

EVALUATION OF POLICY SCENARIOS BY USING MARS MODEL IN MUEANG KHON KAEN, THAILAND

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1. INTRODUCTION

Since motorization has also been coming to local middle-sized cities in developing countries, realizing low carbon society in such cities on early stage of development is strongly required to tackle with global warming problem. Thus, the low carbon scenarios consisted of many policies regarding transport and land-use plans has been proposed. However, timing to introduce each policies which are significantly affected to the impacts has not been assessed in most of the cases.

Therefore, this study applies Metropolitan Activity Relocation Simulator (MARS) model which can simulate the integrated transport and land use structure dynamically and estimate an impact of timing of implementation of selected policies on CO₂ emissions reduction.

2. LITERATURE REVIEW

Kikuchi et al. applied the MARS model to Niigata City and found that change of timing to implement policies brought differences on degree of transport demand and land use development. After that, the policy's introduction effect estimated by CO₂ emission. However, regional cities in developing countries have a little data for estimating. And, very few studies estimated effect to consider in regard to data supplement by policy enforcement timing.

Therefore, this study applies MARS model with Mueang Khon Kaen. And, focusing amount of CO₂ emission, which is given policy enforcement timing estimates.

3. METHODOLOGY

3.1 Study area

This study has selected Mueang Khon Kaen, Thailand as a case study. The study area is shown in Fig. 1. This city is the capital city of Khon Kaen Prefecture. Mueang Khon Kaen which is inland area has population of about 390,000 in 2010. This area is about 950 km². And, population density is about 400 per km². Also, this study area was divided into 54 zones by using JICA STRADA. 13 zones which is central are CBD area. 4 zones which are connected to outside area are configured pass traffic volume. Recently years, some condominiums are developed in suburb area. Additionally, in COP21 Paris Agreement, Thailand government needs to decrease CO₂ emissions 20% by 2030 compared with its of BAU.

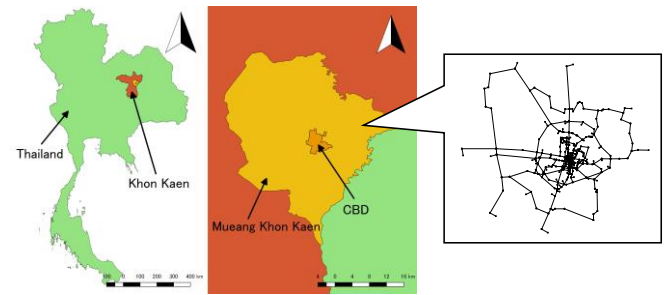


Fig. 1 Position of Mueang Khon Kaen (left) and Road Network (right)

3.2 MARS model

The MARS is an approach for better understanding land use and transport interaction based on the principles of System Dynamics (SD). In addition, the MARS includes a transport model which simulates the travel behavior of the population related to their housing and workplace location in three sub-models. Also, the model has an advantage that is possible to assessment policy timing. In the way of attribute of SD, variables are proximate to variables. Therefore, the breeder of variable volume after simulation can be understood with ease. As variables that change dynamically, exogenous variables include the number of passenger cars, motorcycles, and population elements. Endogenous variables can be grasp factors such as CO₂ emissions, proportion by transportation means, passenger kilometers. As just described, MARS model has a merit which can be gotten many results of factor. On the other side of the coin, MARS model has a demerit which craves many data about growth rates, urban by basic scalar data, zone by basic vector data, pedestrian, bicycle, bus, railway, car, motor cycle, other public transit and other car.

In addition, the MARS model includes a transport model which simulates the travel behavior of the population related to their housing and workplace location, a housing development model, a household location choice model, a workplace development model, a workplace location choice model as illustrated in Fig. 2. All these models are interconnected with each other.

Keywords: MARS Model, System Dynamics, CO₂ Emissions, Timing of Policy Implementation

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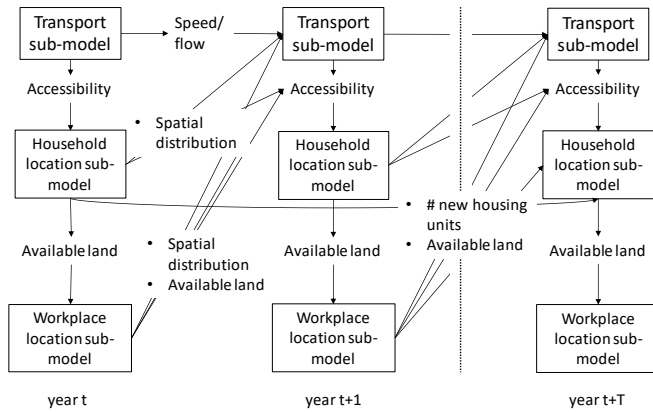


Fig. 2 Structure of MARS model

3.3 Data collection

It is necessary for the MARS to prepare many data about transportations, land use, population, and employments. However, all data of case study cannot be collected. Therefore, Tsuga et al. estimated CO₂ emission in Beijing, Shanghai, and Delhi by using data of Japanese city. In this study, Asahikawa city was selected as a same scale city of Mueang Khon Kaen. Also, Thailand government has forecasted to decrease population from 2023.

3.4 Policy and scenarios

Mueang Khon Kaen is concerned that expansion of urban areas from now on. Therefore, this study needs to consolidate population. Setting up policy that 100 people will be consolidated every year from zones other than CBD district to zones of CBD district.

Therefore, this study set 3 scenarios, namely Scenario 1(Business As Usual; Without policy), Scenario 2, and Scenario 3 (With policy). A policy such as “Consolidated Population” as shown in Table 1. Also, this study launched this policy in the year 2010, and in year 2020 to estimate the impact of implementing this policy measure.

Table. 1 Policy and scenarios

Scenario	Policy(Consolidated Population)
Scenario1(BAU)	Nothing
Scenario2	From 2010
Scenario3	From 2020

4. RESULTS

Fig. 3 shows the estimation results of CO₂ emissions. Scenario 2 has been reduced by about 65% relative to BAU. Scenario 3 has been reduced by about 15%. Also, Fig. 4 shows estimation of VKT of cars. In this figure, value of scenario 2 does not change because of trip length was lower due to population was consolidated to center of city. Therefore, VKT contributed to CO₂ emissions reduction. On the other hand, Fig. 5 shows passenger kilometers of buses. Moreover, passenger kilometers of buses are decreased due to trip length. As policy enforcement timing shifts 10 years, start year more decrease CO₂ emission. This reason is that the space which isn't start policy increases CO₂ emission. Therefore, policy was implemented in early stage, CO₂ emissions reduction were decreased higher. The reason of increasing CO₂ emission is the number of cars increase despite population decrease.

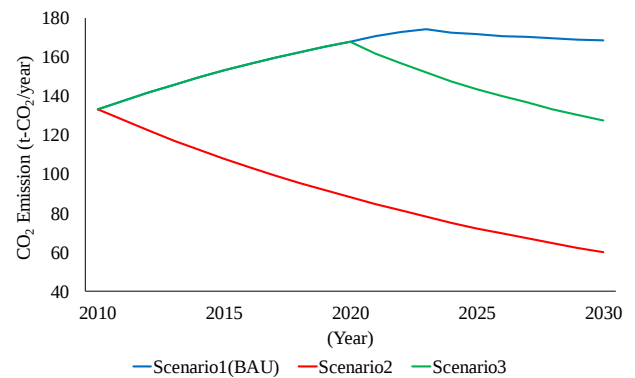
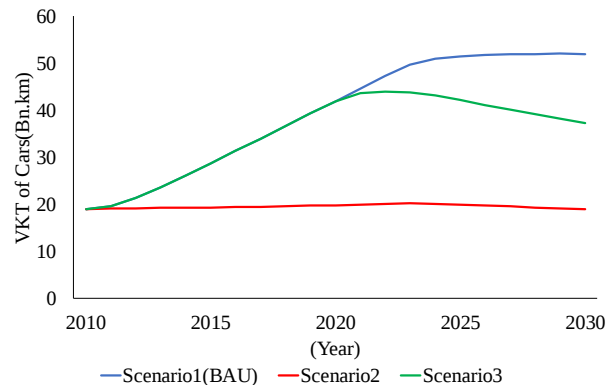
Fig. 3 CO₂ emissions

Fig. 4 VKT of cars

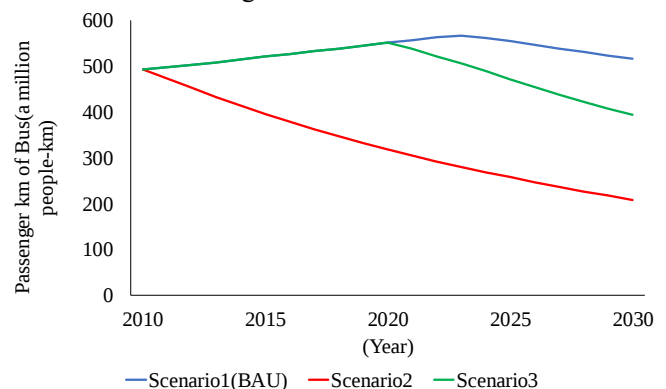


Fig. 5 Passenger km of buses

5. CONCLUSION

Although Mueang Khon Kaen is expected to have a declining population. So, situation is thought that will be arisen to increase CO₂ emissions in the future. However, carrying out consolidated population policies make it possible to decrease CO₂ emissions by decreasing VKT of cars. Also, the space which isn't start policy increases CO₂ emission. Therefore, implementation of the policy at early stage greatly contributed to reduce CO₂ emissions.

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