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| Author(s) | Nguyen, Cao Huan; Nguyen, An Thinh; Narumi, Kunihiro et al. |
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# CLASSIFYING SMALL AREAS IN HANOI FOR URBAN LANSCAPE MANAGEMENT - BASED ON FACTOR AND CLUSTER ANALYSIS METHOD

**Nguyen Cao Huan[*], Nguyen An Thinh[*], Kunihiro Narumi [**], Masanori Sawaki [**]**
(*) Hanoi University of Science, VNU
(**) Osaka University, Japan

## ABSTRACT

Urban analysis and classification on base of integrating infrastructure - landscape - socioeconomic and environment indexes, is a useful tool for urban landscape management practices to enhance urban quality. A conceptual model was established for analysis and classification of small urban areas..

In this paper, multivariate analysis methods (factor analysis, cluster analysis) are used for classification of small area units (basic urban landscape forms) in four districts of Hanoi (Hoan Kiem, Tay Ho, Ba Dinh, Cau Giay districts). Using a data set of more than 200 survey forms with 39 items, 115 smalls area units have been grouped into 13 urban landscape zones representing varied functions and structures of the investigated districts. According to the characteristics of urban landscape zones, recommendation on urban landscape management for Hanoi urban is also given.

## Key words

Classification and characteristics of small urban areas, cluster analysis, factor analysis, Hanoi city, small urban areas, urban landscape management..

## INTRODUCTION

Industrialization and modernization process during the Doimoi period has a very strong impact on urban structure, infrastructure, landscape architecture and environmental quality in Hanoi city. During the Doi Moi period, Hanoi city is much changed, especially in land use. A map of land use change in Hanoi city during the period 1983-1996 has been done by Narumi Kunihiro, Nguyen Cao Huan et al (2000-2003). This map was created mainly on base of qualitative data from survey and it serves as fundamental map for further study. This study focuses on quantitative data of survey in small urban areas at bigger scale for 4 selected districts of Hanoi city: Hoan Kiem, Tay Ho, Ba Dinh and Cau Giay. The districts have 45 precincts (Ba Dinh district - 12 precincts, Tay Ho - 8, Hoan Kiem - 18, Cau Giay - 7). The average population density is very high, about 17 981 persons/km$^2$ (Ba Dinh - 22 767, Tay Ho - 4 068, Hoan Kiem - 33 118, Cau Giay - 11 971) and located in space of 50.6 km$^2$, occupying 5.48% of Hanoi's natural area. Classifying and characterizing small urban areas for urban landscape management have been completed on base of multivariate methods and central models in urban geography.

## SMALL URBAN AREA, DATABASE, CONCEPTUAL MODEL AND STUDY METHODS

### Small urban area as landscape unit for study

Small urban area is considered as a landscape unit at local scale that has its landscape architecture, social-economic function and environmental quality. The four selected urban districts were divided into 115 small units. Every small unit is considered as a spatial unit for studying, gathering and processing data.

**Database**

Major materials used for this paper are statistic data, topographic maps at 1:10000, 1:25000, 1:50000 scales conducted in 1985, 2003; airphotoes taken in 2003, and data from questionnaires and research in 4 districts during April - May - June period of 2004.

The data with 39 items were quantified in 3 groups of variables as meta-variables:
- Infrastructure meta-variables: *Building, Land use, Infrastructure construction, Planning level, Visual landscape, Water supply condition, Electrical supply condition, House quality.*
- Socio-economic meta-variables: *Population rate, Labor rate.*
- Environment meta-variables: *Environmental condition, Pollution.*

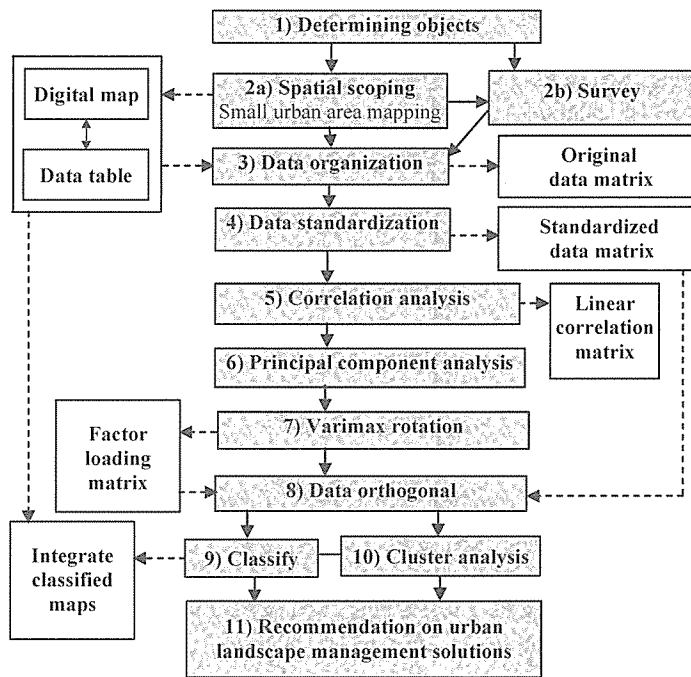**Conceptual model and study method**

*a. Conceptual model*



**Figure 1: Conceptual model of analyzing and classifying small areas for urban landscape management in Hanoi**

Note:
⟶   *indicating a flowing study*
-->   *input/output data*
⟷   *interactive relation*

Figure 1 presents a conceptual model of analysis process of small urban areas in Hanoi. It includes 11 steps: determining objectives (step 1), spatial scoping and survey (step 2), data processing (step 3 to 10) and recommendation on urban landscape management solutions (step 11).

*b. Method of study*

*Factor analysis:* Factor analysis is a multivariate procedure designed to reduce a large number of variables to smaller set of "factors" that account for the most of variance among the original data. Factors are extracted by applying principal component analysis to a standardized correlation matrix. A table of factor loadings shows which variables are grouped together on which common factors, and the degree of correlation between individual variables

and the factors. The factors are interpreted as axes in state space, and the meanings of the axes are inferred from the variables which are most correlated with them *(see N.C.Huan and N.A.Thinh, 2003)*. In this study, 39 variables in dataset are grouped to 9 factors that best represent 9 main characters of the proposed study area.

*Cluster analysis:* Cluster analysis is a multivariate procedure designed to determine clusters in a hierarchical process. It starts with n-1 clusters (n is sample size) and in each step it decreases the number of clusters according to specific criteria. The optimal number of clusters is the lowest number of clusters that have an acceptable level of heterogeneity and reality. Results of clustering analysis in this study show that there are 13 clusters presenting 13 individual urban landscape zones of the proposed study area.

## RESULTS OF STUDY AND DISCUSSION

### Determining factors of urban landscape structure

Factor analysis process with option of initial eigenvalue more than 1 has extracted 9 principal components as factors. These factors were put into continued analysis process. Other components (from 9 to 39) that have small eigenvalue are rejected. The nine factors explained 74.535% of the variation in the data sets. Before using varimax rotation procedure, factor 1 explained 22.578%, factor 2: 18.715%, factor 3: 9.547%, factor 4: 5.768%, factor 5: 4.309%, factor 6: 3.822%, factor 7: 3.526%, factor 8: 3.316% and factor 9: 2.954% of the variation in the data set. Table 1 presents new groups of variables that were obtained by the varimax rotation procedure: factor 1 explained 13.624%, factor 2: 12.869%, factor 3: 12.680%, factor 4: 10.387%, factor 5: 6.877%, factor 6: 5.617%, factor 7: 4.730%, factor 8: 4.222% and factor 9: 3.538% of the variation in the data set. Notice that there are only few variables that belong to one factor. It means that these variable groups represent main characters of rotated factors.

**Table 1: Rotated Component Matrix**

| Variables | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 | Factor 9 |
|---|---|---|---|---|---|---|---|---|---|
| Old house rate | 0.753 | 0.087 | 0.102 | 0.134 | -0.013 | 0.008 | -0.026 | 0.163 | -0.219 |
| New house rate | -0.152 | 0.050 | 0.089 | 0.286 | 0.764 | 0.145 | -0.125 | -0.190 | 0.055 |
| Ancient house rate | 0.794 | 0.096 | 0.033 | 0.245 | -0.184 | -0.058 | -0.087 | 0.125 | 0.091 |
| 3-4 storied house rate | 0.165 | -0.071 | 0.499 | 0.003 | -0.345 | -0.013 | -0.234 | -0.416 | 0.202 |
| Over four- storied house rate | -0.149 | 0.018 | 0.136 | 0.205 | 0.804 | 0.104 | -0.066 | 0.014 | -0.161 |
| Traditional trade building rate | 0.786 | 0.088 | 0.074 | 0.091 | -0.029 | -0.189 | 0.053 | -0.145 | 0.225 |
| Number of supermarkets | -0.039 | -0.123 | 0.062 | 0.311 | -0.165 | -0.002 | 0.638 | 0.204 | -0.042 |
| Number of hotels | 0.233 | -0.086 | 0.144 | 0.089 | 0.007 | -0.035 | 0.569 | 0.039 | 0.229 |
| Business household rate | 0.707 | 0.192 | 0.274 | 0.325 | -0.190 | -0.126 | 0.142 | 0.084 | 0.037 |
| Cultural-historical place rate | -0.171 | -0.381 | -0.260 | -0.213 | -0.138 | -0.039 | 0.018 | 0.021 | 0.568 |
| Administration building rate | 0.068 | -0.182 | 0.116 | 0.059 | 0.003 | -0.012 | -0.035 | 0.647 | 0.008 |
| Industrial building rate | 0.094 | 0.628 | -0.143 | -0.064 | -0.067 | 0.131 | 0.099 | 0.145 | 0.440 |
| Electrical net status | -0.125 | -0.142 | 0.071 | 0.747 | 0.141 | 0.055 | 0.059 | 0.052 | -0.265 |
| Public open space area | -0.387 | -0.483 | 0.143 | 0.498 | 0.102 | 0.087 | -0.140 | 0.025 | -0.062 |
| Street homogeneity | 0.239 | -0.029 | 0.189 | 0.787 | 0.104 | 0.167 | 0.205 | -0.031 | 0.098 |
| Transport convenient level | 0.152 | -0.128 | 0.163 | 0.789 | 0.072 | 0.090 | 0.103 | -0.010 | -0.095 |
| Green cover | 0.011 | -0.285 | 0.062 | -0.009 | -0.203 | 0.208 | 0.273 | 0.612 | 0.185 |
| Wetland area | -0.486 | -0.409 | -0.278 | 0.100 | -0.405 | -0.020 | 0.019 | -0.044 | 0.202 |
| Visibility | -0.664 | -0.335 | -0.147 | 0.412 | 0.092 | 0.154 | -0.014 | 0.076 | -0.021 |
| Noise pollution | 0.122 | 0.782 | 0.012 | -0.008 | -0.051 | -0.113 | -0.164 | 0.008 | -0.081 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dust pollution | -0.049 | 0.826 | 0.073 | -0.028 | 0.135 | -0.138 | -0.061 | -0.087 | 0.071 |
| Solid waste | 0.189 | 0.823 | 0.753 | -0.085 | 0.035 | -0.125 | 0.030 | -0.158 | 0.077 |
| Sewage | 0.250 | 0.754 | 0.138 | -0.138 | 0.064 | -0.095 | -0.016 | -0.139 | 0.072 |
| Gas pollution | 0.152 | 0.860 | 0.090 | -0.096 | -0.107 | -0.002 | -0.101 | -0.013 | 0.027 |
| Public hygiene | -0.046 | -0.511 | 0.029 | 0.042 | 0.101 | 0.328 | 0.365 | 0.309 | -0.024 |
| Agricultural labor rate | -0.175 | -0.175 | -0.795 | 0.012 | 0.143 | 0.202 | -0.003 | -0.219 | 0.110 |
| Industrial labor rate | 0.433 | 0.320 | 0.227 | -0.036 | -0.059 | -0.291 | -0.509 | 0.354 | 0.184 |
| Service labor rate | -0.319 | -0.116 | 0.543 | 0.042 | -0.065 | 0.103 | 0.550 | -0.237 | -0.310 |
| Population density | 0.774 | 0.148 | 0.250 | -0.081 | 0.009 | -0.101 | -0.083 | -0.017 | 0.039 |
| Tap water using rate | 0.174 | 0.110 | 0.912 | 0.132 | 0.095 | 0.049 | 0.061 | 0.036 | -0.129 |
| Well water using rate | -0.160 | -0.106 | -0.914 | -0.136 | -0.093 | -0.046 | -0.059 | -0.036 | 0.138 |
| Living area per household | -0.435 | -0.269 | -0.334 | -0.015 | 0.496 | 0.095 | -0.111 | -0.283 | 0.282 |
| House age | -0.623 | -0.078 | 0.072 | 0.353 | 0.290 | 0.149 | -0.173 | 0.079 | 0.122 |
| Skeptic tank latrine using rate | -0.247 | -0.229 | 0.017 | 0.161 | 0.124 | 0.895 | 0.027 | 0.041 | 0.035 |
| Public latrine using rate | 0.237 | 0.226 | -0.017 | -0.165 | -0.123 | -0.897 | -0.018 | -0.048 | -0.035 |
| Gas cooker using rate | 0.204 | 0.044 | 0.716 | 0.312 | 0.122 | 0.075 | 0.070 | 0.014 | 0.154 |
| Coal cooker using rate | -0.202 | -0.050 | -0.715 | -0.319 | -0.116 | -0.077 | -0.066 | -0.009 | -0.156 |
| Electrical consumption | -0.030 | -0.006 | 0.556 | 0.403 | 0.403 | 0.043 | 0.112 | 0.145 | 0.243 |
| Water consumption | -0.112 | -0.042 | 0.496 | 0.471 | 0.420 | -0.050 | 0.176 | 0.074 | 0.208 |
| **Initial Eigenvalues** | *5.313* | *5.015* | *4.945* | *4.051* | *2.682* | *2.191* | *1.845* | *1.646* | *1.380* |
| **% of Variance** | *13.624* | *12.859* | *12.680* | *10.387* | *6.877* | *5.617* | *4.730* | *4.222* | *3.538* |
| **Cumulative %** | *13.624* | *26.484* | *39.164* | *49.551* | *56.428* | *62.045* | *66.776* | *70.997* | *74.535* |

**Extraction Method:** *Principal Component Analysis.* **Rotation Method:** *Varimax with Kaiser Normalization.*

**Table 2: Title of factors for urban landscape in the investigated districts**

| | |
|---|---|
| Factor 1 : Ancient house | Old house rate, Ancient house rate, Traditional trade building, Business household rate, Wetland area[*], Visibility[*], Population density, House age |
| **Factor 2: Environmental pollution** | Noise pollution, Dust pollution, Sewage, Solid waste, Gas pollution, Public hygiene, Industrial building rate |
| Factor 3: Living condition | 3-4 storied house rate, Agricultural labor rate[*], Tap water using rate, Well water rate[*], Gas cooker using rate, Coal cooker using rate[*], Electrical consumption, Water consumption |
| **Factor 4: Landscape homogeneity** | Electrical net status, Public open space area, Street homogeneity, Transport convenient level. |
| Factor 5: New tenement | New house rate, Over four- storied house rate, Living area per household |
| **Factor 6: Latrine use** | Skeptic tank latrine using rate, Public latrine using rate[*] |
| Factor 7: Service quality | Number of supermarkets, Number of hotels, Industrial labor rate[*], Service labor rate |
| **Factor 8: Administration building and green cover** | Administration building rate, Green plant density |
| Factor 9: Cultural-historical place | Cultural-historical place rate |

*(Note:* [*] *: Negative value)*

The character of each factor is showed in table 2, for example, factor 1 has high correlation coefficient with variables: (1) variables with positive value: old house rate, ancient house rate, traditional trade building rate, business household rate, population density and (ii) variables with negative value: wetland area, visibility, house age that express the character of ancient house in Hanoi. So that, factor 1 is named "Ancient house factor". Factor 2 has high correlation coefficient with variables: noise pollution, dust pollution, sewage, solid waste, gas

pollution and public hygiene (with positive value) that express the character of environmental quality of urban areas in Hanoi. So that, factor 2 is named "Environmental pollution factor". Nine determined factors express 9 main urban characters of the investigated districts. They are the followings: (1) ancient house, (2) environmental pollution, (3) living condition, (4) landscape homogeneity, (5) new tenement, (6) latrine use, (7) service quality, (8) administration building with green cover and (9) cultural - historical building place.

Results of factor analysis present that every small urban area has own factor score. The factor scores are the basic data for classifying small urban areas that can show on the maps by GIS. There are nine maps of classified urban landscape have been created. The figure 2 present some example maps: Map of living condition classification - Map of Factor 3 (fig.2a); Map of landscape homogeneity classification - Map of Factor 4 (fig.2b).
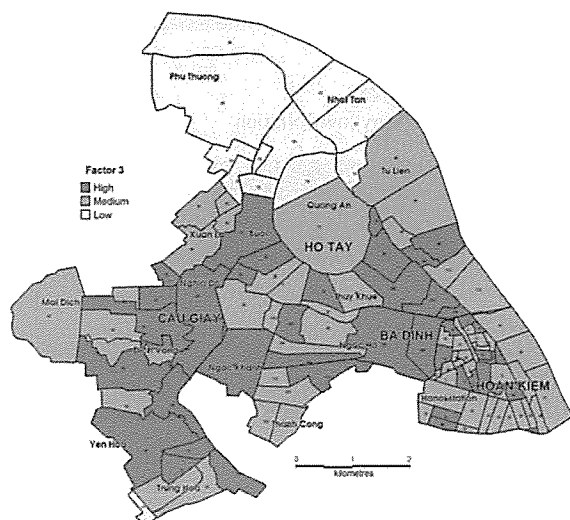


**Figure 2a. Map of living condition classification**
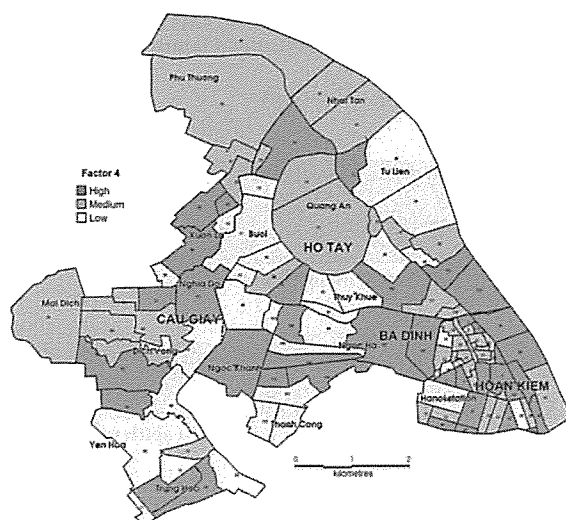
*Method: Natural break classification, range 3*

*Figure 2b. Map of landscape homogeneity classification*

**Figure 2. Maps of urban landscape classification for investigated districts based on factor analysis**

**Area classification by cluster analysis**

A cluster analysis was used for classification of small urban areas according to factor scores. Every cluster has special characters of 9 extracted factors; so this can make advantages for urban landscape management. Results of cluster analysis show that there are 13 clusters in the investigated districts. These clusters have been checked and given by names showed in the table 3 and figure 3. Main characteristics of every cluster can be summarized as followings:

*Unplanned urban settlement landscape zone (C1).* The urbanization process has caused a disorderliness of landscape structure in this zone with high index of old unplanned house and low index of new building for living or service . In this zone, living condition for household is at medium level, service quality and public hygiene at low level. This zone consists of outside dyke region of Hoan Kiem district and Mai Dich precinct of Cau Giay district.

*Urbanizing settlement landscape zone (C2).* The second cluster has high index of cultural-historical place with pagodas and temples, but low skeptic tank latrine rate and landscape homogeneity. It expresses the suburban region during urbanization with problems as sanitation, and disorderliness of landscape structure. This zone consists of Yen Hoa, Trung Kinh (Cau Giay district), Xuan La, Phu Thuong, Nhat Tan precincts (Tay Ho district).

*Ancient house landscape zone (C3).* The cluster C3 having the highest factor score of index Ancient house, express a reserved landscape in which ancient house architecture pattern is

reserved. It is the old trade house quarter with traditional goods that were named 36 ancient streets. In this zone, there are some problems on public latrine use rate with high index and pollution at medium level. This zone located in northwest region of Hoan Kiem district.

### Table 3: Main characters of 13 urban landscape clusters in the proposed study districts of Hanoi city

| Infrastructure: | Social-economic condition: | Environment pollution: | Rank of UDS index: |
|---|---|---|---|
| **Cluster C1: Unplanned urban settlement landscape zone** | | | |
| -0.158<br>Low of new tenement<br>-0.501<br>Low homogeneity of landscape | 0.220<br>Medium living condition<br>-0.177<br>Low service quality | 0.229<br>Medium pollution | -0.166<br>Low |
| **Cluster C2: Urbanized settlement landscape zone** | | | |
| -0.751<br>Low homogeneity of landscape | -1.169<br>High of public latrine using rate<br>-0.569<br>Low of service quality | -1.414<br>Very low pollution | -0.124<br>Low |
| **Cluster C3: Ancient house landscape zone** | | | |
| 1.968<br>High ancient house rate | -0.294<br>Low latrine use rate | 0.329<br>Medium pollution | 0.154<br>Medium |
| **Cluster C4: New tenement landscape zone** | | | |
| 3.436<br>Very high new tenement rate | 0.235<br>Medium living condition | -0.003<br>Low pollution | 0.428<br>Medium |
| **Cluster C5: Landscape zone of citadel quarter and urban settlement with green parks** | | | |
| 0.833<br>Medium homogeneity of landscape | 1.889<br>High service quality | -1.047<br>Very low pollution | 0.406<br>Medium |
| **Cluster C6: Landscape zone of urban settlement mixed with academic institutes** | | | |
| 0.195<br>Medium new tenement rate<br>0.370<br>Medium administration building rate | 0.726<br>Medium living condition | 0.790<br>Medium pollution | -0.013<br>Low |
| **Cluster C7: Administration - trade center landscape zone** | | | |
| 1.436<br>Very high administration building rate<br>1.269<br>High of homogeneity landscape | 0.418<br>Medium living quality | -0.255<br>Low pollution | 0.302<br>Medium |
| **Cluster C8: Landscape zone of cultural-historical tourism** | | | |
| 1.242<br>High cultural-historical places rate | 0.086<br>Medium living condition | -2.355<br>Very low pollution | 0.041<br>Low |
| **Cluster C9: Suburban settlement landscape zone** | | | |
| -0.171<br>Low new tenement rate<br>0.108<br>Medium landscape homogeneity | -2.890<br>Very low living condition<br>0.685<br>Medium latrine use rate | -0.542<br>Low pollution | -0.194<br>Low |
| **Cluster C10: Rapid urbanizing settlement landscape zone** | | | |
| 0.071<br>Medium new tenement rate<br>-0.804<br>Low landscape homogeneity | 0.434<br>Medium living condition<br>1.343<br>High latrine use rate | 0.730<br>Medium pollution | -0.178<br>Low |
| **Cluster C11: Constructing tenement landscape zone** | | | |
| 0.816<br>Medium new tenement rate<br>-0.763<br>Low homogeneity of landscape | -2.035<br>Very low living condition<br>-6.186<br>Lowest latrine use rate<br>1.581<br>High service quality | 1.720<br>High pollution | -1.282<br>Very low |
| **Cluster C12: Landscape zone of tenement house built from 1970s** | | | |
| -1.777<br>Very low homogeneity of landscape<br>0.867<br>Medium of administration building rate | 0.458<br>Medium latrine use rate<br>0.115<br>Medium living condition | -0.420<br>Low pollution | -0.093<br>Low |
| **Cluster C13: Landscape zone of urban settlement mixed with industrial buildings** | | | |
| -0.483<br>Low landscape homogeneity | 0.572<br>Medium service quality | 2.443<br>Very high pollution | 0.040<br>Medium |

**Note:** UDS*: urban development standard index

Level class and average factor score: Very low < -1; Low = [-1,0); Medium = [0, 1); High = [1, 2); Very high: ≥2

*New tenement house landscape zone (C4).* This zone is the newest planned urban area in Hanoi city with main function as settlement centers. It has highest index of new tenement rate and landscape homogeneous level, but low administration building rate. It contains characters of modern urban architecture patterns as high tenement system and new transport - electrical net - water supplying - drainage system. This zone consists of urban areas as Xuan La, Thang Long International village, south of Trung Yen - Trung Hoa - Nhan Chinh .

*Landscape zone of citadel quarter and urban settlement with green parks (C5).* The cluster C5 has high index of environmental quality, service quality, living condition and landscape homogeneous. There is a highest concentration of green cover and wetland area with very fresh environment in this zone. The zone is divided into 2 sub-zone: C5a - Ho Chi Minh reserve area; C5b - Thu Le pack, Truc Bach lake area.

*Landscape zone of urban settlement mixed with academic institutes (C6).* The cluster C6 has a high index of new house and administration building. The special characters of this zone are presented in a disorderliness of landscape structure due to planned academic institutes mixed with unplanned new houses. This zone is located in Nghia Do area of Cau Giay district.

*Landscape zone of administration-trade center (C7).* This cluster has highest index of administration building, trade center and good living condition and environmental quality. This zone has a high concentration of modern trade center and civil services located in Trang Tien, Ly Thai To, Phan Chu Trinh, Tran Hung Dao, Hang Bai... in Hoan Kiem district.

*Landscape zone of cultural-historical tourism center (C8).* The cluster C8 contains the highest index of cultural-historical place and environmental quality, but low index of new tenement. This is the tourism area specified by temples - pagodas and villa patterns of West Lake region in Tay Ho district.

*Suburban settlement landscape zone (C9).* The cluster C9 expresses characters of suburban settlement with high index of environmental quality, but very low index of living condition. This zone consists of Phu Thuong, Nhat Tan, Tu Lien... with rapid ongoing urbanization. As a result, suburban settlement area is decreased and replaced by urban and new tenement housing landscape.

*Rapid urbanizing settlement landscape zone (C10).* This cluster has some characters specified by high index of socio-economical supplying condition, but low index of infrastructure and environmental quality. This zone consists of Yen Hoa, Trung Kinh (Cau Giay district).

*Constructing house landscape zone (C11).* This zone is characterized by old suburban houses mixed with new modern tenement and large open areas. Furthermore, there are many problems as very low living condition for household, lowest skeptic tank use rate and high pollution. In the future, suburban houses will be changed to plan new tenement buildings. This zone is located in Trung Hoa area (Cau Giay district).

*Landscape zone of Tenement house from 1970s (C12).* The cluster C12 has low index of landscape homogeneity, but high socio-economical supplying condition and good environmental quality. The specific structure of this zone is tenement buildings with illegal enlarged parts and disorderliness of streets. It consists of Thanh Cong, Ngoc Ha, and Ngoc Khanh in Ba Dinh district.

*Landscape zone of urban settlement mixed with industrial buildings (C13).* The cluster 13 has the highest index of environment pollution with dust pollution, solid waste, sewage and air pollution, low landscape homogeneity, but medium of service quality. This zone is located in Thuy Khue area (Tay Ho district).

In the broad viewer, by using UDS index based on the average factor score, the results of integrated assessment for rank of urban development standard in these investigated districts shows that: clusters C3, C4, C5, C7, C8 and C13 in a group of average development (among

them C4, C5, C7 are in higher level); C1, C2, C6, C9, C10 and C12 - in a group of low development, C11 is in a very low development level.
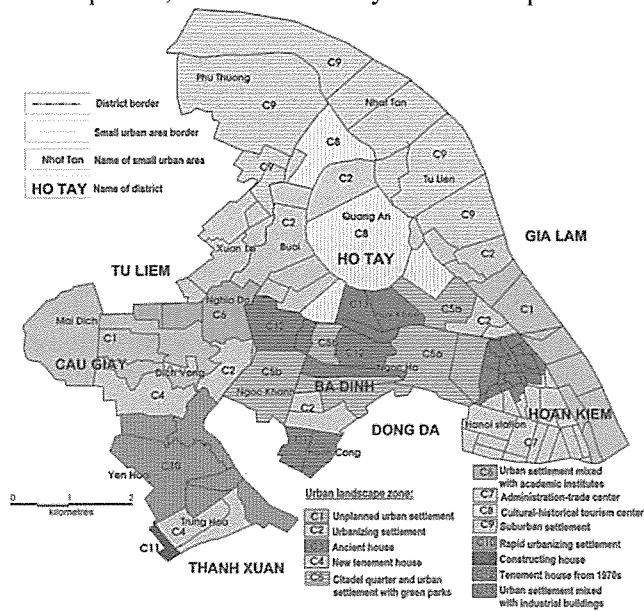


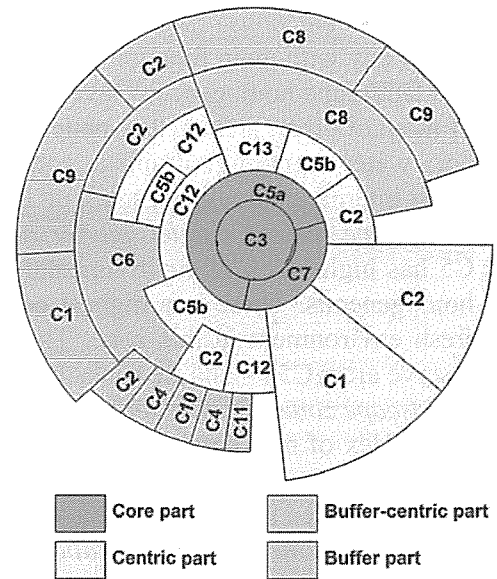**Figure 3. Maps of urban landscape zones in the investigated districts**



**Figure 4. The urban spatial pattern of the investigated districts**

Based on the Central models in urban geography: the concentric ring model (Burgess, 1920s), the sector model (Hoyt, 1939) and the multiple nuclei model (Harris and Ullman, 1945), we present a model of urban spatial pattern of the investigated districts in figure 4. This is an integrated concentric ring and sector model presenting different development periods. The core part as a central administration - business region consists of C3-C5a-C7 located in Hoan Kiem - Ba Dinh districts. This part developed in the past time. The concentric part presents urban landscape developed in periods from 1940s; the buffer-centric part as urban settlement with administration centers developed from 1970s; the buffer part as urban settlement developed from Doimoi period.

**Recommendation on urban landscape management**

Analyzing the study results we can give some proposals on urban landscape management for the investigated districts:
- For urbanizing buffer region it is necessary to implement seriously an urban plan. There are some urgent problems that should be considered as to maintain and develop wide streets, large green spaces, new modern tenement building quarters, to reserve water spaces, to improve living conditions as tap water using and latrine conditions.
- For the core and concentric regions it is very serious to improve and to protect landscape zones as ancient house, citadel quarter... Extension of streets is always necessary, but not suitable for these regions.

**CONCLUSION**

- Urban analysis and classification study is a useful tool for urban landscape management practices to enhance urban quality in Hanoi.
- Factor analysis process show that the nine extracted factors express nine main urban characters as ancient house, environmental pollution, living condition, landscape homogeneity, new tenement, latrine use, service quality, administration building with green cover and cultural - historical building place.

- Results of cluster analysis show that there are 13 clusters: C3, C4, C5, C7, C8 and C13 in average development group (C4, C5, C7 are in higher level); C1, C2, C6, C9, C10 , C12 in low development group  and C11 is in very low level.
- The presenting model of urban spatial pattern is an integrated concentric ring and sector model: the core zone as a business central zone consists of C3-C5a-C7 developed in the past time; the concentric zone developed from 1940s; the buffer-centric zone as urban settlement with administration central developed from 1970s; the buffer zone as urban settlement developed from Doimoi period.
- This is the open study. In the future, we will expand the large space study for all urban districts in Hanoi city, and use other method as GIS.

## ACKNOWLEDGEMENT

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