

Urban Greenspace: Connecting People and Nature

Guy Barnett
Michael Doherty
Matthew Beaty

CSIRO Sustainable Ecosystems, Canberra

Email: guy.barnett@csiro.au
michael.doherty@csiro.au
matt.beaty@csiro.au

ABSTRACT

The influence of enlightened greenspace planning can be seen in some but not all of Australia's cities – notably Adelaide, Melbourne and Canberra. There have been recent suggestions that many contemporary planners and developers have deserted the “garden city” concept in favour of private greenspace. However, there is a considerable level of uncertainty about the impacts associated with the deterioration and loss of urban greenspace and the biodiversity these areas contain, particularly in relation to the sustainability and quality of urban life. In this paper we revisit the connection between people and nature in the city, through a focus on identifying spatial patterns of urban greenspace, health outcomes for people, and knowledge of parks and biodiversity.

The paper draws on the preliminary results of two scoping studies that provide a case study exploration of urban greenspace and the connection between people and nature in Melbourne. The first of these is an interdisciplinary CSIRO project which takes a landscape-scale exploration of the connection between urban greenspace and human health. The second, a collaboration between CSIRO and the Australian Research Centre for Urban Ecology (ARCUE) and examines the way people value and relate to urban parks and the biodiversity they contain. These scoping studies were used to test some assumptions about urban greenspace and address key knowledge gaps.

Our work has shown that remote sensing is a fast, efficient, cost-effective and accurate way of measuring greenspace compared to traditional cadastral or map-based methods. The technique improved the estimation of urban greenspace by up to three-fold, by not only capturing the public greenspace, such as parks and open space, but also private greenspace, such as backyards. We have also shown that private greenspace forms a significant component of the total urban greenspace, the contribution of which has been largely unrecognised and undervalued for urban sustainability.

However, we also found that there was no simple link between health and greenspace. This may be due to the broad geographic scale of the health data – local government area – making comparison with the fine resolution socio-economic and greenspace data problematic. Yet, our survey of 472 residents revealed that 93% like living near, and 86% regularly use, urban parks, so it is clear that they are valued by people and used regularly, which is likely to result in some health benefit.

We conclude with a summary of the implications of this research for understanding the interplay between greenspace, people and nature, and outline the directions of a current project in Sydney.

INTRODUCTION

Australia is a highly urbanised country, with approximately 90% of the population now residing in towns and cities. Thus the experience and contact that the majority of Australian's have with nature is more likely to occur in an urban rather than a rural setting. It is unclear what the long term consequences of this might be for urban residents or biodiversity conservation and we therefore require a greater understanding of the interactions between people and nature in urban areas.

This paper provides a summary of research progress from a growing portfolio of projects being undertaken by CSIRO and several research partners to investigate the role of greenspace in cities and the connection between people and nature. It is based upon the initial findings and insights from two scoping studies recently undertaken in Melbourne. One involved an interdisciplinary team of social and biophysical scientists from across four Research Divisions of CSIRO with the aim of exploring the connection between urban greenspace and human health. The other, a novel collaboration between CSIRO and the Australian Research Centre for Urban Ecology (ARCUE) to examine the way local residents value and utilise urban parks and the biodiversity they contain.

The paper begins with the rationale for our interdisciplinary approach and the background that has informed much of our thinking. We then discuss our research findings, starting with the remote sensing technique we used to identify patterns of urban greenspace in Melbourne, comparing the results with a Public Open Space Database compiled from existing datasets by ARCUE in 1999. With patterns of urban greenspace now established, we discuss the results of a landscape scale exploration of the spatial relationship between urban greenspace and human health, using existing data from the Australian Bureau of Statistics (ABS) and the Victorian Burden of Disease Database. We provide the results of a social survey investigating the community values, knowledge and usage of urban parks in Melbourne. The paper concludes by touching on lessons learnt and the way these have informed a new study in Sydney partnering with the Sydney Olympic Park Authority (SOPA).

RATIONALE AND BACKGROUND

Australia's cities are rich in biodiversity, but much is at risk. For instance, Yencken and Wilkinson (2000) report that more than 50% of Australia's threatened or rare plants, mammals, birds, reptiles, and freshwater fish have habitats located in or around our major cities and population growth areas. The story is similar for nationally listed threatened ecological communities, with over 40% found in and around urban areas. Thus, the places humans chose to live are often home to many species of native flora and fauna. With increasing urbanisation – the UN estimates that in 2025 Australia will have an additional 3.5 million urban residents – it appears almost inevitable that conflict over urban development pressure and biodiversity impact will continue to grow. Recent urban growth debates in several Australian cities serve to highlight the contested nature of our peri-urban landscapes.

While acknowledging the significant impacts of urbanisation on biodiversity, the approach that we have adopted for our research portfolio is to move beyond a focus on impact towards a broader systems understanding of the complex dynamic interactions between people and nature in cities. This means looking not only at the way people use and relate to urban greenspace, but how these areas in turn influence human well-being and quality of life.

City officials in the nineteenth century held a strong belief in the many health advantages of urban greenspace. This belief was used as justification for providing parks and other natural areas in cities, and preserving wilderness areas outside of cities for public use (Parsons, 1991). Toward the end of the 19th century parkland reservations were established around major cities such as Sydney, with the (Royal) National Park proclaimed in 1879 and Kuringai Chase National Park proclaimed in

1891 (Powell 1976). Ostensibly, these areas were natural bushland protected for recreational health purposes, but also providing temporary refuge for people to escape from the urban environment.

During the late 19th to early 20th century, the concept of town planning became more accepted in order to mitigate the more unhealthy aspects of working in or living near industrial areas and to avoid by design undesirable elements of urban living, as evidenced by Frederick Law Olmsted's focus on the benefits of public parks (Olmsted, 1870). One of the more influential ideas to emerge from this period was the "Garden City Movement" initiated by Ebenezer Howard in Britain, which led to the formation of the Garden City Association in 1899. The Garden City Movement attempted to create "new towns" and to partition off industrial forms of land use from where people lived, in order to gain health benefits. The Australian Capital of Canberra was also designed and constructed during this period and although its layout was influenced more by the "City Beautiful" Movement through the architects Walter Burley Griffin and Marion Mahony Griffin, it also reflects aspects of the Garden City concept. The Garden City concept was also more broadly adapted to apply to new suburbs growing around the edges of the existing major cities, particularly after the Second World War, with creation of backyard spaces and suburban parks, ovals and playgrounds (Powell 1976).

The Human Settlements chapter in the 2001 Australia State of the Environment report suggests that the recent generation of planners and developers have largely deserted the "garden city" concept in favour of privatised greenspace (Newton et al. 2001). While the connection between greenspace and human health has not been completely lost, the modern emphasis appears to be much more about amenity, leisure and recreation, but often only as secondary considerations to house size.

There is a considerable level of uncertainty about the impacts associated with the deterioration and loss of urban greenspace and the biodiversity these areas contain, particularly in relation to the sustainability and quality of urban life. Many of the benefits of urban greenspace were originally taken as self-evident with little empirical work undertaken to test or quantify linkages. Research evidence, particularly from the past two decades suggests that many of the reported benefits may be real – improving human health and sense of well being (Kaplan and Kaplan, 1989), reducing stress (Ulrich et al., 1991), enhancing productivity (Tennessen and Cimprich, 1995), reducing crime (Kuo and Sullivan, 2001), as well as boosting property values (Bolitzer and Neutshil 2000, Luttkik 2000) to name just a few. Urban greenspace also plays an important functional role in urban landscapes providing ecosystem services such as the mitigation of flooding and erosion, the collection of airborne and waterborne contaminants, and provision of wildlife habitat (Small 2001).

PATTERNS OF URBAN GREENSPACE

Information on urban greenspace is difficult to access, quantify and compare (Newton et al. 2001). This is largely a result of the different ways urban planning authorities around Australia collect and classify this information. It is surprising how little is actually known about patterns of urban greenspace in Australian cities – how much there is and issues related to distribution and access.

We define the term "urban greenspace" broadly as the range of urban vegetation including not only parks and open space, but street trees, residential gardens, and in fact any vegetation found in the urban environment. Our definition thus ignores tenure and composition – we are not concerned as to whether the vegetation is in public or private ownership or whether it is indigenous or exotic.

Here we discuss the results of a scoping study by CSIRO to explore the relationship between urban greenspace and human health. The first phase of this study involved the use of remote sensing to identify and classify urban greenspace. High spatial resolution (2.5 m pixels) multispectral imagery (blue, green, red and near infrared spectral channels) was obtained from the QuickBird satellite and sensor for an area of inner Melbourne approximately 21 km x 23 km (see Figure 1). The image was

classified using the Normalized Difference Vegetation Index (NDVI), which is commonly used to quantify vegetation cover and has been shown to hold generally for a number of different biomes.

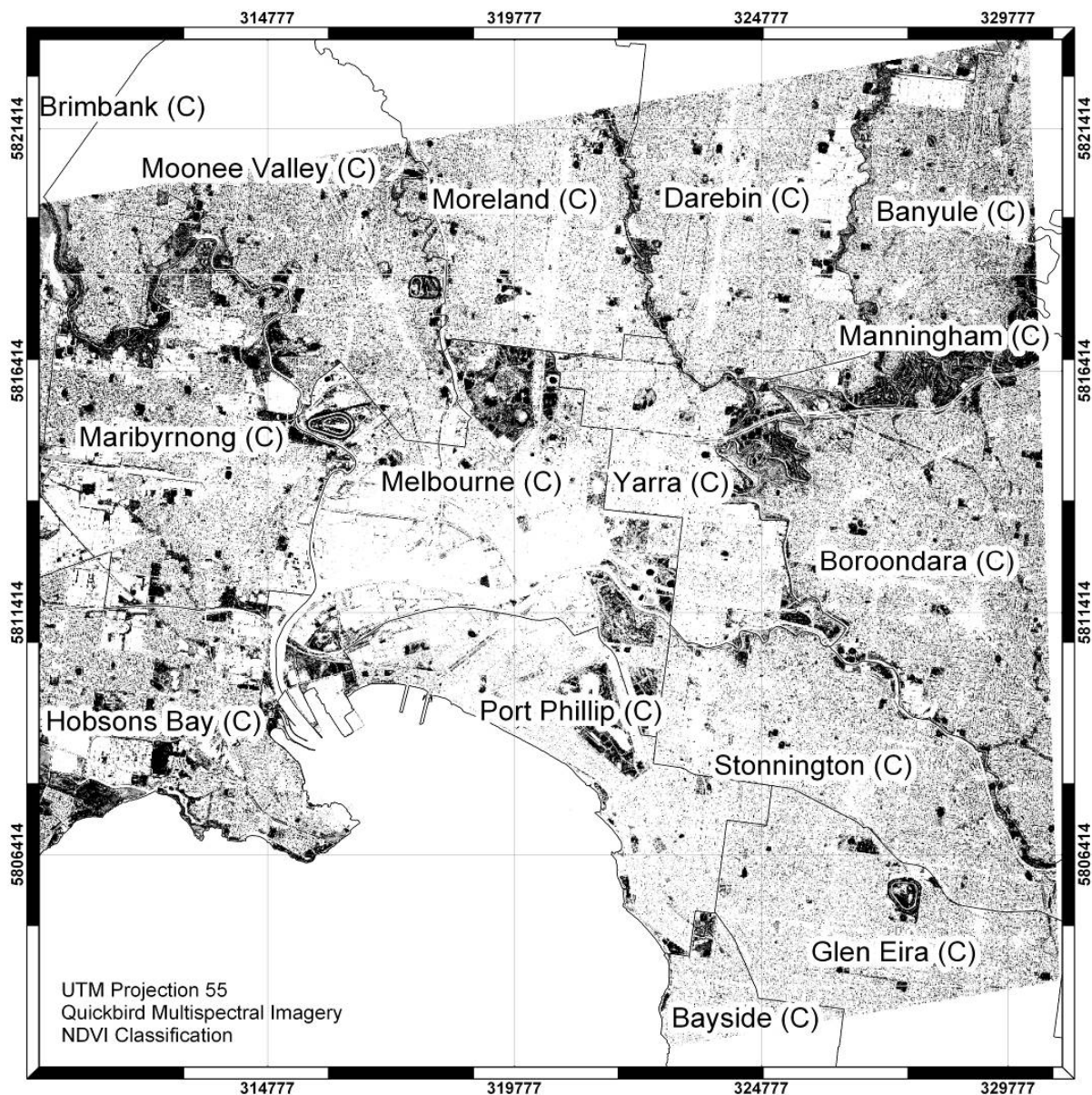


Figure 1: Classified Normalized Difference Vegetation Index (NDVI) 2.5 m QuickBird Multispectral image of Melbourne. Greyscale is indicative of vegetation cover with white areas non-vegetated and dark corresponding to dense vegetation. QuickBird imagery provided by Digital-Globe and Sinclair Knight Merz.

NDVI values range from -1 to +1 and can be easily classified into basic land cover classes. Much of the built component of the urban environment consists of high reflectance materials such as steel, concrete and glass, which have negative NDVI values and are displayed as white in Figure 1. NDVI values greater than 0.4 are displayed in Figure 1 as shades of grey, reflecting three different types of urban greenspace – light grey highlighting native tree crowns, darker grey native grasses, while black is associated with highly vigorous vegetation, in particular, irrigated grasses and backyards.

The classification procedure was refined using training areas within the image that reflected a range of different urban land uses and hence vegetation cover. These training areas ranged from industrial sites with very little vegetation though to residential areas and playing fields with irrigated grasses and photosynthetically active vegetation, through to areas of remnant bushland and native tree cover.

The next step was to compare our greenspace layer with the Public Open Space Database that was compiled by ARCUE in 1999 from (Leary and McDonnell, 2001). The database utilised multiple datasets in its construction including information from local park authorities, field surveys, local council records and street directories. The aim was to compare total greenspace (as measured through remote sensing) with that in public ownership (as mapped by ARCUE). Figure 2 shows the datasets, for a demonstration area, that were used to undertake this greenspace comparison. Importantly, the QuickBird imagery is of sufficient detail to allow detection of individual trees.



Figure 2: (a) QuickBird 2.5 m imagery, unclassified, clearly shows urban infrastructure with brighter tones associated with high levels of reflectance in the visible spectrum (such as roofs) and darker areas of vegetation and asphalt surfaces. (b) QuickBird 2.5 m imagery, classified using Normalized Difference Vegetation Index (NDVI). Greyscale is indicative of vegetation cover with white areas non-vegetated and dark areas densely vegetated. (c) Designated Public Open Space as compiled by ARCUE in 1999 (Leary and McDonnell, 2001).

Four Local Government Areas (LGAs) were selected for more detailed comparison – Stonnington, Maribyrnong, Boroondara and Yarra. There were clear differences in the amount of greenspace in each of the LGAs as estimated by the two approaches with the satellite imagery detecting more greenspace than the cadastral method (Figure 3). In the case of Stonnington LGA, there was three times more greenspace detected by QuickBird than open space assigned by ARCUE and in other cases, such as Yarra LGA, only 20% more greenspace was detected. Overall, there was a 30% increase in greenspace estimates using QuickBird as opposed to a cadastral-based methodology.

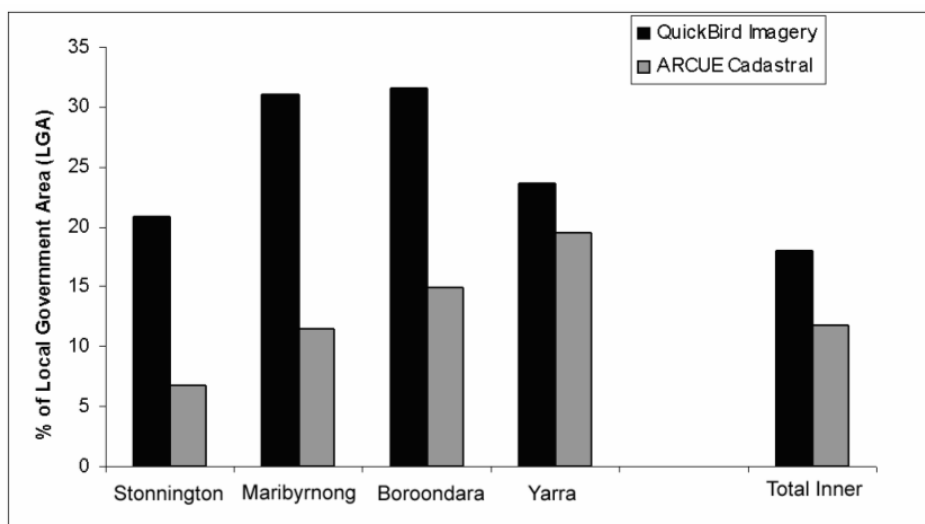


Figure 3: Comparison of total greenspace and public open space for the four LGAs.

If remote sensing data is integrated, or applied in conjunction with, more traditional sources of socioeconomic, administrative, and regulatory data, their potential applicability to both research and policy understanding of the urban environment increases significantly (Miller and Small 2003). For

instance, in the Public Open Space Database, ARCUE have included useful information such as the level of public access to open space into three categories – full access, partially restricted access (such as golf courses and certain school and sporting grounds), through to fully restricted (such as airports or urban water catchments). It is interesting to note that for the area of Melbourne covered by the Public Open Space Database that only 58% of the total area of public open space were listed as full access, a further 13% had restricted access, and the remainder (29%) was fully restricted.

URBAN GREENSPACE AND HUMAN HEALTH

The costs of healthcare in Australia comprise almost 9% of GDP. With an ageing population and increasing incidence of obesity, these costs are set to rise and the most effective way to contain these costs is through greater emphasis on prevention. Understanding the relationship between environment and human health – including mental health – could help to reduce these costs, but so far, research has focussed on the negative impacts of a degraded or polluted environment on health. Yet emerging research is suggesting new health epidemics of asthma, obesity and depression are associated with sprawling urban development and lack of infrastructure (Dannenberg et al. 2003).

In the second phase of the CSIRO scoping study, we conducted a rapid landscape-scale exploration of the relationship between urban greenspace and human health. We chose this broader frame of analysis as our review of the literature revealed that few studies had explored the landscape-scale effect of greenspace on human health outcomes. Most studies took a narrow focus of greenspace, such as views from a window or a specific public park or garden, and were primarily interested in exploring the psychological aspects of greenspace and health from an individual's perspective.

Our approach was to use the greenspace layer developed using QuickBird and to conduct a simple spatial analysis with socio-economic data from the Australian Bureau of Statistics (ABS) and two health datasets – the Victorian Burden of Disease studies (<http://www.health.vic.gov.au>) which shows data at the LGA level and the Social Health Atlas of Australia showing data at SLA level.

The two health datasets provided us with different levels of spatial aggregation, LGA and SLA, and are compiled from different health indices. So far we have undertaken our analysis at the LGA level using data from the Victorian Burden of Disease studies. Our geographic focus was limited by the extent of our QuickBird image, and hence greenspace data, so our focus was again on inner Melbourne and the four following LGAs – Stonnington, Maribyrnong, Boroondara and Yarra.

The Victorian Burden of Disease studies use the disability-adjusted life years (DALY) as a population measure of incident lost years of healthy life due to a wide range of diseases, injuries and selected risk factors. The DALY extends the concept of potential years of life lost due to premature death to include equivalent years of "healthy" life lost by virtue of being in states of ill-health. DALYs for a disease or health condition are calculated as the sum of the years of life lost due to premature mortality in the population and the "years lived with disability" for incident cases of the health condition. For more detail on the use of the DALY as a measure of health impact see Murray and Lopez (1996) and also <http://www.health.vic.gov.au/healthstatus/index.htm>.

The results showed that there was no simple link between greenspace and population health. Maribyrnong LGA, an area with high socio-economic disadvantage also had a high number of lost DALYs, which is not surprising as health is strongly related to socio-economic status. Yet in terms of greenspace, Maribyrnong compares favourably with the other three LGAs, possessing a high amount of total greenspace and an average level of public open space for inner Melbourne (Figure 2). On the other hand, Boroondara LGA, with similar patterns of urban greenspace, is an area with much lower levels of socio-economic disadvantage and better health – low number of lost DALYs.

The broad geographic scale of the health data – local government area – made comparison with the fine resolution socio-economic and greenspace data problematic. While there are plans to continue the analysis using the Social Health Atlas of Victoria which uses data at the smaller SLA level based on the 1995 National Health Survey, it is likely that the mismatch between spatial resolutions of greenspace (fine, 2.5m) and health (coarse, SLA) will again cause problems. We also found that Greenspace was relatively evenly distributed across the Melbourne case study, suggesting comparisons between cities with different distributions of greenspace will be important.

Clearly interconnecting social and economic factors such as education, training, employment, income, diet and nutrition also directly affect human health. The idea that urban greenspace may also play a direct role in human health has not been adequately investigated, with scant empirical evidence to show a direct correlation. A new study being undertaken in Sydney in collaboration with the University of NSW and the Sydney Olympic Park Authority (SOPA) will combine spatial analyses of biophysical variables and human health in urban settings. To get around the issues of coarse scale health data, spatial variability in patterns of human physical activity will be assessed at the individual level with a physical activity survey and structured observation of neighbourhoods, urban parks, and recreational areas. This data will be used to test hypotheses regarding the best predictors of human physical activity in urban environments.

PARKS, PEOPLE AND BIODIVERSITY

Biodiversity conservation in Australia has often been hindered by a lack of understanding about how people actually perceive and relate to biodiversity. Cities provide a good place to study this interaction because they are areas where humans have had a profound influence on biodiversity.

Here we report the preliminary findings of a scoping study undertaken in collaboration with ARCUE where a mail-out survey was distributed to households located around 12 parks in Melbourne (see Table 1). These parks were selected using a stratification process informed by GIS analysis to sample a range of socio-economic contexts (low, medium, high) and biodiversity values (low and high). The survey was distributed to 300 households per park, making a total of 3600 households targeted. With 472 completed forms returned, the response rate was rather low at 8%. Nonetheless, the data provides a rich source of information on community values, knowledge and usage of urban parks. The survey contained 28 questions, but for the purposes of brevity and also given the preliminary nature of our analysis, we only discuss responses to several key questions.

Asking whether survey participants liked having a park near their house was an obvious but necessary question – 93% of respondents said that they did like having the park near their house. When asked whether they visited their local park (maps of the park being referred to, where provided) 86% of respondents said that they did. This figure is similar to the 91% park visitation rate reported by Veal and Dinning (2003) following their telephone survey of 1500 people living in metropolitan Sydney. Common reasons cited for visiting the park included walking for exercise, appreciating nature, watching wildlife, and exercising the dog, as well as walking through on the way to somewhere else. The median amount of time spent in the park was estimated as 30 minutes.

Each of the parks included in the study were classified using a combination of existing datasets and expert opinion as having either a high or low level of biodiversity, and equal numbers of surveys were delivered to each type of site. Of the survey forms returned, 54% were from people living near a park rated as having a high degree of biodiversity, while the remaining 46% were completed by people living near a park with a low level of biodiversity. When survey participants were asked whether they thought their local park had high or low biodiversity, most people agreed with the experts in their estimation. At the sites known to have high biodiversity, 78% of respondents said the level was high and 22% chose low, while across sites known to have a low level of biodiversity,

59% felt that the level was low and 41% thought it was high. The latter result is interesting in that the aim of the study was to examine how people perceive biodiversity compared to what is actually there – suggesting that there may be a tendency for people to overestimate biodiversity values.

Table 1: Stratification results for urban park selection. Socio-economic status was assessed using the ABS SEIFA index of advantage/disadvantage. Biodiversity status was assessed using expert generated species lists.

	Socio-economic Status	Biodiversity Status	Plant Species Richness	Bird Species Richness
Anderson Reserve	M	L	79	15
Ash Reserve	L	L	41	13
Brookville Gardens	H	L	46	13
CH Sullivan Memorial Park	L	H	70	71
Fisher Reserve	M	L	40	7
Foley Reserve	H	L	67	9
Harry Pottage Reserve	M	H	190	74
Kew Billabong	H	H	150	117
Newells Paddock (H*)	H	H	219	67
Newells Paddock (L*)	L	H	as above	as above
Ramu Parade Reserve	L	L	51	18
Steele Creek Reserve	M	H	192	67

* Housing near Newells Paddock was broken into two socio-economic zones, High (H) and Low (L).

To examine further people's knowledge of biodiversity, we asked respondents how many types of birds and plants they thought were in the park, and asked them to name these. Their responses were then compared to species lists generated by experts for each park. Numbers of bird species ranged from 7 to 117, while plant species ranged from 40 to 219 (see Table 1). Given the large numbers of species, the respondents tended to name only a small proportion of those present. Thus for analysis, their level of knowledge was classified into groups of "no knowledge", "less than 5% knowledge", "5 to 10% knowledge", and "more than 10% knowledge". The results are presented in Table 2.

Table 2: Respondents knowledge of biodiversity in the neighbourhood park expressed as a percentage of the number of correct species identified according to species lists generated by experts (plants and birds combined).

	No Knowledge	Less than 5% Knowledge	5-10% Knowledge	More than 10% knowledge
Anderson Reserve	17	16	7	4
Ash Reserve	11	3	8	1
Brookville Gardens	15	3	11	8
CH Sullivan Memorial Park	6	6	3	1
Fisher Reserve	16	4	2	4
Foley Reserve	24	20	14	2
Harry Pottage Reserve	18	35	6	1
Kew Billabong	15	36	9	2
Newells Paddock (H*)	12	24	0	0
Newells Paddock (L*)	8	24	5	0
Ramu Parade Reserve	12	7	5	3
Steele Creek Reserve	20	21	2	1
Total	174	199	72	27

* Housing near Newells Paddock was broken into two socio-economic zones, High (H) and Low (L).

One interesting interpretation is that people don't necessarily need intimate knowledge of biodiversity to either value or appreciate it. More detailed analysis is required to determine whether the social and economic context of the urban neighbourhoods in which parks were located influences the way individuals use, value and relate to biodiversity they contain.

SUMMARY AND FUTURE RESEARCH

This work has shown that remote sensing is a fast, efficient, cost-effective and accurate way of measuring greenspace compared to traditional cadastral or map-based methods. The technique improved the estimation of greenspace by up to three-fold, by not only capturing the public greenspace, such as parks and open space, but also private greenspace such as backyards. We have also shown that private greenspace forms a significant component of the total urban greenspace, the contribution of which has been largely unrecognised and undervalued in urban sustainability debate.

We have successfully demonstrated that new technologies could be applied to health and socio-economic data, providing novel insights across disciplinary boundaries. Yet it also became clearly apparent that unravelling the complex web of social, economic and environmental interactions in cities poses a significant challenge for integrated and interdisciplinary research.

While it is early days for this research, the preliminary results from our exploratory scoping studies are encouraging and highlight some promising areas for further research and analysis.

Through more detailed inquiry into the connection between people and nature in cities, we aim to identify the positive effects of urban greenspace, so that we can design and manage our cities as they continue to grow in size and complexity, for improved human well-being and quality of life.

An innovative new project underway in Sydney in partnership with the University of NSW and the Sydney Olympic Park Authority (SOPA) will pursue this research theme by creatively developing an integrated, spatially-explicit framework and case studies for understanding relationships between urban spatial patterns, biodiversity, and public health in Sydney - Australia's largest urban area.

ACKNOWLEDGEMENTS

Funding for the two scoping studies in Melbourne were provided by CSIRO Social Economic Emerging Science Area and the University of Melbourne–CSIRO Collaborative Research Program. They were led by Guy Barnett in collaboration with Michael Doherty, Nicholas Coops, Anders Siggins, Blair Nancarrow, Elisabeth Bui, Catherine Johnston, Gail Kelly, Carlene Wilson, Wendy Proctor and Russell Goddard from CSIRO and Mark McDonnell and Nick Williams from ARCUE. We thank all of these research participants for stimulating and entertaining discussions and cross disciplinary interaction. We thank the Australian Centre for Urban Ecology (ARCUE) for access to their cadastral open-space GIS layer and Karin Hosking for design of the social survey and analysis.

REFERENCES

Bolitzer, B and Neutshil, N.R. (2000) 'The impact of open-spaces on property values in Portland, Oregon', *Journal of Environmental Management*, 59, pp. 185-193.

Dannenberg, A.L., Jackson, R.J., Frumkin, H., Schieber, R.A., Pratt, M., Kochtitzky, C., and Tilson, H.H. (2003) 'The Impact of community Design and Land-use Choices on Public Health: A Scientific Research Agenda', *American Journal of Public Health*, 93(9), pp. 1500-1508.

Kaplan, R. and Kaplan, S. (1989) *The Experience of Nature: A Psychological Perspective*, Cambridge University Press, Cambridge, New York.

Kuo, F. and Sullivan, W.C. (2001) 'Environment and Crime in the Inner City. Does Vegetation Reduce Crime?' *Environment and Behaviour*, 33(3), pp. 343-366.

Leary, E. and McDonnell, M. (2001) 'Quantifying Public Open Space in Metropolitan Melbourne', *Parks and Leisure*, 4, pp. 34-36.

Luttik, J. (2000) 'The value of trees, water and open-space as reflected by house process in the Netherlands', *Landscape and Urban Planning*, 48, pp. 161-167.

Miller, R.B. and Small, C. (2003) 'Cities from Space: Potential Applications of Remote Sensing in Urban Environmental Research and Policy', *Environmental Science and Policy*, 6, pp. 129-137.

Murray C.J.L. and Lopez A.D. (Eds) (1996) *The Global Burden of Disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020*. Harvard School of Public Health, Harvard.

Newton, P.W. Baum, S. Bhatia, K. Brown, S.K. Cameron, A.S. Foran, B. Grant, T. Mak, S.L. Memmott, P.C. Mitchell, V.G. Neate, K.L. Pears, A. Smith, N. Stimson, R.J. Tucker, S.N. and Yencken, D. (2001) *Human Settlements, Australia State of the Environment Report 2001 (Theme Report)*, CSIRO Publishing on behalf of the Department of the Environment and Heritage, Canberra.

Olmsted, F.L. (1870) *Public Parks and the Enlargement of Towns*. Riverside Press, Cambridge.

Parsons, R. (1991) 'The Potential Influences of Environmental Perception on Human Health', *Journal of Environmental Psychology*, 11, pp. 1-23.

Powell, J.M. (1976) *Environmental Management in Australia. 1788-1914*. Oxford University Press, Melbourne.

Small C. (2001) 'Estimation of Urban Vegetation Abundance by Spectral Mixture Analysis', *International Journal of Remote Sensing*, 22, pp. 1305-1334.

Tennessen, C.M. and Cimprich, B. (1995) 'Views to Nature: Effects on Attention'. *Journal of Environmental Psychology*, 15, pp. 77-85.

Ulrich, R S, Simons, R F, Losito, B D, Fiorito, E, Miles, MA and Zelson, M (1991) 'Stress recovery during exposure to natural and urban environments', *Journal of Environmental Psychology*, 11, pp. 201-230.

Veal, A.J. and Dinning, S. (2003) 'Parks in the City' *State of Australian Cities National Conference 2003*. Carlton Hotel Parramatta, 3-5 December, 2003.

Yencken, D. and Wilkinson, D. (2000) *Resetting the Compass: Australia's Journey Towards Sustainability* CSIRO Publishing, Collingwood.