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Development of Evaluation Criteria for the Forest Garden

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Abstract

Development of forest garden for city dwellers utilizing green space within urban area is nowadays highly regarded as a means to invigorate city and to raise living standard for city dwellers. Thus, development of forest garden has become pressing and important agenda for city governments. Promoting forest garden to solve many environmental and social issues city governments face today requires evaluation criteria to determine whether target green space is suitable to serve as forest garden. In this respect, we believe that evaluation of values of forest garden from previous studies can serve as foundation for developing evaluation index for forest garden. Thus, we aimed to develop evaluation criteria for values of forest garden. First, various evaluation criteria collected from previous studies were assessed by expert groups. Then, the result was studied through AHP technique and we developed evaluation criteria for forest garden based on such result. Especially, evaluation criteria were divided into main and sub-levels for more detailed and precise evaluation system

Keywords: *Values of forest garden, questionnaire survey, Likert scale, AHP technique, Weight*

1. INTRODUCTION

As the government is working to introduce policies aimed at improving living standards including a legislation for 52 working hours per week, spending quality leisure time has become more important. With increased leisure time, people are becoming more interested in spending time in green space and green environment to enjoy nature more. Currently, city forest takes up 49% of city space throughout the country which is quite high. However, city forest where people can freely and easily access in terms of time and cost in their daily life is only 3.7% [1]. City forest within daily life zone is important to city dwellers, because, limited time and economic burden is the biggest reason for not being able to enjoy leisure time sufficiently. [2]. Public also consider city park (48.4%) and small mountains or hills nearby their residence as the most important city forest type. [3].

Also, Korea Forest Service revised “Act on the creation and furtherance of arboretums and gardens” to secure more garden related infrastructure within residential area of cities. KFS is making efforts to develop a

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model for forest garden and to expand 20 local gardens with 1000 day Garden Plan (2017) which is a follow up plan of Garden Promotion Basic Plan. KFS conducted projects to turn existing forest into garden infrastructure with large-scale forests throughout the country as national/public forest and parks. However, development of forest garden using green space within city life zone targeted for city dwellers is now attracting more attention as a means to invigorate cities and is considered an urgent task.

However, forest garden is a concept which was not introduced so far and understanding the concept of forest garden is first required to build forest gardens. Hong (2020) applied Delphi techniques by expert groups to his researches and defined forest garden as following [4].

"Tree, shrub, etc. are collectively grown and are artificially displayed and deployed with a certain theme in a space of structural and ecological value to provide cultural, scenic, and usage value for continuous management".

In order to promote forest garden to solve some of environmental issues we face today, evaluation index to determine if targeted area is suitable as forest garden is needed. For this end, we believe that forest garden should be evaluated based on 5 values we have identified from previous researches. Thus, through this study, we aimed to develop evaluation index of forest garden based on 5 values. Out of 5 values of forest garden, structural value is a basic value required of forest garden and evaluation index for this value was prepared with data from previous studies. Usage value is determined according a purpose when building forest garden. Historical and cultural values can only be evaluated after certain time. Thus, this study focuses only on structural, scenic and ecological values for developing evaluation index for newly built forest garden.

2. RESEARCH METHOD

In order to develop evaluation index for structural, scenic and ecological values of forest garden, we investigated R&D reports and research papers domestic and overseas to understand what type of criteria were being used. Criteria used most frequently from our investigation was selected first and we composed detailed criteria for evaluation. Then, questionnaire survey was conducted for assessing the details of criteria by expert groups.

Experts who participated in the questionnaire survey were from engineering company (10), architecture company (10), construction company (10), R&D center (10) and instructors/professions from universities (10). In the 1st phase, experts were to evaluate the relevancy of each criteria to forest garden based on 5 point Likert scale. In the 2nd phase, researchers (of the study) exchanged opinions on the evaluation result of the 1st phase and final criteria was confirmed. In the last phase, for final criteria selected, average values from the questionnaire survey was calculated and AHP (Analytic Hierarchy Process) technique was conducted to identify importance of evaluation (final) criteria. AHP technique is a technique for analysis, developed by Satty [5], which is used for analyzing complex interaction [6]. Especially, this process is efficient in calculating weighted importance or priority order from factors of subjective judgment and quite useful for studies like this one which aim to develop evaluation index.

For other studies using AHP technique, there was a research on analyzing importance per elements and issues of landscape design contest [7], another research which developed scenic evaluation technique using AHP technique to calculate weighted values used when evaluating scenery [8] and lastly, there is a research that conducted AHP technique with experts to develop environmentally friendly index for villages by improving current environment index [9,10].

3. RESEARCH RESULTS

3.1 Result of development of evaluation index for structural value

Structural value is a basic element required of forest garden in terms of its outer appearance. We have investigated definitions of forest by various international institutions to understand what structural elements

are needed for forest. UNEPCBD [11] defines forest as following. "Forest is a land area of more than 0.5 ha, with a tree canopy cover of more than 10 percent, which is not primarily under agriculture or other specific non-forest land use. In the case of young forest or regions where tree growth is climatically suppressed, the trees should be capable of reaching a height of 5 m in situ, and of meeting the canopy cover requirement." Also, FAO has the definition of forest as "Land spanning more than 0.5 hectares with trees higher than 5 m and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agriculture or urban use." The following table shows the investigation results on definition of forest by Kyoto Marrakech Accord Decision and Korea Forest service.

Table 1. Definitions of the forest

Definition of a forest	Area(ha)	Canopy(%)	Height(m)	Width(m)
UNEP/CBD (2001)	0.5	10	5	-
FAO (2006)	0.5	10	5	-
Kyoto Marrakech Accords Decision(2001)	0.05-1	10-30	2-5	-
Korea Forest Service (2019)	0.5	10	5	20
Suggestion	0.5	10	5	20

We have selected the following criteria for evaluation of structural value. Targeted area should meet all of 4 criteria described below to be selected as forest garden. If not, then target area should be reconsidered.

Table 2. Evaluation criteria of structural value

Morphological Value	Contents of evaluation
Area	At least 0.5ha or more
Height	At least 5m or more(Tall tree)
Canopy	At least 10% or more
Width	At least 20m or more(One side)

3.2 Development result of scenic evaluation criteria

Many researches exist already on scenic values of forest and for this study, we have reassessed evaluation criteria developed from existing studies. As the result, National institute of forest science developed 33 criteria for evaluation of forest scenery of Korea [14]. The highest level of criteria is categorized into 3 groups which are forest environment, view and social environment. The middle level of criteria is grouped into 5 which are vegetation, physical environment, distance, location and disturbance. Then, finally the lowest level of criteria has 12 groups such as vegetation structure. In total, 33 evaluation criteria was suggested. Especially, 3 criteria of water systems, valleys and curious rocks are considered to be essential factors when evaluating new target area is suitable as forest garden. Also, criteria for artificial structure can also be used as evaluation criteria for scenic value of forest garden.

Korea Forest Service developed 6 evaluation criteria [15,16] for a purpose of selecting recreational forest and local landscape forest which are Tourist site / Facilities area, Road, Residential(Urban), Residential(Sub-urban), Waterside(Urban), and Waterside(Sub-urban). There are different index items and weighted values applied for each of 6 criteria. The research result of Korea Forest Service was originally developed for evaluation of landscape forest, thus it can be applied directly to this study. The research by the ministry of agriculture, food and rural affairs (MAFRA) [17] was conducted mainly to select agricultural and rural landscape which includes residential space, agricultural space and urban district. The research result by the ministry of MAFRA may not be completely aligned with the purpose of this study. However, some of

evaluation criteria from MAFRA's research such as a level of greenery and area of water space are considered essential elements for evaluation of values of forest garden which should be applied to this study.

Based on the results of various studies as mentioned above, evaluation criteria that are frequently cited by other studies were first selected, compared with the survey result of questionnaire by expert groups for adjustment, then finally evaluation criteria were extracted.

Table 3. Scenic evaluation items in forest garden

	Evaluation Items	Note
Result of 1st selection	Forest Floor, Water system, Special element, Species of trees, Artificial structure, Landscape scale, Sight distance , Topography, Altitude, Slope, Number of ridges, Autumnal tints, Plants	Preceding research
Exceptional items and reasons	Altitude, Slope, Number of ridges, Autumnal tints, Plants, Water system	Duplicate with other values Low relevance to forest garden Only temporary assessment possible
Addition items and reasons	Surrounding environment, Harmony	Opinions by experts group
Final selection	Forest Floor, Special element, Species of trees, Artificial structure, Landscape scale, Sight distance , Surrounding environment, Harmony	

Scenery of forest garden is largely divided into natural elements, artificial elements and scenic elements. Evaluation criteria for scenic value has more items than structural value and are divided into 2 levels. Given this, scores for each item should have different weighted values and we have conducted AHP technique to understand importance of each item more accurately.

As a result, scenic values of forest garden are largely divided into natural elements, artificial elements and scenic element. For natural elements, evaluation criteria consist of forest floor, special elements and species of trees. For artificial elements, evaluation criteria consist of artificial structure and surrounding environment. For scenic element (landscape? Element), landscape scale, sight distance, and harmony. Natural elements, artificial elements, and scenic elements are the highest level of criteria groups and after analyzing importance of these 3 groups, scenic elements was the most important elements (47%), followed by natural elements (33%) and artificial elements (20%). In other words, scenic elements from existing environment should be well utilized for building forest garden and natural elements are more important than artificial elements for forest garden.

Table 4. Scenic evaluation criteria

Section	Weight	Subsection	Weight	Total weight
Natural elements	33%	Forest Floor	55%	18.1%
		Special element	24%	7.9%
		Species of trees	21%	6.9%
Artificial elements	20%	Artificial structure	65%	13.0%
		Surrounding environment	35%	7.0%
Landscape elements	47%	Landscape scale	43%	20.2%
		Sight distance	15%	7.0%
		Harmony	42%	19.7%

Consistency Ratio : 0.19

3.3 Development result of ecological evaluation criteria

Many researches were carried out on ecological value of forest garden prior to this study. So, we have re-assessed evaluation criteria derived from past studies.

The city of Seoul conducted a study to develop the bio-diversity design index [19] which highlighted functions of ecosystem and planning process. We found that some of criteria were not applicable to forest garden and there was no interpretation or contemplation on the importance of evaluation index. However, criteria under the bio-diversity and maintenance are applicable to this study. Evaluation index developed by National institute of environmental research [20] targeted cities, but some criteria include porous pavement, Park green space, and budget which were not directly applicable to forest garden. Also, the study by National institute of environmental research used a scale of 1 to 5 without weighted value. Index by Korea Forest service [21,22] was targeted for city forest and we found that some criteria were directly applicable to forest garden with minor change. The bio-diversity index of Europe [23] is composed of various criteria such as the bio-diversity index, eco-system money goods, sustainable usage, access and public benefit status, resource conversion status and public opinion and is quite comprehensive evaluation system. However, it was not easily applicable to this study since the scale of bio-diversity index of Europe goes beyond one nation and too extensive vs. that of forest garden. Also, most of criteria was not suitable for this study.

Evaluation index of the bio-diversity [24] by the city of Los Angeles measured the quantity of bio-organisms in 5 year term and calculated changes in the quantity. This did not quite fit the purpose of this study where we focus more on evaluation newly selected area instead of existing forest garden and its change. After selecting most frequently used evaluation items from existing studies mentioned above, we have compared them with the questionnaire result of expert groups. Some adjustment was made to evaluation items then final evaluation criteria was confirmed.

Table. 5 Ecological evaluation items in forest garden

	Evaluation Items	Note
Result of 1st selection	Age of tree, Growth condition, Water system, Connectivity, Diversity of trees, Layer structure, Special species, Vegetation distribution, Canopy(%), Area	Preceding research
Exceptional items and reasons	Special species, Vegetation distribution, Canopy(%), Area	Duplicate with other values
Addition items and reasons	Maintenance	Opinions by experts group
Final selection	Age of tree, Growth condition, Water system, Connectivity of greenery, Diversity of trees, Layer structure, Maintenance	

In the conclusion, the eco-system of forest garden can be evaluated based on 3 categories which are habitat health, bio-diversity and maintenance. Evaluation index for ecological value has many evaluation items and is divided into 2 groups which makes it complex to apply even scale for scores. Thus, we conducted AHP technique to understand the priority of evaluation criteria.

3 categories of the highest level are habitat health, biodiversity and maintenance were analyzed and the priority order was habitat health 44%, followed by biodiversity 41% and maintenance 15%. We also analyzed sub level items of each criteria for priority. The result is that under habitat health, water system was of the highest priority with 32%, followed by age of tree 26% and connectivity of greenery 24%. For sub-level items under biodiversity, vegetation diversity was of the highest priority with 60% followed by hierarchical structure

40%.

Table. 6 Ecological evaluation criteria

Section	Weight	Subsection	Weight	Total weight
Habitat Healthy	44%	Age of tree	26%	11.4%
		Growth condition	18%	7.9%
		Water system	32%	14.0%
		Connectivity of greenery	24%	10.5%
Species diversity	41%	Diversity of trees	60%	24.6%
		Layer structure	40%	16.4%
Maintenance	15%	Maintenance	100%	15.0%

Consistency Ratio : 0.00

4. DISCUSSIONS

This study aims to develop accurate and systematic evaluation index for forest garden and referenced the results of various studies in the past so that the findings of this study can be utilized for policy making. The study re-assessed various evaluation index developed by past studies with expert groups in objective manner, examined the importance of index through AHP technique, then developed evaluation criteria for forest garden. Also, the study categorized evaluation criteria into 2 levels for more detailed evaluation which makes the findings of this study more precise and systematic than past studies.

Structural evaluation criteria of forest garden examines basic qualities needed of a forest and we believe that definitions of forest already established in the past should serve sufficiently as evaluation criteria for structural value. For scenic evaluation criteria, we have categorized criteria into 3 groups of natural elements, artificial elements and scenic elements and further defined criteria to evaluation of various elements of target forest. Especially for evaluation of garden, the study developed evaluation criteria for artificial structure and species of trees. Lastly for ecological evaluation criteria, we have further defined criteria into habitat health, biodiversity and maintenance with an emphasis on maintenance for garden function of forest garden.

In conclusion, the study developed evaluation index of forest garden with detailed criteria for various aspects of forest garden. Going forward, we would need to build up data base after conducting evaluation on newly built forest garden for further verification and correction of evaluation index. So, further research by selecting various forest and evaluation using the evaluation index developed by this study needs to be done. Also, we believe that additional research will be needed on usage value of forest garden in order to more precisely understand forest garden with various forms. With such findings, the evaluation index for forest garden will be more complete.

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