SMALL URBAN GREENERY: MAPPING AND VISUAL ANALYSIS IN KYŐJIMA-SANCHŌME

Jorge Almazán, Darko Radovic, and Tomohiro Suzuki

Abstract
This paper illustrates the practice of maintaining small greenery in a typical high-density, low-rise district in Tokyo through extensive mapping and systematic photographic analysis of vertical green coverage. Overlooked by statistics based on aerial photography, this paper describes small greenery and the way in which it improves urban scenery. As more cities are planning to increase their green surface, this paper aims to bring attention to the potential role of environmental and social sustainability played by small-scale vegetation. Such greenery, spontaneously cultivated by residents, not only contributes to embellishing the streets, but also serves as a social device to personalize and subtly characterize territories, while expressing the creativity and cohesion of the community.

Keywords
Greenery; Mapping; Vertical green coverage; High-density; low-rise

Introduction

Background and purpose
Throughout history, greenery has been considered an indispensable element in architecture and urban design because of its environmental, aesthetic, and recreational benefits. Even in the revolutionary avant-garde developments of the early 20th century, which aimed to make a radical departure from previous ideas on architecture and urbanism, vegetation was a dominant feature, such as in Ebenezer Howard’s Garden City and Le Corbusier’s Radiant City.

Today, studies on sustainability emphasize the multiple environmental benefits of greenery in urban environments: climate modification, carbon sequestration, ozone reduction (and consequently smog reduction), dry deposition of NOx, O3, and PM10 particulates, decreased rainwater runoff, and protection against flooding (Ong, 2003: 198). This thesis aims to inspire practitioners and contribute to the understanding of the relationship between greenery and the everyday practice of space through a case study in Tokyo.
Relevance
The relationship between vegetation and spatial practice was neglected in the modernist predominant tower-in-park typologies inspired by Le Corbusier. Postmodern theory has extensively exposed how such housing developments, originally designed as parks and gardens, too often ended up as abandoned spaces due to neglect and lack of care by their residents.

Tokyo is an example of a city in the midst of an intense debate on means to introduce more greenery. Recent residential developments are following the model of free-standing towers in open green spaces (Almazán and Tsukamoto, 2006). At the same time, there has been a boom of high-tech green facades and rooftops on office buildings, often as a demonstration of eco-friendliness. Several studies have shown the high running costs of these greening systems and the need to explore feasible greening methods for residential areas (Hirayama and Nakai, 2002; Shimomura, 2002; Espec Corp accessed in 2011). Considering the background of this ongoing debate, this paper aims to emphasize the relationship between greenery, architecture, and the practice of everyday life as an alternative to both tower-in-park and expensive greening systems for residential areas.

The notion of spatial practice, proposed by Lefebvre in 1974 (English translation in 1991) and developed by de Certeau in 1980 (English translation in 1988), stresses everyday life activities and the importance in the social construction of urban space. This paper documents a specific spatial practice in Tokyo, which can be found in many neighborhoods, by focusing on one clear case: an area with extremely narrow streets, high population density, and few open green spaces, but an area that nevertheless is often considered as having green character.

Figure 1: Area of public green spaces per capita in Tokyo and other capitals (Source: Tokyo Metropolitan Government, Statistics Bureau, Statistics Division Bureau of General Affairs, 2006).
Current condition of greenery in Tokyo

Tokyo (officially ‘Tokyo-to’, i.e. Tokyo Prefecture) is divided roughly into the densely populated 23 special wards in the east and the almost rural Tama Area in the west. As of 2000, the rate of green and natural areas including rivers was 29% in the 23 wards and 80% in the Tama area (TMG, 2001). Although, the Tama Area is part of Tokyo Prefecture, ‘Tokyo’ in this paper refers to the 23 wards, the most densely populated urban area. The percentage of green space in the 23 special wards is considered low by the authorities, and official policies often stress the necessity of increasing green surfaces. According to data from the Tokyo Metropolitan Government, planned green space and park space is extremely low in Tokyo prefecture compared with other major cities around the world (See figure 1).

Figure 2: Location of high-density, low rise areas according to Mizuguchi et. al (2011).
Major green surfaces in Tokyo are found along rivers and in parks. Greenery was historically connected with waterways, many of which disappeared during the 20th century, although there are still small linear green spaces along rivers flowing through the city (e.g., Nihonbashi River and Sumida River). Linear parks on the embankments of big rivers (e.g., Tama River and Ara river) have preserved their green character and play an important role in the city not only for recreation, but also as evacuation areas in the case of earthquakes and fires (Sejima Lab, 2008).

Regarding parks, most contemporary parks originated in the Edo period on private enclosed residences and garden precincts of feudal lords (e.g., Yoyogi Park, Shinjuku Gyoen National Garden, and Hamarikyu Onshi Teien). Today, these parks are public but they have retained their character by remaining isolated from the surrounding streets (Kitayama, 2005: 83–94).

Japanese traditional houses and suburban developments incorporating private gardens contribute to the overall green atmosphere. However, many housing lots have lost much of their gardens over the last century, mainly due to the gradual subdivision of lots as a result of high inheritance taxes (Kitayama et al., 2010: 38).

The disappearance of waterscapes, isolation of parks, and the gradual loss of residential gardens, as well as statistical comparison with other cities, might have contributed to the perception that Tokyo lacks greenery. However, this point of view often overlooks the smallest range of vegetation, which seems to thrive in densely built-up residential areas through innumerable planters and pots. A precise determination of the boundaries of these areas and the conditions that create this phenomenon are beyond the scope of this paper. However, an approximation of the location can be found on the map of Mizuguchi et al. (2010) showing “high-density low-rise residential areas in Tokyo” (see figure 2), where a high population density is defined as 200 persons per ha or more, and low-rise is defined as residential buildings up to 10m high.

**Case Study: Kyōjima-Sanchōme**

**Selection criteria**

Kyōjima-sanchōme (Sumida ward - Tokyo) was chosen as the area for fieldwork for the following two reasons: First, it can be considered a representative case because it is a prime example of a high-density, low-rise residential area (see table 1); and secondly, because it has one of the lowest green space coverage rates in Tokyo, several studies on this area have emphasized the presence of greenery. Through a series of visits, the authors came to identify greenery as a key aspect underlying the attractiveness of the place.

The clarity of Kyōjima-sanchōme’s urban morphology and the seemingly contradictory perception of vegetation make Kyōjima-sanchōme a case worth exploring in order to extract more general conclusions on the relationship between greenery and the everyday life practice of space.
Historical background of Kyōjima

First, it is necessary to clarify the Japanese address system to understand the boundaries of the area. Cities in Japan are subdivided into chō or towns, which are subdivided into chōme or districts. Kyōjima-sanchōme (meaning third district of Kyōjima town) is a sector in the larger area of Kyōjima.

Kyōjima was an area of paddy fields and marshes in the surroundings of Edo (name of Tokyo before the Meiji Restoration). Development started at the beginning of the 20th century with the construction of two railway lines and the establishment of several small factories. Damage caused by the 1923 earthquake was comparatively low in the area, and Kyōjima rapidly became a residential area as tenement houses were constructed to accommodate those in central areas who lost their houses. Without urban planning, the emerging development traced the patterns of former irrigation brooks.

Allied bombings during WWII destroyed large areas in central Tokyo, but again Kyōjima was one of the few undamaged areas, and people moved in. The population increased gradually, and in 1965 the town’s high density and fire risk due to narrow streets and wooden structures motivated the central government to declare Kyōjima as part of the Disaster Prevention Program (History sources: Rojikomi Map 2004; PPS accessed 2011).

Visits to Kyōjima by the authors in November and December 2010 suggest that the area has retained its economic vitality through a vibrant commercial street, the Tachibanaginza that crosses through the center of the district. However, the population decline, the decrease in the number of small factories, and the risks related to earthquakes seem to pose serious challenges to maintain this vitality.

Green Area Rate

Green space coverage, extracted from aerial photographs, shows that the three adjacent wards of Sumida, Chuo, and Taito have the lowest ratio (<10%) of the 23 special wards (see figure 3). Most of the areas in these wards, which are located east of Imperial Palace (old Edo castle), correspond roughly to the so-called shitamachi (low city) or commoner districts of the Edo Period. Although, Chuo ward contains residential areas such as Tsukishima rich in greenery, most of it surface is composed of commercial areas like Ginza or office areas like Yaesu and Nihonbashi. Taito ward, famous for

<table>
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<tr>
<th>Kyōjima-sanchōme</th>
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<tr>
<td>Population</td>
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<tr>
<td>Area</td>
</tr>
<tr>
<td>Density</td>
</tr>
<tr>
<td>Average age</td>
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<tr>
<td>No. of Households</td>
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Table 1: Urban parameters of Kyōjima-Sanchōme (Source: Authors).
historical sites like Asakusa and Ueno, contains districts such as Nezu and Yanaka rich in greenery, and Sumida has long linear parks along the rivers that form its boundaries. However, both Taito and Sumida wards are composed mostly of urban developments with a high building coverage.

In Sumida ward (see figure 4), Kyōjima is the chō with the lowest green space coverage (3.6%) (Sumida Ward 2010). The study area has an even lower ratio. From the aerial photograph (dated June 6, 2010; Google Earth), the green surface visually recognizable as vegetation has been extracted, and the green coverage rate has been calculated from the number of pixels (see figure 5). The result is 3.2%, which is lower than the 3.6% of Kyōjima. Kyōjima-sanchōme is thus a prime case of scarce greenery when seen from an aerial perspective.

Figure 3: Ratio of green space coverage in the 23 special wards of Tokyo (Source: extracted from online reports of each ward, see websites in the reference list).

Figure 4: Ratio of open green space coverage by town in Sumida ward (Source: Sumida Ward website).
Fieldwork Investigation

Several studies have identified greenery as an important element of Kyōjima’s identity (Tanaka and Nozawa, 2007; Ishizaka and Yamaga, 2008; Rojikomi Kyojima Production Group 2004). This however seems contradictory because the green space coverage is among the lowest in Tokyo. This study maps and examines the visual experience of small greenery which seems to be a decisive factor for clarifying this apparent contradiction.

The green space coverage as seen in an aerial photograph does not seem to reflect the level of greenery visible at eye level on the streets of Kyōjima-Sanchōme. The following two types of graphic documents were developed to clarify the specific patterns in which greenery appears and to further understand the experience of greenery from the street view: a complete greenery map of the area, including extra-small greenery; and photographic samples.

Mapping

Maps were created by plotting the position and type of greenery while walking through the area from November through December 2010. Vegetation was classified according to its visual impact from an eye-level perspective into the following six categories according to volume and height: 1. trees; 2. bushes; 3. hedges; 4. pots; 5. thickets; and 6. low growth. This classification system deliberately ignored the species of vegetation to ensure that the focus was spatial impact in relation to humans. The resulting map, showing all types of greenery and streets is shown in Figure 6. Streets were classified into the following 3 types according to width: Primary (> 4m), secondary (2.5 - 4m), and tertiary (< 2.5m).
Figure 6: Complete map of greenery seen on the streets and in relation to street type (Source: Authors).
Results of mapping
From the maps, each type of greenery was quantified (see table 2), and the following findings were obtained.
- Trees, hedges, and low growth were observable in aerial photographs; pots and thickets were not.
- High trees appeared along the perimeter streets, on elementary school ground, and in small public parks (often called in Japanese pocket parks).
- Hedges were located around pocket parks and in the vicinity of larger collective housing.
- Low growth covered vacant lots. The presence of non-occupied lots is quite common in Tokyo, where houses have an average life of 30 years and where the city is said to be continuously being rebuilt or ‘metabolizing’ (Kitayama et al., 2010).
- Small greenery was scarce around bigger buildings such as clinics, public baths, and collective housing buildings. The presence of pots seems directly related to the front of detached houses, which have footprints of 20 - 60 m².
- The most prominent result was the number of pots observed (910), distributed extensively throughout the area and located mainly in the narrower tertiary streets. The small street scale seems to invite residents to personalize their alleys.
- The amount of pots decreased in streets ≤1.5 m wide, likely because plants in such narrow streets obstruct traffic. In some cases, plants were used to demarcate boundaries in an obvious manner to avoid people from crossing them. Observations suggest that when a street narrows to ≤1.5 m, it becomes more of a gap between houses than a conventional street, and personalization of house fronts receives less attention by residents.

As could be expected, the narrowness of streets and the small individual houses incentivize the personalization of street spaces through pots. The density of the area in this case is such that whole sectors of streets are fully covered by greenery placed spontaneously by residents.

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Visible in Aerial Photographs</th>
<th>Not Visible in Aerial Photographs</th>
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<tbody>
<tr>
<td>Primary (≥4 m)</td>
<td>Tree 133, Bush 44, Low growth -</td>
<td>Hedge 69, Hedge-total length (m) 374.0</td>
</tr>
<tr>
<td>Secondary (2.5–4 m)</td>
<td>Bush 173, Low growth -</td>
<td>Hedge 36, Hedge-total length (m) 356.9</td>
</tr>
<tr>
<td>Tertiary (&lt;2.5 m)</td>
<td>Low growth -</td>
<td>Hedge 25, Hedge-total length (m) 205.1</td>
</tr>
<tr>
<td>Amount</td>
<td>405</td>
<td>1013.8</td>
</tr>
</tbody>
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Table 2: Quantity of each type of greenery by street type (Source: Authors).
Visual analysis
The mapping helped to understand the distribution of greenery and its relationship to buildings and street width. However, the maps were unable to describe the visual experience of space. Six streets were chosen as samples (See figure 7). This sampling does not aim to be exhaustive, and conclusions will be treated as suggestions. However, as a first approach to this complex phenomenon, a series of clues or insights can be extracted through the analysis of the samples. These extracted variables can be applied to other street spaces in future research.

- A: Primary streets (4 m). The selected section is a random sample of the perimeter streets forming the boundaries of the district. On-site observations showed that there were no major visual differences along these streets and therefore the selected section can be used as a representative of this type.
- B, C, and D: Secondary streets (2.5–4.0 m). These streets constituted the bulk of streets in the district (Table 3). Each street was slightly different and all contained all types of greenery. However, the sampled streets were selected to reflect subtle differences. B had a prominent presence of hedges, C was full of small pots, and D had a comparatively higher number of trees.

- E and F: Tertiary streets (<2.5 m). Compared with the secondary streets, tertiary streets presented a predominance of small greenery, especially pots. For sampling, two streets were selected with very little in common: E is a dead-end with few pedestrians, whereas F is connected to a primary street.

<table>
<thead>
<tr>
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<th>Length (m)</th>
<th>Area (m²)</th>
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<tbody>
<tr>
<td>Primary</td>
<td>2,659.7</td>
<td>5,697.8</td>
</tr>
<tr>
<td>Secondary</td>
<td>3,386.7</td>
<td>11,657.9</td>
</tr>
<tr>
<td>Tertiary</td>
<td>4,860.3</td>
<td>8,013.8</td>
</tr>
<tr>
<td>Total</td>
<td>10,906.7</td>
<td>25,369.4</td>
</tr>
</tbody>
</table>

Table 3: Length and area of each type of street (Source: Authors).

**Visual analysis method**

To examine visual experience, vertical green coverage was applied. Vertical green coverage is an index that measures the amount of greenery and is often used in the survey of street landscapes (Moriguchi et al., 2005: 89 - 101). Vertical green coverage is calculated using the presence of greenery in photographs. The method used is as follows (see figure 8):

- A Nikon D90 camera with a 28mm lens was used. According to Aoki (1975: 163 - 68), although the human field of view of approximately 60 degrees corresponds a photographic focal length of 28 to 35mm lens in 35mm format, for the study of vertical green coverage in the case of residential streets with characteristics similar to those of this study, the focal length of 28 mm showed the most accurate correlation between the real view on the site and the evaluation of photographs by residents.

- Shooting points were chosen to reflect the sequence of significant changes in the visual experience. Streets were photographed from five types of points: 1. Edge of street; 2. Curves; 3. Intersections (including the view toward perpendicular streets); 4. Points with width changes; and 5. Points with changes in the amount and distribution of greenery.

- Photographs were taken along the street axis to simulate walking in a particular direction. A height of 1.5 m assumed as average height of human eyes.
The second step was to extract the vegetation from photographs using Adobe Photoshop. Vegetation was classified and separated into image layers (following the same categories as in mapping: trees, bushes, pots, hedges, thickets, and low growth. To reproduce the sequential experience, the images were layered into a composite image and merged (see figure 9). Finally, the ratio of vertical green coverage was quantified from the number of pixels in each image.

**Visual Analysis Results**

Results are summarized graphically in Figures 10 and 11. The amount of vertical greenery (expressed as percentage) showing total visual green rate and type of greenery has been summarized in Figures 12 and 13.
Figure 10: Graphic summary of the visual analysis of streets A, B, and C (Source: Authors).
Figure 11: Graphic summary of the visual analysis of streets D, E, and F (Source: Authors).
Several characteristics concerning amount, type, and distribution of vertical greenery can be observed. Primary Street A (see figure 12) had the lowest average vertical green coverage (10.0%). Vegetation was composed of trees with high trunks placed regularly along the street. In summary, it can be said that this street offered low greenery placed in a homogeneous pattern non-intimately in relation to human vision.

In comparison, secondary streets B, C, and D show both a higher amount of vertical green coverage and more types of greenery (see figures 12 and 13). As seen in the merged image of all vegetation layers, visual density of greenery is closer to eye level and can be considered to have a more intimate relationship with pedestrians (see figures 10 and 11). Slight differences can be observed. Street B has a remarkable presence of hedges, which surround new buildings. Hedges contribute to vertical green coverage, but compared with planters, offer less varied scenery. The merged image of street C shows more density below eye level (pots and bushes), and in street D, the greenery extends above eye level due to the presence of trees.

Figure 12: Percentage and type of vertical green coverage at each shooting spot in streets A, B, and C (Source: Authors).
Maps of tertiary streets showed a higher presence of greenery (See figure 13). Street E showed the highest vertical green coverage (24.2%) and variety of vegetation type. As for F selected for presenting less vegetation on the maps, it was confirmed that visual greenery was also scarce (12.1%), although its width of 1.2 m suggested an intimate atmosphere where residents could personalize the street. The authors observed that this lower amount of greenery might be related to the fact that it is linked with a primary street and that there are numerous pedestrians compared with other tertiary streets.

In sum, visual analysis of samples showed that the presence of greenery is high in the same streets where the map showed only small greenery - not even visible from aerial photographs. This can be explained by not only the narrowness of the street, but also the distribution: small vegetation on the floor is closer to eye level and can be perceived in a more intimate manner. In addition, diversity seemed to be an important factor: more diverse greenery contributes to enhancing its presence. In particular, planters seem to contribute to the experience of greenery in Kyōjima-Sanchōme. Their various densities, shapes, and colors, and...
their placement close to eye level can be said to play a decisive role in creating a green visual environment.

**Discussions and Conclusion**
Statistics show that there are few public green spaces in Tokyo compared with other world cities. However, plenty of small greenery can be seen in high-density low-rise residential areas. This paper maps this type of greenery in a case study area and analyzes the visual experience of several sample streets.

Mapping based on field work showed that the narrowness of the streets and the small individual houses incentivize personalization of the street space with pots. Small greenery does not occupy horizontal area and it is not reflected on aerial photographs but visual analysis shows that many narrow streets have a marked green character created by small vegetation placed spontaneously by residents. Spontaneity creates varied scenery, which contrasts with the homogeneity of tree-lined street and hedges around recently constructed apartment buildings. Judging from the distribution of greenery on the map and its visual experience, it is clear that small greenery plays the most important role in creating a general sense of greenery in Kyōjima-Sanchōme. This study shows that even in small spaces (such as the streets of the study area), a general quality of greenery can be created by promoting and supporting the individual practice of putting and caring for small private greenery such as pots and bushes in public streets.

The appearance of this type of greenery is an unplanned phenomenon that seemed to emerge as a delicate junction of factors, such as appropriate size of the street, appropriate amount of pedestrians, density, and small housing type. This fragile balance can be broken easily. In fact, in recent years, in small urban renovation projects, the increase of pocket parks, the widening of streets and the construction of collective housing has been progressing in Kyōjima, and the small and diverse greenery has disappeared on many sites.

Desirable spatial practices could be reinforced by understanding the physical frame that supports them. Benefits from the practice of taking care of small gardens or planters seem to extend beyond visual and environmental factors; they also become social devices to personalize space, mark territory, and express the creativity of the residents in Kyōjima.

This study has many shortcomings for fully understanding the phenomenon and for developing useful concepts for designers to implement the desirable effects of spontaneous greenery. The focus is on the visual presence of greenery, but a more comprehensive approach will be needed in further studies to include vegetation species and measured environmental impact (e.g., cooling, smell, light, and shade). In addition, fieldwork, performed in November and December, needs to be extended to observe the flow of time and seasons.

In spite of the necessary further studies, this paper might contribute to shedding light on the importance of small greenery in times where cities throughout the world are embarking on plans to increase their green surface. Spontaneous greenscapes supported by small urban spaces and the residents’ practice of space in everyday life can play a relevant role in social and environmental sustainability.
Acknowledgement
The authors would like to acknowledge Ryosuke Fujii, Master's Degree Student of the Center for Space and Environment Design Engineering (Keio University), for his contribution in the development of the earlier phases of this investigation.

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