Case study

Understanding tourist space at a historic site through space syntax analysis: The case of Gulangyu, China

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HIGHLIGHTS

- We examine space syntax analysis as a reflection of general morphological structure.
- We study the effect of street network integration on tourist preferences.
- We evaluate the planned tourist sites based on space syntax analysis.
- We provides a visualized and quantitative approach to the field of tourist management via the application of GIS.

ARTICLE INFO

ABSTRACT

Although tourist development appears to be an effective approach for the further development of historic towns, researchers have often contended that a balance is difficult to maintain between protection and development. This article applies space syntax analysis to provide an understanding of tourist space at historic sites on Gulangyu Island. The relationship between street network integration and the urban fabric as well as tourist preferences collated from data mining are explored and verified. Then, results of the space syntax analysis along with the proposed historic site plan are compared to provide suggestions in plan evaluation. This research provides a visualized and quantitative approach to the field of tourist management via the application of Geographic Information System (GIS) to urban morphological features, tourist preferences and results gathered by way of planning practice. The effectiveness and limitations of this proposed new approach are also debated and substantiated.

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1. Introduction

The protection of historic heritage and the sustainable reorganization of tourist space has become a common agenda for urbanists (Hayllar, Griffin, & Edwards, 2008; McKercher, Ho, & du Cros, 2005; Wang & Bramwell, 2012). However, the conflict between heritage protection and tourism development is also glaringly evident, especially for developing countries (Li, Wu, & Cai, 2008). Due to the pressures of a rising population and the pursuit of local economic goals, the need to better organize tourist space at historic sites is becoming more and more pressing.

Nevertheless, recent advances in spatial analytical tools bring new opportunities for planning tourist spaces more appropriately than before. According to the socio-spatial dialect, spatial arrangements can reflect certain social structures and cultural connotations, and vice versa (Soja, 1980). In other words, by understanding the inherent morphological structure and behavioral characteristics of a space, more sustainable and well organized tourist development approaches be easily achieved.

The main method utilized in urban morphological and behavior research is *space syntax*. Over the years, space syntax analysis has contributed to a greater understanding of the spatial configuration of street and road networks, and how these kinds of configuration affect movement flows, the location of economic activities, and the numerical levels of street life (Hillier, Penn, Hanson, Grajewski, & Xu, 1993; Hillier, 1996b; Karimi, 2000, 2012). With the help of

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computer software, like Depthmap or sDNA, it is possible to visualize the spatial hierarchy of street networks so that we can develop a picture of a particular urban morphological structure, in order to predict pedestrian flows (Griffiths, Jones, Vaughan, & Haklay, 2010; Ye & van Nes, 2013, 2014a, 2014b). In this paper, traditional morphological analysis focusing on urban fabrics will be firstly applied to test the accuracy of the space syntax approach. Real time tourist movement behavior recorded through large data mining of cell phone locations is utilized to provide another perspective in verifying the understanding of morphological features and tourist preferences quantitatively. Tracing tourist preferences through cell phone or GPS technologies is a new technique which has arisen in recent years (Ratti, Williams, Frenchman, & Pulselli, 2006; Shoval, 2008). As a technique able to record the real time movement of people, it brings much new potential for tourist management.

The following paper is composed of five distinct parts. Following the introduction, Section 2 illustrates the research methodology. In this section we examine the case study and the analysis methods. We also discuss our hypothesis and broader issues concerning our research design. Section 3 examines and explores our empirical analysis and discussions. In this section, specifically we unpack our time series analysis of the morphological structure of the research case studies, using the space syntax method; after this process we then overlay the results of the space syntax analysis on a traditional morphological analysis. Then, we investigate the overlaying analysis between street network configurations resulting from space syntax and tourist preferences. Finally, suggestions for optimizing tourist space organization and approaches for sustainable historic conservation will be discussed. In Sections 4 and 5, the strengths and limitations of the research and the conclusions will be reviewed respectively.

2. Methodology

2.1. Research case

As an island located to the east of the coast of Xiamen (in Fujian province in southern China), Gulangyu is around 2 km^2 (0.77 sq. mi) in area. It is home to about 20,000 people and is an increasingly popular domestic tourist destination. The only vehicles permitted on the Island are small electric buggies and electric government service vehicles (Gulangyu Island, n.d.).

As shown in Fig. 1, the evolution of the urban fabric and functions of Gulangyu has left a historic urban footprint at the site. The primary streets of Gulangyu were systematically formed at the end of the 19th century when many consular officials, priests and businessman reached the Island (Hong, 1999; He, 2007). The Nei-cuo'ao area, where the Municipal Council resided, was the site of the earliest aboriginal settlements which were characterized by mixed functions and scattered layouts. The Tianwei area was composed of villas and public facilities and is characterized by its free layout and urban fabric which mirrors the appearance of the colonial buildings which were built years later at the end of the 19th century (Fig. 1a). In Fig. 1b, the Luqiao-fujian area is shown. The area is a reflection of overseas Chinese construction features found during the 'formation and prosperity' period (1890s–1960s). The Luqiao-fujian area is characterized by group layouts, courtyard-style buildings, and long quiet streets. The Longtou area which is marked in dark gray in Fig. 1c is the result of the accumulation of a fairly complex development process on the Island with its compact buildings and packed streets. Its naturally generated spatial structure provides us with clues so that we can begin to grasp the historic development process, cultural diversity and social structure of the Island. The 'pro-tourist development' period (1970s–2010s) displayed in Fig. 1c and d illustrates followed historic

transformations. During this period then, Local authorities carried out tourist oriented development policies. The peripheral areas within the Longtou area (especially near the docks) were developed into tourist service centers. During this process factory districts were moved out to the mainland.

As a well renowned tourist destination located near China's southeast coast, Gulangyu is currently facing a dramatic conflict between booming tourist development and a crucial need to protect the historic heritage of the island. Since the 1990s, local authorities have pursued pro-tourist development policies and as a result commentators have contended that both the existing community culture and the attractiveness of the island have increasingly been under threat (Lin, 2010; Yu & Liu, 2011). Statistical data shows that Gulangyu received more than 11,360,000 tourists in 2013, and the number is expected to hit 13 million by the end of 2014 (Administrative Committee of Gulangyu, 2014). During the May holidays of 2014, the number of tourists visiting the Island per day exceeded 70,000 (Fig. 2).

In this context, Gulangyu has been included in the National Preparatory Directory for World Cultural Heritage, which proposes that tourist development must give priority to historic heritage protection. Apparently, as Yu and Liu (2011) has claimed, for Gulangyu to safe guard the community culture and heritage of the Island, planners and designers need to develop a deep and rich understanding of Gulangyu's inherent morphological structure and how this structure affect tourist behavior.

2.2. Analysis methods

Space syntax is both a theory of urban planning and design and a software-based technology. As a theory, space syntax differs from classical urban morphology because it focuses on open space systems to pursue a form of spatial representation (Hillier & Hanson, 1984). Space syntax theorists call sets of simulated relations between spaces as "configuration" or "accessibility" and these terms are used as ways of describing what they understand to be the intrinsic properties of space (Hillier et al., 1993; Hillier, 1996a, 1999a). Hillier, therefore argues that the form of space, its configuration, can be regarded as the main determinant of urban movement flows. One can easily analyze numerical graphs to investigate the relative importance of each space in the whole spatial system. This argumentation has been partly verified by indicators of movement flows (e.g. human behavior records, micro-scale business distributions) in numerous cases during the past ten years. It is possible to argue then, that space syntax theory sheds some light on the development of urban morphological studies from their empirical and qualitative roots towards a more quantitative based approach.

Space syntax analytics use three types of distance metrics (Turner, Penn, & Hillier, 2005; Turner, 2007) (Fig. 3): 1) topological (fewest turns paths), 2) geometrical (least angle change paths) and 3) metric (shortest physical paths). The instrument then calculates the street network configuration at different scales (radii) according to the size of the research area. The global scale analysis measures the average depth of an axial line or segment to all other axial lines or segments in whole street networks, while the local scale analysis makes the calculation in a limited radius. In this research, local scale analysis is defined as 300 m radius and global scale analysis is defined as 3000 m radius. The DepthmapX developed by UCL (University College London) and the measurement of angular segment analysis by metric distance (ASAMeD) inside the software are applied to our case, so as to measure the spatial configuration of street networks in Gulangyu's morphological structure. The ASAMeD contains two measures — "closeness" and "betweenness". According to Hillier and Iida (2005), closeness (integration) is $C_c(P_i) = (\sum_k d_{ik})^{-1}$, where d_{ik} refers to the length of a geodesic