conceptualised with the flexibility that allows users to test different scenarios. Users may select and adjust variables in a way to align with their own requirements and local knowledge of the place. This was made possible by including sliding bars to vary the parameter variables.

Three functional modules were developed:

- Residential Development Potential Index
- Development Assessment Analysis
- Demand Assessment Analysis for Affordability.

Residential Development Potential Index

This module analyses a combination of potential and constraint factors to identify land that has potential for residential development. The ability to calculate and determine a Development Potential Index (DPI) is closely related to the success of linking the planning dataset with the valuation datasets. DPI identifies lands that are under-capitalised in greyfield¹ areas (established inner and middle ring suburbs).

The resulting DPI index varies from 0 to 1, with higher value indicating high residential development potential. However, determining the DPI alone is not sufficient to make an informed decision about land supply. In this regard, it was necessary to check the potentially available land against the availability of physical and social facilities. This was to determine a way to optimally recapitalise the land for all the stakeholders – developer, council, residents and the next generation.

After the potential developable lands were identified (Figure 4.1), it was important to analyse the constraints that were potentially imposed through planning overlay controls. The second section of the module addresses this element, to interactively determine suitable land for different categories of residential development (Figure 4.2).

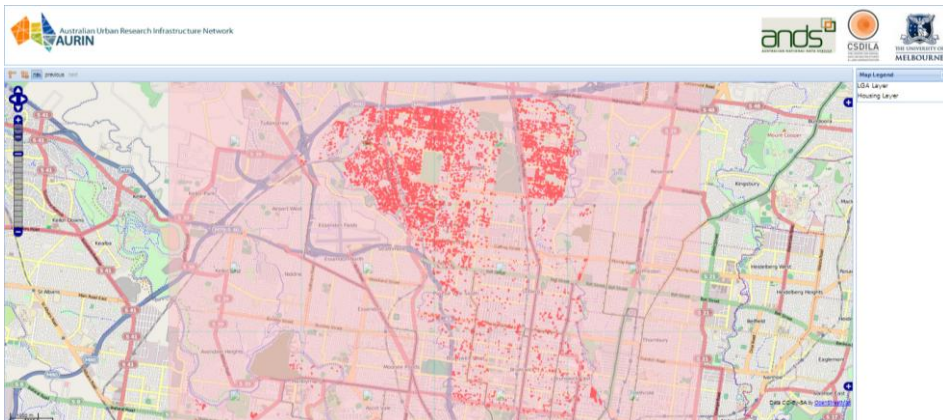


Figure 4.1 Areas with DPI more than 0.7 (red) for selected LGAs (pink)

¹ The ageing, occupied residential inner and middle ring suburbs which are physically, technologically and environmentally obsolescent and which represent under-capitalised real estate assets.



Figure 4.2 Properties with overlay controls highlighted in green (Selected LGAs)

Development Assessment Analysis

Development assessment and building approval processes can be cumbersome and tedious for applicants. Most importantly, the layers of processes and the type of documents required contribute significantly to the delays in land supply for housing production. It is therefore important to:

- i). analyse the development approval processes with a view to determining efficiency and effectiveness
- ii). assess spatial patterns and peculiarities among local councils for comparison of development assessment efficiencies through map visualisation
- iii). support the evaluation of any implications of current practices for strategic planning and legislation.

With the Planning Permit Activity Reporting System (PPARS) recording over 50,000 development assessment data records in Melbourne, it is now possible to determine the implication of third-party objections on development assessment (Figure 4.3). This analysis was possible because of the integration of different data records obtained from the local councils in Victoria that were integrated by the Victorian Government, Department of Planning and Community Development. This further underscores the importance of data integration and the development of data infrastructure. Finally, with more datasets becoming available overtime, the platform can be extended to accommodate time series analysis.

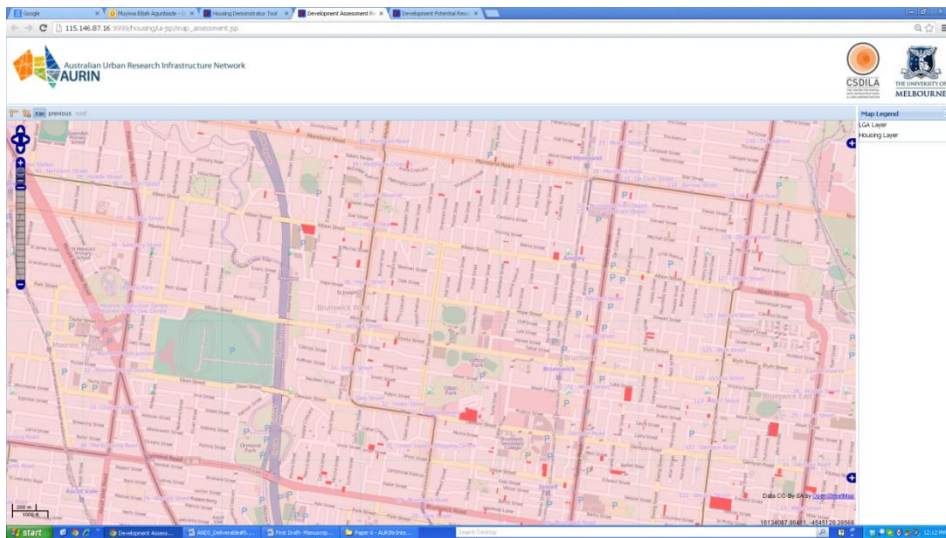


Figure 4.3 Duration of development assessment ≥ 90 day and Number of Objection ≥ 10 (Highlighted in red)

Demand assessment Analysis for affordability

This module builds on previous approaches (Hulchanski 1995; Kutty N. K and A. 2005; Whitehead, Monk et al. 2009) of assessing housing affordability by extending the variable measurements to include environmental, social and institutional considerations. This involves the objective assessment of housing affordability that considers not only economic variables but also the environmental and social sustainability of housing in which different housing locations, quality and access to employment opportunities are important. Within this approach, it is recognised that housing affordability is a complex interaction between household income, housing costs (rent and mortgage repayments) and the cost of living. It also recognises the significance of urban land development land management policies and land administration processes as major contributions to land supply, generating broader wider implications for housing stock and housing price.

The module was developed as an extension of the initial two modules. It offers additional functions to assist in the assessment of demand components of housing affordability, including the ability of residents to pay mortgages or rent in a particular location while simultaneously making reference to factors such as location, environmental and building qualities, as well as safety and access to facilities.

System Evaluation

It is anticipated that Strategic and Statutory Planners at state and local government levels will find the platform very useful to make evidence-based decisions about the efficient and effective allocation of spaces for residential development in Melbourne, initially in the North and West corridor. It is also anticipated that it will guide policy makers regarding decisions that affect greenfield², greyfield and brownfield³ developments.

The platform was initially discussed with a working group of representatives from, state and local government. In particular these were, representatives of ABS, Local government Strategic and Statutory Planners along with researchers and practitioners who were the primary audience. These groups were the envisaged as the data contributors and end-users. Once the platform was finalised, scenarios were tested based on the anticipated expectations of the users.

A stakeholder working group, including industry- and research-based project champions, was established prior to commencing this work. This group met twice with the research team over the course of the project. This was to: inform the content of the housing affordability platform (workshop 1); and provide initial feedback on the conceptual development and technical architecture of the platform (workshop 2). A review of the final assumptions, interface usability, and platform capability are currently underway with select end-users from local government.

Once the platform was finalised, scenarios were tested based on the expectations of the users. The testing was primarily designed to determine the number of properties that have potential for development within 800m of: train routes, tram routes, education facilities, recreational facilities and medical facilities for Maribyrnong and Moreland. The Number of property returned through the analysis = 4,688 with the Sum of Land Area = 1930712 m² (193.07 Ha) Figure 4.4 provides a visual display of the results.

² The hitherto primary land uses that are being converted to urban fringe residential development.

³ Part of the city that has outlived its original industrial-era utility.

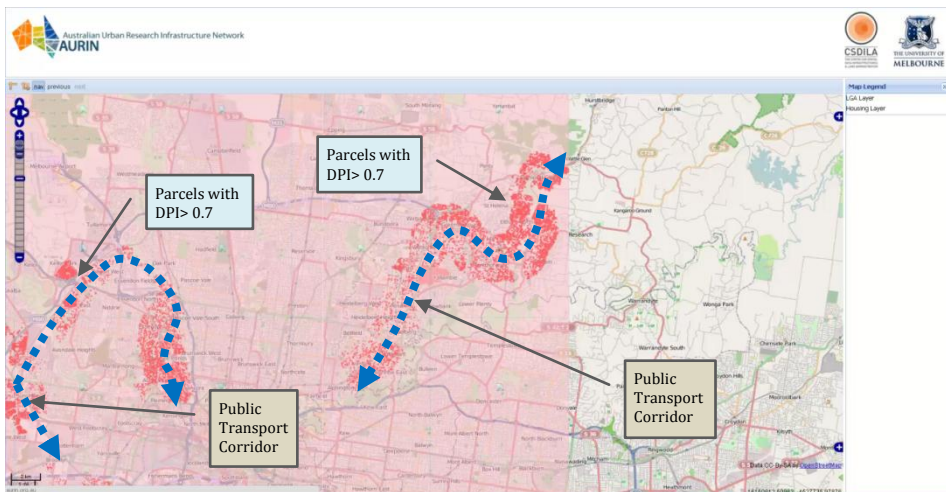


Figure 4.4 DPI > 0.7 along Transportation corridors (Selected LGAs)

A usability test was also conducted by a representative of the City of Melbourne. It was suggested that the terminology used in the user interface be consistent with the industry norms. More descriptions and examples will be provided to help the user understand the impact and influence variables. It was also suggested that an export function be provided so that the result and parameters of the analysis can be downloaded.

Discussion

Through the application of the Residential Development Potential Index module, it was possible to identify properties that have potential for development in all the local government areas of the North and West corridor of Melbourne. It was also possible to make a better judgement of the comparative land availability across the local government areas west corridor. Melton, Hume and Nillumbik were found to be the three LGAs with the highest land areas that have residential development potential (considering DPI value of greater than or equal to 0.7, Figure 4.5).

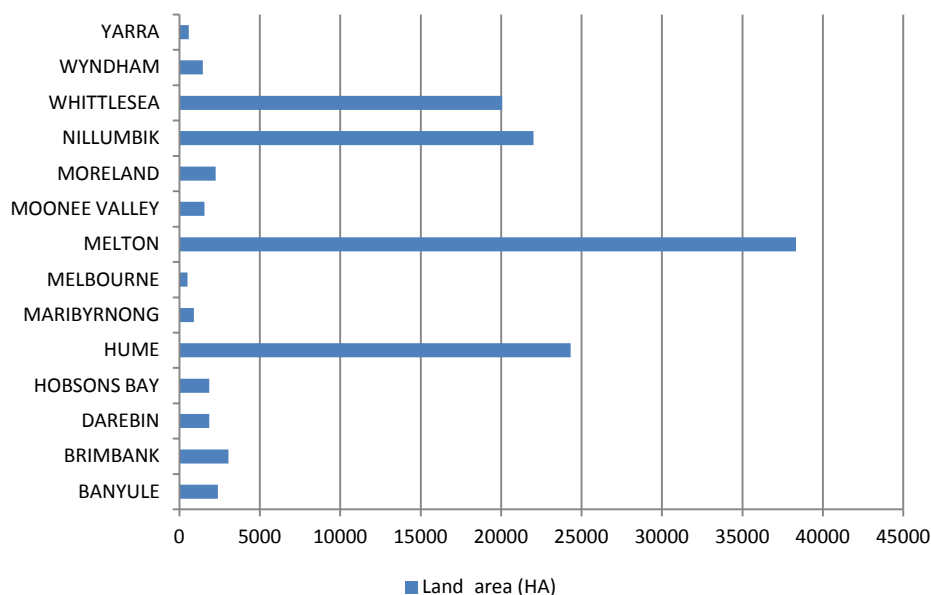


Figure 4.5 Land area of properties with development potential index > 0.7 (Measured in Hectares)

With combined analyses, using two modules, it was possible to provide better insight into the relationships between the variables of income-mortgage ratio, and residential development potential.



Figure 4.6 An analysis of income to mortgage ratio in Whittlesea

As shown in Figure 4.6, a substantial proportion of the residents in parts of Whittlesea spent more than thirty per cent of their income on their mortgage. However, as outlined earlier several other factors may be responsible for this result. For example, through a cursory assessment of the portion shown in figure 4.6, it warrants further investigation as to why people are paying high mortgages on relatively undercapitalised properties. This scenario offered the opportunity to probe further into the characteristics of this neighbourhood,

and to seek out other factors responsible for this pattern. For instance, could it be a function of the locational factors relates to safety? Is it accessibility to better schools and other facilities? Finally, could it be financial issues relating to remortgaging of existing properties?

Therefore, and supporting the expectations of this platform, the platform offers some flexibility of assessment, based on the peculiarities of the properties. Varied analyses could be performed and several conclusions could be drawn from the assessment.

Conclusion

The platform has provided opportunities to critically and effectively combine factors important for the efficient and effective delivery of land for housing production. The flexibility of the modules allows users to choose variables that are considered important, based on the dynamics and preference of the local residents and the policy expectations of the planners as well as the political leaders.

More generally, there are substantial and on-going challenges in data integration. There are issues relating to privacy and confidentiality of analysing data at property level. Therefore the results warrant further discussion on housing affordability in and around this area.

Overall, by developing and applying the modules, it was observed that:

- i). There is a need for more standardisation of data collection and management methods.
- ii). Overall, in the 14 local government areas of the North and West corridor, more than 240,000 properties are undercapitalised. This suggests that, with appropriate policy, more diverse housing units that satisfy the expectations of different household requirements could be provided.

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Chapter 5

Linking Health and Social Infrastructure Data for Equitable Health Planning in Type 2 Diabetes

John Furler and Jane Gunn

Overview

Type 2 Diabetes (T2D) is a common chronic illness. People with diabetes often have multiple coexisting chronic physical conditions (multi-morbidity) and are more likely to suffer from depression. Diabetes, its complications, multi-morbidity and depression are all more common in socioeconomically disadvantaged communities.

This clustering of diabetes prevalence, other physical and psychological conditions and social disadvantage are important issues for those charged with planning and integrating health services, both primary care and hospital services. It means planners need to understand where particular areas of composite vulnerability and disease burden exist and how to match provision of integrated health and social care services to those areas of high composite need.

This demonstrator pilot project drew on a study of the care experiences of a number of people with diabetes from marginalised and disadvantaged backgrounds in the North and West Metropolitan Region (N&WMR) of the Victorian Department of Health. The demonstrator project attempts to make possible the integration of health and social data to identify ‘hot-spots’ of combined or clustered vulnerability and visually represent service location and accessibility relevant to the complex health and welfare needs of people from these locations.

The mapping tool was developed with input from a research and system ‘champion’, technical experts and end-users.

Background

Diabetes, inequity and primary care

Over a million Australians have diabetes, 85% of which is T2D (Australian Institute of Health and Welfare 2008). The prevalence at least doubled from 1989–90 to 2004–05 and is predicted to continue rising. T2D and its preventable complications (eye and kidney disease, cardiovascular disease [CVD] and stroke, neuropathy and peripheral vascular disease) contributes over 8% of the total burden of disease in Australia, and is anticipated to be the leading cause of disease burden by 2016 (Australian Institute of Health and Welfare 2008), shortening life expectancy by up to five years and costs the community over \$14 billion annually in direct and indirect healthcare costs (Lee, Colagiuri et al. 2013). Inequity is a pervasive feature of almost all chronic diseases including diabetes. This illness burden is borne unequally across the community. T2D and its complications are much more common in socioeconomically disadvantaged groups including Aboriginal and Torres Strait Islanders (Australian Institute of Health and Welfare 2008).

T2D is also a leading cause of costly hospitalisation. Nationally, data shows a 40% increase in hospitalisations from diabetes complications between 2001–02 and 2004–05 (Australian Institute of Health and Welfare 2008). Hospital admissions for complications of diabetes mellitus can be classified as potentially preventable hospitalisations (PPH) through timely and evidence-based medical care in the primary care and general practice setting (Australian Institute of Health and Welfare 2010). Complications of diabetes accounted for over a quarter (25.7%) of PPHs in 2008-09 (Australian General Practice Network 2007; Australian Institute of Health and Welfare 2010). The N&WMR has amongst the highest admission rates for long-term diabetes complications in Victoria (Ansari 2004). There are significant inequities in the rate of hospitalisation for ACSCs. People from the most disadvantaged postcodes are approximately 30% more likely to be admitted for such conditions (Department of Health).

Access to General Practice and Primary Care services is critical to delivering better and more equitable outcomes for people with T2D. People with T2D have 80% of their clinical care in GP and effective clinical care can reduce complications, improve outcomes and reduce costs (Council 2006:32). Such clinical care is ideally in accordance with evidence-based Clinical Practice Guidelines (CPGs) (Bernard, Powell Davies et al. 2005), which form the basis of idealised care pathways that outline steps in the care of patients following initial diagnosis through to ongoing care. CPGs focus primarily on disease but also cover psychosocial domains and the involvement of family and work. Such idealised pathways to care depend on available, accessible, affordable, high-quality clinical and associated services and a well integrated and linked health

care system that is able to implement recommended guideline based care. Yet we also know that the 'inverse care law' can operate in General Practice. General Practice care can *contribute* to the production of health inequity, through inequitable access to care and differences in the quality of care that people receive. For example, there is evidence that people with T2D from marginalised groups are less likely to receive appropriate referrals to members of the multidisciplinary diabetes team (Overland, Hayes et al. 2002). General Practice is thus a key area where clinical care can help mitigate health inequity through targeting care to those most in need.

Primary Care Partnerships, Medicare Locals and planning for chronic disease care

Primary Care Partnerships (PCPs) and Medicare Locals (MLs) have an important role to play in responding to the issues outlined above. The Victoria Government funds 30 PCPs 'to improve access to services and continuity of care for people through improved service coordination, as well as chronic disease prevention, integrated health promotion, and partnership development' (Department of Health 2012). The PCP Strategy is focused on partnerships, coordination of services and integrated approaches to health promotion and chronic disease management. In relation to integrated chronic disease care and of particular importance to the Demonstrator Project, PCPs are charged with planning, implementing and measuring service system improvements, including evaluation of impacts and outcomes for consumers.

At the same time, a key structural element of Commonwealth health reform is the establishment of sixty-one MLs over 2011–12, operating across Australia as regional health organisations (Australian Government 2011). MLs, building on the experience of Divisions of General Practice, are a meso-level organisation with a mandate to use population health planning to integrate innovative local service design and provision with the social, environmental, and economic determinants of health (Hancock L 1999; Burns J, Powell Davies G et al. 2003). A distinguishing feature of the ML strategy is the introduction of population health principles into the development and provision of primary care services. Each ML is responsible for a defined population group and will develop their own population health plan to identify service gaps and drive service system redesign as a way to improve health outcomes in their community.

MLs and PCPs face similar challenges in improving whole of community health outcomes and reducing inequities (Keleher 2011), avoiding multiple and potentially competing plans in the same jurisdiction, developing innovative responses to the challenges of cultural and socioeconomic diversity, rapid growth in new areas (a particular feature of the NWMR), and engaging member organisations, clinician groups, citizens and communities.

This Demonstrator Project is based on collaborative work undertaken by the Department of General Practice at the University of Melbourne and the Department of Health North West Metropolitan Region. The Care and Systems Experience – Diabetes (CASE-D) project developed in-depth case studies about the pathways to, and experiences of, health care for people from disadvantaged backgrounds with type 2 diabetes living in the region. The case studies together with workshops with key stakeholders identified important barriers to care. These include where services are located and how they are linked.

PCPs and MLs face challenges in collating health, demographic and service data into a meaningful form to help plan care services to respond to the needs of these disadvantaged clients. The aim of this project is to improve access to an integrated set of health-related (prevalence and service use) and social and physical infrastructure data to aid policy makers and planners.

Policy-relevant question

The research question underpinning the Demonstrator Project was '*Can mapping tools that allow access to integrated cross-sectoral data enhance health planning for health system responsiveness to poorly served marginalised patients with type 2 diabetes in the NWMR?*'

Method

Project Approach

Project methods

The project was structured on a staged, five-phase approach:

- Phase 1: Initial mapping of key functionality requirements based on end-user requirements and feedback
- Phase 2: Selection of participating Medicare Local
- Phase 3: Development and testing of integration of data domains (diabetes, other chronic conditions, health service use, social determinants)
- Phase 4: Overlaying data domains on the spatial maps linked to the Medicare Locals and running different modelling scenarios. Production of summary statistics
- Phase 5: Demonstration of the results via spatial mapping to the working group and other relevant stakeholders.

Collaboration

This Demonstrator Project is a collaboration between researchers from the University of Melbourne, the North West Metropolitan Regional Management

Forum Working Group, Project Champions (Department of Health, University of Melbourne), and technical and end-user group members. Representatives from these groups met twice during the course of this project.

Stakeholder working groups and product champions

The overall project was shaped by input from project champions, a technical working group and an end-user group:

- *Project Champions:* A research-based (senior Primary Care Academic from Melbourne University) and a system-based (senior staff member from the regional DoH office) project champion were identified to provide input and advice and to consider and promote the value and utility of the project outputs including the mapping tool to the wider community including government, academia, and industry.
- *Technical Working Group:* A technical working group was also convened to bring together data custodians (representatives of federal and state agencies including ABS, and Department of Health) with those responsible for GIS and software development. The group comprised met twice with the research team over the course of the project
- *End-user group:* The end-user group consisted of representatives from medicare locals and Primary Care Partnerships (PCPs) within the North and West Region.

Datasets

Data sets were sourced based on the literature outlined above in relation to diabetes prevalence, depression prevalence, socioeconomic disadvantage and a range of primary care services (see table 5.1).

Data was obtained from a range of sources including the Public Health Information and Development Unit (PHIDU) at the University of Adelaide, Government Departments and Medicare Locals. The most complete data set was available for the North West Metropolitan Melbourne Medicare Local but will be made available for the other Medicare Locals in the NWM Region.

Data	Custodian	Availability
Type 2 diabetes prevalence	PHIDU/National Health Survey	Statistical Local Area
Depression Prevalence	PHIDU/National Health Survey	Statistical Local Area
Obesity Prevalence	PHIDU/National Health Survey	Statistical Local Area
Smoking rates	PHIDU/National Health Survey	Statistical Local Area
Socioeconomic Indexes for Areas Index of Relative Socioeconomic Disadvantage (SEIFA IRSD) scores	ABS	Census Collector District, converted into deciles
General Practice locations, fee arrangements and opening hours	Dept of Health Human Services Directory/Medicare Local	
Community Health Centres	Dept of Health Human Services Directory	

Community Mental Health Services	Dept of Health Human Services Directory	
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Table 5.1 Data sets used in the Health Demonstrator

Additional data sets (Table 5.2) that were considered relevant at early stages of the project are listed below but it was not feasible to obtain and integrate them into the mapping tool within the resources of the demonstrator project.

Data	Custodian	Availability
Home and community care facilities	DH	
Social services	DHS; DH	
Health and allied health services	DHS; DH	
Public transport frequency and stops	DOT	

Table 5.2 Additional data sets considered for the Health Demonstrator

Tool development and User-specified functionality

The initial development of the integrated data-mapping tool was based on the literature and preceding work outlined above.

The tool was first developed as a prototype in ArcGIS and refined through a series of:

- two product champion meetings
- a technical working group meeting
- two end-user group meetings.

Issues covered in discussion with these groups included:

- the range of data sets of relevance to the research question able to be integrated into the mapping tool
- useability of the interface for staff of PCPs and MLs who may use the tool for planning purposes
- governance and the need to maintain up-to-date, dynamic access to data sets.

General Practice Service data combined data on:

- geographical accessibility through linking to walkability data opening hours (allowing selection of services accessible after hours and on weekends)
- financial accessibility (allowing selection of GP services that provide bulk-billing or no point of care costs to users).

In keeping with the rationale for the project service data also integrated: Community Health Centre locations (sites of provision of financially accessible integrated health and welfare services).

Outcomes: Simulating and visualising the data

Three tools were produced, integrated in a single online interface:

1. An ecological mapping tool that is able to combine and overlay prevalence data for diabetes, depression, and disadvantage indicators giving a 'heat map' highlighting hot spots of combined need.
2. A selection tool where users are able to use Boolean Operators to progressively select and display areas of combined disadvantage, vulnerability and need.
3. The selection tool also enables the walking distances to service to be included. This walking tool leverages off the work undertaken in demonstration project 1 – walkability as it works using the distances traversed through the road network.
4. A tool to map relevant to primary care services to compare to the areas of high need based on the outputs from the first tool.

The data outputs (see figures 5.1 – 5.3) show the relationships between health service access and disease distribution, identifying areas of particular vulnerability.

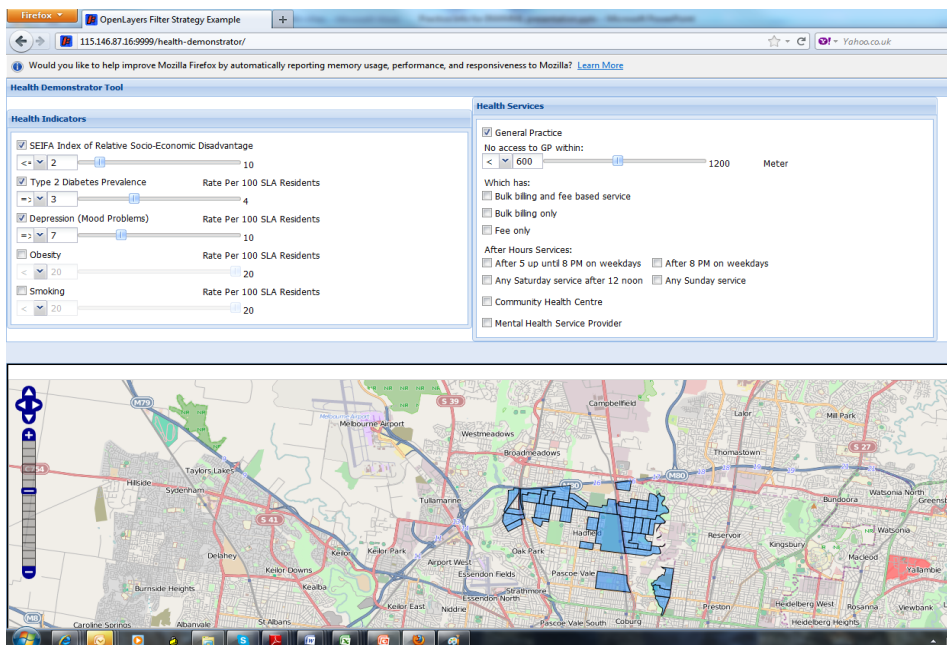


Figure 5.1 Mapping Tool showing Boolean slide-bar operators

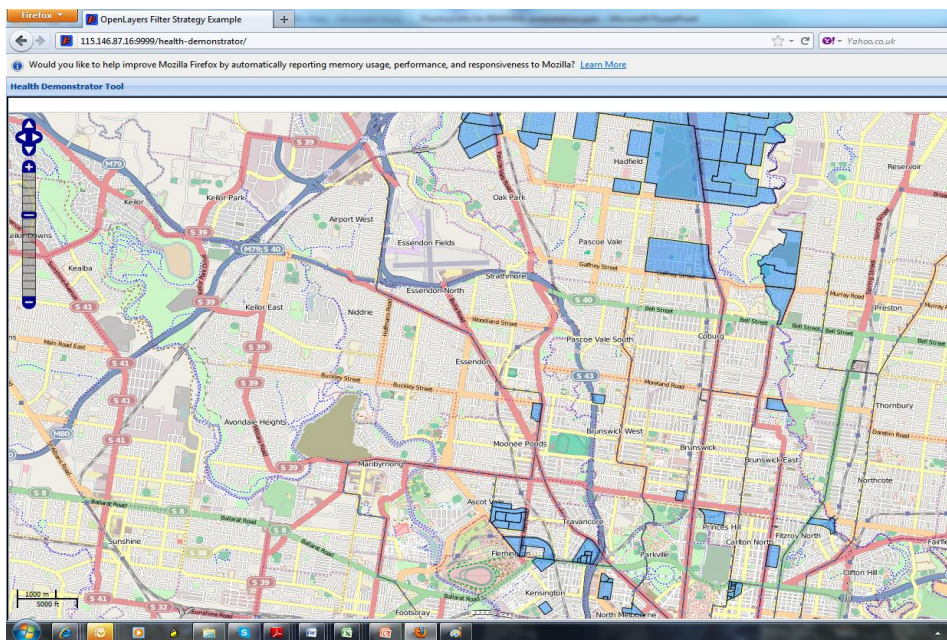


Figure 5.2 Mapping tool at higher magnification, detailed visualisation of small-areas of high need

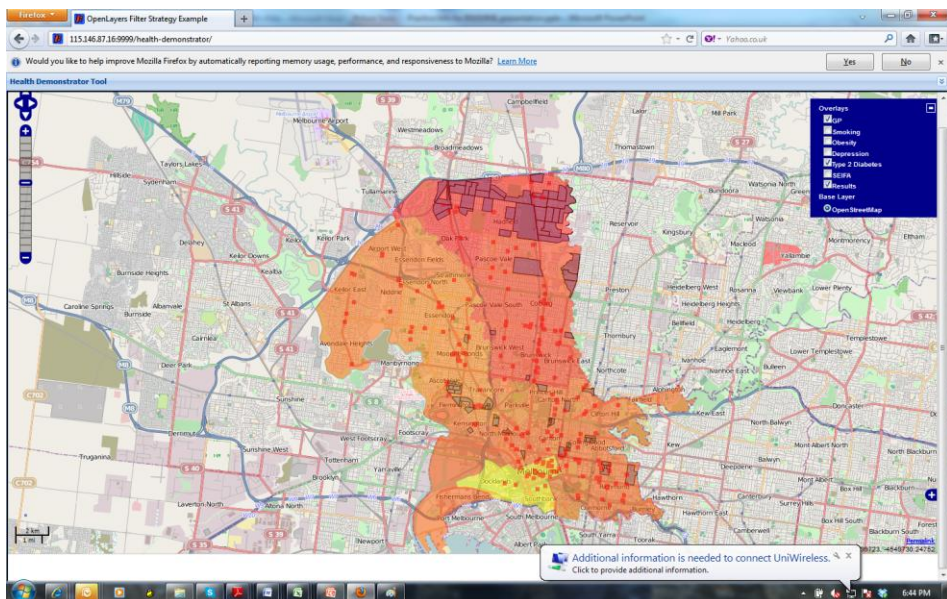


Figure 5.3 Mapping tool showing heat map of combined vulnerability and GP locations

Discussion

This Demonstrator Project addresses an issue of growing importance for the NWMR and for the community more widely. The rising prevalence of diabetes and other chronic illnesses and the understanding that disease prevalence is

not randomly distributed but rather clustered with social disadvantage is a critical issue for planning services. This is particularly important for high-growth areas where service planning often follows population growth and where social disadvantage is more prevalent. There is growing interest in how to integrate services from health and welfare to provide responsive, flexible, accessible holistic services addressing the overall needs of user.

The mapping tool has demonstrated the potential for routine data sets to be combined in a way that allows planners in the region to respond to these complex community needs. It has the potential to be expanded to include other relevant data sets as outlined above, and to link with the other Demonstrator Projects addressing walkability, employment and house pricing and availability.

Previous mapping work has used National Diabetes Supply Scheme data to map diabetes prevalence in Western Melbourne by LGA and overlaid this with food outlet data to assist health planning (<http://www.diabetesinfo.org.au/diabetes-epidemic/diabetes-epidemic-western-melbourne>). Other interactive mapping of chronic illness data have been undertaken at the Medicare Local Level (http://www.publichealth.gov.au/interactive_mapping/aust_ML_2011/atlas.html) and recent work by the Australian Primary Health Care Research Institute is in development mapping diabetes prevalence overlaid by health workforce data at the SLA level (<http://aphcri.anu.edu.au/research-program/national-centre-geographic-resource-analysis-primary-health-care-graphic>).

This Demonstrator project, however, used narrative data to specify relevant social and infrastructure features, including health and allied-health services, for this population and map them in a form useful to policy makers and planners in responding to difficult complex health problems at a local level.

However, the Demonstrator project has highlighted the challenges in accessing data, making it available in an ongoing, up-to-date and dynamic fashion, in particular highlighting how this a resource intensive exercise.

The data outputs will be made available via the AURIN portal to enable further research in this domain. Future work could also include workshops with Medicare Locals.

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Chapter 6

An Open-Source Tool for Identifying Industrial Clusters in a Data-Poor Environment

Jennifer Day, Sophie Sturup and Yiqun Chen

Introduction

This tool provides an analytical process by which researchers can identify spatial clusters of industry in the Melbourne Metropolitan Region (MMR). In turn, these clusters can then be used to address issues of concern to urban policy making in the region such as whether agglomeration policy is creating clusters in desired locations, and whether this is achieved at the expense of nearby clusters of activity – issues that researchers and analysts have previously struggled to address due to a lack of fine spatial data on employment location.

Tool descriptions

Our tool is comprised of a hierarchical clustering algorithm that makes use of three integrated sub-tools, each of which provides various functions and analysis options. This section describes the algorithm and sub-tools, providing specifications for the use of each part. This section also provides a listing of user inputs. The function of these inputs is described later. Each sub-tool can be used separately or in combination with the clustering algorithm. The four tools are:

- MAIN ALGORITHM: A Hierarchical spatial clustering tool
- SUB-TOOL 1: A Spatial dissimilarity index tool
- SUB-TOOL 2: A Value chain tool
- SUB-TOOL 3: A Polygon splitting tool.

MAIN ALGORITHM: Hierarchical Spatial Clustering

At the foundation of our analysis is a Ward's clustering framework, also more generally known as a Spatial Hierarchical Clustering framework (see Carvalho et

al. 2009). In essence, this process constructs clusters based on the similarity of some feature of the spatial units involved in the clustering process. The algorithm uses a minimum variance criterion that minimises the total within-cluster variance.

The specific method applied is Ward's minimum variance method, which is a special case of the objective function approach originally presented by Ward (1963). Ward suggests a general agglomerative hierarchical clustering procedure, where the criterion for choosing the pair of clusters to merge at each step is based on the optimal value of an objective function. This objective function could be 'any function that reflects the investigator's purpose'. In our case we have developed a function adapted from Joshi's Polygon Distance Function (Joshi, Samal et al. 2009; Joshi 2011), which allows us to develop a univariate measure of difference that includes multivariate (spatial and non-spatial) data.

We modify Ward's algorithm in a significant way, by adding a spatial condition that must be met by polygons joining a cluster. One problem with the standard Ward's clustering algorithm is that it does not have, within it, the capacity to incorporate spatial information. This is problematic because the algorithm could cluster polygons that are neither near each other nor spatially adjacent to each other. We address this problem with our MWards algorithm by introducing a distance threshold D_t to force the algorithm to cluster only polygons located within a user-defined proximity to each other. A standard Ward's algorithm will continue to cluster polygons until all polygons have been formed into a single cluster (Ward 1963; Kaufman and Rousseeuw 1990; Carvalho, Albuquerque et al. 2009). Then, it is the responsibility of the analyst to apply an *ex post* decision process that chooses the right number of clusters for the particular data and setting to which the algorithm has been applied. Our tool modifies the Ward's clustering process by introducing D_t , a spatial decision rule that prevents two polygons that are too far apart to be joined in a cluster.

Instead of allowing the algorithm to work until it has collapsed all spatial units into a single unit, our tool stops the clustering process when cluster centroids have become too far apart to form a cluster. The user of the tool specifies this distance threshold. This process has the further advantage of allowing the user to identify clusters at various scales (neighbourhood, metropolitan, regional, etc.). Later in this paper, we demonstrate how the distance threshold affects the size of clusters formed by the algorithm.

SUB-TOOL 1. Spatial Dissimilarity Index

As stated above the Ward's process can only deal with one polygonal attribute at a time. This attribute can, however, be the dependent variable determined by an objective function with multiple variables. Sub-Tool 1 is one such function. It is not a clustering algorithm – it is an optional input into the

MWards clustering algorithm. Based on a process devised by (Joshi, Samal et al. 2009) and (Joshi 2011), Sub-Tool 1 computes a Polygonal Dissimilarity Index (a value for each polygon in the database) using a Polygon Dissimilarity Function (PDF) to distil multivariate information into a format usable by the MWards algorithm. The remainder of this section describes the PDF.

In this sub-tool we define spatial data as any spatial information about a spatial feature, e.g. the vertices, area, location, and centroid of a polygon. Non-spatial data is defined as data ascribed to a polygon that is not spatial in nature, e.g. jobs located inside that polygon. We have built our tool in such a way that a user can load any set of polygons with spatial and/or non spatial variables for use in the tool.

Equation (1) below describes the PDF distance as a function of spatial and non-spatial attributes. In equation (1), P_i and P_j are arbitrary polygons, and d_{ns} and d_s refer to the ‘distance’ (Euclidean or otherwise computed) between these two polygons. The variables w_{ns} and w_s refer to the weighting of importance given to the non-spatial and spatial attributes of a polygon. Then the PDF and $D_{PDF}(P_i, P_j)$ is given by:

$$D_{PDF}(P_i, P_j) = w_{ns}d_{ns}(P_i, P_j) + w_sd_s(P_i, P_j) \quad (1)$$

where

$$w_{ns} + w_s = 1 \quad (2)$$

To compute the distances $d_{ns}(P_i, P_j)$ between non-spatial attributes and $d_s(P_i, P_j)$ between spatial attributes, we use Euclidean distance. The PDF tool allows for multiple non-spatial attributes to be considered, by combining them using a linear combination, with different weights potentially applied by the user to different attributes. The tool allows for only one spatial distance to be considered in the PDF. This distance between intrinsic spatial attributes is computed using polygon centroid-to-centroid distances. The output for this Sub-Tool 1 is a dissimilarity matrix that is interchangeable with the distance matrix in Ward’s algorithm (from the Main Tool).

SUB-TOOL 2. Value Chain Tool

Inputs to Sub-Tool 1 can include any number of non-spatial attributes of a polygon. Sub-Tool 2 is built into the user interface. It takes advantage of the ability of the PDF to include multiple non-spatial attributes by allowing users to select and choose weighting for multiple non-spatial attributes. In the employment data already prepared for example it is possible to input multiple related industries as a linear set of variables, or in aggregated form the jobs from the value chain are pooled prior to calculation of the index. Sub-Tool 2

could be useful for a number of purposes; for instance, helping the user to potentially identify industry sub-clusters. Construction of value-chain relationships is described in studies such as (Feser and Bergman 2000; Feser, Koo et al. 2001; Feser and Isserman 2005).

SUB-TOOL 3. Geographic Splitting

Sub-Tool 3 parses traditional spatial units of analysis into finer spatial units that are suitable for sub-metropolitan spatial clustering analysis, and then attributes economic activity to these finer spatial units. This tool responds to a lack of availability of economic data at spatially disaggregated levels suitable for sub-metropolitan spatial clustering analysis, for Australia. Studies examining local economic development in Australia have typically been forced to rely on Census Journey-to-Work (JTW) data to proxy for the number of jobs located in a particular location. These studies have further relied on the administratively-defined spatial units in which the JTW data is reported, called destination zones (DZNs). This has been problematic because: 1) the DZNs are not constant from one Census to the next; 2) DZNs can contain large areas of land that are residential and do not contain economic activity; and 3) DZNs are generally far too large to be useful for sub-metropolitan clustering analysis.

If an analyst is seeking to examine local economic clustering, the presence of large tracts of residential land can muddle the analysis. For example, a DZN with a large land area may be largely residential, but contain an important and dense economic cluster on a small portion of its land area. If the density of jobs in that cluster is averaged over the entire DZN, the result could be a DZN with an overall low concentration of jobs. As a result of this low density, spatial clustering models may not register the economic activity in that DZN as being sufficient to be added to a cluster. Our tool mitigates this problem by preserving the efficacy of industrial densities in smaller, sub-DZN areas.

To summarise our process, we arrive at our smaller polygons by using Victorian Government spatial land-use and land-use zoning data to parse each DZN into different types of precincts. We keep all precincts where economic activity is likely to occur, and delete the residential, recreational, and other-zoned sections where economic activity is generally sparse. Then, the JTW data is ascribed to these parsed areas within a given DZN, by matching land uses with industry type. In Figure 6.1, the DZN is outlined in blue. The area is parsed according to zoning types and known uses, e.g. hospitals, schools, and parks. Then, the 250 medical jobs are allocated to the hospital area of the zone, and the 34 retail jobs are allocated to the commercial area of the zone. We call these parsed polygons *middle polygons*.

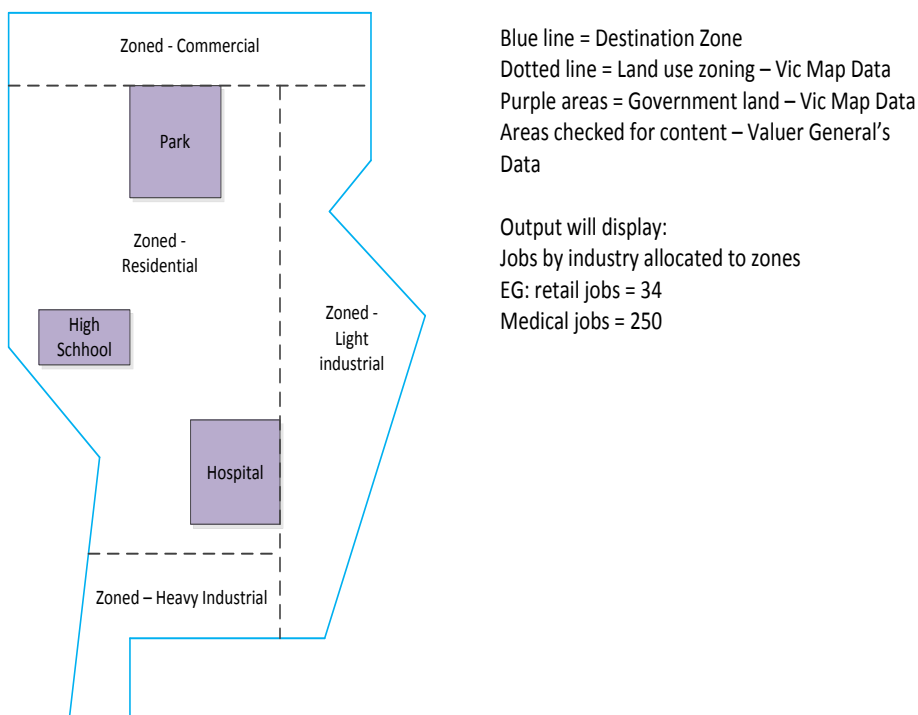


Figure 6.1 Hypothetical Parsed DZN

Tool performance and comparison of outputs

This section provides some examples of the outputs from the tool using the employment data we have prepared for the Melbourne Metropolitan Area (MMA), and particularly for the North West Region of the MMA. We provide and compare outputs from various model specifications in order to understand how changing the parameter inputs changes the model output. We use as our example clusters of motor vehicle manufacturing. After a review of the ANZIC structure we have built a hypothetical value chain of interest involving the ANZIC codes listed in Table 6.1. You will note that the table shows a difference between the number of jobs in the census and the number of jobs the value chain inserts into the PDF. This is because, in the raw Australian Bureau of Statistics data ANZSIC 2310 although it is conceptually the parent of all ANZIC in the form 231X is not the aggregation of the child ANZIC 2311, 2312, 2313, and 2319. Instead it captures some extra firms that failed to classify themselves into one of the four-digit child codes. We have adjusted this data so that ANZSIC 2310 is now the aggregation of 2311, 2312, 2313, and 2319 and the extra firms, which were already listed in it.

ANZSIC	ANZSIC Description	Number of Jobs, value chain inserts into PDF	Number of Jobs, Census	Difference
2310	Motor Vehicle and Motor Vehicle Part Manufacturing	11,334.89	11428	93.11
2311	Motor Vehicle Manufacturing	6,856.98	6867	10.02
2312	Motor Vehicle Body and Trailer Manufacturing	1,055.00	1082	27.00
2313	Automotive Electrical Component Manufacturing	363.00	363	0.00
2319	Other Motor Vehicle Parts Manufacturing	2,917.91	2971	53.09
TOTAL		11,192.89	11283	90.11

TABLE 6.1 Comparison of Algorithm Outputs with Census Job Counts, 2006

Regional versus Local Scale

Figures 6.2 to 6.4 show cluster configurations with 5, 10, and 20 km thresholds. The labels in the map are of the corresponding local government area (LGA), whose boundaries are shown in light grey. Variation in distance threshold specifications has a large impact on the number and types of clusters formed. A small distance threshold generates more clusters, and thus a smaller average number of jobs per cluster, since the algorithm distributes the same number of jobs over more clusters. When we set our distance threshold to one kilometre, the algorithm generated 145 clusters in total, with 119 of these containing more than 50 jobs. At a distance threshold of five kilometres, the number of clusters is reduced drastically to 23. The 10- and 20-kilometre thresholds reduce the number of clusters to 11 and 2, respectively.

The distance threshold also affects the distribution of jobs among the clusters. At 10 kilometre thresholds, the cluster with the most jobs contains about 3,355 jobs. That leaps to 6,627 in the 20-kilometre configuration where there are only two clusters. The selection of the distance threshold is an option that the user is allowed to specify in the input parameters. Smaller distance thresholds generate more clusters, and would be more suitable for neighbourhood-scale analysis. Larger distance thresholds generate larger regional-scale clusters more suitable for analyses at the regional scale.

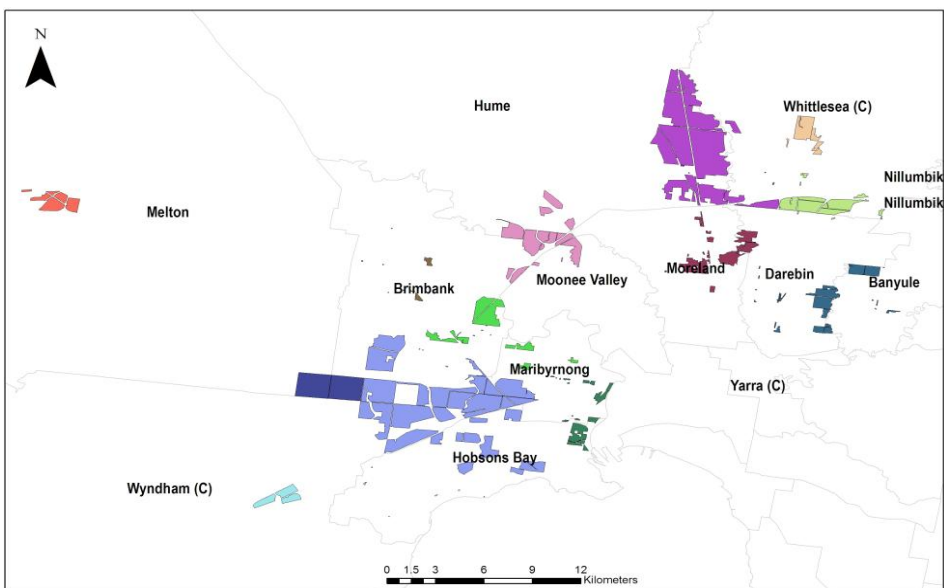


Figure 6.2 Cluster Configuration, ANZSIC Code 2310, 5km Threshold, Spatial Weight = 0.90

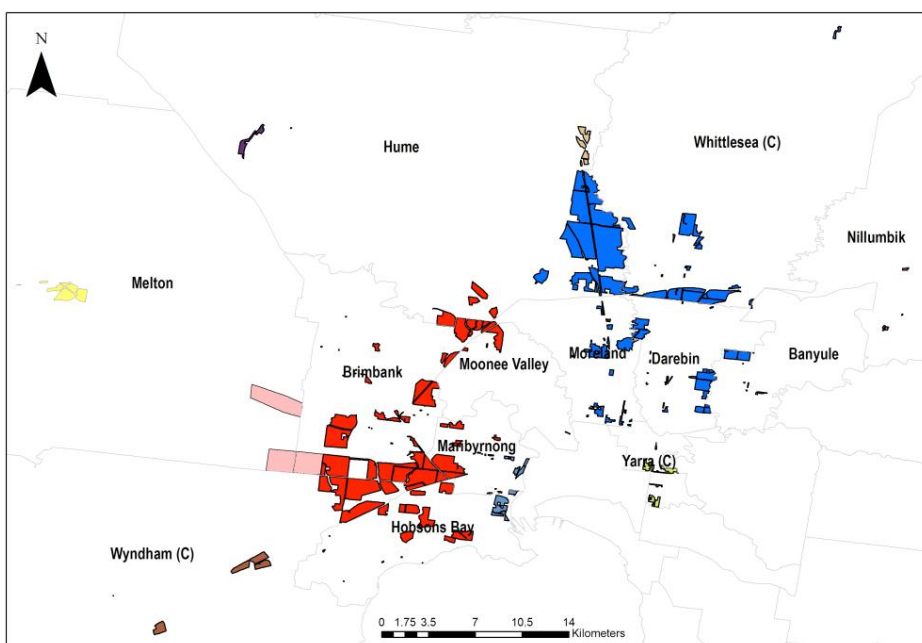


Figure 6.3 Cluster Configuration, ANZSIC Code 2310, 10km Threshold, Spatial Weight = 0.90

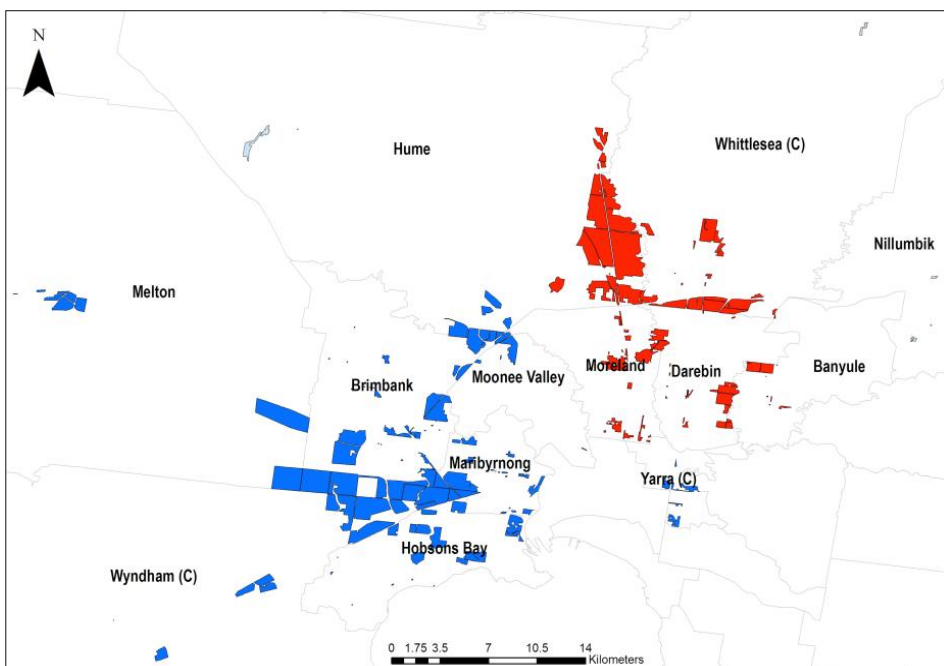


Figure 6.4 Cluster Configuration, ANZSIC Code 2310, 20km Threshold, Spatial Weight = 0.90

Primacy of Spatial versus Non-Spatial Weights

Spatial and non-spatial weights can also affect whether certain polygons are allocated to one cluster or another. We use the maps in Figures 6.5 and 6.6 to illustrate this point. For simplicity, we use an input distance threshold of 20 kilometres (since there are only two clusters in this configuration, polygon membership in a particular cluster can be easily seen).

Figure 6.5 shows the cluster configuration at a distance threshold of 20 kilometres and at $w_s=0.1$ (spatial weights are relatively less important), for ANZSIC code 2310 which is the aggregate of jobs for the value chain. For simplicity, we will refer to the western cluster, in blue, and the eastern cluster, in red. Changing the spatial weights causes some polygons to switch from the eastern to the western clusters. Notably, jobs at the southern end of the eastern cluster (in Yarra) are included in the eastern district when spatial weights are more important ($w_s=0.9$, Figure 6.6). Then, they move to the western cluster when spatial weights are given less importance ($w_s=0.1$, Figure 6.5). This simple example illustrates the importance of careful consideration of the spatial and non-spatial weights in analysis using this tool.

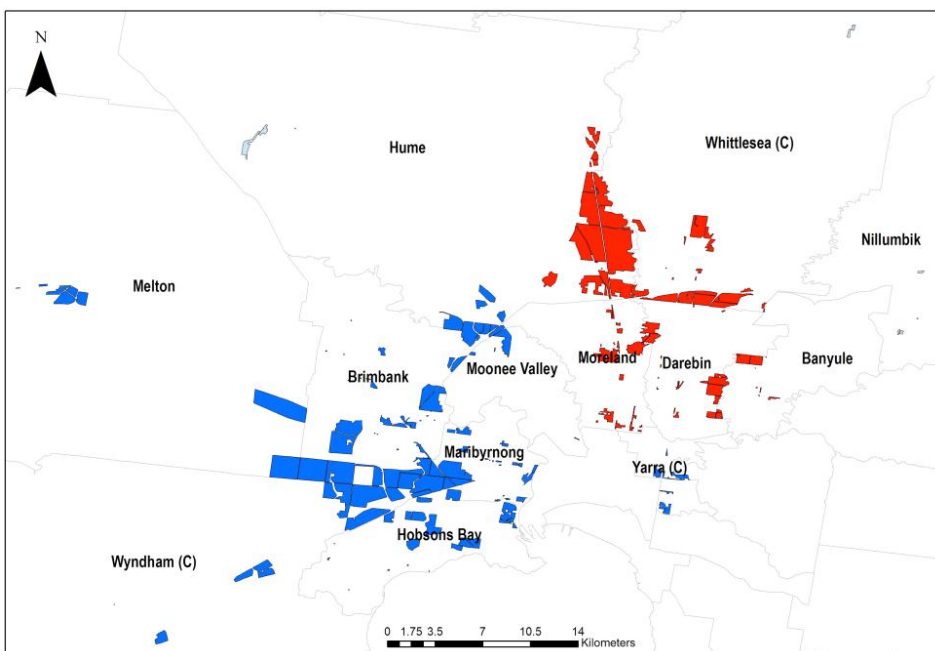


Figure 6.5 Spatial Weights Relatively Less Important, Distance Threshold=20km, Spatial Weight=0.1

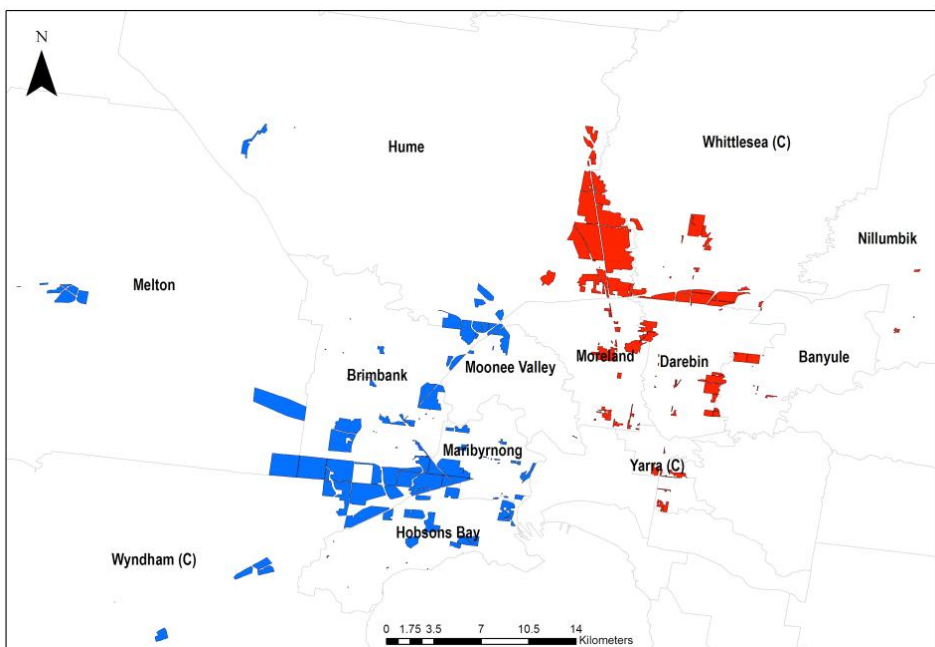


Figure 6.6 Spatial Weights Relatively More Important, Distance Threshold=20km, Spatial Weight=0.9

Value Chain versus Non-Value Chain Specification

In this section, we describe how using the value chain tool changes cluster configuration. Figure 6.7 shows a map of the clusters resulting when the algorithm is run on disaggregated data from ANZSIC codes 2311, 2312, 2313, and 2319 with a distance threshold of ten kilometres and non-spatial weight importance set at 0.1. Figure 6.8 shows the same configuration, but using the combined sum of codes 2311, 2312, 2313, and 2319.

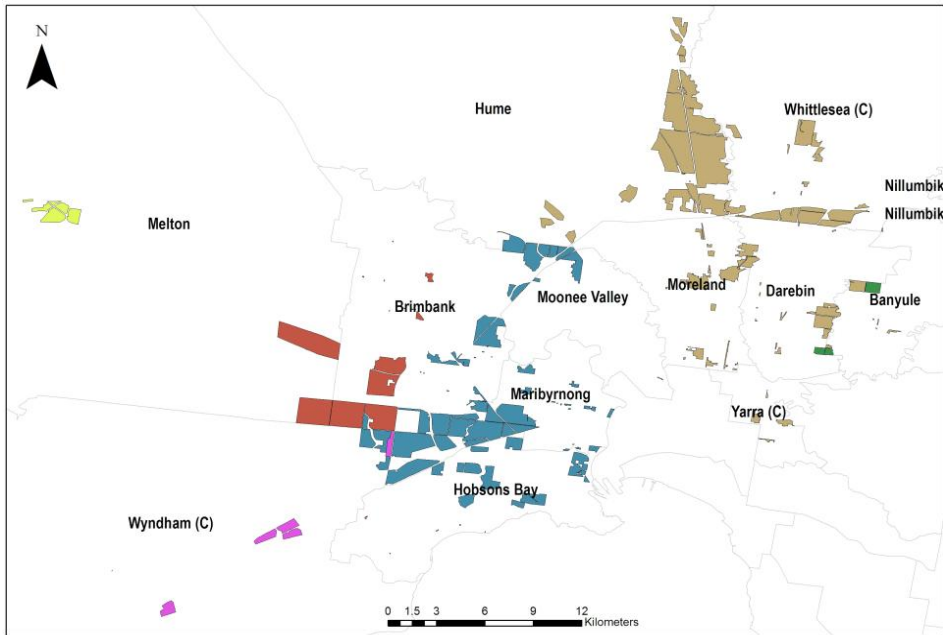


Figure 6.7 Disaggregated Value Chain Components (2311, 2312, 2313, 2319) Entered as Non-Spatial Weights, Distance Threshold=10km, Spatial Weight=0.1

Although the general cluster configurations do not change between Figures 6.7 and 6.8, there are a number of notable shifts by individual polygons. One very striking example is in the Wyndham cluster. In Figure 6.7, where the value chain option is not used, the Wyndham cluster is made up of three middle polygons. In Figure 6.8, another middle polygon joins the Wyndham cluster. The most interesting aspect of the addition of this fourth polygon is where it is located: squarely between polygons that remain in the Hobsons Bay, Maribyrnong, Moonee Valley cluster (which is teal in Figure 6.7 and red in Figure 6.8).

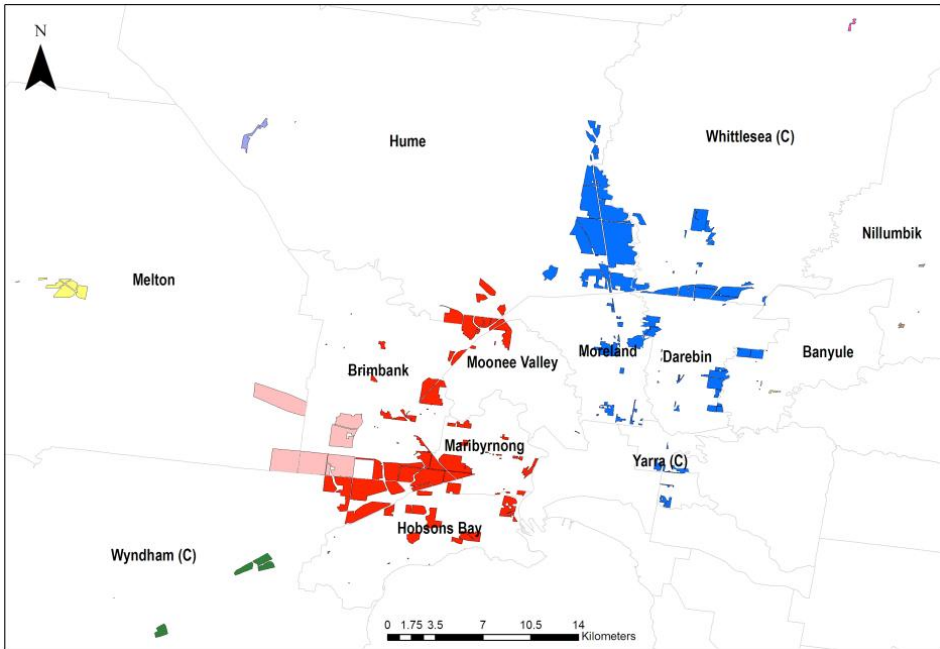


Figure 6.8 Combined ANZSIC Code 2310, Motor Vehicle and Motor Vehicle Parts Manufacturing, Distance Threshold=10km, Spatial Weight=0.1

This discrepancy between the maps implies that the value chain tool is doing its job: to differentiate between places based on the configuration of their spatial and non-spatial attributes, particularly by considering non-spatial attributes differently in aggregated versus disaggregated form.

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Chapter 7

Datahub for AURIN and ANDS Project

Amir Nasr and Azadeh Keshtiarast

Introduction

Central to the AURIN and ANDS project is the ability to access and describe spatial data using metadata. This ability is also valuable to support the research activities outlined in this book. This chapter therefore describes the technical specifications of a series of tools that provide researchers with an integrated data service where researchers are able to retrieve, process, analyse and visualise data from multiple agencies simultaneously. This information is fundamental to liveability data relating to health, wealth and transport that have a spatial reference.

To make data available requires an infrastructure that is able to combine data from multiple sources. It is important to note that to integrate this data requires considerable data cleaning, manipulation and validation to ensure they are 'fit for purpose'. These systems are also required to record the information about the data, known as metadata. Once the data is combined into the datahub, users are able to search for and display the data within the one platform, in turn enabling different points of view of a problem.

Following this premise and as part of the project, we have designed a datahub that contributes data to a portal (AURIN) to allow for data availability. We have also developed functionalities that are required by the metadata specification of ANDS.

The focus of the data collection has been on data held by local and state government agencies. Where possible the datahub is contained within the Department of Environment and Primary Industries (DEPI). The data was used by a multidisciplinary research team to respond to policy-relevant issues specific to Victorian Government priorities, thereby providing an exemplar of an integrated planning approach to improve liveability. Ultimately, the developed framework will improve planning in the initial target region and beyond.

Data Integration

The datasets received in this project were from various data sources and had different data formats. The most common format were shape files, which is a popular geospatial vector data format for spatial datasets. Urban Development Program (UDP) spatial data layers and City of Melbourne cadastral data are presented in this format. A significant part of spatial data, approximately 102 datasets, was accessible through the DEPI Web Feature Service (WFS) server. The AURIN portal could connect to the DEPI server and access the datasets such as VicMap and many other datasets of local and state government agencies. Non-spatial datasets were the most challenging type of data for integration. These datasets were mostly presented in a spreadsheet format, such as Mirosoft Excel and databases such as MS Access. Valuer-General data was the most important data in Access format that had a large number of records and a vast range of attribute data. Also many ABS datasets and Public Transport Victoria (PTV) datasets were presented in Microsoft Excel spreadsheets and needed to be integrated to the AURIN database. The integration process was completely dependent on the existence of spatial enabling fields. In some cases, such as air-monitoring stations from the EPA (Environment Protection Authority), there were coordination fields (X, Y) that made dataset spatial enablement simple. However, in some others there were addresses that needed to be geocoded in order for them to be spatially enabled.

Geocoding is a challenging process as there are many problems in non-standard address matching and non-updated source data. In most ABS spreadsheets, statistical data were related to a standard geographic level such as Statistical Local Area (SLA) or Local Government Area (LGA). These types of spreadsheets could be joined to their geographic layer by using joined fields, such as area name or area code. In addition, there are some relational databases (such as PTV timetable data) that included many tables with complicated relationships. Considerable effort was required to convert these datasets into flat data tables to be integrated into the AURIN Portal.

The main challenges in preparing, checking and uploading datasets to the server were:

- Manual work was required to trim spreadsheets for uploading since some datasets in spreadsheet format (like MS Excel) contained metadata and other additional information on the same sheet or even scattered over a few sheets.
- Encoding needed to be set before using third-party tools to allow importation. Column data types, specifically in Excel files, were mostly lost in importation and required an additional tool to check each value and type.

- The coordinate system of input was not explicitly determined and conversion and checking was needed to find the source.
- Datasets that were of multi-polygon geometry showed errors in ArcGIS software, PostGIS check geometry functions and the Geotools development application programming interface.
- Input dataset structures were sometimes required to be changed and flattened using the MS Excel Pivot table feature, causing datasets to have many attributes in columns. Input datasets that had large record amounts (e.g. 700,000 records) needed the paging functionality in GeoServer to impose changes at the client side to access the dataset in a multi-step manner.
- Datasets without a primary key needed tweaking before importing to the database.
- Datasets without a dataset key but were required to be integrated with spatial datasets needed geocoding to find their proper location.

Datahub

The datahub contained two main components: a GeoServer that had the ability to harvest data; and a metadata tool that provided information on varying levels of metadata from the title and abstract through to the individual attributes. The following paragraphs outline the technical components of each.

Geoserver

The core infrastructure for the project has been the Datahub. This hub accesses data through a WFS GeoServer (an open-source GeoSpatial server), which supports a large spectrum of Open Geospatial Consortium (OGS) services. Through the GeoServer web-based dashboard, various datasets in various formats and standards could be registered as WFS. This layer included those that were already imported into PostGIS database.

In total 102 datasets were available and harvested from DEPI WFS including: VicMap, PTV, and Department of Planning and Community Development (DPCD) datasets. Connectivity to DEPI's WFS server and the existence of all layers was tested by AURIN. Unfortunately the basic metadata elements were not descriptive enough to meet the AURIN requirements. To overcome this problem a solution for the manual enrichment of metadata was implemented.

In the situation where data was not able to be directly harvested, an interim solution was established where data was cleaned, formatted and uploaded into a virtual machine. These datasets were gathered from various custodians

including DPCD, Shire of Melton, EPA, PTV and the Department of Human Services (DHS).

Metadata

Metadata is critical for describing and sharing spatial datasets to its users. It helps you make better decisions about the suitability of the data to meet your needs. There are various formats that are designed to structure the way we define metadata.

The ANZLIC Metadata Profile is among the available metadata definition format that facilitates the consistent collection of metadata (or information about data) across Australia and New Zealand. The profile defines a minimum set of elements that must be collected for spatial datasets and other resources.

Based on AURIN's requirements, to be able to add additional elements including elements describing a layer's attributes in the metadata record, the new metadata profile (known as a new metadata schema) was created. This was by extending the ANZLIC ISO 19139 metadata profile, called the AURIN metadata profile. This new metadata profile included XSD (XML Schema Definition) files describing the elements of metadata records. Each metadata record needed to be validated against its metadata definition schema. To ease the creation of the metadata record compliant with its definition schema, some commercial and open-source tools were developed. The most commonly known tool in the open-source world is GeoNetwork, which is supported by a strong community.

GeoNetwork (a web-based catalogue application) provided powerful metadata editing and supported the ANZLIC metadata definitions formats using XSL/XML technologies. This tool, which has been written in JAVA programming languages and could be run on a Jetty or Tomcat web server, was selected as the core framework to build a customised metadata tool with a friendlier user interface (UI) to meet the AURIN requirements. GeoNetwork had its own XML/XSL-based user interface to create and edit the metadata records and could also harvest the metadata information from the harvesting node using the WFS service (OGC 2005). The communication between its UI layer and the RESTful application layer was based on XSL/XML and JSON technologies. Moreover, GeoNetwork had the robust mechanism (by using XSL technology) to harvest WFS (OGC 2005) layers and convert them into ANZLIC metadata profile compliant records. GeoNetwork also had the benefit of its powerful MVC engine, called Jeeves Engine, which fully supports REST-based and XSL/XML-based services.

However due to the excessive support cost of using the GeoNetwork (Kalantari, Rajabifard et al. 2009) default user interface implementation code (XSL/XML), the new user interface was built using a EXTJS (JavaScript client library) overlay.

Therefore the approach to implement AURIN requirements included:

- adding new AURIN metadata profile into GeoNetwork source code (new XSD file, necessary XSL file to convert WFS getcapabilities XML response into AURIN metadata format)
- implementing a simple user interface for managing a harvesting node, editing metadata records and managing the AURIN metadata elements
- modifying the default GeoNetwork harvesting behaviour to support revision history of changes that occurred at the harvesting node's side.

EXT JS (Sencha) 4.1 was selected to implement a UI that had good support in communicating with the application layer. In some part, especially in managing the harvesting node, the GeoNetwork functionality was also utilised by treating it as a black box so that its services could be called through the new user interface. The metadata tool for AURIN was designed in a way that the AURIN administrator could change the AURIN metadata schema on the fly through the provided interface to add/edit/delete AURIN additional elements. It meant that the AURIN metadata profile schema was generated dynamically, based on elements defined in schema editor grids. Furthermore, in the metadata record editor, the metadata's elements could be added through the metadata User Interface designer using its drag/drop functionality to add various metadata elements to the UI. All these functionalities were implemented using JavaScript/JSON and using EXTJS (Sencha) JavaScript library in a RESTful environment. All of these User Interface logic configurations were stored as one JSON in the server and were able to be retrieved by the metadata record editor.

Also, in the metadata tool, the default GeoNetwork behaviour in the application layer (using JAVA) was changed in a way that it would no longer override the already harvested metadata records with newly harvested ones in each harvesting cycle instantly.

In the first harvesting cycle, the metadata tool kept two versions of the metadata information in two separate XML's (one was the untouched harvested record and the other was modifiable in the metadata editor) and then in the subsequent harvesting cycle, the metadata tool compared newly harvested records with the already harvested but untouched version. This was then stored as the comparison result in a separate table per element using its XPath. Then, it overrode newly harvested records with the already harvested but untouched XML and in this way, in every harvesting cycle, every change from harvesting node's side was recorded.

After this step, the metadata tool's user was informed (by refreshing the page) of any changes in each metadata record at the harvesting node's side, per each element by having its XPath.

The Open Geospatial Consortium Web Feature Service Interface Standard (previously referred to as WFS) was the supported service type in the metadata tool that was harvested using its `getcapabilities` service type and the basic metadata elements (Name, Title, Abstract, Keyword, Bounding box) that could be extracted and automatically inserted in the metadata records. Also by calling the 'describe feature type' the WFS service type, the name and title of the layer's attribute was populated in the metadata record automatically, but the remaining information, (e.g. AURIN additional elements in the metadata record) was completed manually.

To ease this manual step, two buttons were added in the metadata editor user interface: importing CSV and exporting CSV functionality for AURIN additional elements. Through these two buttons, the attribute information (like name, title, description and its statistical type) were stored in CSV format and then populated in the metadata editor to eliminate extra copying and pasting.

RIF-CS

ANDS (Australian National Data Service) were interested in the (RIF-CS Registry Interchange Format - Collections and Services) format of the metadata records that would be harvested by ANDS server into their collections registry through direct harvesting (accessible service URL) or through the OAI-PMH protocol (Open Archives Initiative - Protocol for Metadata Harvesting).

GeoNetwork, through its community, supported harvesting through OAI-PMH protocol containing the necessary XSL files to convert ANZLIC metadata records to RIF-CS format (ANDS's metadata desired format). The issue however was that these predefined elements in the source ANZLIC format in the AURIN metadata tool were not of AURIN's interests. It meant that there was no information in the metadata records that enriched the AURIN metadata tool and could be converted into RIF-CS format. Therefore setting up the automatic harvesting through OAI-PMH protocol, would require a separate GeoNetwork to insert all the necessary elements for RIF-CS conversion through the GeoNetwork default user interface. This requirement, in the long-term, would not be an ideal support for two GeoNetwork-based metadata tools. Consequently, the interim solution was to create RIF-CS records manually and make them accessible through direct harvesting to ANDS. The problem with direct harvesting was that ANDS could not be notified of any new changes in the RIF-CS metadata records so that they could override all the records in each harvesting cycle and finally make any modification in the metadata records – this should be done in the plain editor instead of any metadata editor like GeoNetwork.

Conclusion

The timeframe for this project has been relatively short – 12 months. In this time approximately 150 datasets have been accessed, far exceeding the expectations of the group. There were considerable amounts of manual data cleaning, geocoding and integration work involved for data preparation. Geonetwork was adapted for managing metadata for these datasets. Geonetwork functionalities included its user interface, RFI-CS and harvesting mechanisms and were modified to satisfy the requirement of both ANDS and AURIN. Maintenance of the datasets will be an ongoing issue as there will be a need for manual data cleaning.

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Chapter 8

Demonstration Projects Applied - A Case Study in Footscray

Ian Bishop, Serryn Eagleson and Abbas Rajabifard

Introduction

The preceding book chapters have described the use of spatial information for planning and decision making in the specific domains of walkability, employment, housing and health. Each addressed a component of the urban condition related to liveability. Melbourne is currently undertaking a new Metropolitan Planning Strategy (MPS); one of the key themes within this strategy is the notion of a 20 minute neighbourhood (Department of Planning and Community Development 2013). The Department of Planning and Community Development have based this theme on research that shows that when people can access services and jobs within 20 minutes of their home they spend less time commuting and have more time to spend on social engagement and with families and are in general happier and healthier people (Strazdins, Broom et al. 2011).

The concept of a connected city that prioritises active and local living is not a new one. Cities such as Copenhagen and Salzburg have invested in prioritising active forms of transport within the city design. American cities such as Portland Oregon are also following on 'Portland's Climate Action Plan (2013)', which sets an objective for 2030 calling for vibrant neighbourhoods in which 90% of Portland residents can easily walk or bicycle to meet all basic daily, non-work needs. As reported by the (World Health Organization 1998) urban density is one of the most important factors influencing travel behaviour because it affects the distances between destinations and the proportion of destinations such as shops, services and workplaces, that can be reached by walking or cycling. Using the 20 minute city concept, this chapter shows how the data available within the AURIN datahub can be used with each of the tools developed in demonstration projects to explore, in an integrated way, liveability in a specific study area and hence inform place-based decision making. The selected study area focuses on Footscray, a locality with potential as a centre for active local living.



Figure 8.1 Looking over Footscray towards the Melbourne CBD
(from <http://beaurepaireterraces.com.au/home/about-the-footscray-location/>)

Study Area

Footscray is located approximately 5km west of the Melbourne CBD in the City of Maribyrnong (Figures 8.1 and 8.2). Recognising that the community perceptions of liveability in the area are relatively low combined with a low profile for residential, retail and commercial investment (Department of Planning and Community Development and Maribyrnong City Council 2010) state and local government have been working over the past decade to develop Footscray as a mixed-use liveable activity centre.

The City of Maribyrnong population forecasts reflect the current plans for development in the area with a bold forecast of more than 120% increase in the population from 13,969 in 2011 to nearly 31,000 in 2031; an increase of 17,000 people over the next 20 years. The City of Maribyrnong expect this growth to follow a significant increase in higher density dwellings, especially in and around the railway station, which is currently being upgraded. There are also plans to upgrade other services to the area. There is an increasing trend to convert former industrial, light industrial and other 'under-utilised' land to residential and business purposes (City of Maribyrnong 2013). This is generally increasing the cost of local land.

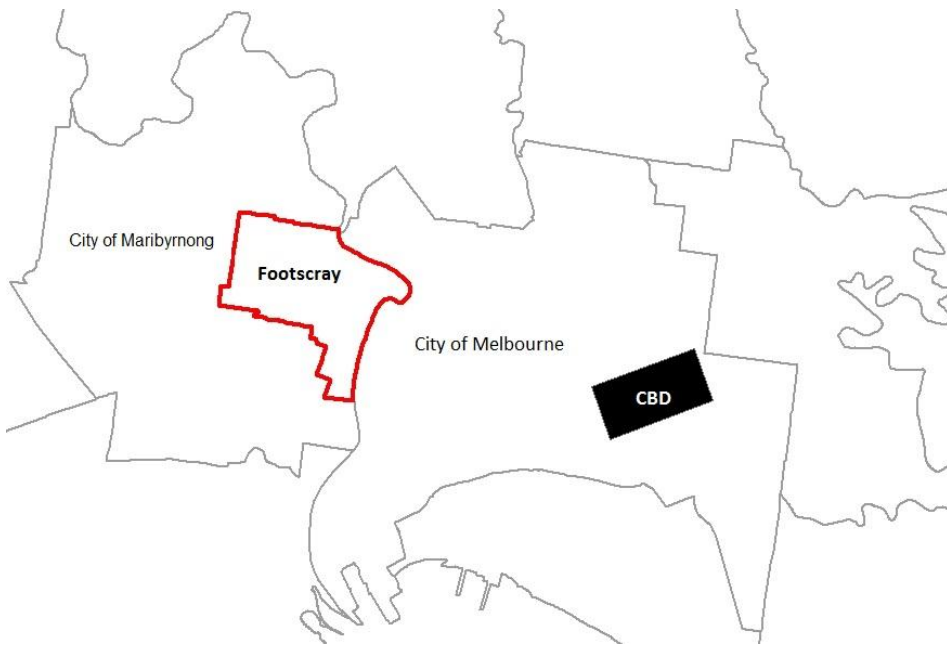


Figure 8.2 Location of Footscray within the City of Maribyrnong to the west of the CBD

Method

This paper brings together the tools developed in each of the demonstrator projects and applies them to Footscray. In doing so we demonstrate the advantages of using an integrated datahub, such as the one developed in this project, combined with well-focused tools. The methodology applied is as follows:

- Review the objectives outlined in the strategic plans for Footscray from 2005 to 2012 and document the objectives in terms of employment, housing, health and walkability.
- Document the data available via the AURIN portal with respect to the demonstrator topics.
- Apply the demonstrator project tools, using this data, and assess the contribution of the outputs against the strategic objectives outlined above.
- Through the process of applying the demonstrator tools, assess the strengths and limitations, as well as the areas for further development of this body of work.

Strategic Plans for Footscray

The objective of the State and the City of Maribyrnong is revitalisation of Footscray into a cosmopolitan mixed- use hub for retail, commercial, civic, health, cultural and educational activities and diverse housing choices. Our analysis is not an attempt to develop new options or new plans for Footscray, but to show how the datahub and developed tools could contribute to decision making.

In the specific context of the 20 minute neighbourhood, we focus on the four areas already introduced: access to employment, development potential for housing, availability of health services, and walkability. Table 8.1 identifies the plans and the actions relating to liveability in terms of the four demonstration projects. These provide the context for the study area and show the direct policy relevance of each of the demonstrators tools to planning and target actions in Footscray.

Plan	Target Actions	Relevant Demonstrator Tools
Draft Council Plan 2013-17 2013/14 Priority Action Plan (draft)	<i>2.4.3 Continue to update and develop strong demographic data base that supports Council's planning and advocacy (p. 11).</i>	Data Integration
	<i>2.5.5 Implement the final year of the Healthy Communities Initiative – 'Incredible, Edible Moveable Maribyrnong,' and build project sustainability (p.13).</i>	Health
	<i>3.5.1 Prepare Planning Scheme Amendment to include, Maribyrnong Economic and Industrial Development Strategy, into the Planning Scheme and protect core employment areas (p.16).</i>	Employment
	<i>3.5.4 In partnership with Western Region Councils develop draft Housing Affordability Development Guidelines (p.17).</i>	Housing
	<i>4.1.2 Continue to implement the Walking Strategy recommendations for Year 2 (p.18). 4.1.4 Deliver the Footpath Improvement Program(p.18).</i>	Walkability
Maribyrnong Walking Strategy (2010)	<i>Vision: Maribyrnong City Council is committed to creating a walkable city that is safe and accessible for all.</i>	Walkability
Footscray Structure Plan (draft for Public Consultation, 2013)	<i>To facilitate a significant proportion of the new housing required to meet the projected population growth to be developed within Footscray Central Activity Area (FCAA). To encourage affordable housing, including social housing, in the Footscray Central Activity Area (FCAA) (p. 12).</i>	Housing

	<i>To attract a broad mix of employment uses that will improve the centre's economic diversity, vitality and sustainability consistent with the role of Footscray as a CAA (p. 15).</i>	Employment
	<i>To create a truly 'walkable' centre improving overall pedestrian safety, mobility and access. (p. 24)</i> <i>To create a 'pedestrian priority zone' in the core of the centre, including continuous weather protection and activation along frontages to designated pedestrian priority routes (p.e 24).</i>	Walkability
Maribyrnong Economic and Industrial Development Strategy (MEIDS), 2013	<i>Increase employment</i> <i>Increase investment</i> <i>Increase Gross Regional Product</i> <i>Diversify the local economy</i> <i>Increase incomes</i>	Employment

Table 8.1 Plans, target actions and relevant tools applicable to the Footscray area

Application of AURIN Datahub and Demonstrator Tools

The following sections highlight the typical data available for analysis by policy makers along with a summary of benefits of applying the demonstrator tools in the Footscray area.

Employment

Employment is a key feature of the plans and strategic thinking for Footscray (Maribyrnong Economic and Industrial Development Strategy, (City of Maribyrnong 2012). In particular, the intention is to enhance the ability of the area to attract a broad mix of employment types that will improve the centre's economic diversity, vitality and sustainability. The size of Footscray's labour force in 2011 was 6,710 persons, of which 2,117 were employed part time and 3,669 were full-time workers. Of these workers the industry sector Accommodation and Food Services had the largest number of people employed (658) and also experienced the greatest increase (172) since the 2006 census (Table 8.2).

Footscray	2006			2011			Change in job numbers
Industry sector	Jobs	% of Total	% in Maribyrnong	Jobs	% of Total	% in Maribyrnong	2006 to 2011
Agriculture, Forestry and Fishing	18	0.4	0.2	0	0.0	0.2	-18
Mining	0	0.0	0.1	4	0.1	0.2	+4
Manufacturing	543	11.3	12.2	526	8.6	9.5	-17
Electricity, Gas, Water and Waste Services	26	0.5	0.7	61	1.0	1.0	+35
Construction	153	3.2	4.7	204	3.3	5.1	+51
Retail Trade	437	9.1	9.4	591	9.7	9.3	+154
Wholesale trade	186	3.9	4.6	229	3.8	4.4	+43
Accommodation and Food Services	486	10.1	7.4	658	10.8	7.4	+172
Transport, Postal and Warehousing	303	6.3	6.3	349	5.7	5.8	+46
Information Media and Telecommunications	163	3.4	3.5	215	3.5	3.2	+52
Financial and Insurance Services	236	4.9	5.4	307	5.0	5.6	+71
Rental, Hiring and Real Estate Services	40	0.8	1.3	41	0.7	1.4	+1
Professional, Scientific and Technical Services	352	7.3	7.7	506	8.3	9.0	+154
Administrative and Support Services	265	5.5	4.7	367	6.0	4.4	+102
Public Administration and Safety	288	6.0	6.0	386	6.3	6.5	+98
Education and Training	363	7.6	7.6	507	8.3	8.2	+144
Health Care and Social Assistance	446	9.3	9.1	589	9.7	10.1	+143
Arts and Recreation Services	139	2.9	2.6	192	3.2	2.9	+53
Other Services	149	3.1	3.1	198	3.3	3.1	+49
Inadequately described or not stated	211	4.4	3.1	160	2.6	2.7	-51
Total employed persons aged 15+	4,804	100.0	100.0	6,090	100.0	100.0	+1,286

Table 8.2 Number of jobs by industry sector of residents in the suburb of Footscray in 2006 and 2011. The table also shows these as a percentage of all jobs of Footscray residents and compares this to the percentages for the resident of the whole City of Maribyrnong. (Source: Australian Bureau of Statistics, Census of Population and Housing 2006 and 2011. Compiled and presented in profile.id by .id Consulting)

Current methods for analysing employment are based on census data combined with Journey to Work data to determine whether the jobs people have identified are within their local area or beyond. Journey to Work data have different spatial boundaries and are not at a fine enough scale to enable detailed land-use planning. To address this issue the employment demonstrator tool efficiently enables the identification of employment clusters disaggregated by industry type. The tool addresses a problem with the current ABS census geographies that do not provide a way to analyse subdistrict clustering (Day, Sturup et al. 2013).

We applied the cluster tool to search for clusters in two categories: (1) the professional and creative industries classified as Finance and Insurance, Information and Media, Retail, Arts and Education and (2) manufacturing

classified as Manufacturing and Transport, Postal and Storage. Overall the job numbers decreased by 15% in these two categories and with the most significant decline (35.1%) in the manufacturing sector (Table 8.3). This result shows that the number of jobs in Footscray in these clusters is very similar to the number of residents working in these areas. Despite this, almost 70% of workers resident in the City of Maribyrnong travel outside the municipality for work (City of Maribyrnong, 2011). Clearly therefore a similar proportion of those working in Footscray come from further afield. Addressing this issue and work towards the 20 minute ideal is thus not simply a matter of creating more local jobs. These may just increase traffic and parking problems unless public transport and walking play a greater role. As detailed in the Walkability section below, among Footscray residents who leave home for work, around 20% use public transport and less than 5% walk. While there is a need to develop employment policies, within a planning strategy, which foster local economic development, these strategies also need to reduce commuting times, and make jobs more accessible to where people live. The clustering analysis helps to tease out these strategic nuances.

	2006		2011		
	Polygons within a cluster	Total Job Numbers in Footscray	Polygons within a cluster	Total Job Numbers in Footscray	Number of workers in this field resident in Footscray
Manufacturing	43	938	39	609	875
Professional and Creative	66	2559	56	2284	1812

Table 8.3 Results of employment clustering in the Footscray area. This table show job numbers in Footscray itself except for the last column, which shows the job types of local residents (from Table 8.2).

[2011] Polygons: 39, Clusters: 10, Distance: 0.50KM, SpatialWeight: 0.5

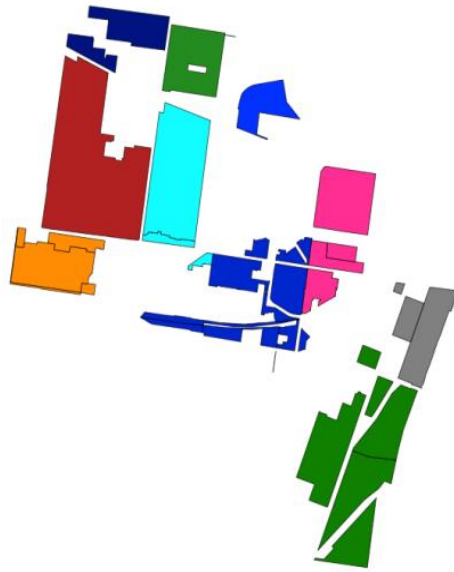


Figure 8.3(a) Employment analysis for Footscray: result of application of clustering algorithm showing main employment zones by employment type (with Spatial Weight 0.5)

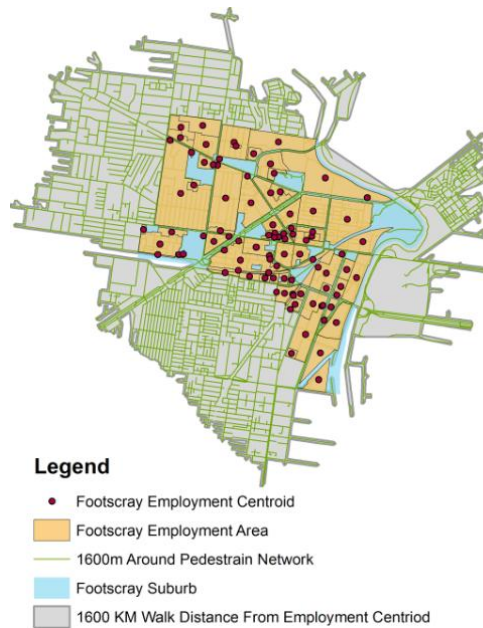


Figure 8.3(b) Employment analysis for Footscray: the centroids of the employment polygons used as starting points to identify residential areas within 20 minutes walk

Housing

Increasing employment availability in Footscray will increase the degree to which residents can work nearby. At the same time, the proximity of Footscray to the Melbourne Central Business District along with the transport infrastructure means that this is a very good strategic location for residential housing (Department of Planning and Community Development and Maribyrnong City Council 2010). The strategic plans for Footscray highlight the need to create a larger permanent population in Footscray within a diverse mix of housing styles including apartments, single houses, shared accommodation and accommodation for the elderly. The plans also highlight the need to promote affordable, diverse housing tenure options as well as culturally appropriate housing (City of Maribyrnong, 2013b).

Strategy documents for the study area highlight the capacity for increased density through infill development and the conversion of the light industrial and under-used spaces such as carparks for residential developments (City of Maribyrnong 2013). If well designed, research shows that some increase in density is compatible with liveability and would serve to increase walkability if any new development was within walking distance of the employment clusters. Analysis of development activity in the area, recorded in the Urban Development Program (UDP) residential development monitor, shows that developers are already working on a number of large strategic sites within the walkable distance to employment clusters. In total there are over five thousand new dwellings either under construction or due for completion in the area within the next ten years (Table 8.4).

STATUS	Number of Development Projects	TOTAL DWELINGS
Completed (since 2006)	12	599
Under Construction	9	1018
Construction 0-2 years	26	1599
Construction 3-5 years	15	1311
Possible Construction 6-10 years	11	1112

Table 8.4 Residential development activity recorded within the employment cluster catchment (Figure 8.3) (Source: Urban Development Program 2009)

What the housing tool provides as a supplement to this data is the ability to strategically analyse areas that have the potential, based on the efficiency and intensity of existing land use, to be redeveloped to a higher value land use. The housing tool has applied the redevelopment potential index outlined in (Newton 2010). This index represents the ratio of the land value (numerator) to the capital improved value (denominator). A RPDI of 1.0 indicates that the property value is represented almost entirely by the land value with minimal contribution from any existing improvement. Analysis by (Newton 2010) in the

eastern suburbs of Melbourne shows that a RDPI > 0.7 (capital improvement < 43% of the land value) is consistent with redevelopment trends. Applying this ratio for potential redevelopment within the housing tool it becomes possible to identify individual properties and significant pockets for infill development. Figure 4 shows all properties with DPI > 0.7 which are both within 800 of a public transport (tram or train) stop and also within 800 m of each of an education facility, a medical facility and a recreation facility. In total there are 3,935 properties identified covering an area of 153 Hectares.

The map also shows the area identified as within 20 minute walk of the employment clusters. Redevelopment within this area could be given priority.

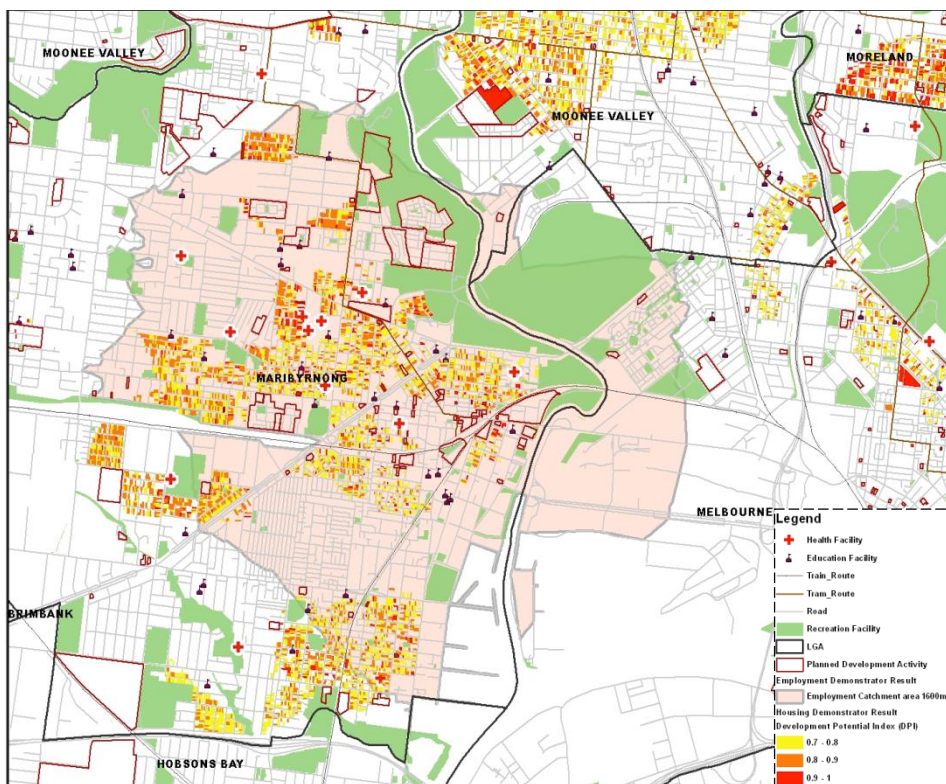


Figure 8.4 Analysis using the housing tool showing properties with the most potential for redevelopment based on their DPI and proximity to transport and services. The pink area is that within 20 minute walk (1600 m) of the main employment cluster.

Health

Local governments are key providers of health services and should respond to local health issues. Within the City of Maribyrnong there are a number of serious health problems, when compared to the remainder of Victoria (City of Maribyrnong 2010). These include a lower life expectancy, the highest rate of

mental disorders in the state and high levels of cardiovascular disease. The health demonstrator provides an exploratory tool for testing the areas with risk factors for Type 2 diabetes. These risk factors include social disadvantage (as measured by the SEIFA score), rate of depression and rate of obesity: together these risk factors can be analysed to identify spatial areas that are most at risk. The tool also enables the user to cross analyse these pockets with accessibility to a GP or health facility such as a hospital or community centre. Unfortunately given the large areas of aggregation for the health data relating to depression and obesity, and the small scale of the study area, it is only possible to analyse the SEIFA data and identify the pockets of disadvantage in relation to the location of health facilities (Figure 8.5).

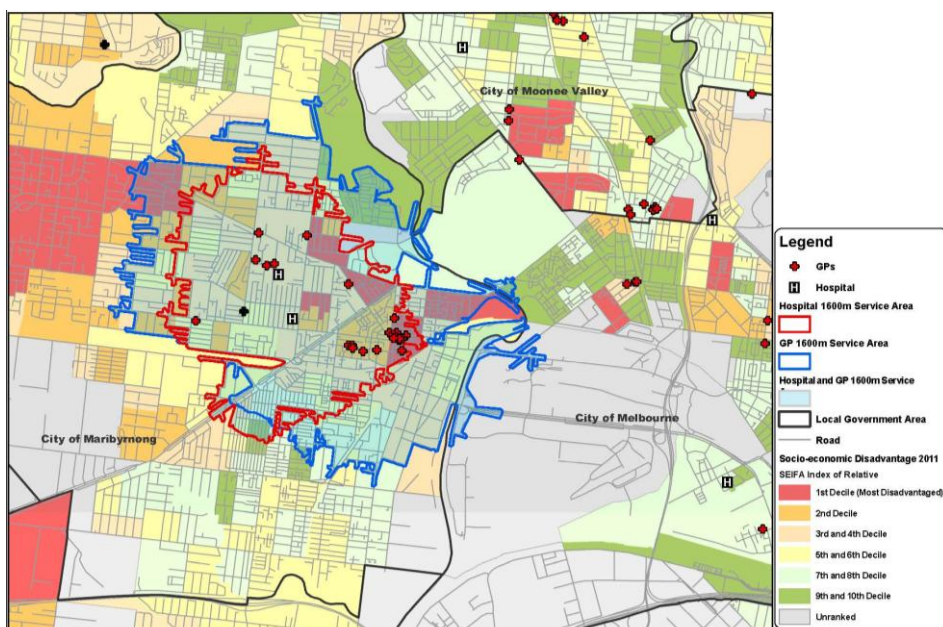


Figure 8.5 Health demonstrator result: walkable distance from Hospitals and General Practices overlaid with the SEIFA Index for disadvantage

Based on the analysis above, we see scope for increasing dwelling density especially within the walkable distance of the employment clusters. Planning for health services should ensure that existing or new services are sufficient to meet the needs of a future population. Figure 8.5 shows the catchments for health services overlaid with the SEIFA index of disadvantage. It is important to note that there are areas of high disadvantaged that are either bordering or just outside the walkable catchments. This is an important consideration for strategic planning of future health locations.

One of the benefits of this integrated data and planning approach is the ability to view information across municipal boundaries. For example the Footscray walkable catchments extend over the municipal boundary into the City of Melbourne. This part of the City of Melbourne is identified in its municipal

strategic statement as having potential for urban renewal (City of Melbourne 2012). Such development should be considered in conjunction with any planning for the Footscray area.

Walkability

Within the strategic plans for Footscray there is a strong focus on pedestrian connections through the activity centre. This includes providing a more permeable, legible, comfortable, accessible, safe and attractive pedestrian environment as well as encouraging people to walk more through greening the streets and ensuring that the built form responds to the street and encourages pedestrian activity (Department of Planning and Community Development and Maribyrnong City Council 2010). The Maribyrnong City Council's Walking Strategy clearly identifies the need to protect and promote walking for the wellbeing of the community. This strategy also draws together a number of data sources relating to walkability in the municipality including ABS data on travel to work, VicRoads data on accidents and travel survey data collected from schools. These data are clearly important in the development and monitoring of the city's walking strategy.

One way to explore the 20 minute concept is to understand the number of people who currently walk to work in Footscray. As Table 4 shows, in 2009 4.2% of Footscray residents walked to work even though 30% of people worked within the municipality. The more dominate transport forms are car as driver (51%) and train (29%).

Footscray	2006			2011			Change
Main method of travel	Number	%	% in Maribyrnong	Number	%	% in Maribyrnong	2006 to 2011
Train	1,082	22.6	15.8	1,770	29.0	18.7	+688
Bus	243	5.1	3.4	338	5.5	3.1	+95
Tram or Ferry	15	0.3	1.0	27	0.4	1.0	+12
Taxi	26	0.5	0.4	8	0.1	0.3	-18
Car - as driver	2,068	43.1	53.3	2,428	39.7	51.7	+360
Car - as passenger	222	4.6	5.4	186	3.0	4.6	-36
Truck	16	0.3	0.5	6	0.1	0.3	-10
Motorbike	30	0.6	0.6	61	1.0	0.8	+31
Bicycle	126	2.6	2.1	226	3.7	2.8	+100
Walked only	252	5.3	3.0	259	4.2	2.6	+7
Other	38	0.8	0.8	57	0.9	0.9	+19
Worked at home	123	2.6	2.5	171	2.8	3.0	+48
Did not go to work	438	9.1	9.2	498	8.2	8.6	+60
Not stated	116	2.4	2.1	75	1.2	1.6	-41
Total employed persons aged 15+	4,795	100.0	100.0	6,110	100.0	100.0	+1,315

Table 8.5 Method of travel to work for Footscray residents and for residents of the City of Maribyrnong

In terms of the walkable catchments many of the plans developed identify existing and potential pedestrian improvements. Applying the walkability tool to these networks has the potential to provide statistics on the catchment. Footscray Access and Mobility Strategy 2011 designate Footscray Central Activity Area as a Pedestrian Priority Zone and identifies the key pedestrian routes to, from and within the centre (Figure 8.6(a)). To test this we have created a dedicated Footscray version of the walkability project available from here <http://115.146.87.16:9999/agent-walkability-fs/agent-model.html> and applied it to Footscray area identified in Figure 8.6 below.



Figure 8.6(a) Pedestrian barriers and potential improvements, Footscray City Edge Masterplan 2012

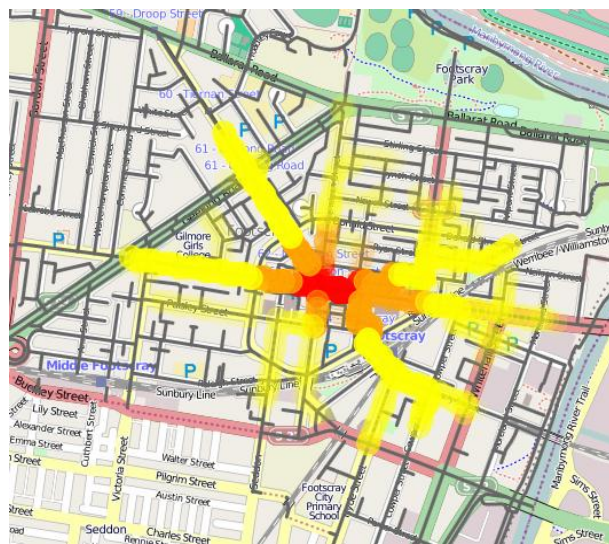


Figure 8.6(b) Walking catchment 20 minutes from central Footscray (walking speed = 1.33m/s, Crossing wait time = 30 seconds).

Using the walkability tool it is possible to visualise the 20 minute walk from the heart of the Footscray Centre and obtain metrics that may be downloaded for separate analysis. These include information on the mean distance travelled (837m) and the mean number of crossings (10).

Discussion

There a number of challenges that still exist before the data and tools illustrated here can fulfil their potential and become a part of everyday decision-making. Nevertheless, this example of linking the four demonstrator tools has shown that employment data can be more meaningfully interpreted through cluster analysis, that this can tell us a lot about priorities for housing development in the context of development potential. That ideas for further housing development need to be consistent with plans for services, such as health services, and that a walkability tool enhances our ability to consider all these factors.

This is just a prototype development and outcomes should be considered in terms of four dimensions: representation, precision, interactivity and evolution.

Representation: this prototype tools applied here are all functional but in different degrees of integration with the AURIN portal. For example the employment clustering tool can be applied from the portal. The walkability tool is online and linked to the portal but running independently, the housing and health tools are still stand alone at this stage and need integration before the processing could be integrated in the way suggested here.

Precision: the scale of the data available, and necessary, for the different analytical aspects is different. This needs to be considered carefully in the interpretation of results. For example the health tool uses data that is largely aggregated to ABS geographies such as the Statistical Local Area (SLA), in contrast the housing tool operates at the individual land parcel level.

Interactivity: It is recognised that not all councils have direct access to Geographical Information Systems and not all planners are experts in using GIS. The demonstrator tools have all been developed to work online removing the need for specialised software. However further functionality and instructions are required for informed use to occur at any location or with the user's own data.

Evolution: while this specific project is coming to an end, work will continue on the AURIN portal. Some key issues will need to be addressed in on-going development. For example, a data updating mechanisms keeping pace with reality in local spaces is essential for the analysis to provide meaningful outputs. With any online systems there will always be problems dealing with

issues such as multiple concurrent users. As an example with the walkability tool, an amendment to the path network by one user will currently be seen by another user, even though this may be just a hypothetical addition.

Consultation with the one hundred project contributors has highlighted the scope for further use and development of the tools into emerging areas not originally considered (Table 8.5).

Tool	Potential Application
Walkability	<ul style="list-style-type: none"> • Plan walking bus routes for schools • Assessment of development applications and the expenditure of development contributions • Extension to enable emergency services to plan evacuation locations and test different points. • Enable planners to test the location of new pathways and street networks proposed by developers and within structure plans.
Employment	Use the clusters to inform the strategic movement of freight and/or goods that service the specific industry clusters. Inform land-use zoning
Housing	Assess capacity for growth in Melbourne and in particular infill development around existing infrastructure.
Health	Target interventions such as the allocation of resources for physical activity and health prevention strategies.

Table 8.5 Additional areas of application of the demonstrator tools

Conclusion

In this chapter we have shown how the different tools developed in this project may be used together to provide more profound insights into ways of achieving a set of planning goals – such as those implicit in the 20 minute neighbourhood concept. Other tools relating to other aspects of urban liveability can be imagined. The key to their success is the availability of data of the best quality possible and supported by unambiguous metadata. We have taken the key developments in data availability (AURIN) and metadata (ANDS) and begun to show how important these can be. Their value will only increase as more tools are developed and integrated such that a series of linked analyses become possible. Then, truly multi-disciplinary planning and decision making becomes a practical reality.

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Scott Watson	VicRoads
Ben Rossiter	Victoria Walks

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Appendix

NWMR Integrated Data

Dataset	Data source
Flora Fauna Wetlands – Vicmap Vegetation	DEPI
Property Map Polygons – Vicmap Property	DEPI
Rail Network – Vicmap Transport	DEPI
Parcel Map Polygons – Vicmap Property	DEPI
Ward Boundaries 2008 – Vicmap Admin	DEPI
Rail Stations – Vicmap Transport	DEPI
Airport – Vicmap Transport	DEPI
Address – Vicmap Address	DEPI
Vegetation – Vicmap Vegetation	
Locality Boundaries (Property) – Vicmap Admin	DEPI
Postcode Boundaries – Vicmap Admin	DEPI
Features of Interest – Vicmap Features	DEPI
Ferry Routes – Vicmap Transport	DEPI
Roads – Vicmap Transport	DEPI
Victorian Government Regions – Vicmap	DEPI
Townships – Vicmap Admin	DEPI
Bus Routes Metro (Public Transport Victoria)	DEPI
Tram Routes (Public Transport Victoria)	DEPI
Planning scheme zones – Vicmap Planning	DEPI
Property View – Vicmap Property	DEPI
Train Corridor Centreline	DEPI
Ecological Vegetation Class	DEPI
Parish Boundaries – Vicmap Admin	DEPI
Planning scheme overlay – Vicmap Planning	DEPI
Planning scheme Urban Growth Area – Vicmap Planning	DEPI
Planning scheme Urban Growth Boundary – Vicmap Planning	DEPI
Local Government Area Boundaries – Vicmap Admin	DEPI
Hydrology – Vicmap Hydro	DEPI
Elevation Contours – VicMap Elevation	DEPI
Parks – VicMap Crown Land	DEPI
Threatened Flora	DEPI
RAMSAR Sites	DEPI
Influenza Infection Age Distribution Victoria Wide by LGA	DoH
Influenza Infection Age Distribution Victoria Total	DoH
Age Sex Distribution of Infectious Diseases Victoria	DoH
Location of General Practitioners	DoH
Locations of Community Centres	DoH
Speed Zones	VicRoads
Road Use Hierarchy	VicRoads
Location of Bicycle Counters in Melbourne	VicRoads
Victorian Road Traffic Volumes	VicRoads
Municipal Bicycle Network	VicRoads
Principal Bicycle Network	VicRoads
Electronic Gaming Machine Information by LGA in 2009–10	VCGLR
Electronic Gaming Machine Information by LGA in 2010–11	VCGLR

Personal insolvency activity by Postcode (2010-2011)	VCGLR
Family Incident Reports – Offences	VICPOLICE
Family Incident Reports (Rate per 100,000 population)	VICPOLICE
Offence report 2011–12	VICPOLICE
Public Transport Victoria Stop Time Table	PTV
PTV (Trams) – Origin Destination Survey 2011	PTV
Estimated Station Entries and Transfers at Metropolitan Stations 2010-11	PTV
Public Transport Victoria (PTV) Stop Information 2012	PTV
Public Transport Victoria (PTV) Stop Line Information–Denormalised	PTV
City of Melbourne Maternal and Child Health Centres	CoM
Outdoor Furniture Assets Information –City of Melbourne	CoM
City of Melbourne CLUE Capacities (2010)	CoM
City of Melbourne CLUE Employment By Industry (2008)	CoM
City of Melbourne CLUE Employment By Industry 2010	CoM
City of Melbourne CLUE Predominant Space Use (2010)	CoM
City of Melbourne CLUE Space Use (2008)	CoM
City of Melbourne CLUE Space Use (2010)	CoM
City of Melbourne CLUE Capacity Measures (2008)	CoM
Melton Footpaths (2012)	City of Melton
Melton Public Street Lights (2012)	City of Melton
Infrastructure and landfill sites for the state of Victoria	EPA
Air Monitoring Stations	EPA
Infrastructure and Landfill information for the Melbourne Metropolitan Region	EPA
Valuer-General Property Data (2010)	VG
Urban Growth Boundary (Aug 2010)	DPCD
Victoria In Future 2012 Projected Population by LGA	DPCD
Victoria In Future 2012 Projected Population by SLA	DPCD
UDP– - Industrial Nodes (2010)	DPCD
UDP – Industrial Proposed Areas (2010)	DPCD
UDP – Major Infill Sites 2009 (regional only)	DPCD
UDP - Major Residential Redevelopment Sites (2010)	DPCD
UDP – Minor Infill Supply 2009 (regional supply only)	DPCD
UDP – Broadhectare Estates (2010)	DPCD
UDP – Industrial Land (2010)	DPCD
UDP – Broadhectare Residential Land (2010)	DPCD
DPCD Grant Data 2011-12	DPCD
Quarterly Median Rents by LGA June2012 1 Bedroom Flat	DHS
Quarterly Median Rents by LGA June2012 2 Bedroom Flat	DHS
Quarterly Median Rents by LGA June2012 2 Bedroom House	DHS
Quarterly Median Rents by LGA June2012 3 Bedroom House	DHS
Quarterly Median Rents 4 Bedroom House by LGA June 2012	DHS
Affordable Lettings by LGA June2012 1 bedroom	DHS
Affordable Lettings by LGA June2012 2 bedroom	DHS
Department of Human Services (DHS) 3 Bedroom House Affordable	DHS
Lettings by Local Government Area (2012)	
Affordable Lettings by LGA June2012 4 bedroom	DHS
Affordable Lettings by LGA June2012 all bedroom types	DHS

SPATIAL DATA ACCESS AND INTEGRATION TO SUPPORT LIVEABILITY

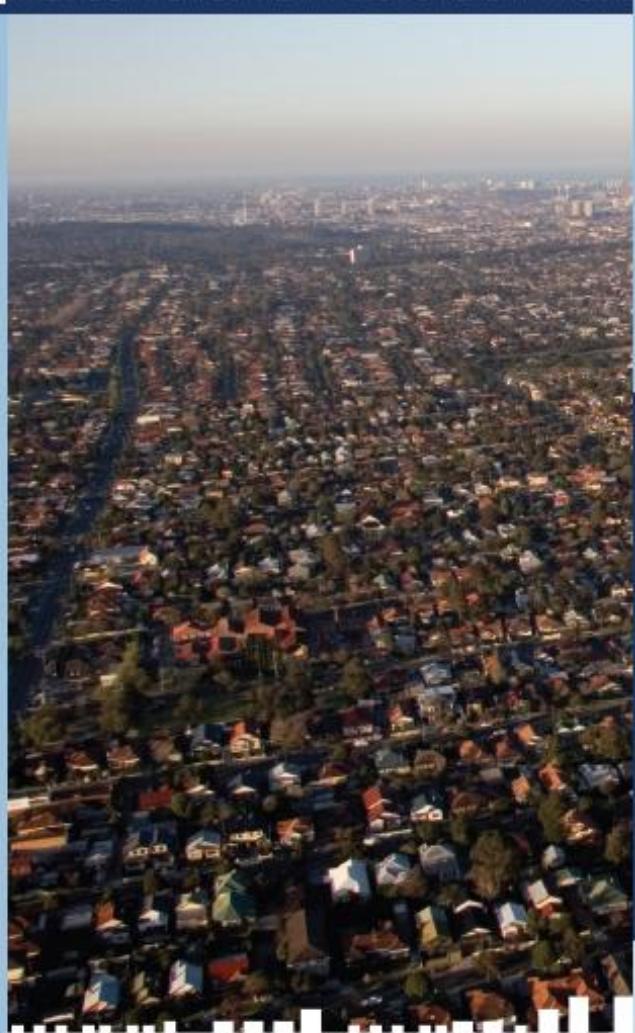
A CASE STUDY IN NORTH AND WEST MELBOURNE

This book aims to promote a better understanding of local area data and tools to support researchers, planners, practitioners and policy makers. The book has been developed based on a 12-month study of the Melbourne North West corridor in which data has been made accessible via the Australian Urban Research Infrastructure Network (AURIN). Such unprecedented data access has enabled world-class research that was focused toward addressing the key policy issues in the North West region of Melbourne, as identified by the North and West Metropolitan Regional Management Forum. The project was conducted through the Centre for Spatial Data Infrastructure and Land Administration (CSDILA) at the University of Melbourne involving three faculties.

Abbas Rajabifard Professor and Director of the CSDILA and Head of the Department of Infrastructure Engineering at the University of Melbourne. Professor Rajabifard is an expert in the area, having published broadly on SDI, land administration, GIS and spatial data management. Professor Rajabifard holds a number of prestigious and influential positions for managing and developing spatial data, spatially enabled government and societies.

Serryn Eagleson, Associate Director of the CSDILA and Director of EdgRESEARCH Pty Ltd. Dr Eagleson has over a decade of experience working with academic institutions and all three levels of government. Career highlights include the development of computer models that improve the ability to gather accurate statistics, thereby assisting with planning for sustainable development, population growth, improved health outcomes and resource allocation for local councils, universities, government and industry across Australia.

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