A Planning Support System as a Tool for Sustainable Urban Planning

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1 ABSTRACT

The process of urban planning includes multiple task fields carried out by planners oder designers. They are confronted with complex planning procedure, complex data management, and multi-dimensional spatial presentation. The advanced computer technologies are able to aid and take over some workscopes in the planning process. The study introduces a developed program named 'eco-city Planning Support System (ePSS)' to help the ecologically oriented urban planning, especially for the planning practices like new town project or new city project which encompasse the entire process from land use decision to detailed building planning. In those planning procedure, the practices are far from ecologically sound planning because the urban planners are provided only some physical data and materials, not the environmental useful informatio, they are engaged in conventional development planning, and only little time is left to take the tasks to carry out additional ecological consideration.

In this background, the pivotal purpose of the introduced ePSS is designed to lead the planners to ecologically oriented planning. The program is composed of various functional subsets which are required during the urban planning procedure. One subset is designed to produce the ecological maps in the field soil, water, biotop, micro-climate, ecological connectivity and recreational suitability, in which result maps are served as spatial decision map for land use planning. This subsystem is constructed both to simply usability using Quick-Menu and to more detailed analysis and assessment. The next subsystem is designed to land use concept and land use plan in which not only 2- but also 3-dimensional planning are possible and the changeover can be simply done. The last part of the ePSS carries out environmental analysis and simulation like solar access, visual openness, and green visuality and visualization of of planning environment.

The end-users of this program are planners in planning companies and planner in engineering firms in Korea. The system is compatible with usual CAD and GIS data so that the wide usage is guaranteed.

2 INTRODUCTION

Sustainable use of natural resources is even more important now where the resources become scarce and therefore must play a pivotal role in the planning. But the reality of the planning is not supposed to reflect sufficiently the urgency to preserve and to use the rare resources sustainably. Analysis of environmental capacity and potentials of the natural resources has to play an important role in the sustainable Land Use Planning.

In Korea, there is a plethora of planning relevant regulations and planning process which make urban planning too complicated and difficult to understand fully. It is not an easily accomplishing task, to perform planning even for planners and civil servants. In particular, the lack of spatial planner's ecological knowledge and supporting planning instrument leads to ignorance and insufficient consideration in the spatial planning.

Often the citizens are excluded from the planning process or the participation is merely fulfilled in a formal way guaranteed by the regulations (Lee 2005), although the enormous progress in computer technologies in Korea might give opportunity to support planning more easily understandable (Kwon 2008).

There are already a number of planning support tools like planning support system (PSS), decision support system (DSS), spatial decision support system (SDSS), and the others in literature and in practice, though all with very different objectives. Geertman and Stillwell (2009) point out the computer-based support systems developed by researchers have not found its application in planning practice or policy making.

The main objective of this paper is to introduce a planning support system developed since end 2008. The software of this PSS is not designed to replace the planning or planner's task, but to facilitate and accompany their planning process and to help decision-makers and other participants understand spatial, contextual plan environment.

3 THEORY AND PRACTICE OF PLANNING SUPPORT SYSTEM

3.1 Definition of terms

PSS is relatively new in planning practice and theory introduced in the mid-1990s to support and improve the performance of those related to the planning (Batty 1995; Klosterman 1997). PSS is associated with GIS. GIS is a system which is serving as capturing, storing, manipulating, analysing and displaying spatial data, whereas PSS carries out GIS-functions and also is related to SDSS or SDD, but its main focus is to support specific planning tasks. PSS enables planners to better handle the complex planning procedure, resulting in the improvement of planning quality and reduction of time and effort (Geertman and Stillwell 2009).

Batty (1995) considers PSS as a subset of GIS which is designed to explore, represent, analyse, visualize, predict, prescribe, design, implement, monitor, and discuss planning related issues. Kim (2004) defines PSS as „computer-aided planning system combining geographic information system (GIS), urban models, and visualization tools, has been actively researched and applied in many developed countries".

Kim (2004) points out the key difference of PSS is to finde in adoption of visualization technologies and possibilities of collaborative planning process.

3.2 Spatial Planning Practice in Korea

The spatial planning system is associated with administrative hierarchy system in Korea. It is from comprehensive national territorial plan to comprehensive province plans, to Metropolitan city plans, and to basic urban plans. As the system indicates, it functions in a top-down approach, so spatial planning system should not contradict the higher-ranked planning system. Also on the ground that the spatial planning in the higher level deals with detailed spatial issues, the possibilities for flexible handling of lower-ranked plan are in general restricted. Moreover, because the basic urban plan is a long-term plan focusing at the comming 10 to 20 years, there is a lot of uncertainty in the planning to flexible, rapid respond and to deal versatile and swift change of planning situation.

The other characteristics of spatial planning in Korea is that the planning environment has been changed from top-down to bottom-up system and in the course of new city development planning many interest groups like communal government, city parliament, NGOs, civil activists are broadly participated. But even though planning participation includes diffent groups, the planning practices stick to the conventional ways, so there are increasing conflicts between different interest groups. This leads to various problems of delay, distortion, and change of the planning(Park 2001).

In order to improve such ineffectiveness of planning-related decision system, a comprehensive decision support system in spatial planning has to develop able to provide with spatial information, to widen civil participation so that the planning decision processes are more transparent both to the decision maker and to the public. For such system improvement, first of all the administration and institutions have to be changed and a supporting system is required to deliever information and data needed. The main aim to use PSS is to reduce irrational decision and to prevent errors resulting from planners' limited information, knowledge and experiences. Especially it is expected to be effective for the case of urban planning process entangled due to complex interests

The rational decision making of urban planning would be possible if there were spatial data available to clarify the spatial context and phenomena and to suggest objectively analysed information. Taking into consideration that a lot of planning participants are related and the interest conflict is anticipated, such data and information are more important.

4 OVERVIEW OF THE PROJECT

Here we present our software tool of an planning support system (PSS) which has been developted since end of 2008 in one of the national R&D Projects supported by Korean Minstry of Land and Maritime research project. The project was created in the response of governmental requests and needs to lead and create the future development power by Research and Development in field of construction technology. Reflecting this, the project has started to develope a ecologically oriented planning support system as a software tool to help the planners and decision-makers in the urban planning process. The Software will accompany the planning practice based on the planning system and practice in Korea.

The background to develop a planning support system is based on the circumstances that the planners devote most time to implement routine administrative tasks such as permit processing, so that little time is left to undertake true planning in conventional terms (Klosterman 2009). Taking into consideration that there is no legal ecological planning instrument like landscape planning, e.g. in Europe, prcaticies of land-use plannng practice in Korea are devoted generally to maximize the built-up environment only following the minimum standard of ecological regulations,. Urban planners are willing to have a ecological supporting tool at their disposal, because spatial decision would be more easily made if some leaning point and arguments would be given, which leads to more ecologically oriented spatial planning.

With regard to planning process which includes spatial analysis, evaluation, goal setting, spatial allotment and developing implementing strategies and last but not least participation of public and agencies, the planning support system is dedicated to provide the planner computer-based tools to handle the complex planning task. Otherwise, the spatial decision support system has its main function in support to find of optimal location for diverse demand on space in area by means of spatial analysis and evaluation.

The main user differ from the planner, decision-makers, planning consulting commitee, and citizens. The designed program is designed to facilitate planners time-consuming task on the one hand and to help decision-makers understand and control the context of space, content, effec of the proposed plans as a control and admission institution.

5 STRUCTURE AND FUNCTION OF "EPSS" PLANNING SUPPORT SYSTME

5.1 Structure of the Planning Support System "ePSS"

The presented eco-city Planning Support System (ePSS) is composed of four different subsystems: the ePSS-Analyzer as spatial decision support system (SDSS), the ePSS-Planner as land use planning support tool, the ePSS-Designer as a auxilary tool to take over the designing task, and the ePSS-Simulator for 3D simulation of the planning area (figure.1).

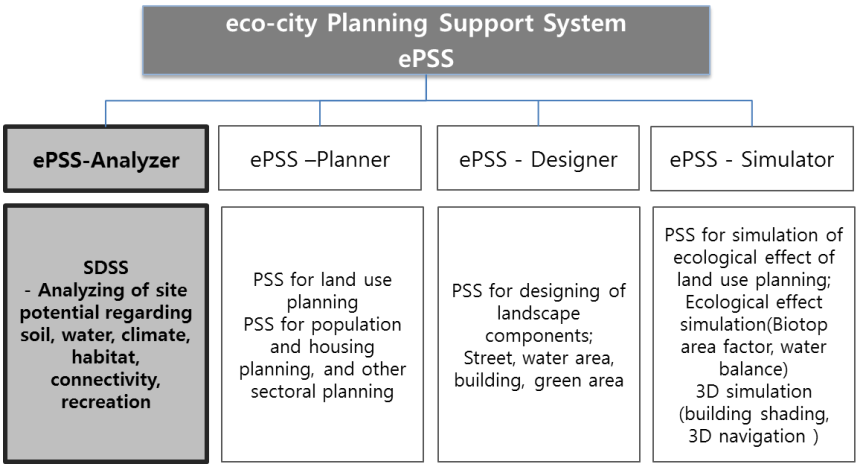

Figure 1: Structure and Submodule of the planning support system ‚ePSS'

The subsystems can operate independently, but are interlocked so that the whole system can be used or the individual subsystem is available for the planning use. The database management framework is integrated as basic system for managing integrated database to drive modules. A graphical user interface is designed.

5.2 Functions of the Planning Support System "ePSS"

5.2.1 The ePSS-Analyzer as a ecological spatial analysing system

The subsystem ‚ePSS-Analyzer' is constructed to analyze and assess the default environmental factors. For the sector of soil, water, climate, biotop (habitat), habitat connection, and recreational potential as natural resources, the default analyzing and assessing algorithm is installed. In case that other additional environmental or ecological sector will be desired, it can be also additionally installed.

This module is of great importance in Korea, because there is no ecological planning instrument with legal planning status. Therefore it can take over an important role for urban planning to lead more ecologically.

ISBN: 978-3-9503110-2-0 (CD-ROM); ISBN: 978-3-9503110-3-7 (Print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI

The instruments like strategic environmental assessment, environmental impact assessment have real influence to check and control spatial planning, even though the need for ecologically oriented planning is not controversial among the planning experts and civil servants (Lee & Suh 2007), there is no real ecological planning instrument.

Recently the discourse about sustainable development and the introduction of landscape planning or environmental planning finds a broad acceptance among planners and researchers and the relevant methodologies have been suggested (Jung 2010). The here proposed spatial decision support system is able to help planners and decision makers provide with useful ecological information and allow effective decision support by analyzing, displaying and visualizing ecological spatial Data applying computer-based information system.

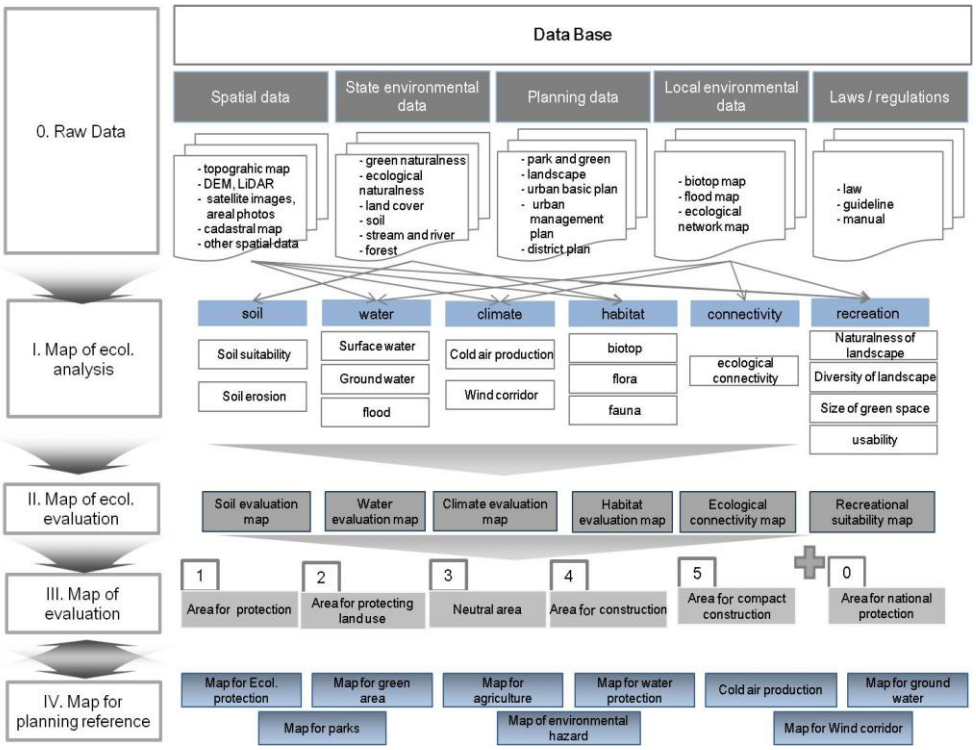

Figure 2 The general procedure of Spatial decision support system

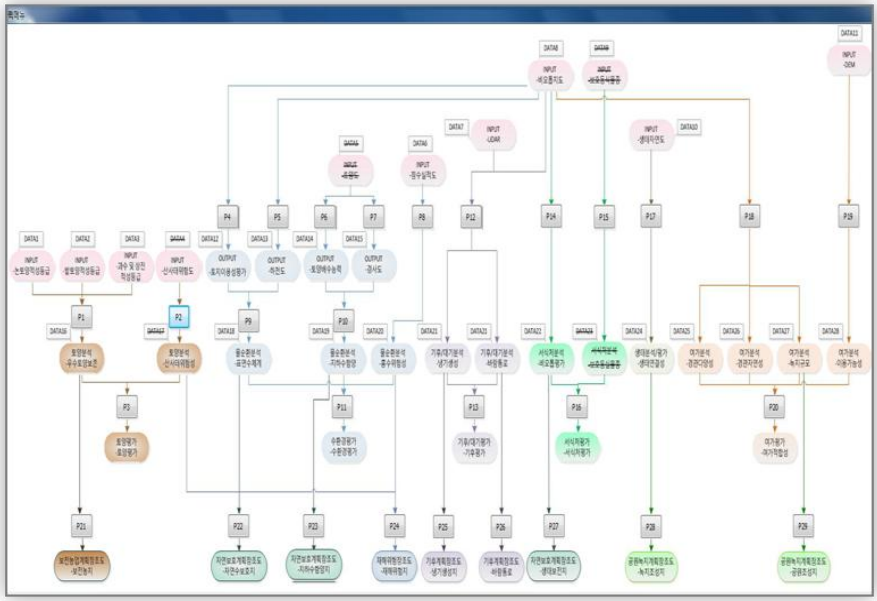

Figure 3: Quick module GUI of spatial decision support system

QUICK MODULE OF SPATIAL DECISION SUPPORT SYSTEM

The above described methodic procedure can be alternately done by "Quick Module" installed. The visual model which is consisted of graphical flow charts in sequence of analysis is an exploration to make the user acquainted to the complex program (Hocevar & Riedel 2003.) The quick module serves to combine the geo-processing into a sequential chain, which can operate automatically. The steps are the same as above mentioned, the quick module can be operated also manual or full automatically. The user can click the button where they want to produce the map, and the default analyzing process can be done. The corresponding raw data have to be uploaded beforehand in the defined folder, so that the process can grab the needed data. The GUI of "Quick Module" is designed in a tree structure, to provide user's convenience (figure 3).

This system is usefully applied, as far as the users have knowledge neither in analysis methods nor computing procedure. The advantage of using the quick module is to speed up the process and the users who have not profound knowledge in GIS and ecological analyzing methods can use the system effectively. The raw data required for this quick module must be beforehand installed in defined location.

5.2.2 The ePSS-Planner as a tool for 2D and 3D Land Use Planning

The ePSS-Planner is a tool to support planning tasks in new city development plan, city renewal plan, building renewal plan, and urban regeneration plan. The system supports to draw spatial structure and to show in 2D and 3D plan format according to plan goal and direction. For these, the ePSS-Planner has different functions as follows:

First, planners are able to inquire informations of landscape-ecology, urban planning, national spatial data etc. Also it enables visualization of the maps analyzed in the ePSS-Analyzer like analyzed, evaluated maps or planning reference maps.

Secondly, it supports for planners to draw land use concept. Land use concept means the procedure of schematic land use concept and structure in coarse level. Prior to the phase of land use plan, zoning the plan area, putting thematic axis, and designating spatial thematic issues (land use concept, settlement concept, green area concept, transportation concept, specialization concept etc.) are displayed in a planning area. The planner uses the drawing tools for these tasks.

Third, it supports the phase of land use plan. The functions are to draw street, and to form blocks, to dedicate land use purpose and density, to construct 3D building, and at last to give planning report.

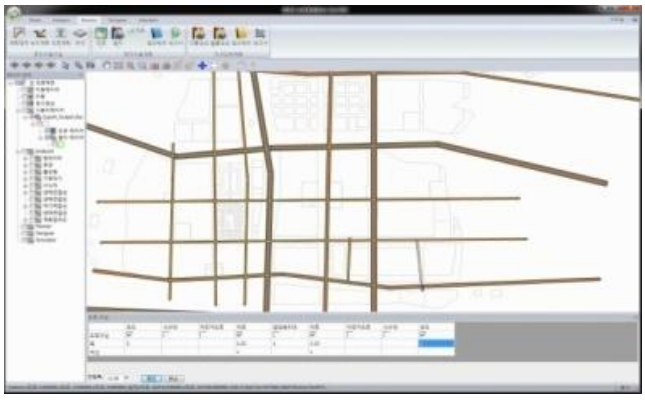

Figure 4: Formation of Road and Block

5.2.3 The ePSS-Designer as a Design tool of planning components in Land Use planning

This system supports to visualize components consisting of urban spatial structure from 2D to 3D map components. By means of this subsystem, components of virtual planning area are provided, so that planner, administrative personals and the public can understand better the spatial structure and contents of the plan. The main design components are building, street, street trees and other outer space elements like topography, green area, and water.

The difference to construct 3D building mass between the ePSS-planner and the ePSS-designer is that building can be drawed easy and rapidly out of the building type library

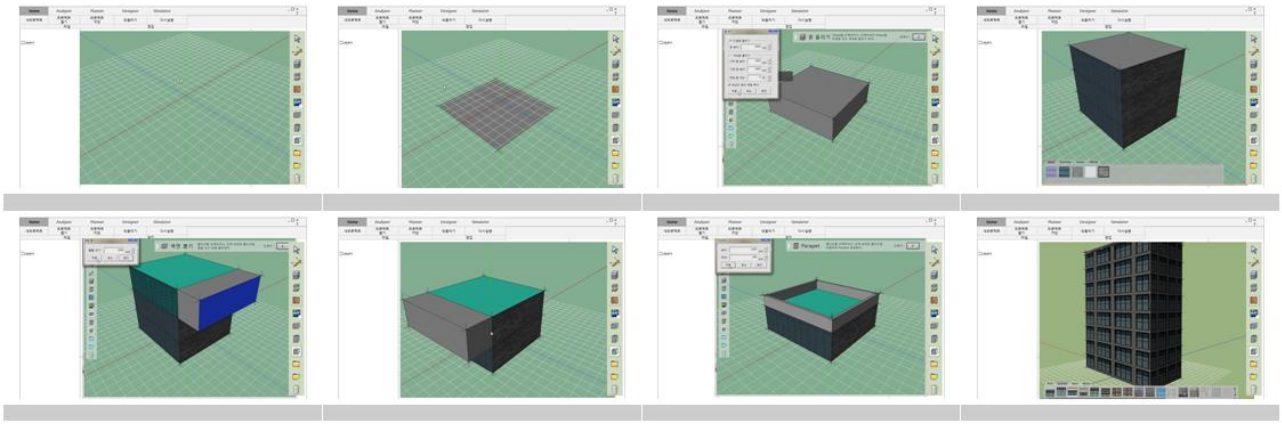

Figure 5: Building Modeling Process

The tool of street designing is to help to design lane type, lane width, pedestrian lane, bicycle lane, street tree lane, or central strip and to enable 3D street modelling. The planner can design and change tree planting intuitive using Drag and Drop function, in which type, shape, number, and space can be determined and visually confirmed.

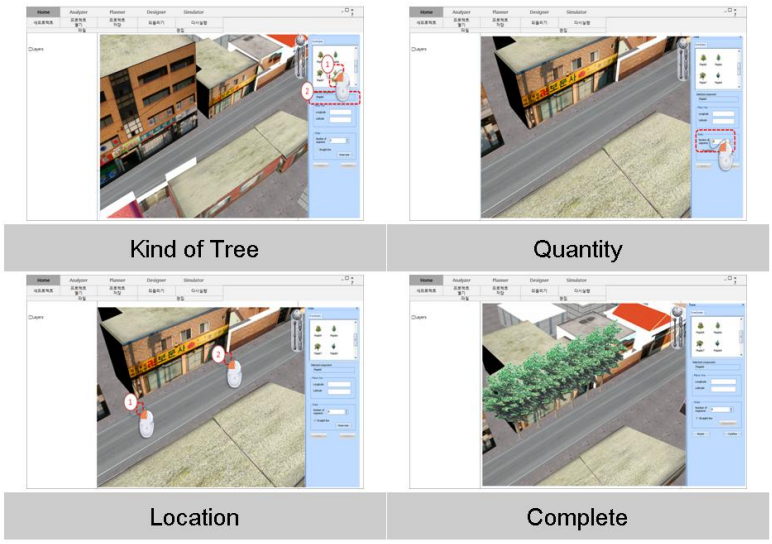

Figure 6: Street Tree Modeling Process

The planner can make and change elevation of topography, and the surface can be decorated with given texture. Within this topographic modelling, lake, see and stream can be made and visualized.

5.2.4 The ePSS-Simulator as a 3D virtual simulation and spatial analysis tool

The ePSS-Simulator facilitates to analyse the 3D-based spatial environment designed by the ePSS-planner and the ePSS-designer. This subsystem is important because environment and visual landscape can be analysed by changing 2D space to 3D space. The main functions of the ePSS-simulator vary from solar access analysis, visual landscape analysis to moving simulation.

The analysis of solar access gains in Korea its importance since high-reise buildings are very common, so that solar accessability is often deterred by neighbour buildings. This analysis can help to avoid later issuing conflict and to improve residential quality previously. This system provides planners with analysis result of solar accessibility and solar duration and thereafter basic dicision information to regulate location, distance, and height.

The analysis of visual landscape varies from visual analysis, panorama, virtical view shielding, to green visibility analysis. The system can calculate visible boundary from certain locational point and draw visibility rate. Panorama analysis enables analysing of sequential view by using visibility amounts. Virtical view shielding calculates the ratio of building-shielded area against targeted landscape object.

Moving simulation is for visualization of planning space observing from the object view point. The moving path, observer's height, and moving speed can be operated, so that visual simulation is carried out from the view point of car driver, bicycle rider, and flying object. Using this visual simulation, various planning environment can be controlled.

5.2.5 Biotope-Area-Factor calculator (BAF-Calculator) as a ecological settlement control instrument

In order to improve the ecosystem's functionality and promoting habitat quality in cities, Biotope Area Factor is recently introduced in Korea. By this control instrument, natural circulation balance of natural ecological components soil, water, climate, living organisms will be promoted and species habitat is not disrupted by soil sealing. Similar to the urban planning parameters, the BAF calculates the spatial ratio of an area that serves as a location for plants or assumes other functions for the ecosystem of the total proposed area.

The BAF-Calculator enables automatically or half-automatically the calculation of the relevant space. BAF is used as a criterion in Environmental Impact Assessment in Seoul, and newly applied in strategic environmental impact assessment, environmental impact assessment, so that its importance in the spatial planning is increasing(Jang & Kim 2008).

The BAF-Calculator is developed as a separate program installed on PC, by which ecologically relevant area can be promoted in development plans and projects. This program can be linked to the ePSS-simulator.

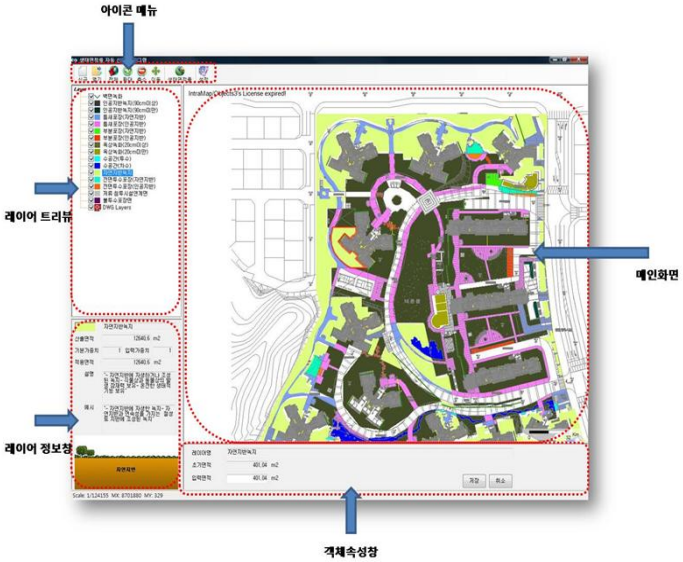

Figure 7: Biotop Area Factor calculator

6 APPLICABILITY OF THE EPSS

In Korea there are meanwihle a lot of spatial data available. Since GIS has been introduced in 1980th, and in 1995 the project for the establishment of GIS basic plan in Korea and the respective regulation and institution framework has begun, the state, local government, and civil organization have tried to establish for a long time diverse data for diverse purpose. But there is still no effective cooperation between the ministries and governmental agencies and the overlapping investment has been criticized (Lee 2006). The data acquisition required for spatial planning is still a difficult, long-lasting task. Another example is the biotop mapping implemented since 2001 by a lot of municipalities in Korea (Ministry of Environment Korea 2010, Moon et al. 2009), which means a valuable data for the analyzing methods of the system.

As the presented PSS, some utility programs for urban planning have been developed. Although we are now facing against some implementation hindrances to combine the spatial DB and implementing tools, there is a hope in near future to coordinate two system fields and to carry out urban planning more effectively and sustainably.

The possibilities to apply the developed PSS are manifold. Taking the fact into consideration that the PSS program has developed recently, the potential user groups encompass from local government, state-run agencies, city-based agencies, planning and engineering firms to architecture and landscape architecture. Since the entire program ePSS is equipped with diverse functions and possibilities of spatial suitability

analysis and evaluation, land use plan, and simulation, the user can choose what they need for their work scope.

As divers in user groups, the PSS is to anticipate multiple applications. As already mentioned, the planning reality which there is no landscape planning in Korea, the PSS can accomplish an important role in urban planning. In Korea, there are many laws and regulations regarding urban development project like urban reconstruction project, housing project, urban regeneration project. Also in outskirt of city there are also many land developing planning and projects like housing, new city, new specialized city, industry, recreation development. The latter occurs in suburbs or natural intact areas, so the environmental destruction of relatively natural areas will be lasted through the respective project. Even though the environmental plan is obligatory, the consideration of environmental aspects into the development plan is not satisfactory, in particular because of the absolute lack of planning time. Characteristic for the PSS is its rapid implementation speed and the quality of the results.

7 CONCLUSION

Recent advances in computing technologies enable the evolution to produce a variety of planning support software, on the other hand networking technology make possible the participation of many groups in the planning process (Kim et al. 2009). There are a lot of developments of planning support system in theory and practice. One of the widely practiced spatial decision support system in Korea is Land Suitability Assessment System.

The program PSS introduced in this study is conceived to perform various tasks needed for spatial planning in Korea, and one special purpose of this PSS is to facilitate planners to ecologically oriented planning. The program supports satial anaysing, land-use planning, spatial designing and plan simulating.

The program is composed of four functional subsystems which are required during the urban planning procedure. One subsystem „ePSS-Analyzer“ is designed to produce the ecological maps in the field soil, water, biotop, micro-climate, ecological connectivity and recreational suitability, in which result maps are served as spatial decision map for land use planning. This subsystem is constructed both to simply usability using Quick-Menu and to more detailed analysis and assessment. The Subsystem „ePSS-Planner“ as a land-use planning supporting tool is developed to carry out land use concept and land use plan in 2- ando 3-dimensions. The Subsystem can be defined as a supporting tool to visualize components consisting of urban spatial structure from 2D to 3D map components. The ePSS-Simulator carries out environmental analysis and simulation like solar accessibitlity, visual openness, and green visuality and visualization of of planning environment.

The end-users of this program are planners in planning companies and in engineering firms in Korea, and also civil servants in admistration. The system is compatible with usual CAD and GIS data so that the wide usage is guaranteed.

The mentioned program is expected to find versatile uses in planning praxis like planning practices and administrative personnel who are responsible for permission of planning in city government or other planning-related agencies. In order to enhance the usability of the program, it is tried to garner and integrate the needs and requests from the city administration and planning companies.

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ISBN: 978-3-9503110-2-0 (CD-ROM); ISBN: 978-3-9503110-3-7 (Print)
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