# The spatial distribution of green spaces in the urban fringe of Bangkok

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**Abstract**

Urban green spaces with a wide variety of functions to ameliorate the urban environment have been decreased and fragmented in the urban fringe areas of Southeast Asian cities. In order to elaborate practical and efficient plans to conserve urban green spaces, it is very important to understand changing process and spatial distribution of green spaces, and to monitor them continuously. From this viewpoint, we inspected green cover, land-use and landholding, and their correlations in the urban fringe of Bangkok using GIS. As a result, the following four facts are revealed. First, urbanization has been proceeding together with land fragmentation, and green cover is finally diminished after the construction of a new house on a subdivided vacant plot. Second, rural land-uses sustain high green cover, while urban land-uses have relatively low green cover with a several range depending on the type of housing. Third, rural land-use is tied to a canal, whereas urban land-use is linked with a road; besides these development patterns influence on the distribution of green spaces. Finally, the inaccessible landlocked plots with high green cover are observed a lot.

**Keywords**: Green cover ratio; Land-use; Landholding; GIS; Bangkok

## 1. Introduction

Urban green spaces have been decreased and fragmented in the Southeast Asian cities due to rapid urbanization recently (Murakami et al., 2004). Most Southeast Asian big cities are located on deltaic lowlands. Urbanized areas have been expanding into the hinterland, or agricultural lands represented by broad rice fields. These peripheral agricultural lands have a wide variety of functions to resist environmental deterioration. Paddy fields, in particular, play a significant role in flood protection (Hara et al., 2002). Therefore, it is practical to regard them actively as future urban greens instead of clearing them for the new foundation of costly public city parks (Yokohari et al., 2000).

In order to conserve agricultural lands as urban greens, and to harmonize them with urban land-uses, we first have to understand their dynamics on a detailed scale. Moriwake et al. (2000) reported the distribution and the structure of urban green spaces in Metro Manila. There have been few case studies on a micro scale, however, that dealt with it in Bangkok.

In this regard, we examine changing process and spatial distribution of green cover, land-use and landholding, and correlations between them using GIS in the urban fringe of Bangkok.

## 2. Study sites

We select two study sites in the urban fringe area of Bangkok (Fig. 1).

Site A is included in SaiMai district of Bangkok Metropolitan Administration (BMA). Originally, site A was covered with intricate natural-based canals and wrap-shaped rice fields (Hara et al., 2004). From the 1980s, site A has been developed as a part of the northern corridor of Bangkok (Kaothien, 1995; Sheng and Rahman, 1995), and urban land-uses have been expanding along the haphazard roads (BMA, 1997). In zoning under BMA comprehensive plan, this site is set equally as low-density residential zone (BMA, 2003).

Site B belongs to LamLukKa district of PathumThani province. Site B was occupied with a grid canal system and large rectangle-shape rice fields historically (Hara et al., 2004). Site B has been urbanized after the construction of the "Outer Ring" freeway that connects this area and the center of Bangkok directly in the middle of the 1990s (LamLukKa district office, 2002).

Thus, these two sites are contrastive in the past agricultural facilities and the beginning period of urbanization.

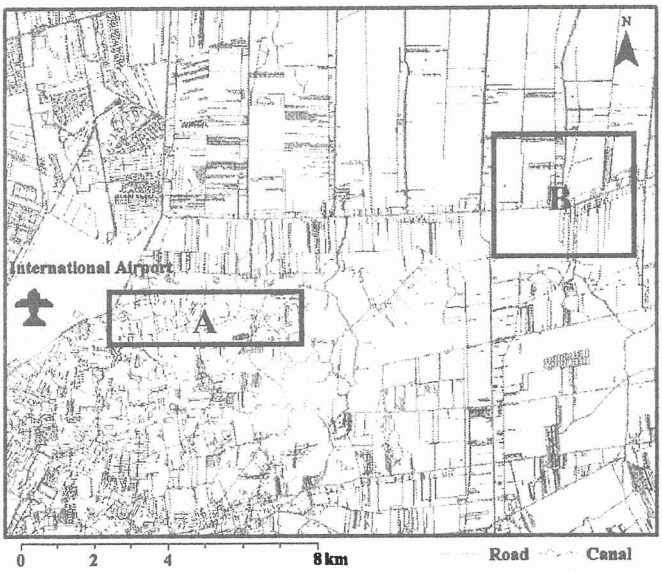


Fig. 1. Study sites.

## 3. Methods

Original data sources are shown in Table 1. Our field surveys were conducted in July 1999, August 2000, August 2001, July 2002 and November 2002, and the total term was about three months.

Table 1. Data sources.

| *Elements* | *Site A* | *Site B* |
|---|---|---|
| Landholding | ◊ Cadastral map for 2000. | ◊ Cadastral map for 2000. |
| Land-use | ◊ Aerial photos taken at 1:6000 in 1998.<br>◊ Aerial photos taken at 1:40 000 in 1952. | ◊ Two QuickBird images on May and December 2002.<br>◊ Aerial photos taken at 1:40 000 in 1952. |
| Green cover | ◊ Aerial photos taken at 1:6000 in 1998. | ◊ Two QuickBird images on May and December 2002. |

### 3.1. Landholding

Traditionally, the land in Thailand belonged to the King. In 1901, the government adopted the Torrens system of land titles, modeled after the Australian system, which provided for cadastral surveys and central land record offices. The Land Code of 1954 is the basis for the legal system of land rights in Thailand today (Tasaka and Nishizawa, 2003). After 1972, systematic surveys using aerial photographs were introduced. We used the cadastral maps that were formed in this context for our landholding analysis. The cadastral maps in 2000, which were obtained from the local land offices, for our two study sites were digitized as vector data using GIS program, TNTmips version 6.8 (MicroImages Inc, Lincoln, NE, USA). The line of the former landholding before land fragmentation marches, moreover, which was verified with the local older people and land officers, was also traced out.

### 3.2. Land-use

Land-use of every lot in the above-mentioned digital cadastral maps for 2000 was decided based on a field survey and interpretations of aerial photographs that were taken at approximately 1:6000 in 1998 (obtained from the Royal Thai Survey Department) and satellite images from QuickBird in 2002. Land-use categories that are shown in Table 2 and Fig. 2 stood on our field survey and previous studies (Iwata and Watanabe, 1988; Hara et al., 2004). We also estimated former land-use per plot from aerial photos taken at approximately 1:40 000 in 1952 (obtained from the Royal Thai Survey Department too).

Table 2. Land-use categories.

| *Types* | *Categories* | *Explanations* |
|---|---|---|
| Urban | Apartment | Typical apartment house. |
| | Village-style housing | New village built by a developer; includes a security gate and wall. |
| | Townhouse | Economical apartment houses that are connected each other. |
| | Shop-house | Linear two/three-story houses whose first floors are shops. |
| | Road | Called *soi* in Thai. |
| Rural | Individual house | Traditional housing usually located along a canal. |
| | Orchard | Main crops are coconut, mango, banana and jackfruit. |
| | Forest | Acacia and bamboo are well observed. |
| | Rice field | Double/triple cropping a year is possible. |
| | Pond | Mostly fishponds, and a just excavation after getting landfill materials. |
| | Vacant lot | Subdivided vacant plot for constructing a new building. |
| | Canal | Called *khlong* in Thai. |

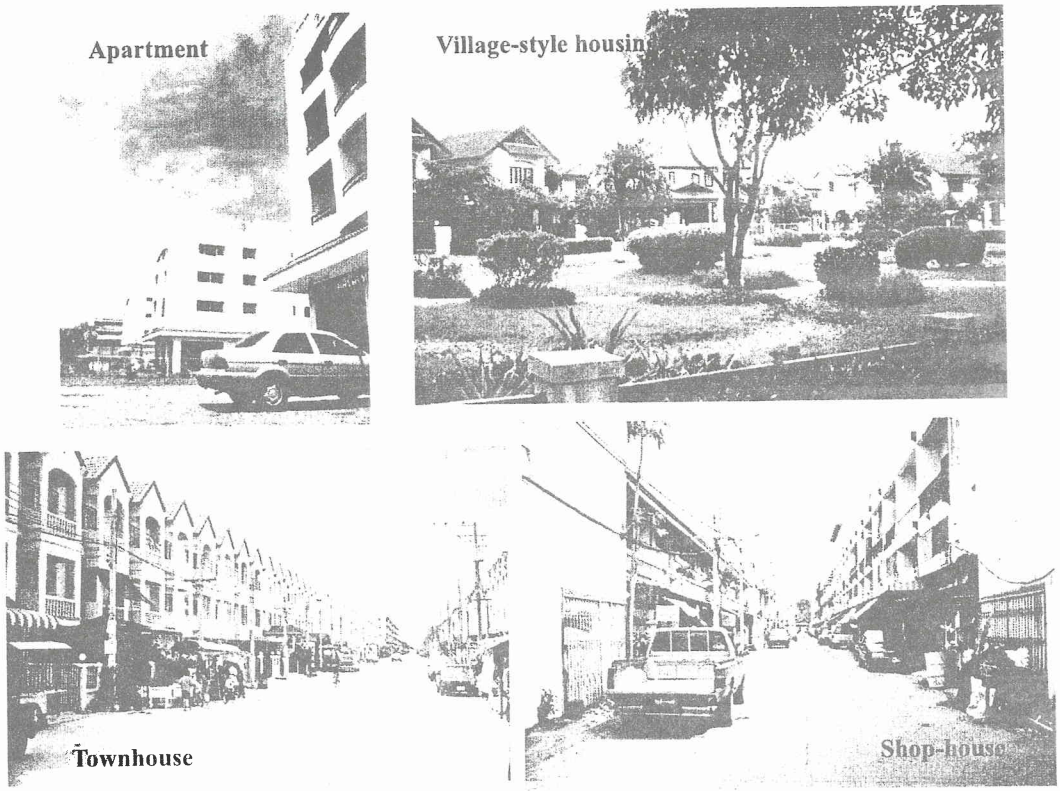


Fig. 2. Typical examples of urban land-uses.

### 3.3. Green cover

In green cover, we determined grass cover ratio and tree cover ratio of every parcel from these photos and images.

## 4. Results and discussion

### 4.1. Landholding and land fragmentation

Fig. 3 is a part of the current digital cadastral maps for both the study sites with remote sensing images (aerial photographs in 1998 for site A and the QuickBird image in 2002 for site B). Aerial photos in 1952 with the reconstructive boundary of original properties were also inserted into Fig. 3. According to this figure, both the sites were founded as large property areas in lands originally. It is supposed that an inhabitant who lived in a traditional individual house along a canal owned a large rice field behind. Original lots of site A were outlined with intricate natural-based canals, whereas those of site B were done with more artificial grid-type canals. The present cadastral maps suggest that urban land-uses have been expanding with indispensable land fragmentation in both the sites.

Table 3 reveals the frequency distribution of the whole parcels. The parcel size classes were defined for clarifying landholding characteristics of both site A and site B. This table implies lands of site A are more fragmented than those of site B owing to the original landholding situation and the beginning period of land development.

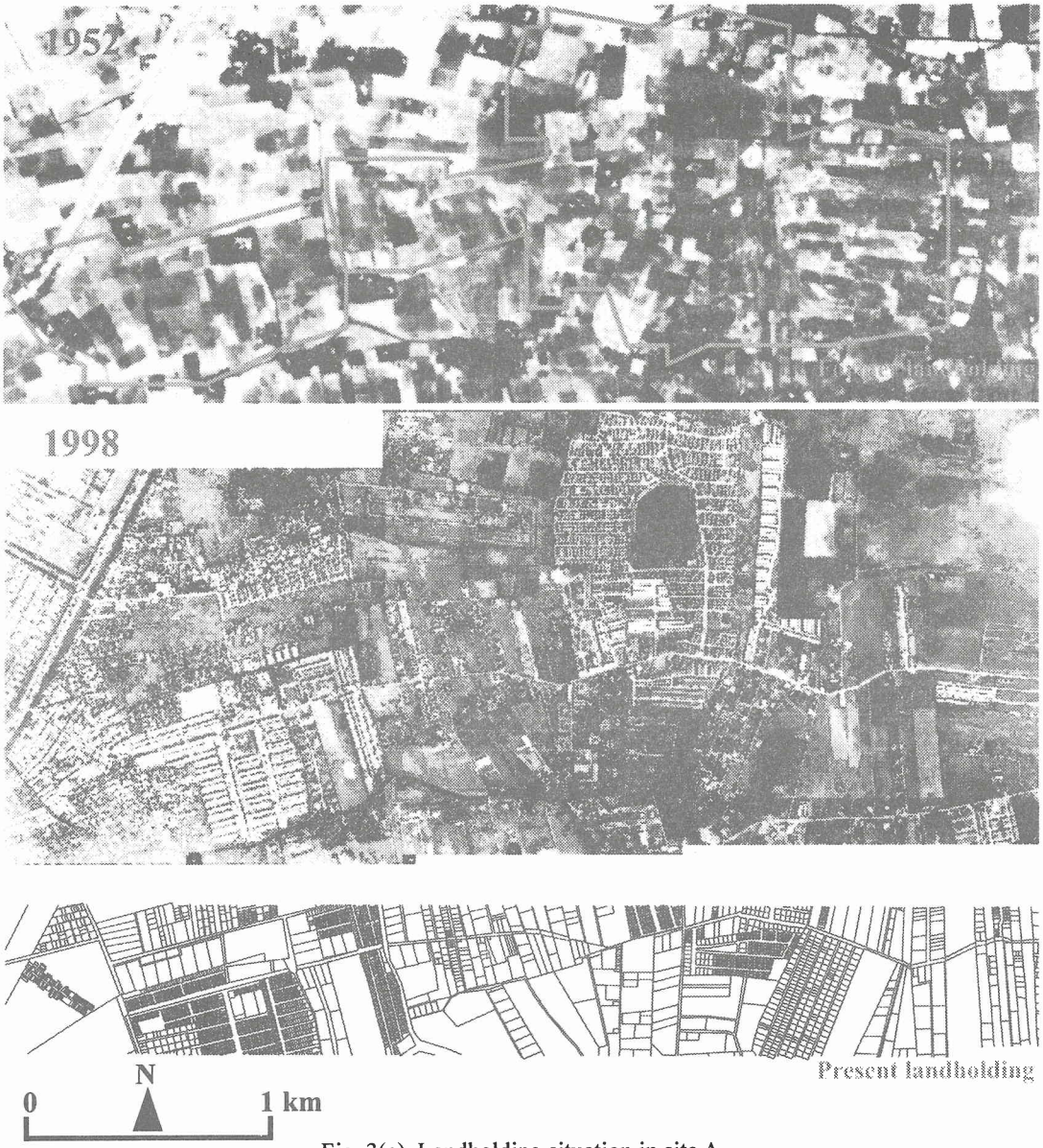


Fig. 3(a). Landholding situation in site A.

Table 3. Frequency distribution of the whole parcels.

| *Sizes* | *Site A* | *Site B* |
|---|---|---|
| **Very Small** (0 – 100 $m^2$) | 1575 | 39 |
| **Small** (100 – 1000 $m^2$) | 864 | 364 |
| **Middle** (1000 – 3000 $m^2$) | 133 | 312 |
| **Large** (3000 – 8000 $m^2$) | 39 | 364 |
| **Very Large** (8000 – $m^2$) | 9 | 368 |
| Total numbers of parcels | 2620 | 1447 |

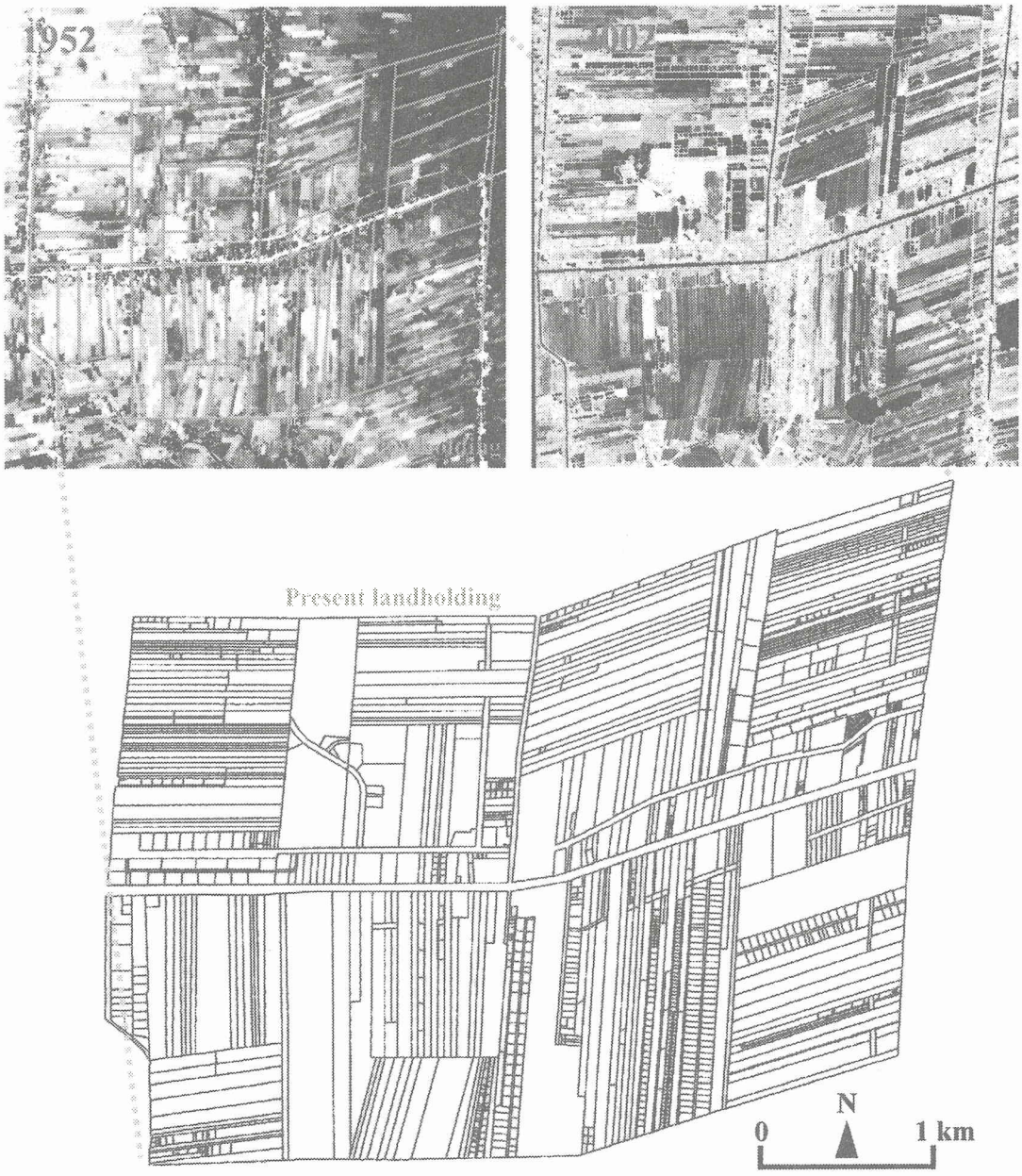


Fig. 3(b). Landholding situation in site B.

### 4.2. The relationship between landholding and land-use

Fig. 4 shows the relationship between the landholding sizes and land-uses; except road and canal as public land-ownership. According to this figure, the less lot size is, the less agricultural land-use is observed in both study sites. Individual houses are seen in a wide range of lot size, whereas townhouses and shop-houses are normally founded on small plots. As for site B, vacant lots occupy quite a number of parcels below middle class in the plot size. The economic recession next to keeping lands for investment might hinder the new construction on these empty lots (Japanese Chamber of Commerce, 2001).

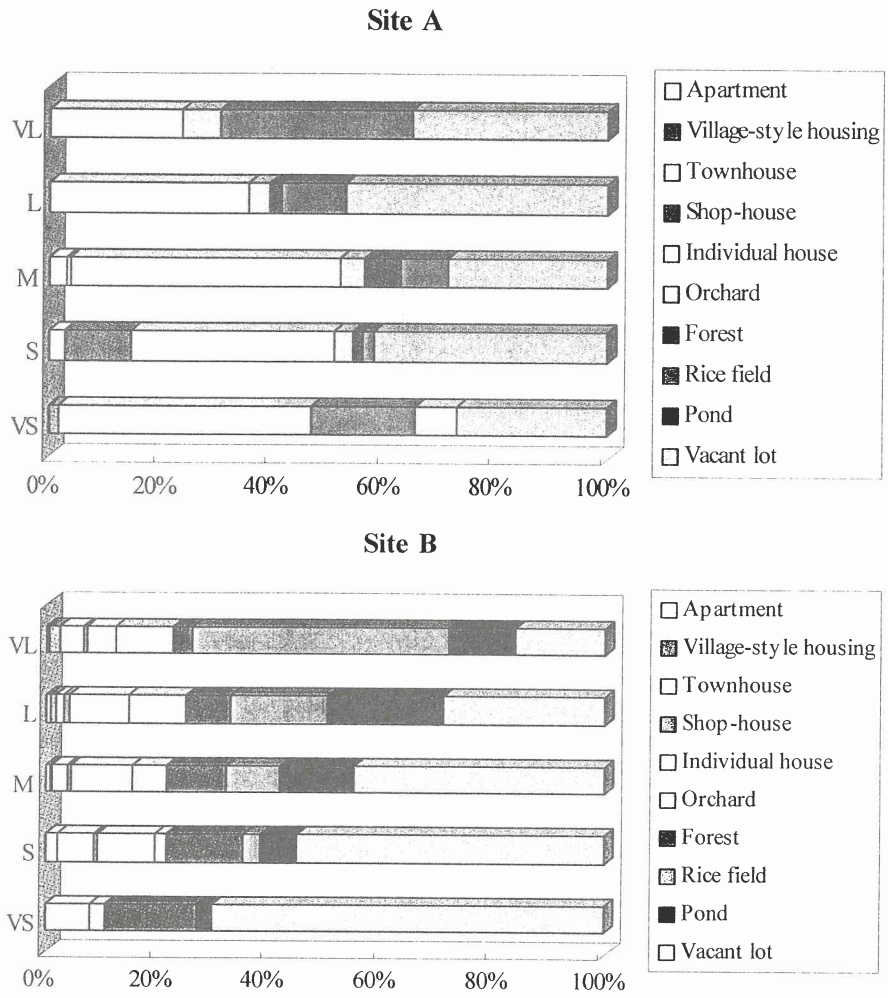


Fig. 4. The relationship between the landholding sizes and land-uses.
(VL=**V**ery **L**arge; L=**L**arge; M=**M**iddle; S=**S**mall; VS=**V**ery **S**mall)

### 4.3. The relationship between land-use and green cover

Fig. 5 shows the relationship between land-use and green cover. On the basis of this figure, in both the study sites, agricultural land-uses keep high green cover ratio, whereas urban land-uses have relatively low green cover ratio. In other land-uses except agricultural lands, a vacant lot has high grass cover ratio, and an individual house sustains high tree cover ratio. In addition, green cover ratio of village-style housing by a developer is higher than that of a townhouse.

### 4.4. The relationship between landholding and green cover

Fig. 6 gives the relationship between the landholding sizes and green cover. In both the sites, grass cover ratio is highest at a largest plot because of a dominant rice field. Green cover of site A falls at a smallest lot class, whereas that of site B keeps high ratio. These small green lots in site B are almost vacant for new housing; hence it seems difficult to keep such green spaces stably in the future.

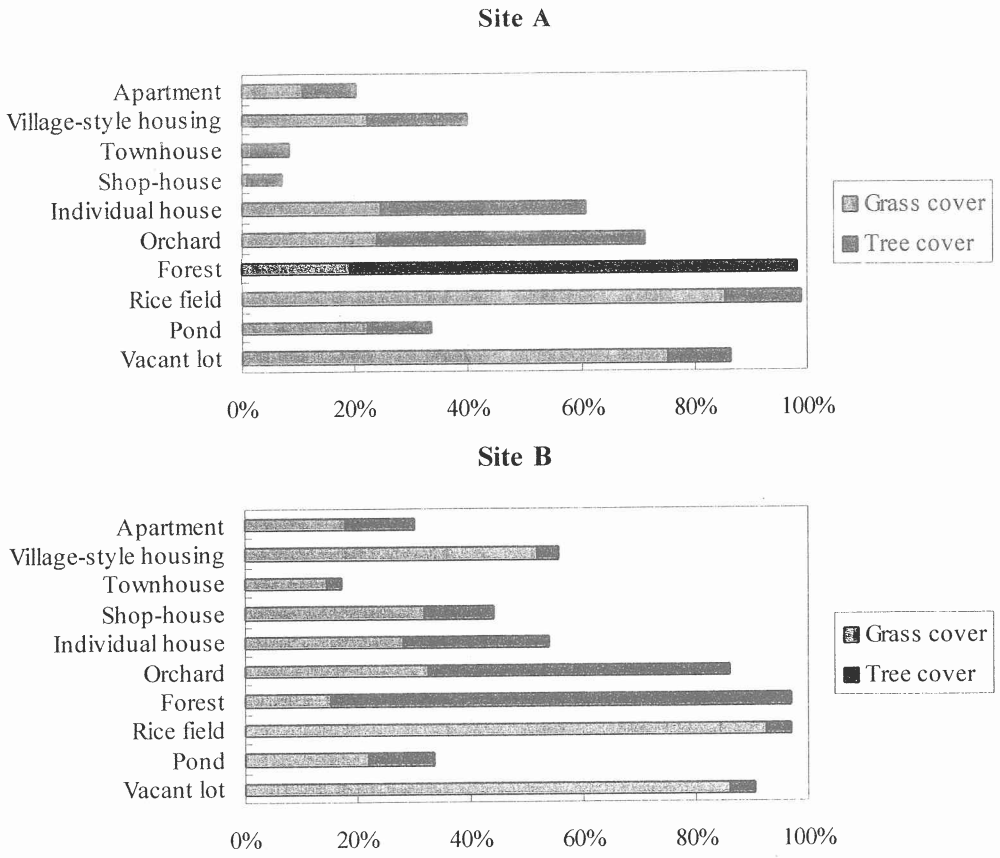


Fig. 5. The relationship between land-uses and average green cover ratio.

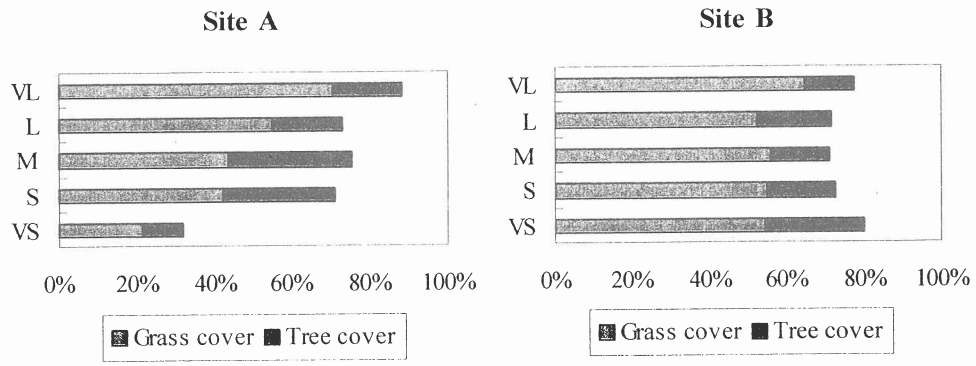


Fig. 6. The relationship between the landholding sizes and average green cover ratio.
(VL=**V**ery **L**arge; L=**L**arge; M=**M**iddle; S=**S**mall; VS=**V**ery **S**mall)

### 4.5. Road and canal impacts on urban and rural land-uses

According to a sequence of the above-mentioned observations, it was expected that the distribution of land-uses and green cover would have close respect to road and/or canal formation in our study sites. We tallied up the polygons, therefore, depending on bordering with or without roads/canals (Fig. 7).

Fig. 8 shows the road impact on urban and rural land-uses. From this figure, it is supposed that urban land-use and a road have been expanding together. In site A, lands without roads, or inaccessible

landlocked plots are well observed at a middle size lot class, whereas the ratio of inaccessible lots is lower than that of accessible lots at any lot size class in site B.

Fig. 9 shows the canal impact on urban and rural land-uses. From this figure, it is supposed that rural land-use had been pioneered together with a canal. In both study sites, large size agricultural lots are located along canals. It might be difficult to draw the water into the fragmented rural plots.

Thus, urban land-use is paired with a road, whereas rural land-use is coupled with a canal. From a pure urban planning standpoint, a planner might consider such a landlocked plot without a road to be useless. In fact, these landlocked plots have relatively high green cover (refer to Fig. 6); therefore, we can also see them as urban green resources hereafter.

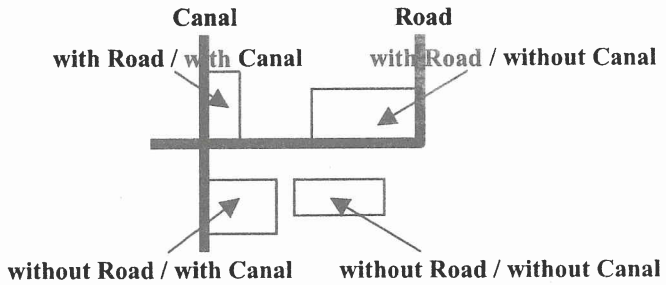


Fig. 7. Classification of polygons.

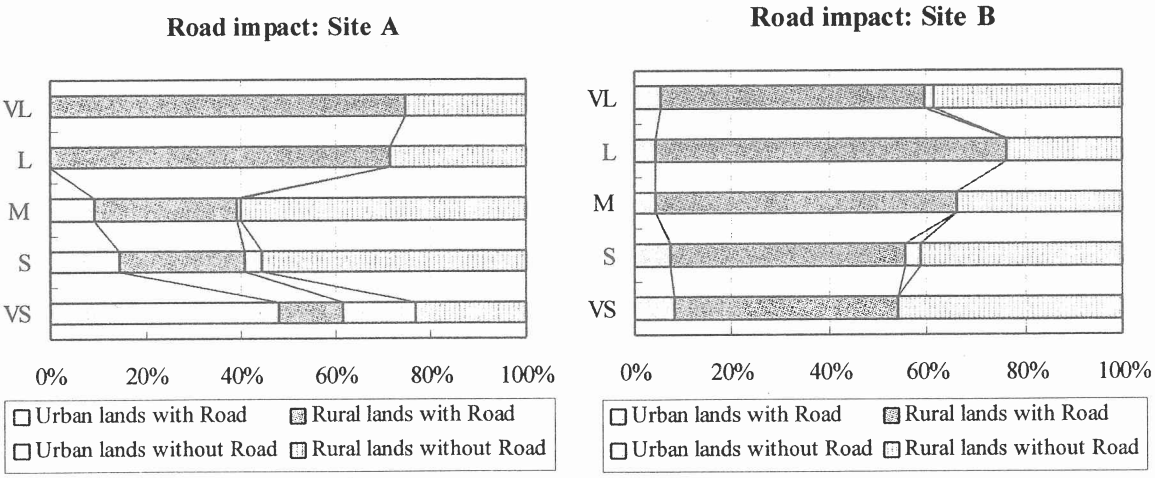


Fig. 8. Road impact. (VL=Very Large; L=Large; M=Middle; S=Small; VS=Very Small)

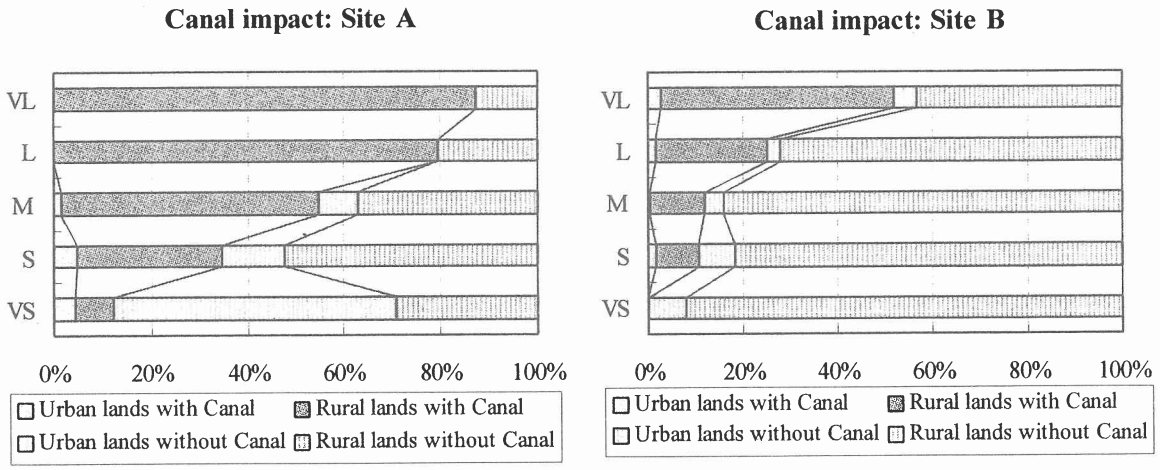


Fig. 9. Canal impact. (VL=Very Large; L=Large; M=Middle; S=Small; VS=Very Small)

## 5. Conclusions and recommendations

The results of this study are summarized as the following four items.

(1) Urbanization has been proceeding together with land fragmentation. Green cover is finally diminished after the construction of a new house on a subdivided vacant plot.

(2) Rural land-uses sustain high green cover, while urban land-uses have relatively low green cover with a several range depending on the type of housing.

(3) Rural land-use is tied to a canal, whereas urban land-use is linked with a road. These development patterns influence on the distribution of green spaces.

(4) The inaccessible landlocked plots with high green cover are observed a lot.

The following propositions to avoid deterioration of green spaces in the future could be added.

(a) To control a rapid expansion of urban land-use through restriction of land fragmentation.

(b) To conserve rural land-use as future urban green spaces through promotive and supportive programs for agricultural activities of both a landowner and a peasant.

(c) To consider appropriate green cover ratio depending on housing style in the case of urban land-use.

(d) To comprehend both road and canal networks as driving forces on land-use and green cover changes.

(e) To elaborate practical plans for using landlocked plots as green spaces.

In the current comprehensive plan, the greenbelt as the area to store inundation is established (BMA, 2003; Kidokoro, 1997). This study reveals that leapfrog development is proceeding in site B as the further area, whereas respectable rural lands with high green cover still remain in site A as the area under residential zoning. Micro-scale land-use and lot size controls focusing on green spaces might be needed.

### References


BMA, 1997. SaiMai District Plan. 394pp. (In Thai)

BMA, 2003. Comprehensive City Plan. <http://203.144.180.217/office/cpd/eng-map.html>

Hara, Y., Haruyama, S., Okubo, S., Takeuchi, K., 2002. Flood hazard response to the urbanized bank up areas of Laguna Lacustrine Plain, Metro-Manila. Transactions of Rural Planning 4, 19-24. (In Japanese with English abstract)

Hara, Y., Takeuchi, K., Okubo, S., 2004. Urbanization linked with past agricultural landuse patterns in the urban fringe of a deltaic Asian mega-city: A case study in Bangkok. Landsc. Urban Plan. (forthcoming)

Iwata, T., Watanabe, S., 1988. A grouping and its estimation on detached housing areas in Bangkok urban fringe area: a study on typology of residential areas in Asian large cities #1. Papers of the Annual Conference on City Planning 23, 85–90. (In Japanese with English abstract)

Japanese Chamber of Commerce, 2001. Economic Situation of Thailand. Bangkok, 497pp. (In Japanese)

Kaothien, U., 1995. The Bangkok Metropolitan Region: Policies and issues in the Seventh Plan. In: McGee, T.G., Robinson, I.M. (Eds.), The Mega-Urban Regions of Southeast Asia. UBC Press, Vancouver, pp. 328–340.

Kidokoro, T., 1997. A study on the cultural factors influencing the introduction of greenbelt in Bangkok. Papers of the Annual Conference on City Planning 32, 193–198. (In Japanese with English abstract)

LamLukKa district office, 2002. LamLukKa 2002-2006 5-year Plan. 99pp. (In Thai)

Moriwake, N., Palijon, A.M., Takeuchi, K., Tsunekawa, A., 2000. Distribution and structure of urban green spaces in Metro Manila. The Proceedings of International Symposium on City Planning 2000, Kobe, Japan, 214-223.

Murakami, A., Zain Medrial, A., Takeuchi, K., Tsunekawa, A., Yokota, S., 2004. Trends in urbanization and patterns of land use in the Asian mega cities Jakarta, Bangkok, and Metro Manila. Landsc. Urban Plan. (Article in Press)

Sheng, Y.K., Rahman, A., 1995. Housing women factory workers in the northern corridor of the Bangkok Metropolitan Region. In: McGee, T.G., Robinson, I.M. (Eds.), The Mega-Urban Regions of Southeast Asia. UBC Press, Vancouver, pp. 133–149.

Tasaka, T., Nishizawa, K., 2003. An Introduction to Land Tenure History in Bangkok. Nippon-Hyoron-Sha, Tokyo, 336pp. (In Japanese)

Yokohari, M., Takeuchi, K., Watanabe, T., Yokota, S., 2000. Beyond greenbelts and zoning: a new planning concept for the environment of Asian mega-cities. Landsc. Urban Plan. 47, 159–171.