# Biotope Networking in a Metropolitan Area of Daegu
## - The Case of Susung gu -

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## ABSTRACT

The biotope network of Susung gu is characterized as dense residence zones forming its core that enable partial biotope in and around the residential zones.

First, in district I, it is possible to make these zones connected to the third district. In district II, which is abundant in biotope, it is very important not to continue destroying the existing biotopes. In the case of district III, old residence zones have fill the severe gap between forests and the Sinchun river, through redevelopment, which covers more than 30% of the biotope area with large scaled linear residence areas. In the case of district IV, limited destruction of biotope and the improvement of nature areas were suggested as the alternative for preservation of biotopes.

Consequently, in the construction of the biotope network in Su-sung gu, the maintenance of existing biotopes is required. In the old residence zones, as redevelopment occurs, by maintaining biotope area of more than 30% and making the scale of residential complexes more than 1ha, it is possible for old residence zones to accomplish the role of providing important green spaces. In the case of newly developed residential zones, by reducing the rate of pavement of traffic conducts, utilizing small sized parks at the junctions and the plantation of trees along the corridors, the entire residence zones are able to accomplish the role of providing important green space. The problem of isolation in the private housing complexes would be relieved by getting rid of the walls of the private houses and connecting the inner green space of the private houses with the green spaces of the streets in some areas. Furthermore, green spaces of forests must not be used for urban development. Dual planting on sidewalks, planting plots dispersed among streets and median strips must be established on road, too.

*Key Words : Biotope network, Residence zone, Redevelopment, Pavement*

## I. INTRODUCTION

With the tendency of population to gravitate toward cities and the thoughtless of urban development, today's urban ecosystem is in an unstable condition. Especially, the fragmentation and isolation phenomena of biotope internal and external to the downtown area support this fact.

As a means to resolve these problems, advanced countries encourage the creation of a network

between urban green space and biotope(Oh and Choi, 1996) studies are acting in progress in this nation. For example, a study on the type of classification and characteristic research of urban biotope, presents a basic index for evaluating the value of biotope(Ra et al., 2001), a study on the construction of green space system in a new town(Hong, 1990), and a study on the potential and assessment and creation programming for biotope in small and medium cities(Jung and Lee, 2000).

However, these studies show an interest in evaluating urban biotope itself, while they do little to address the issue of mutual connection function between biotopes throughout the cities. Thus, the purpose of this study is to supply basic data necessary for developing a biotope network, selecting Susung-gu in Daegu, as a study area.

To this end, first of all the investigation and evaluation of all biotopes in the study area was performed. On the basic of that, biotopes appearing in the study area were reclassified with core, strategy-point, point, and a strategy for developing of biotope network was established. But, it is defined in advance that the investigation and evaluation of all biotopes appearing in the study area is based on the result of a study already performed(Ra et al., 2001).

## II. METHODS

### 1. Charactistics of Study Area

Susung-gu, the study area, lies to the middle-east of Daegu, forming a boundary with Nam-gu and Jung-gu by the Shinchon river to the west, and with Dong-gu by the Kumho river to the north(Figure 1).

Due to the topographical characteristics of Daegu, an inland basin, Susung-gu shows a severe

annual range in temperature with the highest temperature of 40℃ and the lowest one of -17.6℃, and the air tends to be excessively dry.

The gross area of Susung-gu is 764,000m², and in regard to land use type, forest and fields including Daedeok mountain occupy over half the gross area at 52.3%. In addition, there is substantial green space with 16.5% of the gross area not in use, 14.3% is productive green space, 3.4% is river and 0.6% is park(Daegu, 1996; Daegu, 2000). In total, mountains and productive green space occupy about 70% of the gross area, and those green spaces are important ones connecting the forest of the north with Mt. Apsan to the south, while forming the outer green space of the south-east in Daegu.

But, with rapid urbanization, Susung-gu is an area where the reduction rate of forest zone is very high. Also, the continuous pressure of development will be applied all the more, thus it's predicted that disappearance of green space and biotope may speed up(Park and Jung, 1999). Picture 1 shows a view of Susung-gu from Mt. Apsan.
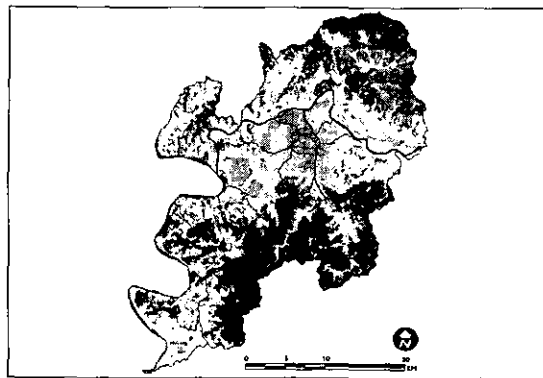


Figure 1. Location of the study area



Picture 1. Perspect of the study area

## 2. Scope of Study

Most forests and biotopes within the study area are distributed at the outer area of a residence zone. Specifically, because a residence zone, forming a distinct boundary with forests, assumes the form of intensive concentration, demolition between forest and residence zone is drastic.

Therefore, the investigation zone of this study is limited to the residence zone including the part of forest zone around residence zone. Also, on the basis of the results of the land use type analysis and the value evaluation of biotope in Susung-gu which was performed in advance, all biotopes appeared were reclassified with core, strategy-point, point, especially the district-setting centering around a residence zone and the development of biotope network according to the proposed standards are the concern of this study.

## 3. Method of Study

1) District-setting for development of biotope networks

In forming biotope networks, the degree of isolation of biotope becomes an important criterion(Kohn and Walsh, 1994; Simon, 1999). For example, when the mean distance between biotopes is over 1,000m in the case of a place where many biotopes are around, it is isolated. If over 500m in case of a place where biotopes are evenly scattered, and over 100m in the case of a place which is unhabited, the biotope is isolated(Wolfgang and Robert, 1985).

On the other hand, these places in Susung-gu are represented as forests, agricultural and residential zones. It's judged that the presented distance becomes an important foundation in formation of additional biotope to prevent biotopes

from isolation according to the adjacent land use type. Thus, in this study the forest zone of Susung-gu is divided at 1000m × 1000m intervals and agriculture zone is subdivided at 500 × 500m intervals, and residence zone at 100 × 100m intervals. And each lattice including biotope was classified and marked with core(●), strategy-point(◉) and point(○) on the basis of the evaluation results of the biotope. But, in cases where a part of biotope is cut by the lattice, the biotopes of over 1,500m² only, the minimum size of the investigated biotopes, in their zone were marked.

All biotopes were classified by their mean zones; very large biotopes over 100,000m² are for core, large biotopes 20,000-90,000m² are for strategy-point as a transition zone between core and point, and biotopes 1,500-20,000m² functioning as a stepping stone between core and strategy-points for point. A detailed biotope network was developed centering around residence zones in which the smallest lattice were intensively distributed.

2) Development of biotope Network

The lattice divided for district-setting visualizes the maximum distance of non isolating-biotope, which means that Biotopes should exist in each lattice. On the basis of that, additional biotope would have to be constructed, which is important for developing the biotope network. But because Susung-gu is already highly urbanized, construction of biotope in all lattices may be difficult. So, in this study, with three additional standards proposed, a model for the development of a biotope network was suggested. First, the wide zone around the main biotope was selected, focusing on a buffering function. Second, the arrangement direction of biotopes in the district is proposed by considering biotopes performing a connecting function and the distribution direction of present biotopes, so that all

biotopes could be connected with core, strategy-point, or biotopes of high grade in proximity. Third, the possibility of biotopes construction within a selected site was examined. The site in which the possibility of the existence of the existing biotopes or the newly constructed biotopes was high, was put to practical use to the maximum. The biotope construction plan was discriminated according to the current land use.

As a biotope-constructing strategy in the selected site, the improvement of natural value of the site, with the analysis of structural significance in the district rather than constructing biotope in each space, was given emphasis. That is, an site where the appearance of biotope was very rare was graded as first-class for having the potential of constructing biotope, and in case that its appearance was regular, that site was readjusted upward by one class from the existing class.

Land use type in the selected site was directly recorded on a topographical map(1/5,000) with a field survey, and ArcView GIS 3.2(ESRI Inc., 1999) was used for an area shared by utility form. Also, Auto CAD 2000(Autodesk Inc., 1999) was used so that one could easily ascertain the distribution of the

existing core, strategy-point, and point and the place of additional formed space.

## III. RESULTS

### 1. District-setting for Biotope Network

The zone investigated was divided into 4 districts by lattice centering around an residence zone including a part of adjacent forest zone. The lattice distribution state shows that in the greater part of west Susung-gu and the part of east Susung-
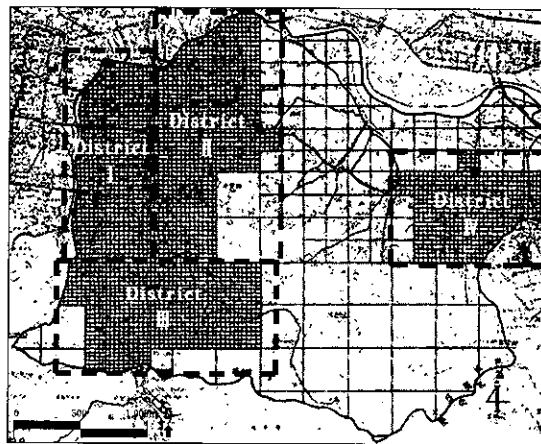


Figure 2. Distribution of the residence zone

Table 1. district division and characteristics of each district centering around residence zone

| District | Dong name included | Characteristics of each zone |
|---|---|---|
| District I | Susung-dong, a part of Hwangkum and Doosan-dong, Jung-dong | · Located between Dongdaegu-ro and Shinchon river, showing severe shortage of biotope.<br>· Poor linkage relation between outer forest zone of district II and green spaces in residence zone.<br>· Shows clear difference in biotope-possessing zone between newly constructed housing complex and aged one. |
| District II | Manchon-dong, a part of Bumo-dong, Hwangkum-dong, a part of Jisan-dong | · Located between eastern outer zone of Daegu and Dongdaegu-ro, and it functions as buffer zone for outer forest zone. |
| District III | Bummul-dong, a part of Doosan and Jisan-dong, Pa-dong | · Located in south of district I and the district II, and shows high linkage relation with north residence zone having poor biotope.<br>· Residence zone formed between two forest zones shows clear difference in distribution of biotopes due to the difference in the formative time. |
| District IV | Siji-dong, Shimae-dong, Sawol-dong, Maeho-dong, Raewhan-dong | · It is apart from other districts, forming the boundary with forest zone, and functions as buffer zone. |

gu, most lattices of 100×100m were distributed with a part of the lattices of 500×500m distributed going along with a boundary line. The above result shows that in Susung-gu, residence zone, an one unfit for habitation, was centralized in a part of western and eastern Susung-gu, and in the other zones, the distribution of biotopes was generally consecutive and wide-ranging(Figure 2). But, it's found that the outer forest zone in the southeast of the study area has a high possibility of being damaged because it is adjacent to the residence zone without a buffer zone. Thus, it seems that in Susung-gu the emphasis should be put on the construction of a biotope network in the residence zone.

## 2. Development of Biotope Network in Susung-gu

### 1) District I

District I, in which a main road in the vertical direction was well developed compared to the other zones, was approximately a 10% share. But, there was scarcely natural green space except for a river which was a 5% share, and it seems that it was a typical residence zone where more than 80% was occupied by private houses and shopping buildings. Housing complexes could be divided into two types; one newly constructed after 1980's and the other constructed before that time. Newly constructed housings in the east of Susung-gu had, in general, green space of about 30% of the area, being distributed on the scale of over 10,000m². Also, private gardens constructed artificially showed good growth condition of trees regardless of the time of their construction. It's judged that concrete-paved alleys and high walls between residence buildings had a possibility of causing a discontinuation of garden, but that place could be considered as a green space composed of the many folds of lines when



Piture 2. Private housing biotope with abundant green space

looking on the whole, functioning as a strategy-point.

Aged residence buildings distributed in Susung-dong and the west of Susung-gu were crowed closely in complicated forms, passing roads were narrow, and the pavement rate of vacant lots in front of buildings was over 70%.

This district was between the housing complex around the east of Susung-ro and Shinchon river, separating two biotope areas from each other(Figure 3). Therefore, it seems that in district I, it is necessary for the aged housing complex between Shinchon river and Dongdaegu-ro to be planted with trees and to promote scheduling a linkage with district III by connecting it with the biotope-abundant housing complex in the south. It's judged that, in the case of redeveloping, Reservation of over 30% in biotope space between buildings should be required with residence complexes of over 10,000m² in size so, the function of strategy-point could be made. Also, construction of overall biotope in district I may be possible by increasing the nature quality of roads and rivers.

Especially, because most shopping buildings placed along the street have poor biotope spaces, it's necessary for a construction strategy of additional biotopes such as planting double rows of trees on both sides of street and construction of road island or a road reservation.
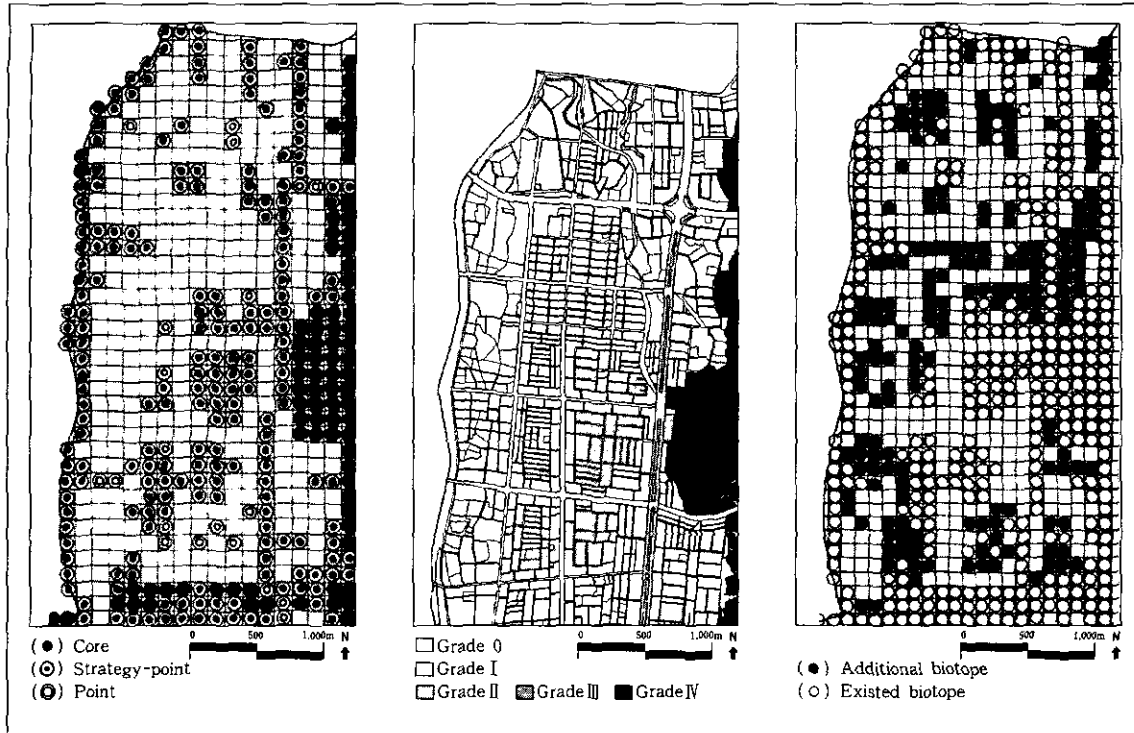
( ● ) Core
( ◉ ) Strategy-point
( ◯ ) Point

☐ Grade 0
☐ Grade I
☐ Grade Ⅱ   ▤ Grade Ⅲ   ■ Grade Ⅳ

( ● ) Additional biotope
( ◯ ) Existed biotope

Figure 3. Development of biotope networking in district I

Table 2. Analysis and development measures of biotopes in district I

| Area | Present state analysis of biotope | Reform measures |
|---|---|---|
| Around between susung-ro and dongdaegu-ro | · Medium and high building scattered. <br> · Children park and vegetable garden as biotopes play an important role. <br> · Large-scale housing complex in Doosan-dong possesses relatively even green space. | · Construction of strategy-point biotope around neighboring park. <br> · Conversion of non-developed park into biotope space of high natural value. <br> · Strengthening of linkage by use of point-type biotopes. <br> · Preservation of small-scale biotope space. |
| Around the west of Susung-dong and Susung-ro | · Shows clear isolation of biotopes with built-up area of high-rise shopping buildings or aged housings. <br> · Sporadic appearance of point type biotopes like grass or vegetable space within housing area <br> · Shinchon functions as an important biotope connecting isolated biotopes. <br> · It's isolated among housing buildings having high pavement rate. | · Strengthening of tree-planting around Shinchon. <br> · Strengthening of linkage housing area with a neighboring area. <br> · Continuous management of vegetable garden or grass area. |

2) District Ⅱ

In this district, one in which most of the outer forest zone in the southeast Daegu is distributed, residence and shopping zones occupy 40% of the whole area, with nature-typed neighboring parks

over 50%. But, because it is bordering on the forest zone and residence zone, it seems that a protection measure through construction of a buffer zone and damage prevention of the outer green zone should be prepared.

Presently, nature-type parks such as Citizen Park in the west direction of the outer green zone are neighboring, and biotope-abundant housing' between 'Bumu' Park and the outer forest zone and around Citizen Park exist in a group, so it is properly functioning as a buffer zone. Most residence zone of district II except for a part, though it was newly constructed after 1980's, had poor biotope compared to district I, especially A severe biotope shortage is between Citizen Park and the eastern outer forest zone.

On the other hand, this district was not separated clearly from the biotopes of district I due to the street green space of Dongdaegu-ro possessing abundant trees, while residence and shopping mixed zone centering around Dalgubul-ro showed a clear discontinuation state between neighboring parks on both sides and a part of

biotopes was distinct(Figure 4). Thus, in district II in which the forest zone and the nature-type parks are abundant, preservation of the existing green space is a matter of great importance, demanding the prevention of converting the existing biotopes for other purposes. Also, improving the natural value of children parks or neighboring parks distributed everywhere around residence zone is needed, conversing small-scale vacant lots as additional sites for construction of a biotope.

### 3) District III

In this district where a residence zone is developed along the low land and the valley of the forest zone, water space occupies 5% of the whole district, with residence and shopping zones 30%, forest zone 55%, and the edge biotope exists at a high rate compared to other districts. Jisan and
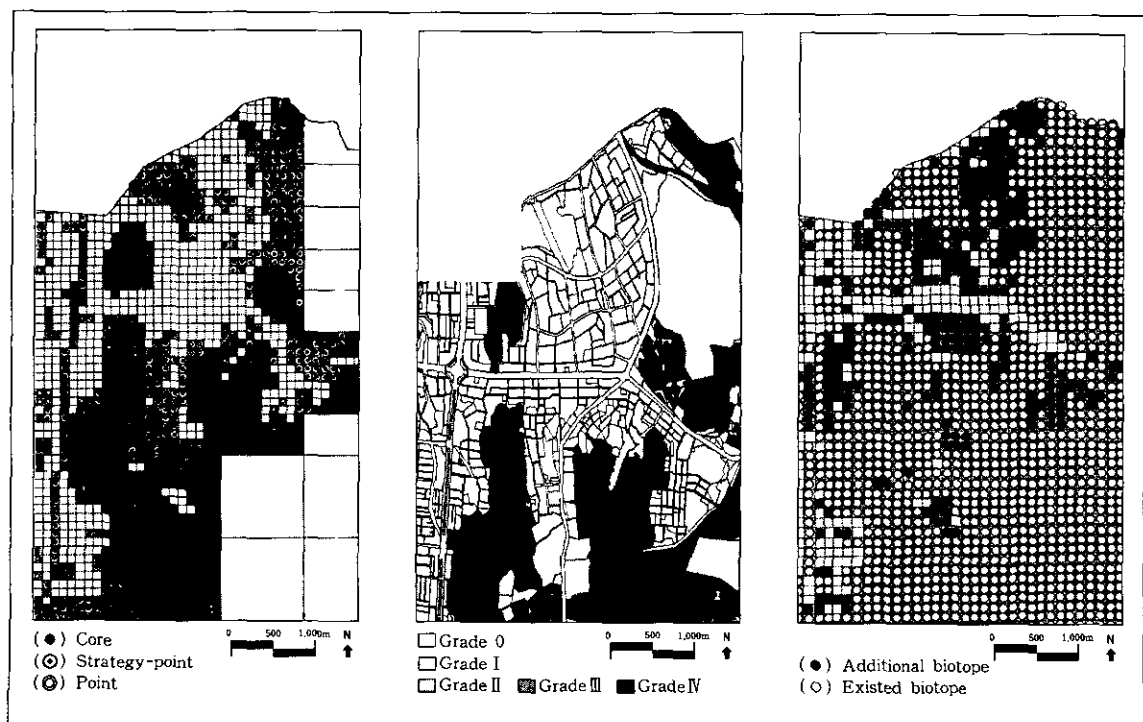


( ● ) Core
( ◉ ) Strategy-point
( ◎ ) Point

□ Grade 0
□ Grade I
□ Grade II   ▨ Grade III   ■ Grade IV

( ● ) Additional biotope
( ○ ) Existed biotope

Figure 4. Development of biotope networking in district II

Table 3. Analysis and development measures of biotopes in district II

| Area | Present state analysis of biotope | Reform measures |
|------|-----------------------------------|-----------------|
| Around the north of Dalgubul-ro | · Mainly forest zone and army troop located in the east of Mooyeol-ro.<br>· Neighboring park and school in the west of Mooyeol-ro show clear isolation state.<br>· Poor linkage of biotope appears in the west and east of citizen park. | · Reservation of 30% in green space rate in place of scheduled re-development housing complex.<br>· Preservation of strategy-point biotope through extension and additional construction of neighboring park.<br>· Reservation of additional green space in the east-west direction of citizen park.<br>· Arrangement of small-scale biotope in housing complex, public building and APT complex. |
| Around the south of Dalgubul-ro | · Poor biotope in both sides of Dalgubul-ro.<br>· Most middle high-schools possess abundant green space relatively.<br>· Green space between Bumu park and Mnachon park functions as strategy-point biotope.<br>· Hwangkum APT complex in the south of Bumu park shows poor plant-growth state even though it possesses biotope area of over 30%. | · Revitalization of private garden tree-planting is needed in the housing complex of high density around neighboring park.<br>· Construction of small-scaled biotope in the housing and shopping multipurpose building<br>· Arrangement nature-type tree-planting plan when Hwangkum APT is reconstructed.<br>· Strengthening of function as strategy-point biotope centering around housing zone with abundant. |

Bummul-dong showed a descending mutual linkage relationship of the forest zone around the residence zone with rapid enlargement of residence zone, while Pa-dong showed high linkage relationship because the distance between forest zones divided by linear residence zone was not far away.

When looking at the space distribution of biotopes on the basis of a difference like this, we could find out that the edge adjacent to forest zones and residence zones showed high distribution of biotopes relatively, but the more further the distance is from the forest zone, the more distinctive the discontinuation state is.

But, with enlargement of a residence zone after 1990, by new construction of large-scale APT complex in Jisan and Bummul-dong, it now occupies 50% of the whole residence zone. Biotope space was about 20% in the APT complexes, and there were many children parks and neighboring parks newly constructed everywhere around the APT complex(Figure 5). Therefore, it's necessary

for large-scale APT complex or private housing complexes newly constructed after 1990 to keep biotopes maintained(Gilbert, 1991), especially additional construction of biotopes using a small area in buildings or by planting trees on the rooftops is needed.

It's judged that in the linear residence zone of Pa-dong, improvement of the linkage relation between the forest zone and the Shinchon river is needed by reserving green space of over 30% when redeveloping. Also, prevention of damage to the edge biotope's between forest zone and residence zone is necessary.

4) District IV

This distict can be divided into two zones; the south of Dalgubul-ro where APT complexes are intensively distributed and the north where they are sparsely distributed.

In the eastern zone, biotope-abundant factory and residence zones are distributed. When looking at land
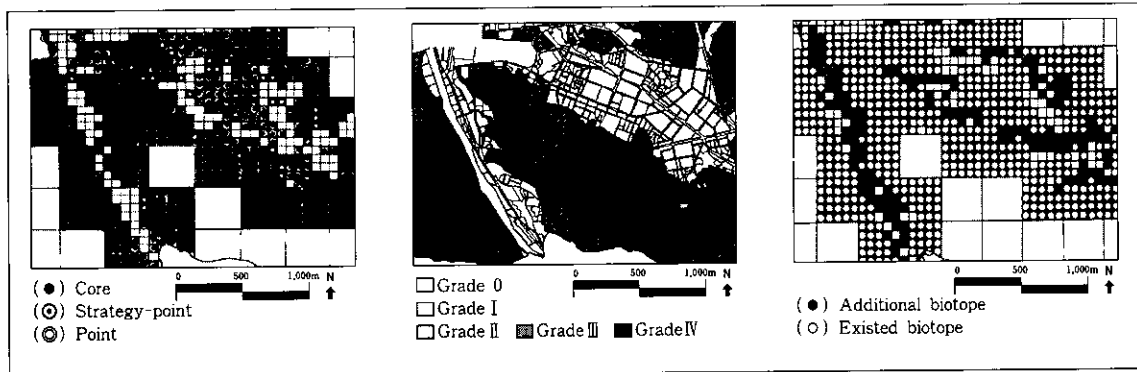
( ● ) Core
(◎) Strategy-point
(◯) Point

☐ Grade 0
☐ Grade I
☐ Grade Ⅱ  ▨ Grade Ⅲ  ■ Grade Ⅳ

( ● ) Additional biotope
( ◯ ) Existed biotope

Figure 5. Development of biotope networking in district Ⅲ

Table 4. Analysis and development measures of biotopes in district Ⅲ

| Area | Present State Analysis of Biotope | Reform Measures |
|---|---|---|
| Around the south of Doosan-ro and Jisan-ro | · Various biotopes are located around Susung lake.<br>· APT complex has relatively regular distribution of biotope of about 30%.<br>· Main route, having abundant trees, between APT complexs promotes linkage between them.<br>· Private housings possess relatively poor biotope.<br>· Large-scale vegetable gardens distributed function as a stepping stone between forest zone and residence zone. | · Positive construction of children park or private garden in the side of activation of point biotope within residence complex.<br>· Continuous management of the large-scale vegetable garden.<br>· Easing of forest zone continuation through tree-planting at the west of Chungho-ro.<br>· Strengthening of linkage function between forest zone and residence zone by planting trees in schools among the housing complex. |
| Around Pa-dong | · The east of Padong-ro is adjacent to forest zone, and vegetable gardens or tombs behind the residence zone function as transition zone between forest zone and resident zone, having abundant trees around.<br>· Housing buildings far away from forest zone are low in linkage relation, having high pavement rate.<br>· Aged housings formed along Shinchon river are high in pavement rate, low in green space rate, especially they show severe discontinuation between green space, having few children and neighboring park. | · Construction of small-scale biotope-space through afforestation of private garden and rooftop in the housing complex around Padong-ro.<br>· Nature-type tree-planting induction around Shinchon. |

use, residence and shopping zones occupy 40%, parks 15%, and forest zone and farmland 45%. Dalgubul-ro, as a main route going across Daegu from the east to west, is passing through the outer forest zone of Susung-gu after passing district I and II.

Also, the northern side of Dalgubul-ro is composed of artificially-planted trees, and farmland and forest zones are distributed. It's forecasted that,

in the forest zones cut by roads, the plant community within a range of 10-20m from the road would be changed by dust occurring from the road(Naveh and Lieberman, 1994; Forman, 1995).

The real residence zone begins around Yeonho-dong, and in this zone, biotopes are abundant. On the other hand, in the southern zone of Dalgubul-ro where many APT complexes were constructed, the

occupation rate of biotope was high, while in the northern zone, it was very poor with a high pavement rate(Figure 6).

Because farmland, a transition zone between forest zone and residence zone surrounding the south and north of district IV, rapidly decreases, so construction of a buffer zone is needed. Thus, in developing aged residence zones, it's recommended that construction of large-scale green zone by linking the interior and exterior zone after

demolishing the walls surrounding private houses or buildings should be made.

Also, it seems that an extension of green zone around main streets would help it's function as a linear biotope in the residence complex. Children's parks and neighboring parks located around main streets of newly constructed residence complexes would function as a buffer zone if they are linked with linear biotopes in the residence complex.
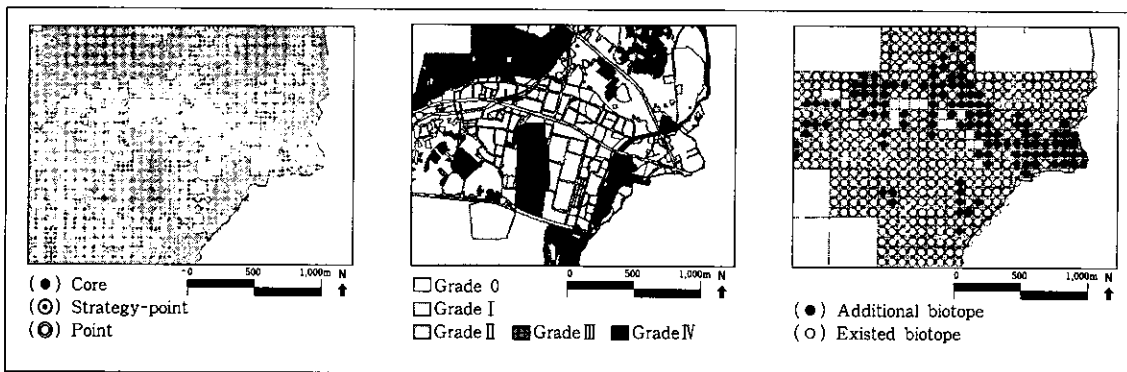


( ● ) Core
(⊙) Strategy-point
(◐) Point

☐Grade 0
☐Grade I
☐Grade II  ▦Grade III  ■Grade IV

( ● ) Additional biotope
( o ) Existed biotope

Figure 6. Development of biotope networking in district IV

Table 5. Analysis and development measures of biotopes in district IV

| Area | Present State Analysis of Biotope | Reform Measures |
|---|---|---|
| Around the north of Dalgubul-ro | · Small-scale biotope developed around the tributary of the Kumho river.<br>· Kosan elementary school possess abundant biotope, but poor in neighboring residence zone.<br>· Housing complex formed along a streamlet shows poor flora with high pavement rate.<br>· Main route between APT complex, having abundant plant , eases discontinuation of biotope.<br>· Housings and factory facilities are distributed along the tributary of the Kumho river, but vacant lot and vegetable garden appear everywhere. | · Strengthening of biotope function with additional afforestation around main route.<br>· Revitalization of point green space such as vegetable garden, child park, playground of school is needed.<br>· Construction of children park or neighboring park possessing high nature-property as strategy-point biotope.<br>· Reservation of additional green space at the industry zone between Kumho river and productive green space. |
| Around the south of Dalgubul-ro | · Daegu Science High School functions as an important-poit green space, having abundant trees.<br>· The south of Dalgubul-ro possesses abundant biotopes.<br>· Productive biotope is distributed between forest zone and residence zone. | · Continuous management of biotope in transfer region like productive green space.<br>· Improvement of the linkage relation between Daegu Science High School and large-scale APT complex.<br>· Periodic management of nature-type biotope space in the east of Wooksu streamlet. |

# IV. CONCLUSION

This study is to develop a biotope network with understanding of the space-functional characteristic of each biotope. The results of the study are as follows;

1) Residence zone was divided into 4 districts which could be linked entirely, constructing a partial biotope network. In district I where residence complex between Shinchon river, a linear biotope of south-north direction, and Dongdaegu-ro exists on the large scale, whole afforestation was induced to prevent isolation of two linear biotopes. Especially, because the housing complexes of Hwangkum-dong, Sang-dong, Doosan-dong, having abundant biotopes, were distributed in the south-north direction, it's possible for them to be connected into district III.

2) In district II where biotopes are abundant, it's important not to spoil the existing biotopes any more, and for schools or small-scale park being distributed at regular intervals, natural elements were expanded to be bigger so that they could function as a point. Also, buffering zones were constructed to prevent discontinuation of forest-type neighboring parks with outer forest around residence zone.

3) In case of district III, when redeveloping aged residence zones distributed along with forests, large-scale linear residence zones were constructed, reserving biotopes zone of over 30%, to prevent excessive discontinuation between forest and the Shinchon river. Also, natural linkage between neighboring forest and residence zone by securing biotope space around Shinchon low in natural value was implemented.

On the other hand, it was suggested that in a region where biotopes were equally distributed with large-scale APT complexes, continuous management should be made with preservation of biotope zone in the residence zones.

4) In district IV, APT complexes on both sides centering around Daegu Science High School were distributed consecutively, and artificial biotopes between forest and residence zone widely exist, so minimization of destruction and improvement of natural value were recommended as a reservation measure of biotope.

5) Finally, the solutions for several matters such as land-purchasingr, and private land afforestation, should be presented in the future. Also, biotope management strategy would have to be studied through precious animal and plant phase investigation.

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