VISUALIZING ENVIRONMENTAL INFORMATION ON THE GEO-SPATIAL URBAN MAP

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Abstract. Environmental and residential destruction caused by urbanization and land development raises a serious issue. In addition, advanced technology has quickly changed the structure of cities, followed by revolutionary changes are growing faster these days and this requires us to turn our attention into developing a symbiotic eco-city, which will make it possible for further sustainable development. In this regard, it grows much more important to manage a flood of information from various intelligent devices and systems for environmental maintenance. The structure and meaning of modern info-oriented cities have changed their focus from tangible materials and resources, or energy into intangible information and knowledge. Now it has become the most important on how to manage and utilize a vast amount of information in order to strengthen the competitiveness and improve the life quality. This study finds methods for an effective city management and planning, or visualization of information for ecology-friendly education in order to provide a comfortable city life and develop a cleaner city, by efficiently managing information on several ecology protection areas and their sauces of pollution in the centre of a city. The goal is to help city managers or planners to be better aware of environmental information related to their work.

Keywords. Ecology-friendly city; environmental information; geo-spatial urban map; classification, visualization

1. Introduction

A new change with information and globalization late in the 20th century has influenced greatly on our lifestyles, with the development of technologies in communication resulting in whole different kinds of societies, economic structures and cultures as well as revolutionizing various services and systems. Accordingly, new forms of relationships and telecommunications dependent on computer networks have been widespread, which demands us to take a new approach to the concept of space and accessibility to information.

While recent studies related to the green movements just remain at guiding principles for users or relevant services, it is necessary to consider how these studies can be developed on the basis of architectural space, and how user information in the space and its environmental information are related. In a flood of information around us, it is not easy to capture necessary one quickly among them. Even worse, text or figure information makes it hard to notice and understand it at a glance. It is also necessary to devise a method to help the better understanding of information as well as its delivery in real- time manner. The environmental information covers a wide range so we find it necessary to classify them efficiently.

[1] How to find an effective way to classify environmental information?
[2] How to understand them easily (Environmental Information)?
[3] How to access to the real data easily based on a geometrical location and distinguishes them meaningfully?
[4] How to utilize the data visualized for the construction of ecology-friendly city?

By visualizing various and invisible information and grouping them, this study aims to find a new way to visualize information, which makes it easier to manage them for constructing an ecology-friendly city (ECO-city). This visualization of information, categorized based on a geometric location, can be used as a tool for effective planning of city management and as eco-city construction system. By visualizing information for more improved processing of various eco information, we try to make the best use of it for a better lifestyle. The objective is to develop a visualization method as a means of controlling environmental information efficiently and reflecting it on city planning when city managers or planners use the information on a virtual platform.

2. ECO-city

Being an ECO-city means working together for a better social, economic and environmental outcomes for our children, our grand children and ourselves. It means working with people and communities to build a strong local economy, create attractive town-centres with good roads and passenger transport access, protect and expand the “green network” which links our streams and parks from the ranges to the sea, use resources better, and produce less waste and improve the well-being of residents. The sustainable development of this ECO-city confines its range to the extent that it does not harm environment, changing the nature within its capability based on the developing plan to preserve the ecosystem. After all, it includes both “environment” and “preservation”.

TABLE 1. Case of ECO-city.

Case	Goal	Developing factors
Laguna west (California, U.S.A)	Planning and carrying out based on the New Urbanism[1] theory	-Waterfront -Radial structures -Follow plan -Commercial centers and a densely populated district
Vikki Newtown (Helsinki, Finland)	Developing a high-tech city and eco- friendly residence in nature intensive areas	- Science Park - Utilizing territory/transport/greens/parks - Utilizing water resources - Building communities - eco-point (establishing evaluation standards)
Malmo(Sweden)	Combining the concept of sustainability with landscape and city structures	- utilizing territory/follow plan - plan for greens and open space - utilizing rainwater - nursing and reusing resources - design(a tango house)
Poundbury (Dorset, U.K)	Sustainable developing and recovering of traditional British cities	- plan for a road for both a footpath and a roadway. - plan for territory usage and city planning - considering eco friendly building - plan for city space(skylines, squares)
Hammarby Sjostad (Stockholm, Sweden)	A sustainable residence mixed with architecture and modern technology, considering environment	- commercial and public service - Mammarby Model - Minimizing demands for transportation
Fredensgade (Kolding, Denmark)	eco-renovation helping to save water and energy	- utilizing natural energy - utilizing rainwater - Bio-Works pyramid - labs for sustainable
Klosterenga (Oslo, Norway)	Developing buildings for saving energy and regenerating cities with sustainable technology	- utilizing territory/follow plan plan for greens and open space - adjusting indoor
Kiel Hassee (Kiel Hassee, Germany)	Developing eco-friendly buildings and living space	- utilizing territory/follow plan - utilizing natural resources(rainwater and sewage)

3. Environmental Information in an ECO-city

Environmental information is defined in the EIRs[Scottish Information Commissioner] and covers a broad range of topics, such as: the environment itself and things that affect the environment and other forms of pollution, policies, plans and laws on the environment.

[1] The state of elements of the environment – such air, water, soil, land, landscape and natural sites, flora and fauna, including cattle, crops, GMOs, wildlife and biological diversity – and it includes any interaction between them

[2] The state of human health and safety, conditions of human life, the food chain, cultural sites and built structures, which are, or are likely to be, affected by the state of the elements of the environment and the interaction between them

[1] As a solution for problems arising form sprawling cities, it first launched in the U.S and Canada in 1980s with a slogan of making cities the neighbourhood unit. It synthesizes cities with a rural lifestyle by creating space for eco-movement, greens in the suburbs, parks and walks.

[3] Any factor such as substances, energy, noise, radiation or waste, including radioactive waste, emissions, discharges and other releases affecting, or likely to affect, the state of the elements of environment or any interaction between them

[4] Measures and activities affecting, or likely to affect, or intended to protect the state of the elements of the environment and the interaction between them. This includes administrative measures, policies, legislation, plans, programmers and environmental agreements

[5] Emissions, discharges and other releases into the environment

[6] Cost benefit and other economic analyses used in environmental decision making

This kind of information helps designers to set up and accomplish environmental policies more scientifically and rationally, and support private research and development by utilizing environmental information. Utilizing environmental information for ECO-city helps to support for city administration (management) and provide various service such as offering citizens accurate information, or educating experts/non-experts - the final goal is to maximize the quality of citizens' life.[Lee, 2004]

Before classifying environmental information, we studied cases of building ECO-cities and compared them in order to categorize eco information necessary for ECO-city based on basic elements of city space: human, place and things. After synthesizing plans for eco-city building, we divided them into the following three groups: information about environment already given to us, information about users who build cities utilize them, and technical information about advanced technology for more comfortable cities as shown in Figure 1.

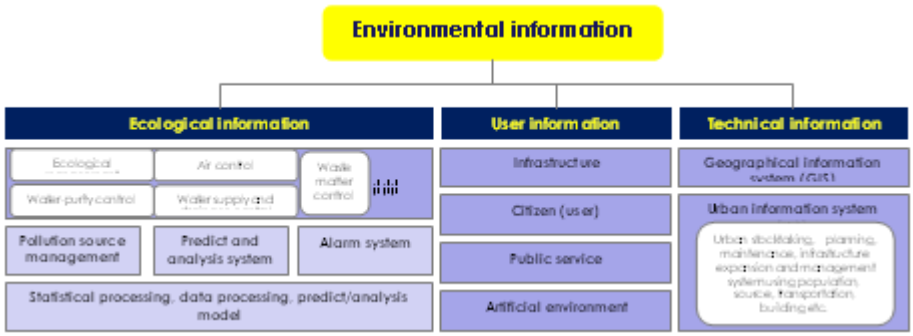


figure 1. Grouping of environmental information

4. Information Visualization

4.1 Visualizing Information

Data visualization, which helps analyzing and communicating of huge amount of information, is used to affect human perceptions for better understanding of data reading.[Heer et al., 2007] In a study of converting spatial and high dimensional data into visualization through maps[Skupin et al., 2003], more rich and clear visualization is attempted by applying cartography to visualization using computer technology. Data visualization therefore converts various and different contexts of information into more useful information, meanings, and knowledge by focusing on methods that reveal patterns hidden inside the dataset.[Moere, 2007] It puts as much importance on beautification of data visualization in an inconographic way as on its clearness. The purpose is to help users understand it more easily and recognize many kinds of information by its characteristics.

4.2 Classification of Data Visualization

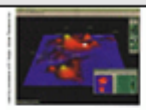
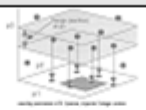
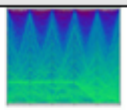
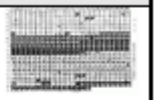
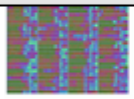
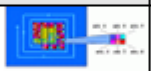
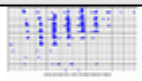
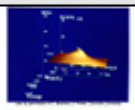
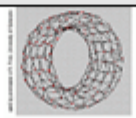
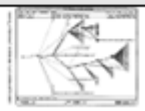
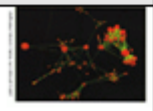
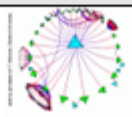
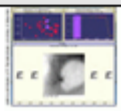
In the process of data visualization, it is one of the most important tasks to group different kinds of information for efficient accessibility. It is also important to display this information effectively. The types of visualization can be divided in various ways: 11 types in Experimentally Motivated Classification[Lohse et al., 94] and 8 types of position, length, angle, Slope, Area, Volume, Color, Density[Mackinlay, 88] based on its accuracy. Table 2 shows the visualization types classified in the preliminary study.

TABLE 2. Classification of Data Visualization

	Mackinlay (88)	Lohse at al. (94)	Daniel A. Keim (97)	Shneiderman (98)
Data types	Position, Length, Angle, Slop, Area, Volume, Color, Density	Graph/Tables (numerical/ graphical), Charts(time/ network), Diagrams (structure/network), Maps/ Cartograms, Icons/Pictures	Geometric, Icon-based, Pixel-based, Hierarchical, Graph-based, Hybrid	One-dimensional, Two-dimensional, Three-dimensional, Multi-dimensional, Temporal, Hierarchical, Network

Further, table 3 shows examples of various visualization methods classified by characteristics of information. Based on previous studies about visualization classification mentioned above, different kinds of methods are selected to provide clearer information. The information we deal with in this paper also can be classified in this way.

TABLE 3. Example of Visualization techniques

Landscapes	Schematic representation	Parallel Coordinates	Chernoff-face	Stick Figures	Shape Coding
					
Recursive Pattern	Color Icons	Circle Segments Technique	Dimensional Stacking	Worlds-within -Worlds	Treemap
					
2D Graph Drawings	3D Graph Drawings	Hygraphs	Naricissus	3D Hyperbolic Representation	DEVise
					

4.3 Constructing Visualization Patterns

Large data can be classified on a basis of a simple visual method, then divided into several data sets to which each visualization method is applied according to their characteristics based on the Keim's study. Then, the data sets are represented as visualized patterns on a virtual space, using the data mining method[2]. The visualized data are shown around the space and the second level information is tagged without exposure to provide a searching function.

The main concept of this study is not only to apply the visualization method to a large volume of environmental information according to their characteristics, but also to build a network of information using a tagging technique for efficient acquisition of information displayed.

For this, we first induce users to get a clear understanding of visualized patterns of information classified into three groups. Then, we use a tagging method[3] in part to avoid the traffic of information displayed one by one till they reach to the final level.

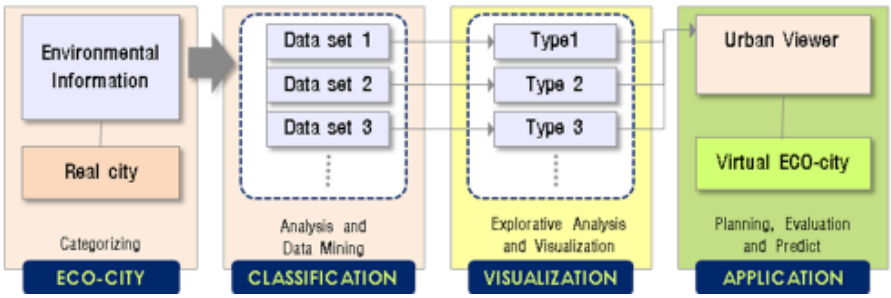


Figure 2. Constructing Visualization Patterns

5. Relationship between Geo-spatial and Environmental Information

With the revolutionary development of information technologies such as digital information space, information service, and intelligent information providers, new types of activities and cultures called “virtual communities” have appeared. The result cities have replaced the existing cities or changed them a lot, making the boundary of city roles vague. Virtual places like ‘Second Life’ operates human activities such as office work, shopping, banking, residence and education in real time as well as showing a huge amount of information indicating such activities. Based on this technology, our study aims at visualizing vast information including city roles for the eco city plan. So we try to find a method to visualize environmental information based on classification of data meanings.

That is, we select visualization methods introduced above according to the characteristics of classified data. A large volume of data sets can be made using accumulated records of samples and phenomena in a real world when showing specific object or phenomenon data in two-dimension. Such method can be helpful to understand the phenomena of the space and relationship between space and non-space data. It also delivers information converting high dimensional data into visualizations in virtual space.

6. Applications

Using the data contents model created in this study, we are going to build an ECO-city development system. The system can be used as a tool for building ECO-cities for management and evaluation as well.

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[2] Data mining is the extraction of interesting patterns or models from observed data.
This method automatically shows relationship between each data in its intelligent system, as well as finding connections of the data which are hard to turn into figures.

[3] A tag is a keyword or classification given to certain information as metadata. Tagged keywords may not be recorded in the text, making it possible to search the internet data objects by typing words. A normal tag consists of a word, but it often contains several words integrating into one meaning. Especially in the Web where vast information is created, exchanged and shared, using a tag makes it possible for users to search desirable information.

The main function of the system are like this: minimizing the environmental influence in building cities, planning environmentally sustainable cities, saving and reusing energy by controlling energy supply and providing infrastructures, and finally developing cities in harmony with environment through the intensive, efficient, and complex city planning system. As shown in the example below, this web based application interface has five components such as Basic Toolbar, Viewer, View Controller, Graphical and Quantitative Visualization Layer.

For instance, when a user selects the mode of environment data that he or she wants to see(on the bottom of the interface), the interface displays visualized graphical information on the right with a specific explanation of the selected data, which further can be divided into several types. It is also possible to see multiple information simultaneously layers enables users to analyze different types of information in the 3D viewer. (In the example below, one can examine both demographical and traffic information at the same in one area to predict air pollution and find a solution.)

Figure 4. Prototype of Virtual ECO-city

7. Conclusion

This study verifies how visualizing data in a 3D space can be used to manage and utilize intelligent space. It can be also used to save time and energy in new city planning or ECO-city construction process, and provide a environmental information map which tells us about the flow of information. This visualization method shows the relationship between virtual and real spaces, making it possible for users to see information transfer without a gap in time and space as well as being applied to various environmental services in ECO-city space. We need further studies on how to use the visual data mining method for more profound and useful application of environmental data, and visualize them according to their characteristics.

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