COMMUNITY AWARENESS OF GREEN ROOFS IN SYDNEY

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Abstract

There are environmental, economic and social benefits of installing green roofs on city buildings. The environmental benefits are lower building related operational carbon emissions, reductions in the urban heat island, increases in bio-diversity and reductions in storm-water run-off. Economically, the benefits are reduced roof maintenance costs, lower running costs, higher capital and rental values for commercial buildings. Finally the social or community gains are the creation of aesthetically pleasing spaces, landmarks and cultural capital as well as provision of recreational spaces. Furthermore social, psychological and therapeutic gains accrue when the roof is visible to people and is used for social interaction and leisure activities. The perceived drawbacks are perceived greater risk of building leaks, high costs of installation and maintenance, and access and security issues.

Whilst the technology to design and install green roofs has existed for hundreds of years the uptake and the demand for green roofs has been affected by poor understanding and a lack of data. Overall, the environmental social and economic gains are not perceived sufficient to create significant demand to set up green roofs. In Sydney Australia, the existing number of green roofs is testimony to this observation. With the aim of addressing the barriers to the uptake of green roofs; it is essential to understand the way in which the key stakeholders; here the community, perceive the technology. With this knowledge it is then feasible to develop an agenda to mitigate any erroneous perceptions that exists. This research reports on a survey with the Sydney community to determine their perceptions of green roofs. Adopting a qualitative methodology using questionnaire surveys, this paper aims to evaluate community perceptions and views in the City of Sydney with regards to green roofs. The findings with regards to social, economic and environmental sustainability will inform the City of Sydney's policymaking and support of green roofs in the city.

Keywords: *Green roofs, Sydney, community, community engagement.*

Introduction

There is increased and increasing densification of our urban settlements globally (Brand, 2011). In some cities, in developing countries the pace of urbanisation is so rapid, that it puts pressure on existing infrastructure such as sewer systems, transportation networks

and provisions of open space for residents (Brand, 2011). Developed countries also face pressure in increasing urban density; Australia for example is one of the most urbanised societies globally with 89% of its population residing in cities, and 40% living in just two cities (ABS, 2014. DIRD, 2014). In Sydney the amount of green space is less than 22 metres per resident and the urban canopy covers only 15% of the city area (Greening our City, 2013). This lack of urban green space leads to a number of unwanted outcomes which include, increasing the urban heat island effect, reductions in urban bio-diversity and increases in pluvial run-off and flash flooding (Lamond et al, 2014). In addition there is less recreational space for residents to enjoy and relax in (Skinner 2006). This lack of recreational space leads to disconnection with nature which can be detrimental to human psychological and physical health as well as a lack of understanding of and empathy with wider global environmental issues facing mankind (Castleton, 2010).

Roofs can represent up to 32% of the horizontal surface of urban settlements (Frazer, 2005), and herein lies potential to create green spaces in places not typically used such as horizontal gardens on rooftops. These green roofs could provide much needed recreational space for urban dwellers. What are community views and perceptions towards the adoption of green roofs? This paper explores community perceptions towards this technology in Sydney Australia using a qualitative approach and questionnaire survey.

In 2014 the City of Sydney adopted the first green roofs and walls policy for Australia, which sets out a commitment to increase the number of high quality green roofs and walls in the City (City of Sydney, 2014). The policy includes a 3-year implementation plan to ensure the policy is understood, properly adopted and integrated. There are 59 green roofs in Sydney currently (City of Sydney 2014), 62.7% of which have no public access.

There is a growing body of research extolling the benefits or otherwise of specifying new or retrofitting green roofs. However much of the empirical research has been undertaken in cities outside of Australia, particularly in the northern hemisphere which has quite different climatic conditions. This research addresses the question; *what is the community awareness and perceptions of green roofs and green in the Sydney CBD*? The objective is to identify the gaps in knowledge for the city and to establish a research agenda to close the knowledge gaps.

Green Roof Attributes

There are numerous environmental, economic and social benefits of installing green roofs on city buildings (Wilkinson and Reed, 2009). Often these benefits co-exist regardless of the primary goal of the designer, so for example a roof which is intended to improve thermal performance by providing an additional layer of insulation will also attract some biodiversity (Williams et al, 2010). The environmental benefits include lowering building related operational carbon emissions through improved thermal performance, which includes cooling in summer and heating in winter (Castleton, 2010). If sufficient green roofs were specified it is posited that they would reduce the urban heat island, whereby city centres are a few degrees hotter than outer suburban and rural areas due to trapping of solar energy by urban surfaces. In this instance the green roofs can reduce sensible heat flux through evapotranspiration (Santamouris, 2012). The increase in planting in cities will attract insects and birds. This increase in faunal biodiversity in turn will help pollinate the flora, which absorbs carbon dioxide and emits oxygen thereby increasing air quality (Castleton, 2010: 62). Getter and Rowe (2009)

calculated that if the city of Detroit (USA) greened 15,000 hectares of rooftop, over 55,000 tonnes of carbon could be sequestered. It is possible that wide scale retrofit of existing buildings with green roofs could help to deliver zero carbon goals. Finally green roofs can absorb rainfall, improve the quality of stormwater runoff and reduce the quantity of runoff into sewer systems (Mentens, 2006; Hilten, 2008). It is considered that if specified widely, the installation of mass green roof technology could mitigate pluvial flooding in some cities and research is currently underway to model this potential (Wilkinson et al, 2014).

Economically, the benefits of green roofs are reduced roof maintenance costs, lower running costs and higher capital and rental values for commercial buildings (Wilkinson et al, 2013). The membrane, which is the waterproof component of the roof is protected in green roofs by the substrate and planting. The life of the membrane is extended by estimates of as much as 100%, therefore a bituminous felt roof may last for 50 years in the northern hemisphere compared to 25 years without a green roof (Kohler, 2008:91). Lower building operating costs are achieved because the improved thermal performance of the roof results in lower energy consumption. In hot climates green roof technology can reduce the heat load by absorbing heat and reducing the amount of heat entering the building (Castleton, 2010:62), though it is acknowledged that white roofs or cool roofs are the most cost effective way of reducing heat load through rooftops (Hes et al, 2012). Fuerst and McAllister (2011a, 2011b) conducted a study in Europe and the US which found that sustainable commercial buildings had higher capital values as well as higher rental values. Newell et al (2013) replicated the study in Australia and made similar conclusions about the positive effect of sustainability features on commercial property.

The social or community gains are the creation of aesthetically pleasing spaces, landmarks and cultural capital as well as provision of recreational spaces. Furthermore social, psychological and therapeutic gains accrue when the roof is visible to people and is used for social interaction and leisure activities. The perceived drawbacks are perceived greater risk of building leaks, high costs of installation and maintenance, and access and security issues. Access to recreation space, including green rooftops, has the potential to create healthier communities psychologically (Wilkinson et al, 2013). Green roofs provide access to outside space where city dwellers and workers are increasingly detached from nature. Kellert and Wilson (1993) stated that people have a deep need for 'regular contact with the natural environment for continued wellbeing' and detachment contributes to rising anxiety and frustration (Shepard, 1982). Having access to outside space on roofs and/or engaging in rooftop gardening involves taking up an inspiring, 'ecological and productive activity, and developing new links with the food chain, the seasons, the environment and the community' (Germain, 2008). A further social benefit of rooftop agriculture may be community programmes where residents engage in food production, for example Eagle Street Rooftop Farm in Brooklyn New York (Rooftop Farms, 2013).

Green roofs in Sydney

Sydney is located in a temperate climatic zone with rainfall spread throughout the year. Annual meteorological data for 2012, showed 1213.6mm of rainfall, a mean maximum temperature of 22.7°C and a mean minimum of 14.4°C(BoM, 2013).Sydney's annual average of sunshine is almost seven hours a day (City of Sydney, 2012). Sydney's rainfall averages 11 wet days per month, with over 40% falling between March and June. Generally these climatic conditions are favourable for growing plants and vegetables. To date most empirical data about the performance of green roofs comes from examples in

Europe and North America (Wilkinson et al, 2013). Furthermore some European and Canadian jurisdictions have mandated green roofs in their development plans to require developers to specify green roofs. As a result the number and area of green roofs in these cities far outweighs current provision in Sydney and there is a need to ascertain what the community awareness and perceptions of green roofs are.

Methodology

This was a qualitative research study adopting the characteristics of an inductive, holistic and naturalistic approach as advocated by Silverman (1997), seeking to establish the opinions of the research population (Naoum, 2003: 38-43). Time, finance and physical distance precluded the use of interview data collection and therefore a combination of online and face to face questionnaire surveys was adopted as a means of collecting information. The questionnaire was designed using best practice methods (Moser and Kalton, 2002; Robson, 2011) and comprised seven sections. Survey items were generated through a combination of direct consultation with research panels, and expert advice, both from the City of Sydney project team and other independent parties involved in building development in the City of Sydney Local Government Authority (LGA). The survey had to be brief enough to facilitate rapid completion but detailed enough to cover the key concepts. The survey included respondents awareness, need evaluation / environmental priority assessment, perception of environmental benefits, level of support of green roof concepts, price sensitivity, funding options/alternatives, demographic and background items and finally an opportunity to make an open ended commentary. This paper reports on demographic data and awareness and perceptions only. The questionnaire was designed to provide descriptive, bi-variate and inferential statistical data for analysis using SPSS software.

Two survey methods were used to collect data; a self-completion online survey and a face to face survey executed as a street intercept survey of random respondents. Street intercept surveys occurred at locations around the City of Sydney LGA. The online survey was accessible from the City of Sydney website and was promoted on the website, in email newsgroups, and a large number of emails were also sent as invitations to improve participation in the survey via a URL link. The street intercept survey aimed to ensure suitable participation from City of Sydney residents rather than just those working or visiting the CBD, or those accessing the web link. This survey ensured that a suitable number of responses were not through self-selection which is the case with all online/email surveys. A team of at least two interviewers attended each location and randomly approached people in the street. Interviewers were trained on the survey and the concept of green roofs so that they could execute the survey effectively. Interviewers were assigned different locations around the city and different survey sessions covering different days, day parts (morning, early afternoon and late afternoon). The main locations that were used for the survey were Glebe, Newtown, Central Sydney CBD, Surry Hills and Woollomoloo.

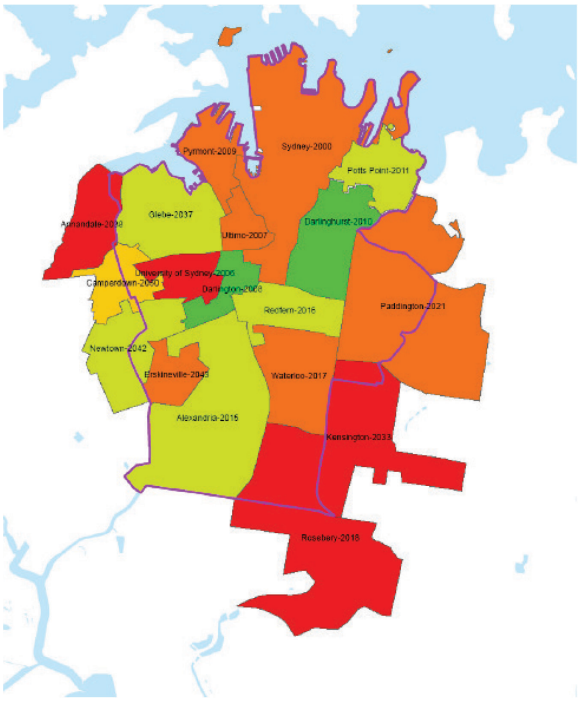

Figure 1 City of Sydney Local Government Area (LGA).

Results and interpretation

416 surveys were completed, see table 1 for a break-down of characteristics. 193 respondents (46.40%) were male and 218 or 53.60% were female; a reasonably even distribution of gender. In terms of residency, 244 respondents (58.65%) were City of Sydney residents and 172 or 41.35% were non-residents.

The total maximum error margin (at the 95% confidence interval) based on this sample is approximately ±5%. This means that we can be confident 95% of the time that the proportional survey results are within 5% of the true population value for results. This makes the assumption that the sample is representative of the target groups and that the distribution on items is approximately normal. The error margin can be considered in several ways when assessing the sample, as a total or as subgroups of data, depending on the level of analysis in question. As subgroups have smaller samples the error margins are larger. Table 1 shows the ranges of error margins. Significance testing takes into account error margins depending on the contrast being examined.

Table 1 Sample Characteristics

Sample Grouping	Sample Range	Approx. Max Error Margin
Total Sample	416	±5%
Gender	193M/218F	±7%
Age Groups	n=20, up to n=132 (26-35 yo)	±22% to ±8.5%
Residential Location	244 COS Residents, 172 Non- Residents	±6.3% to ±7.5%

The sample is reasonably close to the expected fifty per cent split between males and females. Generally, females, particularly older females are more responsive to surveys in most market research methods and it is commonly found that they are slightly overrepresented in data sets unless quotas are enforced. The face to face component had the effect of correcting the online sample which was slightly pro male. This final difference of ±3% is not sufficiently large to justify weighting of data by gender. The age profile is distributed around a median age group of 36-45 years, with the most populous age group being aged 26-35 (see figure 2).When the age profile in the sample is compared to the full City of Sydney LGA, from the 2011 census, the profiles are similar, with some under representation in the sample survey of those under 35, and over-representation of those over 35 years of age. Overall it is a reasonably similar age curve. The sample is likely to be more representative of a 'CBD working age population' than LGA residents per se.

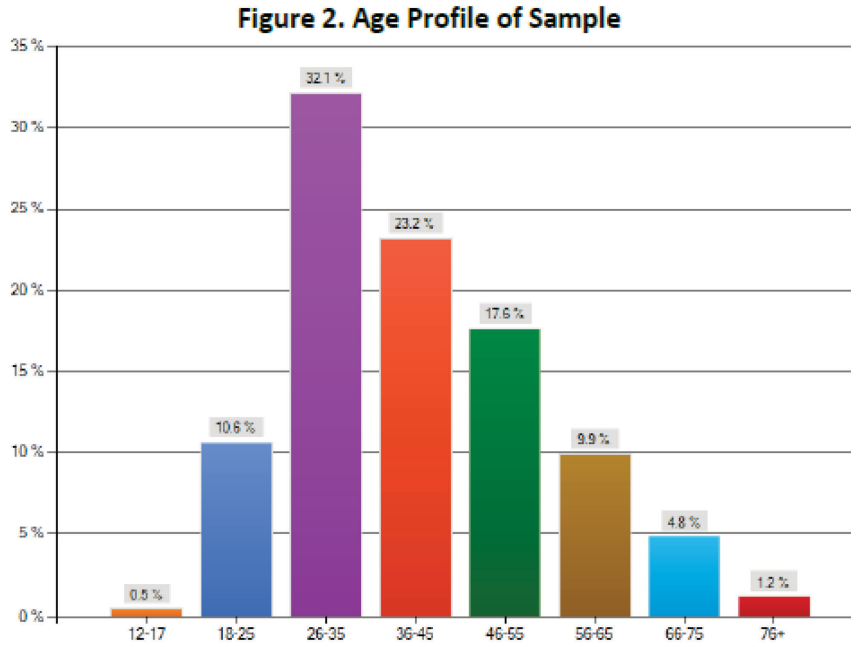

Figure 2 Age profile of survey respondents

The income levels of the sample is shown in figure 3 and reveal that respondents are well paid compared to the median City of Sydney resident. For example the proportion of City of Sydney LGA residents earning greater than $80,000 per annum is around 23%, however in this sample it is almost half the respondents. As surveys were conducted during working hours it is more likely respondents were employed than unemployed. Furthermore the respondents had high levels of education which is positively correlated with income levels. In the sample 79% were degree educated compared to 33% in the LGA.

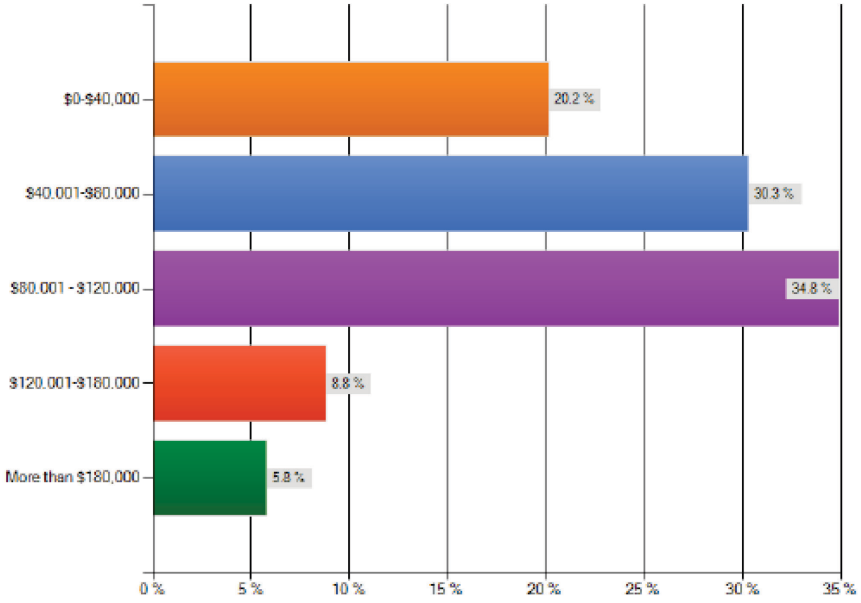

Figure 3 income levels of survey respondents

Awareness

Three visual representations of green roofs were shown to respondents so that they could unambiguously see the concept being assessed. They were then asked which of five statements best described their understanding of green roofs. Responses are set out in table 2. Overall self-reported familiarity is high. Those either working in the area or having a strong understanding were more likely to be male than female. There is limited knowledge and awareness in around a third of the sample (33.8%) who expressed either no knowledge (10.4%) or having 'seen something' (23.4%) about green roofs. Finally 28.7% described having a general knowledge and interest in green roofs.

Table 2 Green Roof Awareness

Best description of respondents' understanding	Proportion of responses
No awareness prior to survey	10.4%
Seen or read something about green roofs	23.4%
General understanding	28.7%
Strong interest in the concept	31.2%
Working in an area involving green roofs	6.3%

Where gender is concerned women expressed less understanding of green roofs than males, although only marginally, where 61.8% of males stated either a general understanding or a strong interest in GR compared to 58.2% of females. In terms of age, the oldest and youngest age groups displayed least awareness. Those aged 46 years plus ranked highest followed by the 26-35 years old age group. The lowest understanding of GR on age was found in the 18-25 year old age group. Interestingly those surveyed in the intercept surveys expressed lower levels of understanding than those who completed the surveys online. Perhaps people feel less able to give an impression of knowledge when speaking directly to another human or it is more likely that those who completed the online survey were motivated to do so by their interest in green roof and so there is some degree of self-selection bias in the sample.

Perceptions of green roofs

The respondents were asked to rate a number of sustainability attributes of green roofs by assigning priority ratings to areas where green roofs could deliver benefits. The attributes they were asked to rate were;

1. Increasing habitat and bio-diversity.
2. Improving air quality.
3. Reducing building energy costs.
4. Improving views and city landscapes.
5. Reducing urban heat island.
6. Providing space for recreation and leisure.
7. Managing stormwater run-off.
8. Acting as noise buffers.
9. Reducing glare between buildings.

Figure 4 shows the results where items at the top of the bars and coloured purple show the higher priority ratings.

The items with the highest priority were increasing habitat and bio-diversity (72.3%), improving air quality (71.6%), reducing building energy costs (69.3%) and improving views and city landscapes (68.1%). If sustainability is considered to comprise three components of environmental, economic and social sustainability (Elkington, 1997), this data reveals that the first two items are environmental. The third attribute is economic and the fourth is environmental / social. In the mid-range of priorities reducing the urban heat island and, providing more recreational space; an environmental and a social attribute respectively. The lowest priorities were managing stormwater runoff (56%), acting as noise buffers (45.4%) and reducing glare between buildings (33.6%). Stormwater runoff and noise are environmental attributes, whereas reducing glare is a comfort issue and therefore classed as environmental / social.

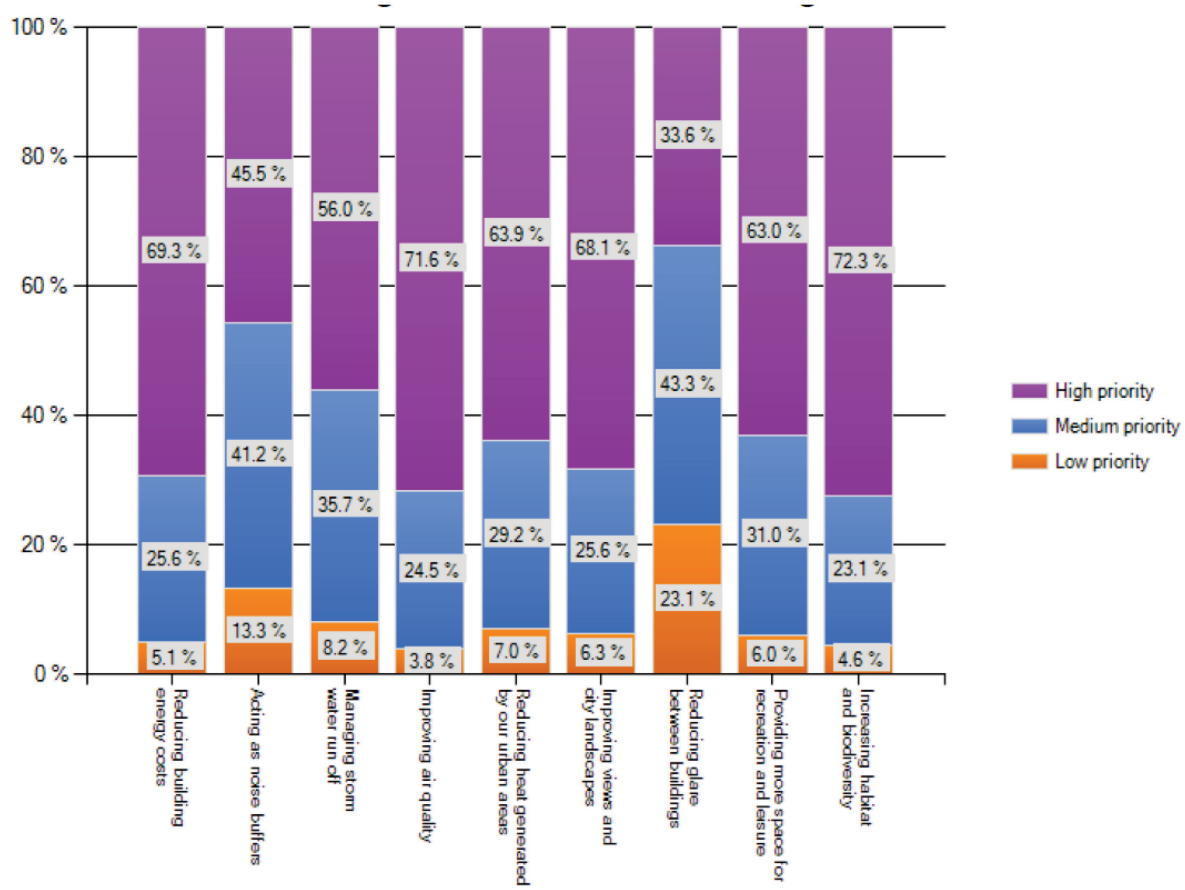

Figure 4 Sustainability ratings of survey respondents

When gender difference was examined at the 0.5 significance level females assigned higher priority to reducing building energy costs, acting as noise buffers, air quality and, increasing habitat and bio-diversity. Across all attributes females rated environmental attributes more highly than males (see figure 5).

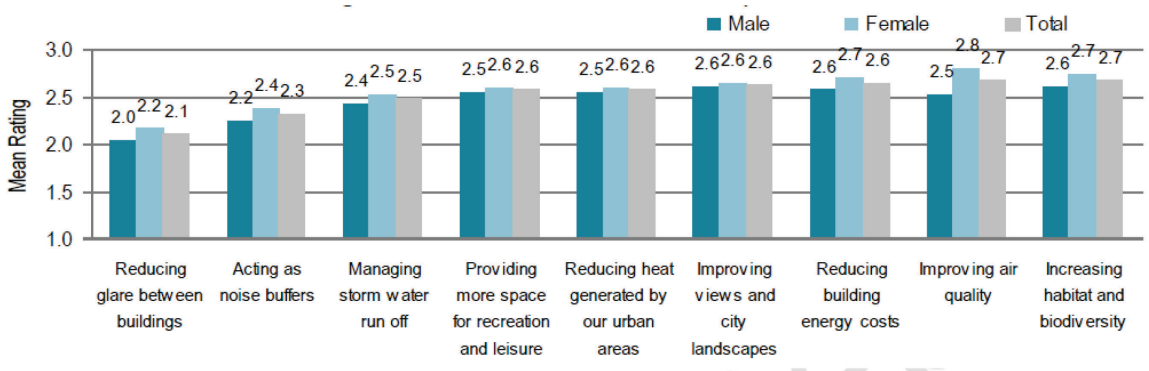

Figure 5 Sustainability priorities and gender

Where age is considered two attributes ‘acting as a noise buffer’ and ‘reducing glare’ became more important to older respondents. Equally when respondents’ residential location was evaluated the City of Sydney residents in the sample were more concerned about noise and glare issues than non-residents. With urban densification, and an aging population, increasing noise and glare issues may become more prominent. Interestingly the workers in the sample, who are non-residents, were more concerned about improving views and city landscapes. Visitors to the city were more concerned with air quality and travellers more concerned about habitat and biodiversity. Visitors are those paying a short visit to the city, whereas travellers tend to have extended stays and often work in the city during their stay. These results reveal the interests and concerns of respondents vary depending on the type and extent of their relationship to the city.

Perceptions of social and functional benefits

The survey asked respondents about the importance of green roofs for direct human use such as exercise, growing food, a space to catch up with friends, a peaceful relaxing space to enjoy and a place in which to get some fresh air in. The results showed considerable variation depending on the functional use being considered. Figure 6 shows the results in categories of very important, important, moderately important, slightly important and not important. The highest importance was attributed to getting some fresh air (where 88% stated either very important or important). This was followed by a space for ‘peace and quiet’ (81%). Growing food rated at 61%, followed by social space to catch up with friends (53%) and a place to exercise (45%). Interestingly these respondents were more interested in personal environmental benefits over social engagement. The gender analysis showed significant differences in this item. Females rated social aspects such as exercise, a space to catch up with friends and grow food higher than males. When age was considered all age groups valued fresh air and peace and quiet highly.

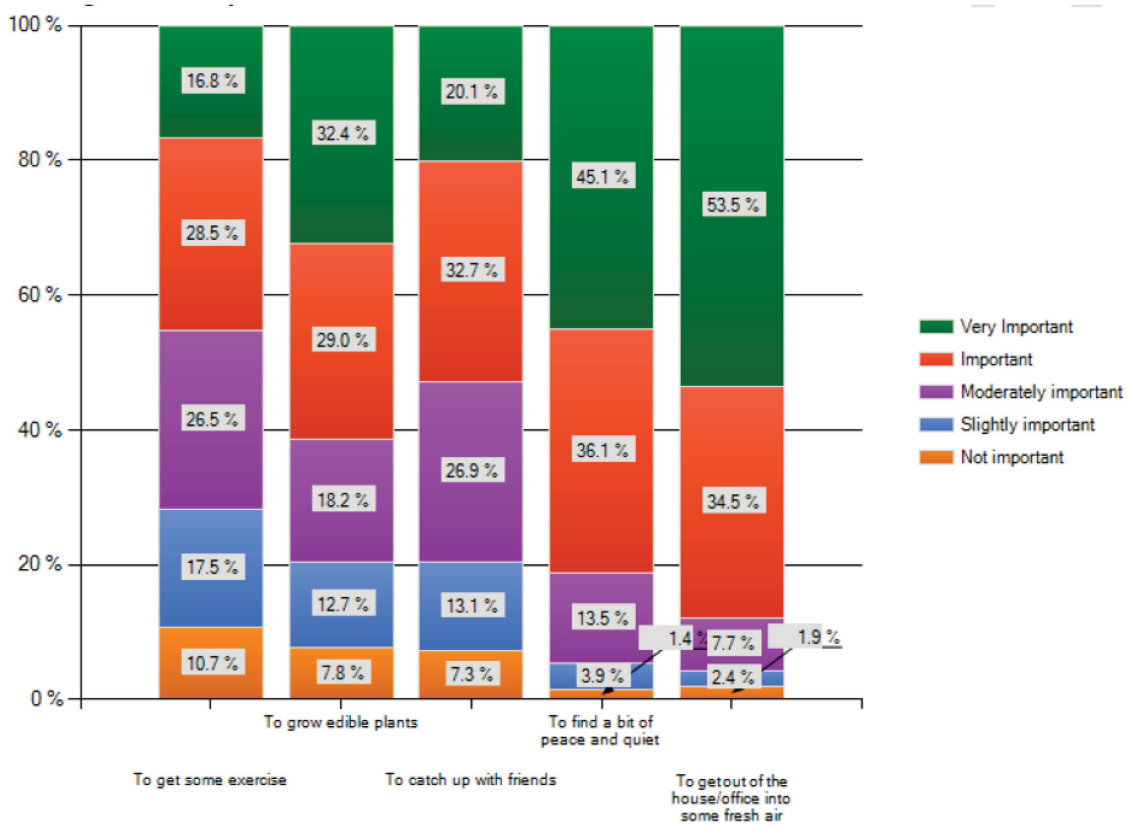

Figure 6 Importance of social / functional benefits of green roofs

General attitudes to development of green roofs

Respondents were asked to state their levels of agreement with six statements related to the development of green roofs. The statements were;

1. As long as they meet current building standards I think GR projects should be allowed to develop on their own merit.
2. Encouraging new building techniques that minimise environmental impacts should be a priority for the City of Sydney.
3. If we don't build more greenery into the CBD, Sydney will fall behind other global cities as an attractive place to live.
4. We are better off investing in normal suburban parks than green roof projects.
5. It is well worth encouraging greater use of building materials with even a small environmental advantage, and;
6. The benefits of having greenery around us outweigh a small additional cost.

For statement one the highest score was 37.7% agreeing followed by 30.3% agreeing strongly. Statement two scored highest on strongly agree (64.7%), followed by agree (30.8%). Statement three scored highest on strongly agree (38.6%) followed by agree (33.2%). With statement four, the highest score was disagree (41.7%) with the notion that the City were better off investing in parks than green roofs. Statement five rated 'agree' the highest, with 48.7% followed by strongly agree (33.7%) and; finally statement

six with 55% stating they strongly agreed that the benefits of greenery outweighed a small additional cost. Therefore support was strong across all aspects.

Females consistently ranked all aspects higher than males. Overall the strongest rating was that the City should prioritise building techniques that minimise environmental impacts, followed by acknowledgement that the benefits of greenery outweigh a small additional cost, which is very positive. The lowest ranked item was the statement that conventional street level parks should have priority over green roof spaces. This result shows a strong community commitment to green roofs at the expense of investment in conventional parks.

Conclusions

This paper addresses the question *what is the community awareness and perceptions of green roofs and green in the Sydney CBD*? The literature review identified benefits relating to green roofs with which the survey sought to determine the level of awareness in a sample of residents, workers and visitors in the City of Sydney. The sample was generally representative of the population in terms of gender and age, but was better paid and educated compared to the median for the area. There were marginal differences of awareness of green roofs based on gender. On the basis of age there was least awareness in the old and young.

Improvements to habitat and bio-diversity and air quality were perceived as the most important environmental sustainability attributes of green roofs. Given that Sydney has only 4% of its native flora remaining, the other 96% having been destroyed since the arrival of Europeans just over 200 years earlier, this is an interesting outcome. Some differences were found with respect to age, where older respondents considered attributes such as noise buffering and glare reduction as more important than other age groups. Furthermore differences as to the importance of particular attributes were found between residents and non-residents.

Of the social and functional attributes, access to fresh air, peace and quiet and growing food were most important. With these attributes there was consistency among the age groups but significant differences based on gender.

Finally the general statements showed overall the strongest community view was that the City should prioritise building techniques that minimise environmental impacts, followed by the view that the benefits of greenery outweigh a small additional cost. In this respect, wide scale retrofit of existing buildings with green roofs could support delivery of zero carbon goals. The lowest ranked perception was that street level parks should have priority over green roof spaces and shows a strong community commitment to green roofs.

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