A LIFE CYCLE ESTIMATION SYSTEM OF VARIOUS ENVIRONMENTAL LOADS FOR URBAN RESTRUCTURING

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Key words: Life Cycle Assessment, environmental impact, urban structure, and cohort model.

BACKGROUND

As the concern for the environmental issues on global and local level becomes higher, the evaluation of the impacts of environmental loads becomes more important than ever. In terms of a city, there are several proposals for environmentally friendly cities. However, these proposals only deal with the final shape and resulting environmental loads from the city, although from the process of building and demolishment, a lot of environmental loads are generated.

This paper presents a model system that can estimate the amount of the major environmental loads from a city considering the change of the city structure. And by using the unique indicator these environmental loads can be evaluated together. To cover most of the environmental load sources, the model deals with most of the infrastructures, buildings, and transportation.

LIFE CYCLE ASSESSMENT AND ENVIRONMENTALLY FRIENDLINESS POINT

To quantify the amount of environmental loads from a city, Life Cycle Assessment (LCA) is applied. LCA is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle. Usually LCA is applied to an industrial product and a facility, and is applied to the estimation of CO_2 and energy consumption in terms of environmental loads. In this paper to cover a whole city and coordinate with the models constructed, LCA is applied to “Zone”. And in terms of environmental loads, ten kinds of environmental loads are estimated.

To consider the tradeoffs across many pollutants and wastes, unified indicator, Environmentally Friendliness Point (EFP), is applied.

DEFINITION OF LIFE CYCLE ENVIRONMENTAL LOAD AND EXTENDED LIFE CYCLE ENVIRONMENTAL LOAD

Existing researches about Infrastructure LCA have dealt with the Life Cycle Environmental Load (LCEL) from each facility. However, when treating a whole city, not only each facility itself generates environmental loads, but also the condition of urban stock, which is composite of the facilities, changes the activities in a city and this also causes the change of the amount of environmental loads from a city. Kato (Kato 1998) defines the Extended Life Cycle Environmental Load (ELCEL) as environmental loads from urban stock (LCEL) and environmental loads from the activities that relate to a city. In this research, the concept of ELCEL is applied.

MODELING AND COMPUTATION

Landuse model and transportation model are constructed to describe the process of restructuring and to analyze the relationship between landuse and transportation policies and environmental loads. In terms of landuse model, cohort model of house is developed to quantify the number of house built, existing, and demolished in a period, which has similar concept of demographic cohort model.

As this system requires a lot of data and enormous amount of calculation, a system is constructed with GIS software (Arc/Info) and its language (Arc Macro Language) and C. This system is composed of four modules: database, forecasting landuse and transportation change, quantification of environmental loads, and display.

MEASURES

The study area is Nagoya City, Japan and its population is about 2 million. The simulation period is 50 years from 1991 to 2040. The policies applied are summarized in Table 1.

Table1. Measures and Their Effects

Classificatio	Measure	Condition	Effects
BAU	ç BAU	ü Trend	ü \
Housing	ç Longer Durability	ü Double the durability	ü Decrease of the amount of waste from building demolishment ü Decrease of the newly constructed building
	ç Efficient Energy Use	ü 30% off of energy use for air conditioning	ü Decrease of the energy use in operation of the building ü Increase the insulating materials
Structure of City	ç Concentration	ü Concentrating the HHs of demolished houses to around the major rail and subway stations	ü Increase of the modal share of the subway ü Decrease the total trip length of vehicle
	ç Green Belt	ü Greening the brown field	ü Fixing the carbon dioxide

CONCLUSION

The knowledge gained from this study is summarized as:

– In BAU, the amount of LC-CO_2 from facilities in 50 years will increase by 21%. Also the amount of waste from housing demolishment in 2036-40 will be three times as much as that is in 1991-95. However, by applying combination measure (Longer Durability, Efficient Energy Use, Concentration and Green Belt), it is possible to reduce them,

– When evaluating by EFP, the waste from the housing demolishment dominates a lot. So Longer Durability Measure can contribute to reduce EFP,

- The amount of LCEL from the housing sector is much larger than that from sewage, water supply and land development. So the housing sector is important element to reduce the environmental loads,
- And the Concentration Measure has a potential to reduce the environmental loads from the transportation sector and can contribute to reduce ELC-NO_x. Also together with the Green Belt Measure it can reduce ELC-CO_2 a lot.

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