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Preferences for street configuration and street tree planting in urban Hong Kong

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ABSTRACT

This study aimed to explore people's perception of tree planting in street canyons and the perceived tree impacts through a questionnaire survey. Also, by using a discrete choice experiment, it aimed to reveal how people performed tradeoffs among three streetscape attributes: namely permeability (i.e. spacing between buildings), aspect ratio (i.e. ratio of street width to building height), and tree planting. A secondary aim was to determine respondent's willingness to pay for streetscape features and tree planting. Despite published research results that indicate tree planting can have a negative impact on air quality, the survey results from 509 respondents in Hong Kong indicated that the majority of them held positive views of tree planting in street canyons. The probability of having an overall positive view was found to be higher if an individual perceived that trees could improve air quality, provide shading or did not obstruct footpaths. The preferred streetscape was high permeability, regardless of whether respondents thought that trees could or could not contribute to improving air quality. However respondents who perceived that trees could improve air quality preferred tree planting at both sides of the street over lower aspect ratio whereas those who perceived that trees did not improve air quality preferred low aspect ratio over tree planting at both sides of the street. Both sets of respondents did however agree on the preferred order of tree planting options, namely planting on both sides of the street was preferred to planting at the center of the street which in turn was preferable to no tree planting at all. The overall willingness to pay was estimated to be HK$163.4, HK$132.4 and HK$121.1 per month for high permeability, street-level tree planting and low aspect ratio, respectively. The study clearly identifies high permeability as the most preferred planning option. However, the perception held by the majority of respondents that trees can improve air quality is contrary to recent research findings. This poses a dilemma for urban planners in that schemes that may be more beneficial, i.e. low aspect ratio, may face more public opposition than less beneficial schemes involving tree planting. Although the study was conducted in Hong Kong the findings should be applicable to other modern metropolises characterized by high rise buildings.

Introduction

Nowadays, urban greening is a popular program with an ultimate objective of improving the environmental quality within urban areas including roadside environments. Urban greening can mitigate the urban heat island (UHI) effect and improve thermal comfort by moderating micro-climatic conditions (Avissar, 1996; McPherson, 1992; Ng et al., 2012; Park et al., 2012; Shashua-Bar et al., 2009; Taha, 1997) and provide shading (Dimoudi and Nikolopoulou, 2003; Ali-Toudert and Mayer, 2007; Shahidan et al., 2012). It can bring other benefits including the ability to attenuate noise levels (Ozer et al., 2008; Islam et al., 2012; Van Renterghem et al., 2012), improve air quality (Akbari et al., 2001; Jim and Chen, 2008; Nowak et al., 2006) and reduce urban storm water runoff (Bartens et al., 2008; Armson et al., 2012).

Trees can also help improve individuals' well-being by helping people reduce stress (Ulrich, 1983; Van den Berg et al., 2003; Gidlöf-Gunnarsson and Öhrström, 2007) and recover from stress (Kaplan and Kaplan, 1989; Ulrich et al., 1991; Hernandez and Hidalgo, 2005; Nielsen and Hansen, 2007; Mitchell and Popham, 2008; Grahn and Stigsdotter, 2010). Additionally, trees can help alleviate the sense of oppressiveness in crowded urban areas by bringing other benefits such as an aesthetic pleasing effect (Tyrväinen et al., 2003; Escobedo et al., 2011). For example, placement of trees in front of buildings could reduce the unpleasantness of the environment,

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especially when located in front of taller buildings (Asgarzadeh et al., 2012).

Trees do have some negative aspects such as allergies from pollen (Comtois and Schemenauer, 1991; D'Amato et al., 2007), and attracting insects (Jim, 1987; Nuckols and Connor, 1995) besides potential annoyances like obstructions in the footpath of urban streets and inconveniences due to fallen leaves. However, many urban residents held very positive overall views on street tree planting (Flannigan, 2005; Schroeder et al., 2006; Weber et al., 2014; Davis and Jones, 2014). Preferable features included tree planting on both sides of a street to produce a 'canopy closure effect' produced by the tree crowns (Sommer et al., 1990; Schroeder et al., 2006) which was found not to be achieved by planting along the centerline (Arnold, 1980). When planted at the roadside, trees could also act as barriers between pedestrians and moving cars in order to provide a more enjoyable walking environment (Fukahori and Kubota, 2003; Giles-Corti et al., 2005)

Contrary to the conventional perception that tree planting can improve air quality, both recent field experimental (e.g. Buccolieri et al., 2011; Mitchell and Maher, 2009; Vos et al., 2012; Wania et al., 2012) and numerical simulation studies (e.g. Amorim et al., 2013; Buccolieri et al., 2009; Gromke and Ruck, 2012; Gromke et al., 2008; Li et al., 2013; Salim et al., 2011) have discovered that street-level tree planting, especially planting in high pollution areas (i.e. 'hotspots') like traffic junctions and within street canyons, might actually result in an increase in ground-level pollutant concentrations. The effects were found to be even stronger for deeper canyons (i.e. with aspect ratio >2) (Ng and Chau, 2012). So there is a fundamental question of whether people would still favor tree planting in streets if they thought trees were likely to bring further detrimental impacts to air quality.

Nevertheless, the successful engagement of any planning option, including tree planting schemes, requires broad consent from stakeholders. Without soliciting a majority of people's support, it is difficult to seek public budgetary approval and subsequent fund allocation for a specific planning option. So understanding peoples' preferences or views is a key to the successful smooth implementation of planning decisions (Rydin and Pennington, 2000).

Besides soliciting people's attitudes toward street trees, it is also important to solicit their preferences for tree planting schemes in relation to other street and building configurations. Aspect ratios and building spacing are of particular interest as they also exert effects on shading provision (Ali-Toudert and Mayer, 2006; Takebayashi and Moriyama, 2012), urban air quality (Kastner-Klein et al., 2004; Liu et al., 2005; Ng and Chau, 2014; Vardoulakis et al., 2003) and oppressivenes (Asgarzadeh et al., 2012).

Preferences for different street and building configurations have been frequently studied. Building spacing is favored by people while enclosed settings or blocked views are disliked (Herzog, 1992) as unbroken blocks of building generate a sense of enclosure in the urban environment, which is created by having streets and sidewalks act as "floors" and the sky as a "ceiling" (Ewing and Handy, 2009). Wider spacing between buildings is preferred because it can alleviate the sense of oppressiveness created by tall buildings situated in narrow streets (i.e. high aspect ratio). With care, planners can create a people-focused street environment to increase the walkability of people within the neighborhood and thus enhancing their physical activity levels (Leslie et al., 2005; Southworth, 2005).

Yet as an important limitation, previous tree planting preference studies were largely confined to urban street configurations that do not represent deep urban canyons that are quite common in high rise high density cities. Also each of the proposed street and building configurations, namely tree planting, building spacing and aspect ratio have an associated cost which must be borne by public funds. It is therefore of interest to elicit public's willingness to pay for improvements to the street canyon environment.

Accordingly, this study has four major objectives: it aims (i) to explore the general attitude of people toward street planting; (ii) to disclose preferences for planting schemes in relation to aspect ratios and building spacing, (iii) to determine whether people's perceptions of street tree planting affects the tradeoff between preferences on tree planting and canyon configurations, and (iv) to determine peoples' willingness-to-pay values for selected streetscape features. These objectives were investigated by using Hong Kong as an example for a compact city with deep street canyons.

Methodology

Questionnaire surveys were conducted via face-to-face interviews so as to reduce the chances of misunderstanding the content and methodology of the surveys. The questionnaire consisted of three parts: Part A was intended to elicit respondents' preferences for trees and other streetscape attributes that have been shown to be able to reduce oppressiveness, provide shading and improve the air quality in urban streets. Part B aimed at exploring respondents' perceptions toward the impacts of street trees. Part C embraced questions aimed at collecting personal details, including gender, age, income and education level from respondents.

Questionnaire surveys

Eliciting relative preferences for different streetscape attributes

Part A was designed to elicit respondents' preferences for different streetscape attributes using the discrete choice experiment method, of which the theoretical background and analysis will be discussed later. In identifying the major attributes, emphasis was placed on street and building configuration attributes which would influence oppressiveness, shading provision and air quality inside streets. Three major attributes selected for this study are: (i) aspect ratio (which is defined as the ratio of the average building height to street width); (ii) permeability of building (expressed in terms of the ratio of total distance of the building spacing to the overall length of street segment, which was measured at street level); and (iii) street tree planting. A fourth attribute for cost was included to determine the respondents' willingness to pay.

'Aspect ratio' was included as it displayed a strong relationship with oppressiveness and people's preferences (Jacobs, 1993; Stamps, 2005). For aspect ratio, two levels were defined: *low* for an aspect ratio of 2 and *high* for aspect ratio of 6. Aspect ratios in this experiment were obtained by varying the average building height on both sides of a street while keeping a constant road width.

'Permeability' was also included as it has been generally perceived as a factor which affects the perceived openness of a street. For permeability, two levels were also defined: *low* for a value of 10% and *high* for a value of 35%. These values were based on the input values used in one of our previous computational studies (Ng and Chau, 2014).

The attribute 'Tree planting' was included for representing the tree planting arrangement in streets. Three different types of settings were assigned for tree planting: ((i) no trees in the street, (ii) trees located along the centerline of a street; and (iii) trees located at both sides of a street).

A cost attribute, which used environmental tax as a payment vehicle, was included to estimate the willingness-to-pay values for individual streetscape attributes. Three levels were defined for the cost attribute and they were expressed in terms of paying environmental tax for HK$50, $100 and $200 per month. Table 1 shows the four studied attributes together with their associated levels.