Study on urban distribution change toward a low carbon transport society

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1. Introductions

These days, global warming problems had become one of huge problems in international society. Many institutions investigate the way to prevent the environmental issues and there are lots of negotiations in the international society for CO_2 reduction. However, because of the rapid economic growth, CO_2 emission has dramatically increased especially in Asian countries like China and India. In such circumstances, we have to notice that cites is the big emission source and 70% of CO_2 emission in the world is emitted from cites. Then countermeasures should be developed to each city according to their characteristic. These days, the concept of low carbon city which is approach from demand side that attract had the attention as one of the solutions. Actually there is large amount of plan toward building low carbon city like cites which are selected "Eco-Model City Project".

Transport sector is regarded as one of major emission source when planning to build low carbon cities, and many countermeasures are proposed to reduce the CO_2 emission. And some plan refers to the urban spacial distribution like compact city Transportation Demand Management policy. However, many plans had not yet confirmed the effectivity and the possibility, therefore it is the plans just forecast on the target and the avenue. Therefore it is important to check the availability and to show the road toward a low carbon city in many cities.

Onishi (2009) built estimation model of CO_2 emission in urban city and this model was named "Urban Simulator". They enabled to evaluate the efficiency on low carbon city plan which mentioned urban spacial distribution. However, this model does not include the transport sector. Then this research adds the CO_2 estimation model of transport sector to Urban Simulator and permit decision maker to estimate easily and more correctly.

2. Method and Model Construction

2.1 Framework of Urban Simulator

First and foremost, I would like to explain the Urban Simulator model in this paragraph for the good understanding of this research.

Objective place is Nagoya city and research period is from 2000 to 2050, and the data set is collected at 500m square mesh. Population of each mesh is calculated by age cohort method. And the numbers of households are estimated by applying the family nurturer rate for the population. Regarding housing sector, when the houses are broken along the cohort probabilistic distribution model, new building would be built within the mesh based on the scenario. And the numbers of houses are decided by households. The number of commercial building and the gross floor area of the building are estimated on each mesh from the survey on Nagoya city. And the gross number of commercial building is reflected by the gross population of Nagoya city.

This model enables to duplicate the cycle of construction and disposition of urban buildings. And when the building is disposed, the aggregation scenario is applied to the building whether they moves to aggregated area or not. By applying this scenario, this model enables to explain the efficiency of urban spacial distribution. To find out the efficiency of the aggregation, three scenario is applied; BAU scenario, mono-centric scenario, and poli-centric scenario. Mono-centric scenario aggregate buildings to the city center (Naka word, Nakamura word, Nishi ward) and poli-centric scenario aggregate buildings to the 500m near to train and bus rapid transit system station.

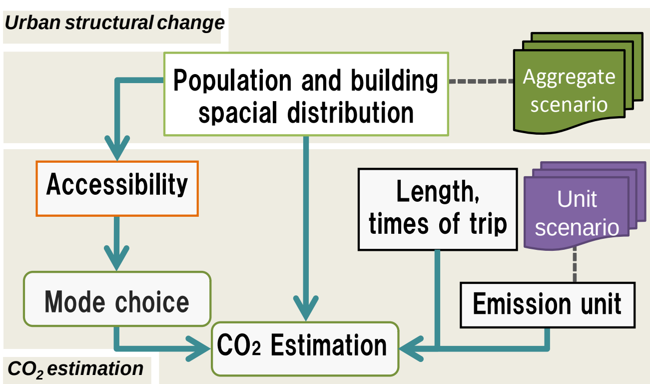

Figure.1 Flow chart of CO_2 estimation model

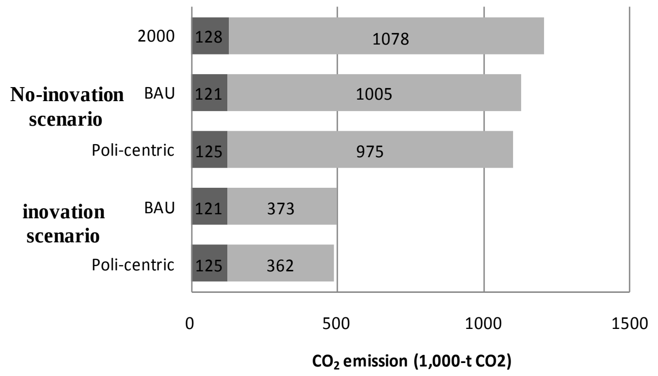

Figure.2 CO_2 emission on Nagoya city

2.2 CO_2 estimation from transport sector

Kachi (2006) says Accessibility Index is the index stands for convenience of accessing to convenient facilities of the place on each transport mode. If the place is located near the city center and it is much easy to access, therefore index value would be high. If the place is located in an area where it takes much more time to access to facilities, the index value would be low. This index is calculated by the urban structure of each transportation measure and building distributions. And it would help to indicate mode choices of citizens.

Takeshita (2009) says Accessibility Index could explain the people's mode of choice by logistic carves. In this research, in order to estimate the probability, Accessibility Index is introduced to logistic mode choice model as substitution of utility functions. And in addition to this, introduction of population makes this mode choice model successfully and correctly. CO_2 emission is estimated by the following equational sentence.

$$E_{trans\,i} = \sum_k e_s^k \cdot Pr_i^k \cdot l_i \cdot c \cdot pop_i \cdot 365.25 \quad (1)$$

$E_{trans,i}$: CO_2 Emission from *i* district of transport, e^k_s : CO_2 emission unit of the mode *k* (kg-CO_2/pop・km), Pr_i: probability of mode choice, l_i : Length of a trip (km), pop_i :population, *c*: number of times on trip

For consideration of innovation of the technology, CO_2 emission unit scenario is adopted to this model. Daisyo (2009) predicted the rate of popularization of new technology and the CO_2 emission unit. His scenario considers the 100% popularization of hybrid car and electric car at 2050. Then applying this scenario to our model makes it possible to consider the future improvement of energy efficiency. Estimated CO_2 emission of each scenario on Nagoya city is shown at Figure.2.

2.3 Estimation model at Toyama city

When the urban spacial distribution is changed, statistic estimation of CO_2 emission from transport sector became possible by using above method. Secondly, this model is applied to other cities for building up the reliability. It also makes it possible to compare between city and boundary conditions within the city.

Toyama city had adapted the "Eco-Model City Project" because of their policy and challenge for building the Compact City by using the LRT and other public transport. Therefore it is useful to compare the situation with Nagoya city regarding compact city policy. To estimate the urban spacial distribution, simple model is built by simplification of Urban Simulator. By applying the population cohort model to the mesh and by considering the plan of Toyama city, edited urban spacial distribution is estimated. And the CO_2 emission from transport sector is calculated by applying the distribution into the estimation model.

3. Conclusions

This research enables to estimate the probability of mode choice and CO_2 emission reduction from the transport sector by the urban spacial distribution change. Moving to the aggregation area has the potential to decrease the CO_2 emission from transport sector. However, the amount of CO_2 reduction is extremely remitted compared with the innovation of technology. And the efficiency of CO_2 reduction is depended on the urban scale and distribution.

Acknowledgment

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