論文 / 著書情報
Article / Book Information

題目(和文)	熱帯メガシティーにおける現在及び将来の都市気候シミュレーション
Title(English)	Present and future urban climate simulations in a tropical megacity
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出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第11171号, 授与年月日:2019年3月26日, 学位の種別:課程博士, 審査員:神田 学,木内 豪,髙木 泰士,中村 恭志,中村 隆志,VARQUEZ ALVIN CHRIST
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第11171号, Conferred date:2019/3/26, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨
THESIS SUMMARY

系・コース： Department of, Graduate major in	Transdisciplinary Science and Engineering, GEDES	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Engineering)
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要旨（英文 800 語程度）

Thesis Summary（approx.800 English Words ）In this study, we introduce a general method for modeling the urbanization effects on present and future climate that can be applied to any city. The general objective is to find a solution on how to predict and project present and future urban climate in a tropical megacity in developing country through numerical simulations, and how it impacts the future populations. The challenges of conducting such urban climate study in developing countries are related to data scarcity and selection of realistic future scenarios affecting urban climate without local stakeholders' support. Overall, this study offers a general method for projecting future urban climates, not only for Jakarta but also for other megacities in developing countries.

This study is presented in 8 chapters with 3 main study themes which correlated each other. First, creating urban morphological parameter dataset required in mesoscale numerical model solely from globally available sources and its validation in the model. Second, developing future projection of background climate condition using Representative Concentration Pathways (RCP) and estimating urban morphological parameter dataset based on Shared Socioeconomic Pathways (SSP). Third, projecting the future effect of combined background climate change and urban effect towards heat-related mortality in urban population.

The first research theme is brought up by recent trends in defining and mitigating urban atmospheric phenomena which involving the application of mesoscale numerical weather simulations coupled with urban canopy models (UCMs) using an urban aerodynamic parametrization scheme. To improve the accuracy of these simulations, urban morphological parameters of higher spatial resolution are needed. In this paper, we introduce an approach to derive 1-km scale urban parameters from globally available satellite images of Landsat 8, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010), and nighttime light (NL) images from the Defense Meteorological Satellite Program Operational Linescan System (DMSP-OLS) for use in numerical weather models. Empirical equations were derived to estimate λ_p and λ_f and from Landsat 8 images. Using a neural network, subtracted ASTER-GMTED data were combined with the DMSP-OLS nightlight image to define a function for deriving H_{ave} in 1km resolution. Including urban parameters derived from global datasets in the simulation provided better agreement, especially with regard to wind speed, than did a simulation that used the default parameters provided in the WRF with single layer urban canopy model (WRF/SLUCM) model. The improved representation of wind speed and thereby improving temperature, especially improvement in nighttime wind speed over the urban area. Application of satellite-derived urban parameters in WRF/SLUCM simulation gives evidence of simple and zero-cost solution in conducting mesoscale urban climate analysis in developing cities that mostly lack of actual building database, such as Asian megacities.

Second research theme is aimed to answer future urban climate impact issue. The effects of urbanization on the future atmospheric environments of cities worldwide remain uncertain in the context of climate change. We introduce a general method for modeling the effects of climate change and urbanization that can be applied to any city and apply the model to Greater Jakarta megacity. Using Pseudo Global Warming dynamical downscaling from is sufficiently providing future

meteorological boundaries on background climate condition and mitigation scenarios in RCP. On the other hand, global SSP model results provide a general country's socio-demographic parameters in the future which can be derived to predict future city's population and energy consumption. Using empirical function on GDP and population with urban morphological parameters, future urban parameters are projected accordingly.

Global climate change scenarios (RCP2.6 and RCP8.5) were coupled with distributed urbanization scenarios (compact and business-as-usual (BaU), based on projections of future urban morphology and anthropogenic heating) in a mesoscale weather model. Despite the predominant influence of global effects, the urban effects of individual grids were spatially varied. The highest temperature increase caused by RCP8.5&BaU scenario was detected in the northwestern outskirts of Jakarta. Meanwhile, the projected temperature was one-third lower in the RCP2.6&Compact scenario.

The results of this study imply that urban effects can reach the same magnitude as global effects in tropical city. Even though urban signals dominated the climate signal by an average factor of 12.2 (13.0) under the RCP2.6&Compact (RCP8.5&BaU) scenario, the findings showed that the urban signal distribution values were highly and significantly spatially diverse. Lower restrictions on urban planning could realize the RCP8.5&BaU scenario, which could increase urban temperatures up to 1.47±1.38°C from present conditions. Otherwise, best mitigation-adaptation strategy promoting urban resiliency of RCP2.6&Compact planning could minimize the temperature increase to 0.66±0.67°C.

This study provides an insight of how mitigation-adaptation strategies could leverage the heat-related mortality risk in urban area. Without any mitigation and adaptation scenario assumed in this study as RCP8.5&BaU scenario, may escalate heat-mortality risk to 0.03 daily-death/km^2/100,000 populations of >65yrs. old. On the other hand, a best mitigation-adaptation strategy assumed as RCP2.6&Compact scenario is potentially reducing this values to 40-50%.