AN OPEN SPACE WITH SCENERY: 'Greenscape Index' for Performance Based Planning of High Density Urban Habitation

JIN YEU TSOU, JIE HE
Department of Architecture, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China.
jinyeutsou@cuhk.edu.hk
hejie@cuhk.edu.hk

AND

YUCAI XUE
Department of Geography and Resource Management, The Chinese University of Hong Kong, Shatin, New Territories, Hong Kong SAR, China.
xueyucai@cuhk.edu.hk

Abstract. This paper presents an improvement of the original openness ratio concept, which has been formulated as an integrated index for early-stage urban open space planning and design support. The 'greenscape index' is a rating system which quantitatively integrates human visual perception with the visible landscape resources to evaluate the visual quality of open space vision within high-density urban environment. This new index is expected to provide more comprehensive environmental performance consideration criteria for urban planning and design. The research team also discusses the potential of the introducing this index to assess both psychological preference and physical form of urban open spaces. The new concept also has shown its feasibility on integrating key environmental considerations in visual sensitivity, urban wind, urban noise and solar heat gain into simple massing study which is applicable in the preliminary planning stage.

1. Introduction

In Hong Kong, about 22% of the total territory's area can be classified as built-up area and potential development area. Only 6% of this area is allocated to district and local open space for the 6.8 million populations, which means only $2m^2$ per person. Therefore, open spaces are omnipresent in Hong Kong public housing estates, and contribute important social functions in the hyper dense habitation environment. With the planning standards for high-density housing estates allowing as many as 2,500 to 2,800 persons per hectare, open space is important for relieving the sense of over-congestion. And sensible planning of the limited area to enhance the livability

and environmental quality has become a challenging issue for quality urban living of the mass population. However, a post-occupancy evaluation (POE) study conducted by the research team shows that the usage of open spaces is as low as 1.36% in several housing estates built from the 1970s to 1990s. It is concluded that the low usage rate is largely due to inappropriate planning and design rather than insufficient area (Tsou and Lam, 2002).

In order to improve the future open space planning and design, since 2000, the research team has been investigating a multi-discipline environmental-behavioural (E-B) study and a planning/design support index to pursue the quality and livability of open spaces in Hong Kong public housing estates. We have completed extensive field study and simulations with respect to visual sustainability, daylighting, airflow and acoustics. We have successfully developed the geographical information system (GIS) to support the openness ratio calculation; daylighting simulation for shading condition, solar access, illumination and lumination, and glare assessment; computational fluid dynamics simulation for airflow pattern and pollution problem in the urban environment; and acoustics simulation for assessing the urban acoustical quality. With these urban studies, the research team has found out that for environmentally responsible open space design in hyper dense urban context, the openness ratio, static pressure contour and sound pressure level distribution do share similar pattern (Tsou et al., 2003, 2004).

Spatial visibility is proved to be significant for human environmental perception (Appleton, 1996; Kaplan, 1987). And many researches, such as Stamps (2001), indicate that the visual openness greatly affects the people's preference of urban spaces. Therefore, in the above-mentioned studies, we have introduced the 'openness ratio' parameter to interpret the spatial visibility and consequently respect the human psychological preference (Tsou et al., 2004).

However, 'openness ratio' approach still has limits in comprehensive visual quality interpretation. In urban environment, natural landscapes are usually more preferable visually than man-made constructions for most of peoples (Kaplan, 1983; Anderson and Schroeder, 1983). Especially in high-density urban areas, its advantage in visual preference is precious. Moreover, former landscape researches have a consensus that the visual quality is composed by both resource and perception (Jacques,1980; Dearden, 1985). But the 'openness ratio' concept only considers the physical visibility within urban open spaces, and ignores the effects of visible natural resources. This shortcoming urges us to innovate the algorithm.

2. Greenscape Index

Based on the former researches, we develop the "openness ratio" methodology to an approach of integrating visual perception and visible resources to evaluate the open space visual quality. The new parameter is called 'Greenscape Index', which

interprets the visibility of urban natural landscapes in different resource quality. The value of greenscape index is conducted through a mathematical model, which quantitatively simulates human visual perception quality within high-density urban environment. The values of evenly-distributed study viewpoints are mapped into a greenscape contour representing the performance of natural landscape perception within the studied open space (Figure 1).

Figure 1. System framework of the 'greenscape index' and its implementations in planning support.

We also study the application of greenscape index in planning support. The research team explores inventories of greenscape indices (Figures 2 and 3), visual impact assessment and planning option evaluation by greenscape index comparisons (see also Figure 1), and flat/open space value review based on greenscape performance (He et al., 2005). These application possibilities demonstrate the potential of scientific planning, design and management support of this approach.

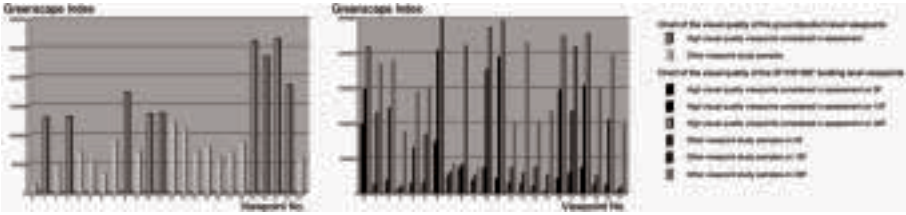

Figure 2. Greenscape indices inventories of key viewpoints of a case study (left: viewpoints on the ground/podium level; right; viewpoints on 5F/15F/30F building levels).

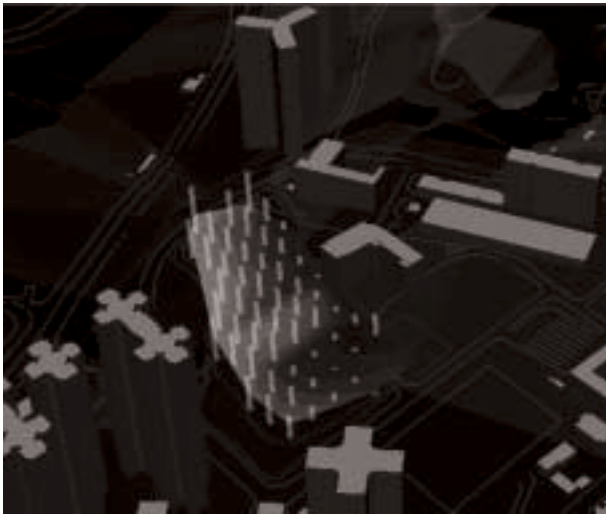

Figure 3. 3D illustration of the in-site visual greenscape contour in indices of sum value & average value of viewpoints.

3. Planning Support for Multi-level Consideration

Thematic maps in different environmental performance aspects of former study cases already have been conducted to graphically represent the relationship between activity patterns and the environmental simulation results. Through the same case study, greenscape index maps are also overlaid with the former thematic maps to identify the key factors and correlation between the physical environmental settings and human social behaviour in the open spaces, as well as to make vertical comparison between the preliminary “openness ratio” model and the ‘greenscape index’ approach.

Combined with the former activity mapping and environmental simulation results, we investigate the potential of the new methodology of interpreting the

residents' using module of the public open space. Meanwhile, since the "openness ratio" has also been introduced in an integrated index to provide a comprehensive rating system for open space evaluation in early stage of planning and design, we also explore role of 'greenscape' scenario applied in the above-mentioned index, and validity of the substitution of the former parameter.

4. Discussions and Future Work

The previous openness ration parameter has been concluded that could not exactly reflect the performance of every environmental aspect. But it does offer indication regarding multi-level environmental factors consideration and planning judgments (Tsou et al., 2004). The new greenscape index can also play the similar role in this environmental concern system. But there are also other potentials and challenges, in the planning support implementation.

Compared to the nature openness ratio computation, which is based purely on the relatively physical form, the premise of greenscape index introduces more considerations on human perception. Although many of the variables of the current algorithm is still translated from the physical urban form and landscape resources features, but our hint of this index is trying to establish a reliable landscape evaluation criteria, in which the visual quality is interpreted from both resource and appraisals (Croft, 1975; Jacques, 1980). Resources can be directly measured from the physical features by GIS and spatial analysis. But on the other hand, the preference of these resources is a more psychological-related aspect according to the review of landscape evaluation models (Daniel and Vining, 1983). The visually psychological perception within the urban open spaces is more appropriate for our original concern on E-B study. And it can become an important approach to investigating the social significance of the urban open spaces. For this research direction, behaviour modelling based on visual perception may become a potential development trend for further open space studies.

On the other hand, there are also other innovative researchable scopes for physical spatial form study. The initial openness ratio parameters are insufficient in predicting the impacts from building heights (Tsou et al., 2004). The greenscape index is also from the same methodology of 2.5D-based GIS analysis. So the disregarding has not been improved. In further research, to conduct the landscape evaluation, the research team intends to measure the landscape resource perception from projected images of a 3D model instead of 2.5D-based GIS planimetric analysis. This approach can also measure the sky and building façade exposure into human visibility consideration. These variables are also significant impacts to urban wind and daylighting. Therefore, the quantified visual performance can be integrated with other environmental respect concerns directly through the same physical urban form measurement. Through regression statistics, we can even investigate their

interrelationship, and consequently, the possibility and validity of using greenscape index to interpret the ventilation and daylighting performance.

5. Conclusion

In the planning and design for the hyper dense urban environment, the greenscape index approach improves the visual sustainability indexing ability, and provide appropriate methodology and assessment tools which provide designers to highlight the potential problems in the planning stage and support the integrated thinking of multi-level performance aspects with daylighting, airflow and acoustics. This index introduced does offer great potential for multi-level performance consideration. It has been shown to be applicable on simple massing study which is applicable in the preliminary planning stage through case studies. With complicated massing information, distribution patterns could have much variation and expertise of specific environmental aspects is essential. The introduced concept is helpful for macro scale preliminary planning where horizontal spatial formation is emphasized and details of urban townscape are excluded. Meanwhile the methodology and innovated tools developed in these works have been applied to several government projects to enhance the urban living quality.

References

Anderson, L. & Schroeder, H. 1983, Application of wildland scenic assessment methods to the urban landscape, *Landscape Planning*, vol. 10, pp. 219–237.

Appleton, J. 1996, *The Experience of Landscape*, Revised Edition, John Wiley & Sons, New York.

Croft, R. 1975, The landscape component approach to landscape evaluation, *Transactions of the Institute of British Geographers*, vol. 66, pp. 124–129.

Daniel, T. & Vining, J. 1983. Methodological issues in the assessment of landscape quality, In I. Altman and J. Wohwill (ed.), *Behaviour and the Natural Environment*, Plenum Press, Dordrecht, pp. 39–83.

Dearden, P. 1985, Focus: landscape aesthetics, *Canadian Geographer*, vol. 29, p. 263.

He, J., Xue, Y., Tsou, J. & Chow, B. 2005, Sight of the beauties: a GIS-based visual Landscape assessment approach for high-density urban development, Conference paper for *CAAD Futures 2005* (in progress).

Jacques, D. 1980, Landscape Appraisal: the Case for a Subjective Theory, *Journal of Environmental Management*, vol. 10, pp. 107–113.

Kaplan, R. 1983, The role of nature in the urban context, *in* I. Altman and J. F. Wohlwill (ed.), *Behavior and the Natural Environment*, Plenum Press, New York, pp. 127–162.

Kaplan, S. 1987, Aesthetics, affect, and cognition: environmental preference from an evolutionary perspective, *Environment and Behaviour*, vol. 19, pp. 3–32.

Stamps III, A. 2001, Evaluating enclosure in urban sites, *Landscape and Urban Planning*, vol. 57, pp. 25–42.

Tsou, J. & Lam, S. 2002, Open space and its social implication in Hong Kong public housing estates,

in *Proceedings of the 2nd Asian Streets Symposium: Public Space 2002 (GASS 2002)*, Singapore.

Tsou, J., Lam, S. & Xue, Y. 2003, Scientific modeling for bridging the environmental design and social behavior in hyper dense urban open space planning, in W. Dokonal and U. Hirschberg (ed.), *Digital Design: Proceedings of the 21th Conference on Education in Computer Aided Architectural Design in Europe (eCAADe)*, Graz, pp. 125–129.

Tsou, J., Lam, S., He, J. & Xue, Y. 2004, Performance based planning for high density urban habitation. *Proceedings of the 22th Conference of Education in Computer Aided Architectural Design in Europe (eCAADe)*, Copenhagen.