Abstract

[Project Information]

Project Title :	Synergies of Mitigation and Adaptation of School Buildings to the Heat Risks of Climate Change
Project Number :	JPMEERF20222M01
Project Period (FY) :	2022-2024
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Cooperated by :	Shibaura Institute of Technology, Tokyo University of Science, Bulletin of Nagano Environmental Conservation Research Institute
Keywords :	Climate change impacts, synergy between mitigation and adaptation strategies, school buildings, environmental design, insulation retrofitting, machine learning

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Public buildings such as elementary and junior high schools were predominantly constructed during the period of rapid economic growth, necessitating the renovation of both structures and facilities. Japanese public schools are generally characterized by reinforced concrete (RC) rectangular buildings with minimal insulation. Given their decades-long lifespan, it is essential to implement insulation retrofits that account not only for the current climate but also for future warming.

This study employed the latest CMIP6-based GCM data to generate meteorological data for building thermal analysis. Based on this data, we targeted school buildings and gymnasiums, exploring the optimization of design variables that maximize the synergistic effects of mitigation and adaptation strategies. Specifically, we utilized machine learning to identify effective insulation retrofit specifications, aiming to reduce operational energy consumption and mitigate health risks.

Furthermore, this study facilitated environmental communication among government agencies, school officials, architectural design firms, and researchers. By sharing academic findings and receiving feedback from various stakeholders, the research benefited from a diverse range of perspectives.

The study revealed that rising outdoor temperatures due to climate change were particularly pronounced in higher latitudes. Calculations of heating degree days based on future projected outdoor temperatures indicated that the regional classifications of energy efficiency standards could shift around 2010 or, depending on the scenario, as early as the mid-2000s. Although the current regional classifications rely on standard data from 2000 to 2010, subsequent warming suggests the possibility of shifts to warmer classifications. Moreover, the background data for primary energy calculations are based on data from 1980 to 1995, and such reliance on historical observations may lead to policies that underestimate future warming.

In addition, a large-scale simulation of building thermal analysis based on CMIP6 data was conducted, and multi-objective optimization was used to extract recommended insulation specifications for each region. Commonly effective measures included enhancing roof insulation and reducing solar heat gain through windows. Roof insulation is particularly important because it reduces heat influx in summer and heat loss in winter. It is advisable to prioritize this measure, and by performing waterproofing and insulation work simultaneously, both costs and labor can be minimized.

This research was performed by the Environment Research and Technology Development Fund (JPMEERF20222M01) of the Environmental Restoration and Conservation Agency provided by Ministry of the Environment of Japan.