Shading Liveable Cities: exploring the ecological, financial and regulatory dimensions of the urban tree canopy

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Abstract: Trees are known for their positive impacts in cities including: the provision of shade, reducing heat island effects, improving amenity, reducing social vulnerability, processing carbon and improving health outcomes. Perhaps unsurprisingly, greening policies at the local and state level have proliferated. Despite these initiatives, tree cover remains stubbornly uneven. A cursory analysis of vulnerability and tree-cover by location shows that those who are most vulnerable to extreme heat events (Loughnan et al 2013) often live in those parts of cities that are most poorly shaded (ISF, 2014).

Drawing on a new set of 50 online questionnaire and face-to-face interviews with local council officers in Melbourne conducted in 2014, the aim of this paper is to identify the actors and processes shaping the provision of the urban tree canopy. The results emphasise: i) the wide range of public and private organisations that, in collaboration, provide and maintain tree-cover; ii) the key role of residents within these governance frameworks; iii) the impact of urban development histories on opportunities and limits for urban greening. Theoretically, the paper advances relational models of urban governance in the context of resilient cities showing the urban canopy is the product of diverse actors and agents operating across hybrid and fluid public and private spaces (McGuirk 2012). Recognising this, the paper highlights opportunities for engagement with residents in greening initiatives; and a new integration of ecological and social data through which greening strategies can target those of greatest heat vulnerability.

1. Introduction

Trees are known to have positive impacts in cities in a warming world. In the literature, multiple benefits or 'environmental services' have been noted, including the reduction of heat island effects (Loughnan et al. 2014), enhancement of neighbourhood amenity, property value (Sander et al. 2010), the processing of carbon in the atmosphere and associated contributions to quality of life and health outcomes. These and other benefits (see Wolf, 2004; Young et al. 2014) have seen the proliferation of innovative greening policies including urban forest strategies in Australia, partly designed to counter hot and dry urban spaces with increased canopy cover. Despite these initiatives, tree cover remains uneven so that those who are most vulnerable to extreme heat events often live in those parts of cities that are most poorly shaded.

The relationship between tree cover and vulnerability to heat in Australian cities remains largely unexplored. While there exists a body of literature exploring vulnerability to extreme heat events (Bolitho and Miller, forthcoming; Loughnan et al., 2013), this work is yet to integrate vulnerability with the provision of trees into one data-set (but see Norton et al. 2013). Conversely work charting the coherence of the canopy, while rich in ecological detail and species performance, has not to date explored the relationship between canopy cover and socio-economic variables (e.g. ISF, 2014) These gaps are important in developing policy responses to shade deficits in vulnerable neighbourhoods, especially as heat is increasingly regarded as an everyday hazard (Bolitho and Miller forthcoming). A clearer understanding of the relationship between heat vulnerable populations and tree cover will enable targeting of resources and policy responses.

Developing small area socio-ecological data is an important step in managing canopies and this is the subject of ongoing research. The financial and regulatory contexts underpinning the development and maintenance of the canopy across public and private space is also poorly understood. This is the key focus of this present work.

Urban forests occupy both private and public space (and, in some parts of cities, mostly private space). While the development and maintenance of trees requires financial investment, trees generate social and

economic benefits (Sander et al 2010; Wolf et al. 2013; Young et al. 2014). Accounting for such benefits is important not least because green infrastructure are just one of a range of urban services vying for space such that the place of trees on nature strips, median strips and overhead spaces (such as those occupied by power-lines) is by no means assured. Urban forestry is further complicated by the urban development process, which over time has advanced new expectations about density relative to greenspace, so that 'suburb age' has measurable impact on canopy cover (see Kirkpatrick et al 2007).

The role of residents in the development of the canopy is also important given the significant proportion of canopy found in private space. While resident opinions about trees are certainly mixed (Kirkpatrick et al. 2013), the practices of residents have attracted new attention as a source of everyday resilience (Gibson et al. 2015). Following the literature on socio-natures (e.g. Castree and Braun 2001; Smith 1996), non-human actors such as trees and plants have been seen to exert their own force in human-plant relations, not only shaping practices of home-making (Power 2005) but changing human mood through the generation of biophilia – 'the love of plants'. As a result, traditional models of urban governance that maintain strong distinctions between public and private actors and between human and non-human actors, are arguably ill-equipped to identify the potential of these diverse actors and agents to produce ecologies of shade in a warming world.

Drawing on two new qualitative data sets, this paper aims to advance these themes in two key ways. First, using the results of an online questionnaire completed by 50 local council officers in Melbourne, the paper identifies the existing regulatory and financial systems underpinning the development and maintenance of the urban canopy. Second, through face-to-face interviews, conducted with council officers in five local government areas in Western Melbourne, the paper explores what is happening 'on the ground'. Before exploring these themes in more detail, the paper reviews national and international literature that links canopy cover to socio-economic features and urban resilience.

2. Literature review: patchy canopies, leafy politics

Interest in the relationship between canopy cover and socio-economic difference in and through urban space has flourished in North America (Heynen 2003; Heynen, Perkins and Roy 2006) and Australia (Kendal et al. 2012; Kirkpatrick et al. 2011). Researchers working in North American especially have explored how and why vulnerable populations in particular urban spaces disproportionately lack tree and green space provision. Such explorations lead to the framing of canopy cover as an issue of environmental justice (Heynen, Perkins and Roy 2006; Wolch et al. 2014). This is particularly true for scholars who have come to environmental concerns via attentiveness to wider questions of injustice and exploitation as they are produced in (not only) urban spaces. As Heynen, Perkins and Roy (2006) argue, in relation to urbanisation and nature more broadly, that:

> What remains for scholars working within the context of Marxist urban-political ecology is making the links between capitalist processes and the injustices of uneven urban ecologies more explicit (Heynen, Kaika and Swynedouw 2006).

In urban political ecology a production and consumption approach is favoured. In such analyses, the canopy is produced (distributed) across both public and private space and 'consumed' by urban residents.

Using this approach, Nick Heynen, Harold Perkins and Parama Roy (2006) explore the 'inequitable distribution of urban trees' in the city of Milwaukee, US, at the scale of the neighbourhood census tract. Household income, housing inequality, as well as racial and ethnic inequality were found to be compounded by environmental inequality in the form of low canopy cover (Heynen, Perkins and Roy 2006). Poorer households (in terms of median household income), the housing-market vulnerable (those in rentership), and African-American and non-White Hispanic groupings suffer disproportionately from low canopy cover in Milwaukee (Heynen, Perkins and Roy 2006). In their discussion the authors show how canopy 'production' includes both 'where trees are planted and/ or allowed to grow', highlighting collaborations across public-sector actors including the Forestry Department, local government and not-for-profit organisations, and private actors including tenants, landlords and aborists (Heynen, Perkins and Roy, 2006). Key processes adversely affecting tree canopy cover in areas where it is most needed include: financial disinvestment; high population density and low household incomes; not-for-profit canopy

increase work as a practice of middle-class White residents; and the removal of 'volunteering' (self-seeding) trees due to real or feared property damage (Heynen, Perkins and Roy 2006)

Spatial uneveness and injustice is also raised in a study of Hangzhou, an exceptional and celebrated 'Garden City' in China (Wolch et al. 2014). In this case, explicit policy to ameliorate uneven access to green space in this city was attempted. The study concluded such strategies can have unintended effects on poor residents through increased property prices near retrofitted green space. While a study of 'green space' rather than canopy cover, this research shows that attempts to benefit urban residents most in need 'can lead to […] a displacement of the very residents the green space strategies were designed to benefit' (Wolch et al. 2014, 234).

Returning to tree canopy specifically and the Australian context, similar dynamics are observed, though the emphasis has largely been on linking trees to one or more socio-economic variables, rather than explicitly addressing questions of environmental injustice. In their comprehensive study of six eastern Australian cities at the scale of city suburbs within Local Government Areas, Kirkpatrick, Daniels and Davison (2011) found that:

> increasing levels of both income and education between 1961 and 2006 have been accompanied by a general increase in both the frequency and density of [private space] trees. (Kirkpatrick et al. 2011, 49).

Street trees, in contrast, were found to be affected by 'cultural differences between times and cities that were expressed through the action or inaction of local government [in planting and removing street trees]' (Kirkpatrick et al. 2011, 49). In areas with higher median household income, street tree canopy cover was also higher, however the authors caution that:

> given the socio-economic heterogeneity of most LGAs [this] may reflect pressure from ratepayers to plant more street trees in richer suburbs and pressure not to plant trees, or to remove them, in poorer suburbs (Kirkpatrick et al. 2011, 50).

Although an anecdotal example is given for the latter (that of Midway Point, Hobart), no details regarding the basis for requested tree removal or tree vandalism is given. In a study of the drivers of diversity and tree cover in Ballarat, Victoria, conducted at census collection districts within suburbs, Kendal et al. (2012) similarly found a strong relationship between education level and tree cover. Like Kirkpatrick et al, these findings 'are consistent with the idea that unequal power relationships between the community and local government can lead to an increased public investment in public landscapes in more advantaged areas' (Kendal et al. 2012).

Resilience: to what, for whom?

These studies raise critical questions about the uneven capacities of different groups to achieve urban resilience in a warming world. While resilience-based research is concerned with the ability of complex systems to adapt to uncertain circumstances (Davoudi 2012), scholars have nonetheless questioned the assumption that socially diverse groups are equally positioned to act within complex systems (Miller et al 2010; Davoudi 2012). As Porter and Davoudi (2012) ask *'resilience to what for whom'?* Although socio-ecological thinking is at the centre of resilience-based research, urban development processes are often at odds with the ecological risks and impacts in which such development occurs (Davis 1995). Taking a non-anthropocentric approach to cities challenges 20th century notions of comfort based on private fossil fuel transport and greenhouse gas emitting cooling and warming.

Social vulnerability and ecological thinking needs to be a core component of policies and practices gathered under the rubric of urban planning towards resilience. However critical geographical work cautions against the assumption that residents do not, or cannot also engage in practices of survival and resilience. Drawing attention to the household scale, such work locates the resources for resilient cities in the everyday practices of home maintenance, neighbouhood care and dwelling (Gibson et al. 2015; Fincher et al 2015; Driscoll and Derickson 2015). Such interactions can have lasting effects, producing lay knowledges of climate change (Brace and Geoghegan 2010). Moreover, research at the interface of human and non-human interactions shows that trees can cultivate positive attitudes and capacities amongst residents – expressed as biophilia. Thus while vulnerability shapes adaptive capacities, resident-plant relations also appear to be an important vector through which to advance community resilience.

These literatures then, highlight the uneven ways in which people experience canopy shading, but also foreground the potential for residents, local government and other actors to collaborate in canopy development and care. In challenging traditional assumptions about the relationship between states and residents, humans and non-humans, canopy governance appears to be a relational achievement, not unlike carbon governance more broadly (McGuirk et al 2014) Drawing on analysis of questionnaire and interview data with council officers in Melbourne, we offer an initial exploration of the governance contexts in which greening occurs within Melbourne.

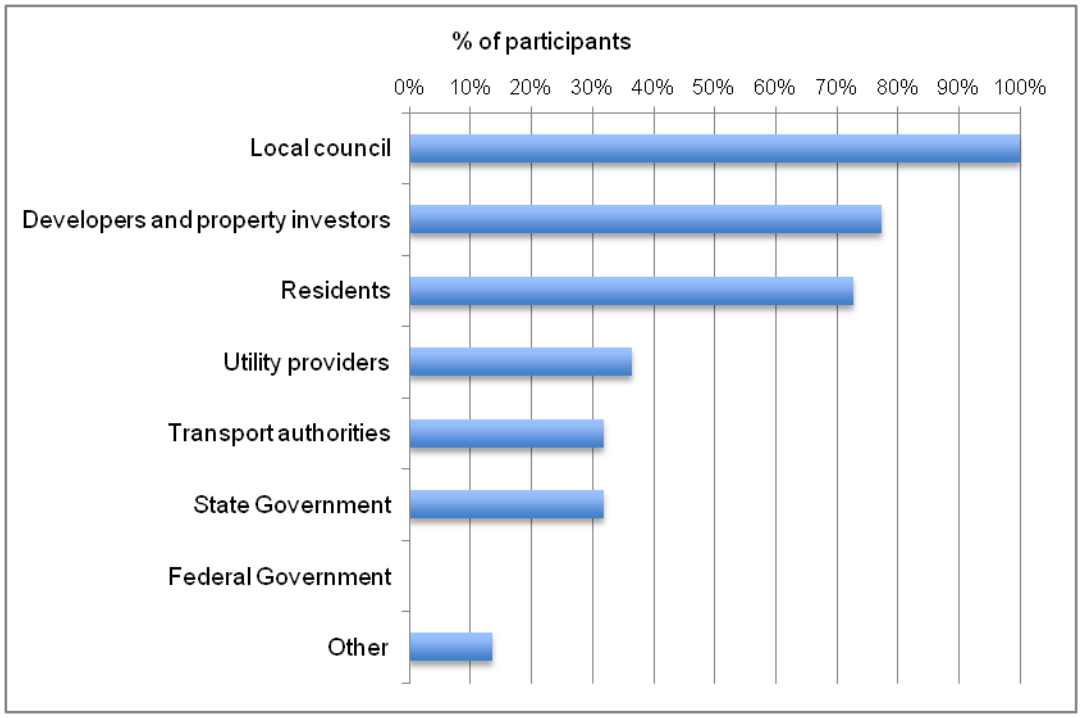
3. Governing the urban tree canopy

The argument for increasing tree cover reflects growing consensus about the environmental and health outcomes of greening. However, the practice of developing and maintaining the urban forest occurs through the combined actions of many organisations and individuals across public and private space in situated practice. In order to better understand the local contexts in which tree canopies are developed and managed, this part of the paper draws on the views of 50 local council officers who participated in an online questionnaire as part of the *Shading Liveable Cities* project[1]. The questionnaire was promoted through *Greening the West*[2] and includes responses from council officers working in 13 different local government areas in Melbourne. The questionnaire was designed to establish more clearly the roles and responsibilities of diverse actors in the provision and maintenance of the canopy; and the regulations and policies underpinning greening. In order to consider geographical location and area of professional expertise, direct quotations are attributed to the council in which participants worked. No respondents are named, and position titles have been removed.

In order to gain a sense of who is most involved in developing and maintaining the urban canopy, participants were asked to identify the 'key people' involved in the provision of trees in their jurisdiction. Multiple responses were permitted and, as shown in Figure 2, all participants in this question nominated local councils as playing a key role (44/44). Still, over three-quarters of respondents (34/44) identified developers (25/44) or property investors (9/44) showing the significance of the commercial sector; and seven in ten respondents nominated residents. A smaller proportion nominated utility providers (16/44) and transport authorities (14/44). Nearly a third of all respondents recognised the State Government as playing a key role (14/44), while no one felt the Federal Government played a role (0/44). Six participants specified other groups who played a key role, including contractors (1/6) and 'friends of' groups (2/6). Overall, these data suggest that the provision and maintenance of the urban forest involves a range of players with councils, developers and residents all involved.

[1] *Shading LIveable Cities* is funded by The University of Melbourne Carlton Connect Initiative 2014-2015.
[2]Greening the West is led by CityWest Water: initiative (http://healthyurbanhabitat.com.au/wp-content/uploads/2013/11/GTW_Strategic_Plan_web.pdf

Figure 1: Key people involved in the provision and maintenance of the urban forest



Second, in order to better understand the financial relationships through which such greening occurs, we asked *'what are the financial considerations of your organization regarding trees?'* . As shown in Figure 2, most participants (27/37) reported the different financial costs incurred by councils: these were not limited to the cost of buying trees but include labour to plant, repair and maintain trees and compliance costs. Second, around a third of respondents observed the uncertainty of funding highlighting the potential for budget cuts and limits for key aspects of canopy development such as planting. Third, participants identified *potential* financial considerations, including that trees be valued for their 'monetary asset value'; that they be incorporated into local government carbon accounting strategies; or that stricter penalities apply for removal. While comprising a smaller set of somewhat speculative responses, these additional suggestions highlight the broad assumption that the urban canopy is a cost, rather than an asset through which social and economic benefit can be gained.

Figure 2: The financial considerations of local councils regarding trees

	n (%)
I) Costs to councils	27/47 (57)
ii) Funding context- limits and uncertainties	14/47 (30)
'Limited yearly budget for tree planting, not adequate to address much lower canopy cover compared with other parts of the city' (Urban Design, Council not stated).	
'Once the Urban Forest Strategy was endorsed, it received funding for implementation for the first year. I think this was considerably reduced for the second year' (Landscape, Darebin).	
iii) Other financial considerations	6/47 (13)
'Biodiversity Incentive program plants trees to offset carbon emissions from fleet' (Environment, Yarra Ranges Council)	
'Not according trees a monetary asset value' (Urban Design, Brimbank)	
'Developers are fined for removal or destruction of council street trees' (Planning, Darebin).	

Finally, to gain a clearer understanding of the regulatory framework, participants were asked *'what are the relevant regulatory frameworks?'* and *'are different people responsible for different types of trees in your area or jurisdiction?* Responses to these questions pointed to the key role of the Local Planning Scheme (LPS) in connecting a number of State-wide planning instruments relevant to tree removal and maintenance – such as zones and overlays – to specific units of land within a given municipality. Many zones and overlays contain controls over particular activities and objects within those boundaries – setting out prohibited and restricted uses, along with landuses and landuse practices that require permit applications. While the LPS sets the broad planning framework for the municipality, in most urban areas, most of the time, private land is excluded (the exception being when a development is proposed, or for a small number of significant species).

Among participants, the Vegetation Protection Overlay, Environmental Significance Overlay, Heritage Overlay, and Significant Landscape Overlay (each containing controls over plant removal) had been applied to only some parts of municipalities, to only some types of native trees only and often only in non-urban areas. As summed up by one Open Space Co-ordinator (Hume): 'There is little or no protection for private trees nor public trees other than for native vegetation on larger parcels' (Open Space Co-ordinator, Hume). The LPS also includes discretionary controls where, for instance, the retention of trees, and the provision of a landscape concept plan with a development application is encouraged (Planning, Darbein). In addition to regulations and discretionary controls are local councils' own greening targets, set out in policies with timeframes, budgets and assessment processes.

In contrast to the discretionary nature of planning controls in relation to greening, the canopy itself is highly regulated relative to any intrusion it may make on other urban services. As summed up by one participant: 'there is too much going *against their planting* in terms of rules about setbacks from roads, clearance of assets, blocking of CCTV cameras etc.' (Urban Design, Council not specified). Powerline clearance was commonly mentioned, applying to trees on both public and private property.

Overall the results suggest that the provision of the tree canopy depends on a wide range of actors. Despite the significance of the urban canopy to urban resilience in a warming world, only a small proportion of trees are, and can be, 'protected'. Still, the argument for stronger controls appears to be limited as long as the value of trees remains hidden: they are almost exclusively seen as 'costs' or 'write-offs'. Participant responses show an emerging interest in making the benefits of trees calculable, thus positioning the canopy as a core asset and important object of urban governance. Notably, the integrity of the urban forest also hinges on the activities of private landowners and residents on whose beliefs and behaviours much of the canopy depends. Whether and how local councils are positioned to champion urban greening across different stakeholder groups is by no means clear and, through an engagement with five councils 'on the ground' in Western Melbourne, we turn to this question next.

4. Local government and canopy cover in Western Melbourne

Melbourne has 13% canopy cover overall, which is, according to a national report, the lowest canopy cover of all Australian State capitals (ISF 2014). For the five Western Melbourne LGAs for which our study collected interview data four were recorded as being in the 0.0-9.9% canopy cover (Hume, Brimbank, Hobsons Bay and Melton), while the fifth (Moonee Valley) was recorded in the next highest percentile band of 10.0 to 19.9. Despite these rankings, numerous opportunities for greening exist in Western Melbourne. In this section we first explore council greening in urban renewal and development processes before focusing in more detail on council engagement with residents and neighbourhoods that in particular may be expected to experience higher levels of vulnerability to heat.

Greening through planning and development

Public space greening comprises a core component of Western Melbourne city councils' development of the urban forest. Annual street tree planting in new streets, as well as 'gap' or 'infill' planting in established streets, are in the order of 2-5000 trees per annum in each of the five councils. Councils are increasingly adopting whole-of-city and canopy-minded approaches through the development of Urban Forest Strategies, tree audits and tree registers. This leads to detailed accounting and management from the scale of the urban forest, through precinct, suburb, neighbourhood, street and down to individual trees. Financial incentives in terms of external funding schemes for councils seem relatively few, but

include: the (Melbourne Water) Living Rivers Program, the (State Government) Ten Thousand Trees initiative, and the (Federal Government) Healthy Together Program.

Particular attention is also paid by councils to public space greening inherited from greenfield and brownfield developers. In growth areas such as Melton, developers near to match the numbers of trees planted by city councils. Councils have various policies and processes for managing the 'handover' of greenfield estate development, especially around street trees, open space, and 'features' (such as stormwater treatment areas). Hume has a sophisticated multi-stage process and bond system, whereby the bond is retained by council if 'green assets' are not handed over in the good condition required. In Melton, council and developers explicitly share knowledge about which tree species will be optimal for the area prior to development taking place. For the non-growth area councils the issues that arise are less those associated with large greenfield developers, and more those associated with developers of comparatively smaller areas.

Despite these opportunities for greening, almost without exception councils were concerned about the loss of trees in private space due to subdivision and infill development, recognising this as a difficult issue due to private property rights and the drive to greater urban density. One council officer (Moonee Valley City Council) noted possible equity effects of any future tree protection overlay for the city. She suggested that residents' plans to sub-divide larger blocks (to build an additional dwelling, in the process often removing trees) were sometimes 'their [sole] retirement plan'. In this and other councils' discussion of possible tree protection overlays, officers reflected that their LGAs were less able to 'afford' such a mechanism – when compared to wealthier Bayside LGAs – and that it would be prohibitively unpopular among residents. In the growth area of Melton, council officers also reflected on a general national (urban Australian) tendency to build larger houses on smaller blocks thereby negatively affecting existing canopy or space for future canopy trees.

Interviews nonetheless identified opportunities within councils to work collaboratively on greening with other Departments. For instance, one participant who humourously referred to those like himself working in Parks and Gardens or Open Space as 'tree people', felt there were opportunities for more engagement with their community development or public health colleagues, i.e. those concerned with heat vulnerable populations.

Council-resident engagement

Councils are attempting to encourage biophillia amongst residents in numerous ways, including Adopt-a-Tree programs or Significant Tree Registers (which may include both remnant native and non-native tree species). Officers are vocal tree champions, and often engage in incidental education of residents as to the significant positive effects of trees. They also resist resident requests to remove trees. Councils generally have strict policy on the reasons why a tree might be removed – usually limited to direct endangerment of life or property. As one interviewee put it, "the days of the mantra 'if in doubt, pull it out' are long gone".

Perhaps as a result of this, the nature strip emerges as a space of contestation not only between council and resident (over issues of ownership, control, care and maintenance) but also as the contact zone between public and private greening. Nature strips are not private property (not owned by residents), but councils expect and encourage residents to maintain these spaces. In addition, some councils actively encourage residents to look after their street tree within the nature strip. For example, the City of Hume reported dropping off a watering bucket and explanatory note, and Moonee Valley letter boxes a card to the resident. This encouragement often relates to opportunistic watering, and reporting disease, pest or vandal attack.

Interviewees were less likely to report on projects that had *explicitly* engaged or targeted heat vulnerable communities. Two exceptions were greening by the City of Hume of a low income area with a high concentration of public housing, and in Hobsons Bay, where plans for additional street tree planting have targeted a poorer and more culturally diverse suburb to aid local pedestrian mobility or 'walkability'. More broadly, this study found that the approach taken by local government to the question of canopy distribution was to work towards greater overall canopy cover in all ways possible. Participants were

highly attuned to *canopy need* but perhaps less likely to explicitly connect greening to social need. Significant attention was paid for instance, to 'value-adding [trees]' through existing planning or development projects including park upgrades, storm water treatment developments, new recreational, commercial, road or green space developments. Brimbank Open Space, for example, had used 'linear park' walking and cycleway developments to plant trees, and discussed tree planting in park upgrades that were simultaneously sensitive to providing new vectors of access to these parks (which doubled as connective tissue between residential areas). This integrated and opportunistic approach to canopy increase, in addition to ongoing street tree planting regimes, was evident to different degrees across all five interviewed councils.

5. Conclusions

Western Melbourne local government areas are over-represented in low national quintiles for canopy cover; they comprise socially diverse neighbourhoods and are characterised by rapid urban development, brownfield development and urban intensification. They therefore provide an apposite site through which to explore opportunities and projects for greening in an urban context, as well as to observe and advance models of governance and urban resilience. Critically, the rankings of LGA by tree cover conceal the greening opportunities that emerge through collaborative partnerships, programs and strategies comprising state, developer, council and resident networks. Through online questionnaire and interview data, this paper has explored the interaction of these agents in the provision of trees supporting urban canopy. We conclude by highlighting three opportunities through which canopy could be advanced.

First, while greening often follows existing urban renewal plans the canopy is mostly governed independently of the social context. Opportunities for greening are tied to existing plans for urban renewal or development. Whether and how such planting addresses vulnerability to heat in diverse suburbs is not well established. Developing an integrated data set combining ecological data and human vulnerability, as well as economic and other social benefits, would allow councils to further target their strategies and efforts with communities in most need. Data calculating the benefits of greening may also help centralise a perception of the canopy as a core asset to councils. An important side effect of integrating social and ecological data is the development of knowledge that unsettles anthropocentric thinking. This way of thinking would be better attuned to the ecological and health services that trees provide as non-human lifeforms to both human and non-human lifeforms.

Second, there appears some opportunity for collaboration across council departments. That is, for 'tree people' (as one respondent described himself) to work more closely with health and social planning officers to leverage shade into vulnerable neighbourhoods. Recognising the effects of GIS and visualisation methods in advancing knowledge and new policy formation, such collaboration may prove key to enabling cross-departmental experimentation that advances adaptive capacities through local government.

Finally, there is a latent capacity to build on community engagement and relations not only in Melbourne's West, but in all vulnerable neighbourhoods. Adopting a focus that recognises the capacity of trees to animate human feelings and emotions, greening projects targeting vulnerable neighbourhoods that facilitate and enable human-plant engagement may go some way to materially and politically advance urban resilience in a warming world. Assessing the impacts of such projects may well invite methods that move beyond the questionnaire/ interview format that we have used in this initial data sweep, embracing affective atmospheres and embodied approaches attuned to the micro-politics of everyday life.

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