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Development of an evaluation system for urban environment

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1. Introduction

Today, in the wake of mass urbanization, environmental issues have become a major global concern. The enormous consumption of resources and energy that accompanies urban activities has placed an excessive load on the natural environment that surrounds cities, and consequently on the entire earth. Furthermore, urban expansion has weakened nature's ability to restore itself. To solve this problem, we must redefine the rules pertaining to urban activities.

In this paper, we have established basic ideas about the creation of cities that will contribute to the global environment, and have developed planning supporting tool that evaluate urban environment.

2. Concept of ecological urban design

We have established new planning methods to create cities that are fully integrated with the urban ecology. This new planning method is known as "ecological urban design", a concept that incorporates the following two points (Fig.1)¹⁾

- 1) The urban metabolism of resources and energy will be structured in order to minimize the load on areas surrounding the city. The city is thus made more self-sufficient.
- 2) By improving the degree of interdependence among the various elements that constitute a city, we will create a pleasant urban environment where people,

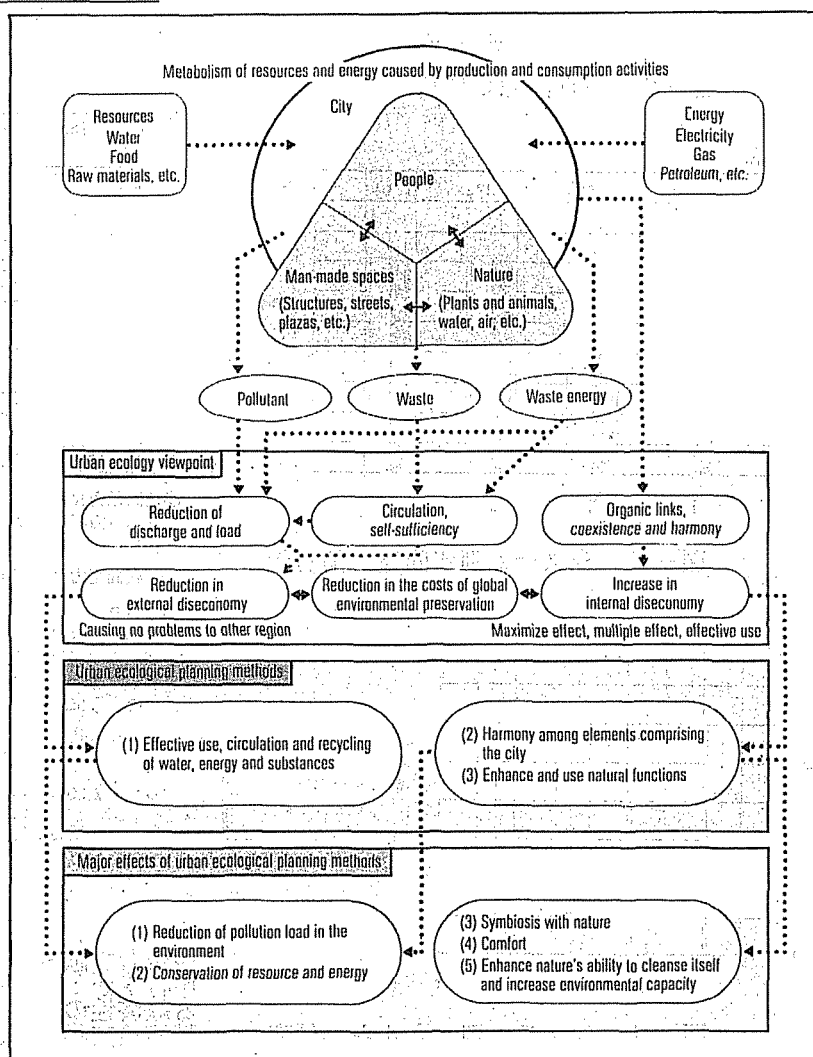


Fig.1 Conceptual flow of ecological urban design

nature and man-made spaces exist in harmony.

Next, we have developed a computer-aided planning system to evaluate a urban environment. The system monitors the effects of urban development on the surrounding environment during the initial planning stages. So that entire cities can contribute to the global environment, the system selects technologies which correspond to the characteristics and scale of the region. This process is conducted based on the following three criteria : a city's "livability", "self-sufficiency and "sustainability for use by future generations".

3. Building an evaluation system for urban environment

As shown in Fig.2, the system to evaluate a urban environment consists of the following subsystems.

- subsystem 1 : Evaluation of a city's livability
- subsystem 2 : Evaluation of a city's self-sufficiency
- subsystem 3 : Evaluation of a city's sustainability of urban development

Each subsystem in turn consists of data files, calculations and evaluations. After inputting planning data, subsystems can quickly work out quantitative evaluations for each plan.

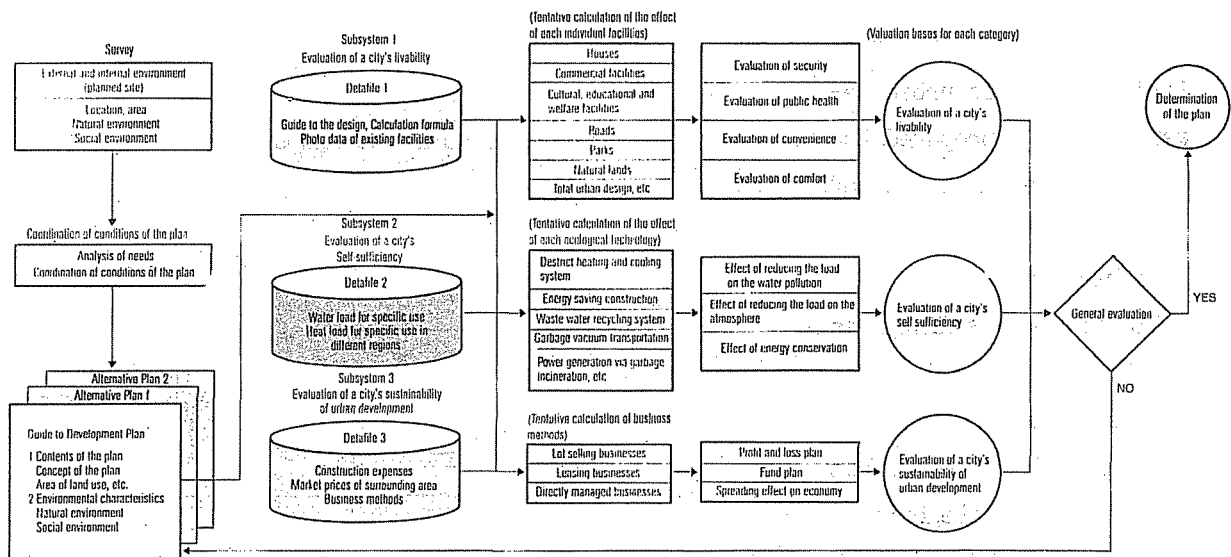


Fig.2 Overall flow of the system for creating a global environmental city

4. Evaluation of a city's livability

4. 1 Selection of valuation bases

We have selected 31 facilities as evaluation objects. These facilities, which includes houses, commercial facilities, parks and green areas, are considered key factors in creating a pleasant urban environment. And total urban design was included in these facilities, because we also need to evaluate the quality of the landscape, the accessibility of water and greenery, as well as the compatibility between individual architectural de-

signs and the townscape. Furthermore, we selected 106 detailed functional valuation bases using Pareto analysis for proposed facilities (those which are required to support public health and security as well as overall convenience and comfort).

<Detailed Valuation Bases>

- Housing quality (e.g., spaciousness, aesthetic qualities)
- Accessibility to commercial facilities
- Ratio of green areas
- Presence of water and greenery along main roads

4. 2 Process of valuation

(A) Bases that can be evaluated quantitatively (e.g., percentage of the population that lives within the area serviced by public facilities, number of pedestrian walkways, area of parks) : We gave scores based on a valuation functions (Refer to table 1).

(B) Bases which cannot be evaluated quantitatively (e.g., spaciousness, aesthetic design, accessibility to green areas, suitability of architectural design to the townscape, etc.) :

By exploring a survey of typical Japanese urban development, we prepared the design concept, photos of propose facilities, and land use plans.

To develop standards which could be used to evaluate our plans, we classified the examples into the four categories :

best in Japan, best in the region, average for the region and poor for the region. We then compiled a data base on these standers.

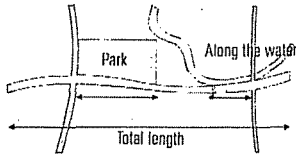
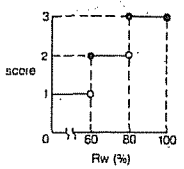
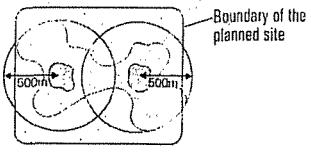
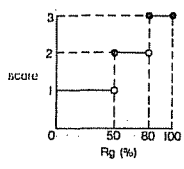
By comparing the plans with the photographs that make up the date base, we gave scores based on how successfully the design concept was implemented.

4. 3 Sample valuation

Fig.3 shows the results of a evaluation performed on alternative plans for a new town with an area of 100 ha and a population of 7,000. Radar charts have been used to express the results, which indicate the following :

1) The public health and convenience are same scores. However, there is a large dispari-

Table 1 Valuation bases

Facillies	Functions	Valuation bases	Relationship between valuation standard and valuation value
Main road	Comfort Presence of water and greenery	Ratio of main roads in contact with greenery and water : $R_w(\%)$ $\frac{\text{Length of roads in contact with parks and greenery} + \text{length of roads in contact with water}}{\text{total length}} \times 100$ 	$80\% \leq R_w \leq 100\%$ 3 scores $60\% \leq R_w < 80\%$ 2 scores $R_w < 60\%$ 1 scores 
		Extent of conservation of valuable greenery visible from residential areas : $R_g(\%)$ $\frac{\text{Area of housing land visible from valuable greenery (within 500m)}}{\text{Whole area of housing land}} \times 100$ 	$80\% \leq R_g \leq 100\%$ 3 scores $50\% \leq R_g < 80\%$ 2 scores $R_g < 50\%$ 1 scores 
Greenery	Comfort Spaciousness aesthetic qualities, landscape		

ty between the two in terms of safety and comfort.

- 2) The disparity in safety accounts for the higher transportation safety scores awarded to Plan B, which has curved roads and correspondingly slower automobile traffic.
- 3) In terms of comfort, plan B is superior to plan A in its space and beauty, its accessibility to water and greenery, and its promotion of an active community.

5. Evaluation of a city's self-sufficiency

5. 1 Selection of valuation bases

As a basis for us evaluating a city's self-sufficiency, we have used the amount of reduction in the load on the environment together with energy and resource management. We included other items which have a great impact on the environment and which are quantifiable as detailed evaluation bases.

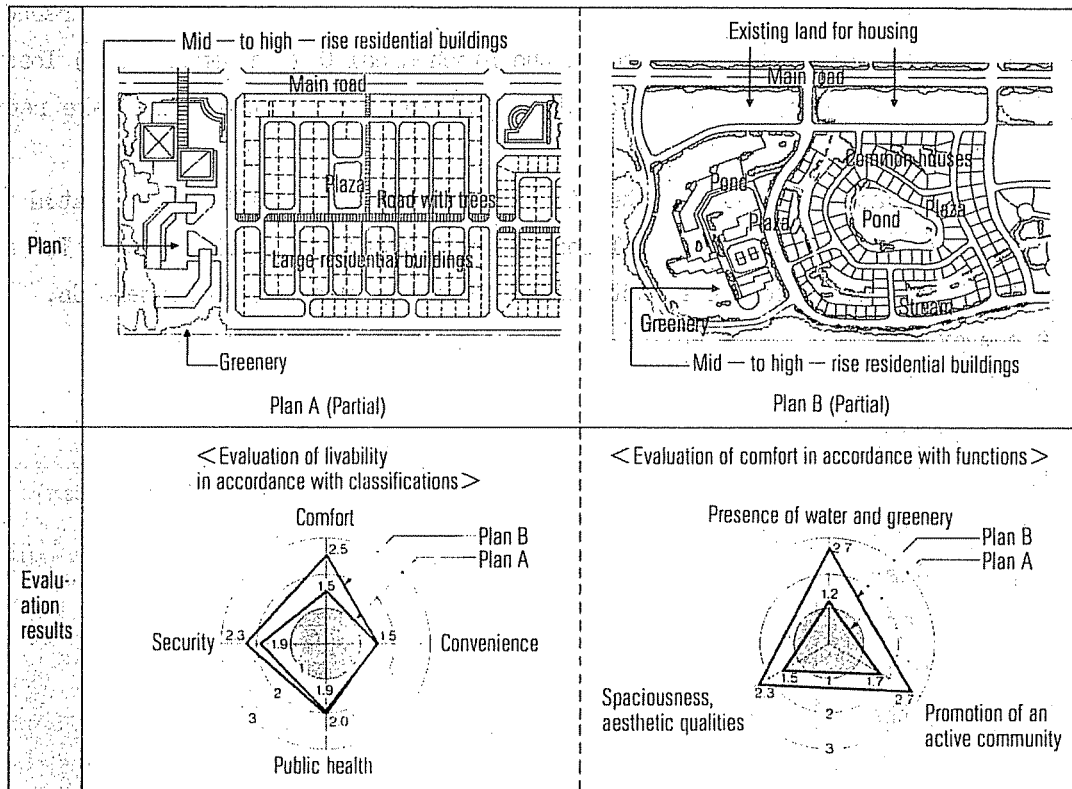


Fig.3 Sample output of the evaluation of a city's livability.

<Reducing the load on the environment>

- Index for air pollution : NO_x, CO₂,
- Index for water pollution : BOD, SS, etc.
- Unit price for heat sold, using district heating and cooling systems.

<Conservation of resources>

- Recycling of waste water
- Amount of potable water saved
- Costs for recycled water

<Conservation of energy>

- Use of sewage heat discharge
- Heat emitted from waste incineration.

We have input the following items into a data base :

- Heat load for specific use in different regions
- Water load for specific use
- Water recycling rate
- A group of model formulas (e.g., heat load, recycled water amount, formulas to calculate NOx discharge amount)
- The costs of related systems.

5. 2 Sample Valuation

Radar charts have been used to express the results.

Fig.4 shows the results from a sample evaluation of the new town.

(A) Water

1) Once a waste water recycling system is available throughout the new town, reductions in the amount of potable water used and in the Biochemical Oxygen Demand (BOD) load will be significant. However, increased costs for piping construction will make recycled water more expensive than potable water.

2) If the waste water recycling system is only available to facilities located in the center of the town, recycled water will cost about the same as potable water. The amount saved will then be equal to the amount needed to supply about 1,000 households.

(B) Heat energy

1) Once district heating and cooling systems are available throughout the new town, the discharge of NOx and CO₂ will be greatly reduced. However, the increase in piping construction costs will boost the unit price for heat by 60% over that for the individual air conditioning and heating methods.

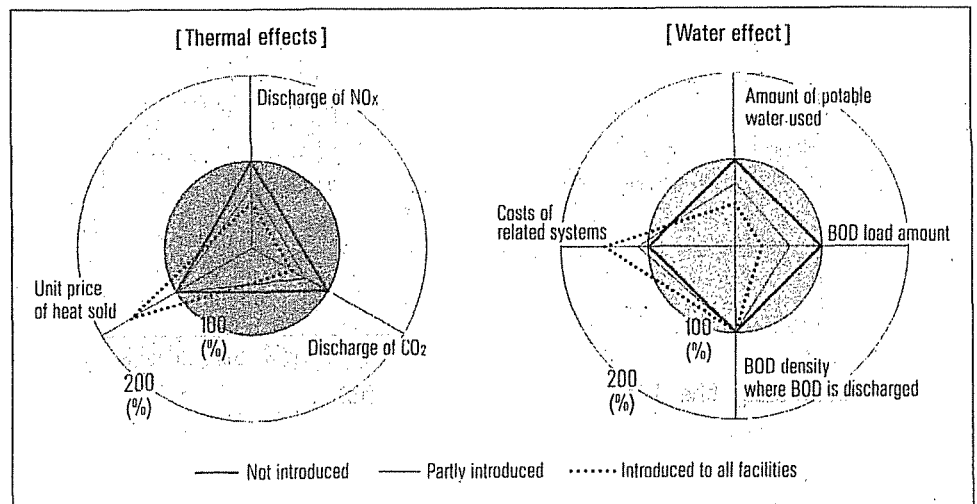


Fig.4. Sample output of the evaluation of a city's self-sufficiency

2) If this system is only available to facilities located in the center of the new town, the unit price for heat will be almost the same as that using the air conditioning and heating method. NOx discharge will be reduced by an amount equivalent to that discharged by 100 vehicles (4tons).

6. Conclusions

1) Livability, a qualitative concept based on feelings and experience has been quantified through a photo comparison process using specific examples. Consequently, urban environments can be evaluated objectively.

2) Complex calculations using multiple related systems were required to quantify the effect of reducing the load on areas surrounding cities through recycling and the use of waste energy, and also to evaluate the city's self-sufficiency. The system enabled us to quickly and readily grasp these effects during the initial stages of the planning.

Based on these capabilities, the system provides an overall evaluation index for planners.

We are convinced that it will become an effective method of independently creating cities and carrying out environmental improvements in which residents can participate. This will increase the role of the system in the creation of future cities and in the continued management of the urban environment.

7. References

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