Measuring the Development Patterns of Urban Villages in Shenzhen

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ABSTRACT

Urban villages are widespread in many Chinese cities, providing affordable and accessible housing for rural migrants. These urban villages are developed by the indigenous village population base on a self-help approach and in an unauthorized style. Consequently, urban villages are characterized by rapid physical development. This paper uses GIS applications and Municipal building surveys as instruments to examine the development patterns of urban villages in Shenzhen, one of the most dynamic cities in China. Analyses reveal significant variation in development patterns and trends across urban villages, which can provide informative support for policy making associated with urban village (re)development.

INTRODUCTION

Dynamic urbanization in China during the reform period has led to the emergence and proliferation of so-called urban villages in many cities. Urban villages are created when agricultural land is used for urban expansion and the built-up component of the rural village remains untouched in order to avoid costly compensation and relocation programs. These urban villages form very distinctive spatial and social spaces as they are spatially enclosed by formally planned and developed urban built-up areas which are designed for urban functions and lifestyles (figure 1). In the face of massive amount of migrants who are excluded from the formal urban housing market, urban villages become popular migrant enclaves as they provide them with affordable and accessible housing units (Zhang et al. 2003).

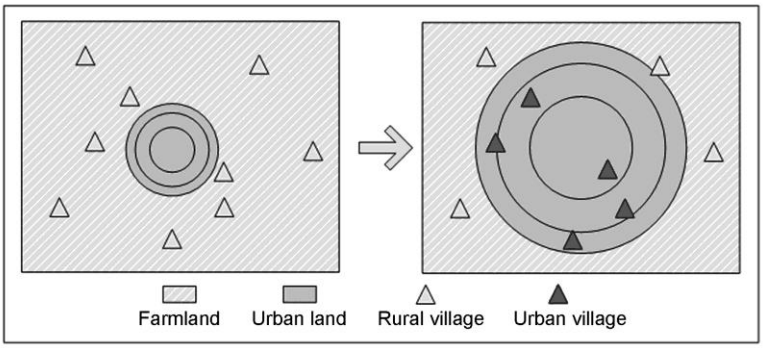

Figure 1: The transformation of rural villages to urban villages

Since little empirical research has examined the land use of urban villages, the heterogeneity of the development in different villages has not been recognized nor explained. It is clearly though an issue with multiple perspectives and both positive and negative connotations for the residents and for the city. For example, although urban villages are in fact the only feasible living place for the huge amount of rural migrants, the general policy rejects those urban villages, leading to large-scale urban village demolition-redevelopment programs. These programs hardly differentiate between urban villages. It is necessary to have a better picture of how urban villages develop and function in order to attune the policy to the specific characteristics of each of the urban villages and to consider implications for new resettlement areas. More importantly, planning strategies should be broadened to avoid mass demolition and relocation (Song et al. 2008; Hao et al. 2010). To this end, this paper uses GIS applications and Municipal building survey data to examine the land use development of urban villages in Shenzhen, one of the most dynamic and populous cities in China. The results exhibit great

spatial diversity of urban village development depending on the location of urban villages in the urban fabric.

Shenzhen was set up as a city in 1979 for establishing an export-oriented economy owing to the proximity to Hong Kong. In 1980, the Shenzhen Special Economic Zone (SEZ) was established as an experiment to attract foreign capital, technology and management skills, making it the first city in socialist China to experience the operation of a market economy. Thereafter, the astonishing development of the city has led to its population growth from about 310,000 to 14 million in just three decades. Spatial expansion of urban development has been swallowing its rural hinterland, leading to the creation of 320 urban villages (figure 2). These urban villages are distributed throughout the city and exist as an interwoven component of the formal urban landscape and economy. In Shenzhen, urban villages are thought to provide shelter for approximately seven million people, which is a half of the total population (Zacharias and Tang 2010).

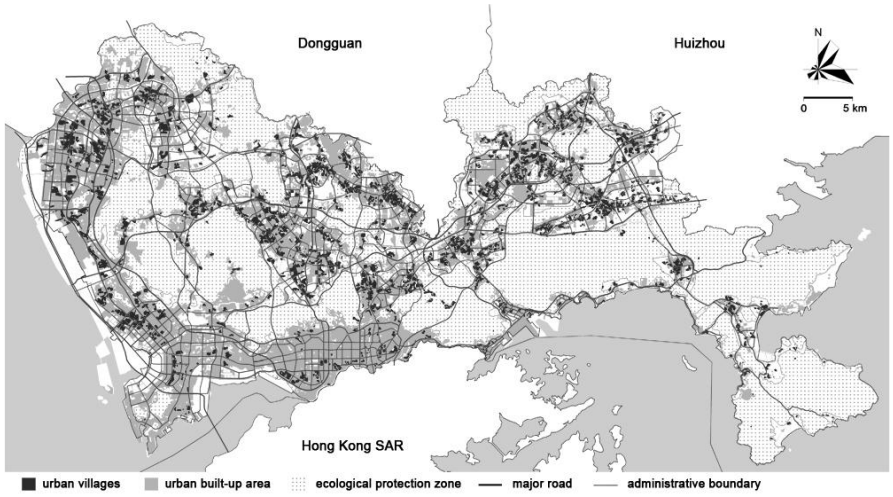

Figure 2: The distribution of urban villages in Shenzhen (source: Shenzhen Urban Planning Bureau)

URBAN VILLAGE DEVELOPMENT

The possibility for urban villages to provide a large quantity of inexpensive housing has its roots in China's dichotomous land ownership (Zhang et al. 2003). While the state owns urban land whose use rights can be leased to users in exchange for payment, rural land is allocated to rural communities free of charge (Tian 2008). The collective ownership of village land does not allow villagers to alienate their lands other than to transfer ownership to the government. However, the specific occupancy of a house plot turned each village family into a *de facto* landlord with unrestricted tenure (Zhang et al. 2003). As a result, the indigenous urban village residents can take advantage of their land's prime location and exploit it via highly profitable room rental to migrants. As development projects in urban villages are not scrutinized by urban planning or regulations, indigenous villagers are able to provide sub-standard housing and services. This not only substantially reduces the construction and management costs thus enabling low rents, but it also enables quick and massive constructions that provide large quantities of housing units to satisfy the increasing demand (Hao et al. 2009).

In response to increasing housing demand from the migrants, housing units are developed through more intensive use of their land. As the existence and distribution of urban villages are predetermined, the rural landscape of the villages – low-density residential settlements surrounded by farmland – determines the initial settings of the urban village development. These include their original size, layout and natural and man-made landscape. In the early stages of urban village development, encroachment on adjacent agricultural land was easy and more important within the constraints implied by financial considerations and technology. New houses were built on the vacant land around the village, causing the village to expand. The encroachment becomes increasingly difficult over time as the expansion of both the village and the urban development have converted the limited agricultural land. However, inside the village there is still potential for more houses as the built-up density is still low. Consequently houses are built within the village, yards are occupied by house extensions and new houses, open spaces are developed, roads are narrowed, all of which increase the villages'

density. As the developable land inside the village becomes scarce development pressure gives rise to increased building heights. By replacing traditional low-rise houses with concrete high-rise apartment buildings, the growth of floor space can be further sustained. Consequently the development path of urban villages involves three phases, namely expansion (more land), densification (higher built-up density through infilling) and intensification (increasing floor space per plot). Facing increasing natural and institutional constraints, this development path is a logical response for the indigenous villagers to exploit the economic potentials of their property.

Given that urban development can be diverse, the effects of urban development on urban village development are also likely to be diverse. For example, an urban village in a prime location is an attractive proposition to become a popular housing neighborhood and thus is likely to experience significant development. It is expected that the physical development of urban villages will exhibit variance across different villages. Detailed knowledge and insight in these variances is of extreme importance to be able to design proper policy measures concerning their future. The following sections will demonstrate how such variance is explored using GIS measurements.

DATA AND METHODS

This study uses Municipal building surveys as a primary data source to explore the physical development and land use of urban villages. Urban villages are recognized by their collective land ownership and the administrative boundaries. The study area is the whole city of Shenzhen including a 410 km^2 Special Economic Zone (SEZ) comprising four districts of Luohu, Futian, Yantian and Nanshan, and a much larger non-SEZ area comprising Baoan and Longgang districts covering 714 km^2 and 845 km^2 respectively (figure 3).

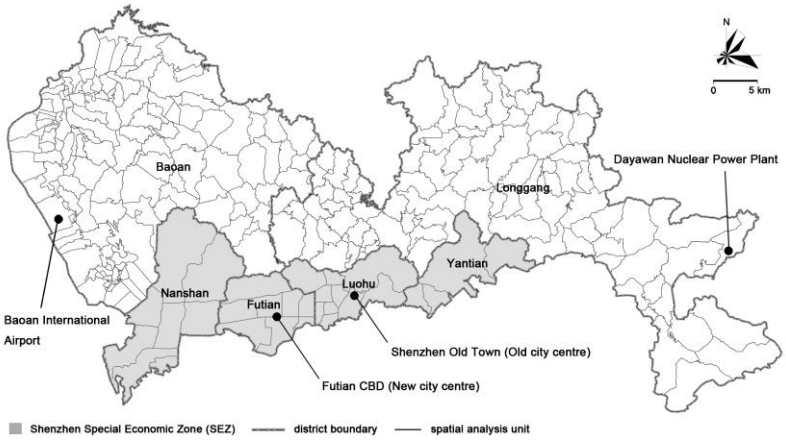

Figure 3: Administrative divisions of Shenzhen and analysis unit boundaries

Data which were collected by the Shenzhen Urban Planning and Design Institute contain physical status of all urban villages in Shenzhen in 1999 and 2004 respectively. The data include gross land area, the number of buildings, total built-up area and total floor space. A more detailed survey was commissioned by Shenzhen Urban Planning Bureau in 2009, which provides data of every building in urban villages including their plot area, house footprint area, the number of stories, and floor space. These are aggregated at the administrative village[1] level for comparison with the data of 1999 and 2004. The city is divided into 261 analysis units, 255 of which accommodate the city's 320 urban villages.

The focus of this study is on the temporal and spatial changes of urban villages in terms of the three forms of growth – expansion, densification, and intensification – discussed earlier. This is carried out via an analysis of three variables: gross land area (the land coverage of the urban village), built-up area (the sum of the areas of all building footprints) and total floor space (the sum of the floor

[1] An administrative village (*xingzhengcun*), which is a bureaucratic entity, is different from a natural village (*zirancun*), which spontaneously and naturally exists. An administrative village can be composed of one or more natural villages. However, it also can be a part of a natural village when the natural village is very big.

areas of all buildings). The expansion is measured by the change of gross land area. The densification can be measured by the change of built-up density (built-up area / gross land area) and the intensification can be measured by the change of floor area ratio (total floor space / built-up area). Consequently, the amounts of urban villages' expansion, densification and intensification can be mapped and compared.

Two empirical measures (table 1) are employed to evaluate the spatial development patterns of urban villages. First, the spatial autocorrelation of urban villages' expansion, densification and intensification are measured respectively. This aims to examine whether it is the case that locational similarity of urban villages is matched by value similarity of urban village development. The global Moran's *I* is used to identify the existence and degree of spatial autocorrelation in terms of expansion, densification or intensification at the city scale.

Table 1: Measures of urban village development patterns

Scale	Measurement	Variable measured
city	1) Moran's *I* $I = \frac{N \sum_{i=1}^{N} \sum_{j=1, j \neq i}^{N} W_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\left[\sum_{i=1}^{N} \sum_{j=1, j \neq i}^{N} W_{ij}\right] \sum_{i=1}^{N} (x_i - \bar{x})^2}$ $\bar{x} = \frac{\sum_{i=1}^{N} x_i}{N}$	• Increase/decrease of total land area • Increase/decrease of built-up density • Increase/decrease of floor area ratio
village	2) LISA $I_i = z_i \sum_j W_{ij} z_i$ $= \frac{x_i - \bar{x}}{\frac{\sum_{j=1, j \neq i}^{N} x_j^{\,2}}{N-1} - \bar{x}^2} \sum_{J=1}^{N} W_{ij}(x_j - \bar{x})$	• Increase/decrease of total land area • Increase/decrease of built-up density • Increase/decrease of floor area ratio

The equation of the Moran's *I* index is in table 1. Where, x_i is the value of variable in the unit i and the $W(i, j)$ is a spatial weight matrix where $W(i, j) = 1$, if the unites i and units j are contiguous, and $W(i, j) = 0$ otherwise. A positive Moran's *I* means that adjacent urban villages have similar change in terms of specific development form, while negative spatial autocorrelation can be interpreted as spatial dispersion in terms of specific development form.

At the local level, the Local Indicators of Spatial Autocorrelation (LISA) (Anselin 1995) is used to detect the spatial development concentrations. It allows for the identification of both local clusters reflecting positive or negative spatial autocorrelation as well as spatial outliers. The purpose of inclusion of LISA statistics is to provide an alternative approach for identifying the density clusters independent from classification schemes used in choropleth mapping. The latter is highly dependent on the ways that data are organized and thus could lead to biased interpretations.

In the LISA calculation (table 1), a local Moran index for a unit i is defined, where z_i is the standardized form of x_i, and the $W(i, j)$ is the same as that in the global Moran index. The sum of all the local Moran's indices is equal to the global Moran's index. The significance level is set as 5 percent and 999 permutations are used to test the significance of the global or local Moran's *I* against a null hypothesis of no spatial autocorrelation. According to the calculation result, LISA cluster maps are plotted.

DEVELOPMENT PATTERNS

Table 2 lists the Moran statistics of urban villages' expansion, densification and intensification respectively. The Moran's *I* coefficient of the expansion of urban villages for the first period of 1999 up till 2004 is 0.36 (significant at 0.1% level), exhibiting a significant positive spatial autocorrelation. This indicates that urban villages with a similar geographic location tend to expand at more or less same scales and thus village expansion tends to cluster in certain places. For the second period of 2004 up till 2009, the Moran's *I* coefficient is 0.08 (significant at 5% level), exhibiting an almost random distribution of the growth. As the expansion of urban villages significantly slowed down in the second period due to diminishing land availability, the concentration pattern of the expansion also diminished in the second period.

Table 2: Spatial autocorrelation measured by Global Moran's *I* index

	Expansion		Densification		Intensification	
Period	99-04	04-09	99-04	04-09	99-04	04-09
Moran's *I*	0.3617	0.0813	0.1590	0.1453	0.4274	0.3439
p-value	0.001	0.037	0.001	0.004	0.001	0.001

The densification of urban villages exhibits small positive spatial autocorrelation for both period (first period: Moran's $I = 0.16$, significant at 0.1% level; second period: Moran's $I = 0.15$, significant at 0.5% level). The pattern and trend are different from the ones oberserved for land expansion. The clustering of densification was not prominent. This is because constructing more houses through infilling provides relatively more equal change for different villages, comparing to the situation that land expansion is confined by different level of land inadequacy in different locations such as the city center and peripheries. However, the trend of a mild clustering pattern sustained throughout the two periods.

For the intensification of urban villages, the statistics reveal significant positive spatial autocorrelation for both time periods. The Moran's *I* coefficient is respectively 0.43 and 0.34 (both are significant at 0.1% level). This implies that the production of floor space by increasing building heights is significantly concentrated in certain places, which are likely to be more popular for migrants. Facing the situation of land inadequacy for urban village development, intensification has become the most important measure for the villages to further grow.

These results demonstrate that in general urban village development tends to cluster in space, probably because certain places such as urban villages close to job locations are concentrated with more migrants. In facing housing demand, expansion, densification and intensification are used as means to provide more housing units. However, expansion is the least sustainable form due to diminishing land availability in the surroundings of urban villages. Over time, as expansion becomes more and more difficult, its clustering pattern also diminishes. The densification process is also facing increasing difficulties due to diminishing land availability inside urban villages. However, for intensification process, the lack of land entails much less constraints. By increasing the height of buildings, the production of housing units maintained. Consequently the clustering of intensification sustained at a high level.

The spatial clustering of expansion, densification and intensification of urban villages results in spatial patterns, which are indicated by the LISA cluster maps (figure 4). For land expansion, in the first period the high-high units were clustered in two groups. One was in Baoan district, adjacent to the city center. The other cluster, which was in Longgang district, was relatively further away but it still has good access to the city center. The low-low units were clustered in the SEZ where vacant land can barely be found. However, in the second period, land expansion was much more confined. Consequently the clusters of high-high units were much smaller. The low-low units are found in the remote Dapeng Peninsular on the east.

For densification, in the first period the high-high units were clustered in the places which are very close to the city center. The low-low units are mostly found in the eastern part of Longgang. In the second period, the high-high units were clustered in more peripheral locations than the ones in the first period. And there were no obvious low-low clusters.

And for intensification, in the first period, the high-high units were clustered inside the city center. The clusters of the low-low units were in Dapeng Peninsula at the remote eastern part of the city. In the second period, the clusters of high-high units shifted from the city center to Baoan district, and the city center turned to be clustered with low-low units. This implies that urban villages in the inner districts had gone through a dramatic intensification process thus lack potentials to future do so. However, urban villages in outer districts followed the same development trend to produce more housing units. The patterns of urban village development over time, from a spatial point of view, confirm that urban villages would seek more housing units by expansion first and then by densification and intensification.

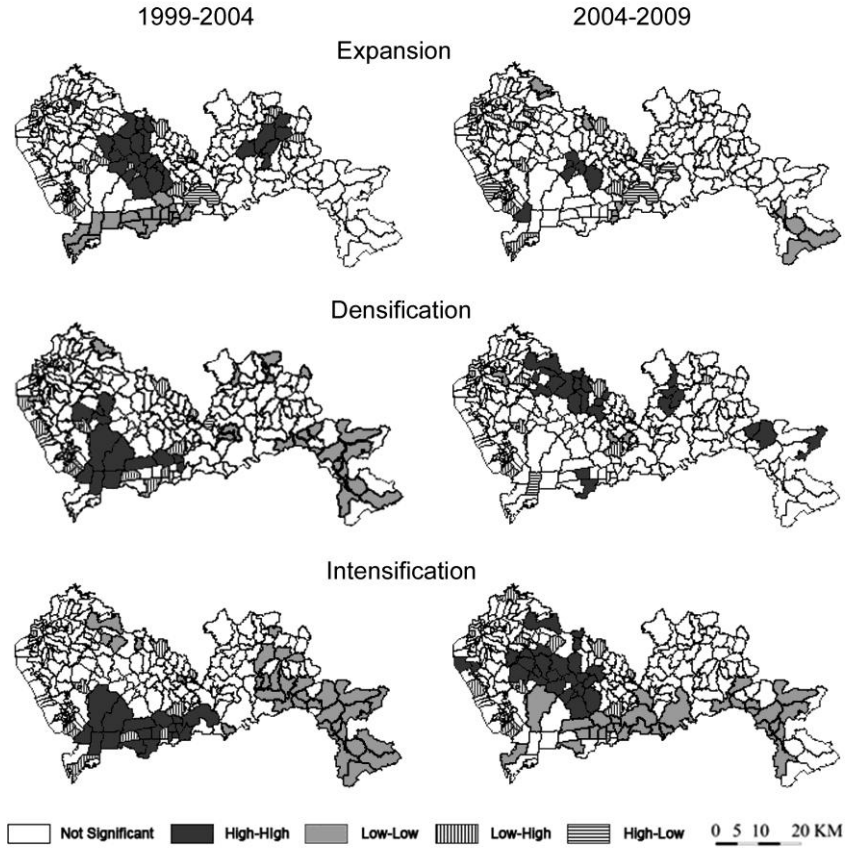

Figure 4: LISA cluster maps of urban village development in terms of expansion, densification and intensification respectively

The analyses have shown significant diversity of urban village development across the city. The development speed and scale of an urban village is determined by its location in the urban fabric, making the development phase of urban villages vary. At the city scale, the development of urban villages tends to be clustered and village development in terms of each development phase (expansion, densification and intensification respectively) manifests itself as a spillover effect from the inner districts to the outer ones. In terms of phases, the urban villages in the outer districts generally lagging behind those in the inner districts but following the same general development trajectory.

CONCLUDING REMARKS

This paper demonstrates the usefulness of GIS applications and measurements such as spatial autocorrelation in measuring the spatial and temporal structures of urban village development. At both city and urban village scales, the variance of urban village development is indicated. With the help of these measures, urban villages can no longer be viewed as uniform migrant enclaves as have been regarded in urban planning, but be viewed as a dynamic and heterogeneous urban component. The results generated by these measures could contribute to making more robust policy decisions about how to deal with urban villages in general and especially with specific ones in particular.

Moreover, the measuring and mapping of the land use of urban villages can also help to suggest possible contributing factors of the variance in their development, which is essential for the understanding of urban village development. For instance, good access to job locations may positively influence the growth of urban villages; and the land use pattern in urban villages' surroundings may impact their own land use development. To uncover the driving factors of urban village development is another challenging research topic, which is the subject of ongoing research that will be reported subsequently.

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