



Green roof systems: A study of public attitudes and preferences in southern Spain



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ABSTRACT

This study investigates people's preconceptions of green roofs and their visual preference for different green roof design alternatives in relation to behavioral, social and demographical variables. The investigation was performed as a visual preference study using digital images created to represent eight different alternatives: gravel roof, extensive green roof with Sedums not in flower, extensive green roof with sedums in bloom, semi-intensive green roof with sedums and ornamental grasses, semi-intensive green roof with shrubs, intensive green roof planted with a lawn, intensive green roof with succulent and trees and intensive green roof with shrubs and trees. Using a Likert-type scale, 450 respondents were asked to indicate their preference for each digital image. Results indicated that respondents' socio-demographic characteristics and childhood environmental background influenced their preferences toward different green roof types. Results also showed that green roofs with a more careful design, greater variety of vegetation structure, and more variety of colors were preferred over alternatives.

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1. Introduction

The space occupied by urban settlements is increasing more rapidly than the urban population itself. It is expected that from the year 2000–2030, the world's urban population will increase 72%. In addition, the built-up areas of cities of 100,000 inhabitants or more could increase by 175% (United Nations, 2007). Due to the rapid urbanization process, natural ecosystems are being replaced by urban areas, alienating people from natural space (Li et al., 2005).

Numerous studies have examined the consequences of sprawl, identifying multiple negative impacts on the environment, such as the reduction of water supply and quality (Van Metre et al., 2000), the degradation of air quality (Frank, 2000), and fragmentation and loss of natural habitats (United States Environmental Protection Agency, 2000). Further, there are social problems associated with uncontrolled urban development, including the loss of public spaces (Power, 2001) and community spirit (Frumkin, 2002).

Moreover, urban sprawl has been linked to numerous human health problems, both physical and mental (Handy et al., 2002).

Ensuring adequate green space in urban areas and improving access to natural areas surrounding the cities can help to offset these negative effects (Li et al., 2005). The multiple benefits of nearby nature are well-known, as they have been studied frequently (Brethour et al., 2007; Grinde and Patil, 2009; Lewis, 1996; Lohr and Pearson-Mims, 2000).

The creation of parks and gardens, urban agriculture, and urban forestry are the three most important forms of urban greening. They have important ecological, social, and economic effects (Lütz and Bastian, 2002; Tyrväinen, 2001). However, high-density urban development limits the availability of green spaces, which necessitates a search for new alternatives. In this sense, the exterior surfaces of buildings offer plenty of space to be covered by vegetation; therefore, the planting of green roofs and the greening of facades have become two of the most innovative forms of urban greening (Emilsson et al., 2007; Wong et al., 2010a; Yuen and Nyuk Hien, 2005).

Green roofs are becoming a standard way of introducing vegetation in dense urban areas. Several cities are working with elective systems such as e.g. financial subsidies, reduced stormwater fees or density bonuses, or more strict compulsory regulations such as e.g.

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land-use plans or mandatory ecological compensation of lost ecological function (Ansel, 2011). The use of these elective or compulsory systems has been most prolific in Europe but there are several examples developing in North America and elsewhere.

The last years have also seen a growing interest in urban green in a global context even in normally water limited climatic regions. In the Mediterranean region, green roof installation also has important potential benefits, but its progress is slower than in other regions, largely due to a lack of knowledge of its characteristics and benefits, and by the lack of governmental incentives (Ntoulas et al., 2012). In cities of Greece and Italy several green roofs have been installed, both public and private ones and there has been on-going research in order to adapt green roof technology to the singularities of the Mediterranean climate (Fioretti et al., 2010; Nektarios et al., 2011).

Also in Spain, there has been some spectacular installations during the last 10 years (Werthmann, 2008) most notably the green roof at Barajas T4 Terminal airport parking with an area of 54,000 m² (IGRA, 2007), the Expo in Zaragoza covering approx. 70,000 m², and the green roofs on top of the new Financial City of Santander Bank in Boadilla del Monte (Madrid) with an area of approx. 100,000 m² (IGRA, 2006).

The multiple benefits that green roofs offer to urban areas are well-known and studied. The most prominent are the: mitigation of the “heat island” effect in cities (Schmidt, 2006); reduction of total air conditioning energy requirements of buildings (Ip et al., 2010; Kontoleon and Eumorfopoulou, 2010; Schmidt, 2007; Wong et al., 2010a); increase in air quality in cities (Currie and Bass, 2005); stormwater runoff reduction (Bengtsson, 2005; Bengtsson et al., 2005; Stovin, 2010); increase in biodiversity and habitats (Dunnett and Kingsbury, 2004; Fernandez-Cañero and Gonzalez-Redondo, 2010; Francis and Lorimer, 2011); emergence of new opportunities for technological, economic, and employment development (Bass and Baskaran, 2003); increase in property values (Ichihara and Cohen, 2010); and provision of spaces for recreation and amenity (Dunnett and Kingsbury, 2004).

It is striking how rarely the ornamental value of green roofs is mentioned or emphasized. However, in many cities in which roofscapes are dominated by grey colors and unattractive structures, the aesthetic value of green roofs can be important (Oberndorfer et al., 2007). Still, very little information is known about the impact of the actual design of these novel vegetation systems. Numerous studies have evaluated individuals' preferences for different types of landscapes or various landscape design alternatives (Hagerhall, 2000; Karjalainen and Komulainen, 1998; Özgüner and Kendle, 2006; Spinti et al., 2004; St. Hilaire et al., 2010; Van den Berg and Koole, 2006; Yang and Brown, 1992; Zheng et al., 2011). However, although it is undeniable that greening technologies contribute to improving the visual and aesthetic appearance of urban areas (Dunnett and Kingsbury, 2004), there are few studies about the aesthetic value of green roofs and the manner in which design features can influence people's perceptions toward them.

Yuen and Nyuk Hien (2005) conducted a study in Singapore on public perceptions of rooftop gardens installed in the city and the most valued benefits associated with their installation. Citizens generally had favorable views of the installation of green roofs. The benefits most valued by respondents were the aesthetic pleasure and opportunity to build new playground and rest areas. Related to this study, Wong et al. (2010b) performed research to discover the current perception of vertical greenery systems in Singapore and barriers to their widespread adoption. In their study all respondents agreed that vegetation can enhance visual interest to walls and roofs. However, Wong et al. (2010b) found that there is a lack of technical information, maintenance instructions, and information on suitable plants, which may become a barrier to convincing building owners to install vertical greenery systems.

The aesthetic possibilities of a green roof are determined by its typology. Extensive green roofs usually have a natural appearance, similar to dry wildflower meadows that change with the seasons. For this reason, they should not be compared to lawn and traditional gardens (Ngan, 2004) whose appearance is intended to maintain stable over the year.

Recently, White and Gatersleben (2011) presented a study in which they examined whether vegetated houses (with green roofs and façades) would be more preferred than non-vegetated houses. Results suggested that houses with certain types of building-integrated vegetation could be more liked, aesthetically pleasing, and restorative than houses without vegetation. Although the differences were small, the results showed that, in the case of green roofs, the type of vegetation used in the construction influenced the assessment of the respondents.

The aesthetic goal of green roofs must be considered from the initial stage, as it determines both the design and the maintenance. The ornamental objectives can be achieved more rapidly by installing prefabricated vegetation but even projects planted or seeded onsite will achieve high plant cover within one or a few growing seasons (Emilsson, 2008). On the other hand, plant selection can vary greatly according to the priority (e.g., aesthetic or functional goal). This is a significant difference with respect to the design of a garden or landscape, for which the visual appearance might be important. Irrigation management may also be affected by visual and aesthetic objectives. When these objectives are important, it will probably need watering during the summer to maintain growth and the desired ornamental quality, especially in a Mediterranean climate with hot and dry summer periods (Dunnett and Kingsbury, 2004).

The aim of the present study was to examine the relationship between several behavioral, social, and demographic variables and individuals' preferences among different green roof design alternatives. People's preferences and expectations in this area will be of great importance for designers and planners when setting up compulsory planning permissions or when designing subsidy systems for this type of green technology. An additional goal was to examine individuals' preconceptions about green roof technology.

Previous research on people's perception of urban green space has shown that it is primarily linked to socioeconomic factors such as income level (Jim and Chen, 2006). In this study, we have not investigated the impact of different income levels on the acceptance of these green technologies but we are more directed towards increasing our understanding of the different design options that are apparent when working with novel urban green systems. There is also previous data supporting the idea that people's perception of urban green is linked to knowledge about the system and that vegetation systems that are designed for a naturalistic design can be perceived as untidy and unmanaged (Rohde and Kendle, 1997; Özgüner and Kendle, 2006). Based on this research we hypothesize that more pruned and maintained green roofs are preferred before naturalistic ruderal systems. We also hypothesize that there are differences in the perception of these green systems between different members of the community.

2. Research methods

The research examined individuals' preconceptions about this technology and preferences for green roof types. A visual preference survey (Karjalainen and Komulainen, 1998; Tahvanainen et al., 2001; Zheng et al., 2011) was utilized.

2.1. Visual stimulus

Because the preference ratings were based on digital images in a picture survey, the content and quality of the images were

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