In this supporting information, we provide supplementary results from the application of the framework demonstrated in this paper, and provide additional references for the readers to better understand the results in the paper. This supporting information includes 8 pages with 3 figures and 3 tables.

Table of contents

1. The calculation of intermediate grid values

Table S1 shows how the intermediate grid values were calculated using edge detection methods and the corresponding operators.

Table S1. The edge detection methods and the corresponding operators used in this study, along with calculation processes.

No.	Edge detection method	Operator and calculation (given A as the original NTL image, G as the intermediate grid values)
1	N/A	$G_1 = A$

2	3*3 convolution	$G_2 = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \cdot A$
3	5*5 convolution	$G_3 = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix} \cdot A$
4	Sobel (Sobel & Feldman, 2015)	$G_{x,4} = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix} \cdot A,\ G_{y,4} = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \cdot A,$ $G_4 = \sqrt{{G_{x,4}}^2 + {G_{y,4}}^2}$
5	Prewitt (Prewitt, 1970)	$G_{x,5} = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{bmatrix} \cdot A,\ G_{y,5} = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \cdot A,$ $G_5 = \sqrt{{G_{x,5}}^2 + {G_{y,5}}^2}$
6	Laplacian (Prewitt, 1970)	$G_6 = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix} \cdot A$

2. Candidate model types for model optimization

Since the boundaries between many models are not distinct, and a number of hybrid models combining the characteristics of multiple models have been developed in previous studies as the research progressed, completely including all potentially available model types as candidate within this framework becomes impractical. Therefore, the decision of candidate models will depend solely on the actual needs of the users of the framework. In this case study, for the sake of reducing the computational cost, after referring to the model types appeared in previous literatures, we decided to select 4 types of base models with as much difference as possible from each other, and use them as the candidate models in model optimization process (**Table S2**).

Table S2. The model types used as candidates.

No.	Model type
1	Linear Regression
2	Decision Tree Regressor
3	Gradient Boosting Regressor
4	Multi-layer Perceptron Regressor

3. Average floor height in the case study area

The average height of each floor $\bar{h}_{floor}$ in the case study area was set as 4.1m (standard floors) with reference to a local commercial building code (**Figure S1**)

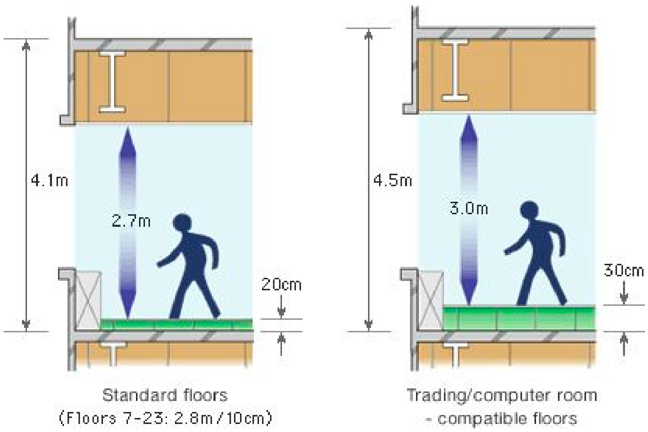

Figure S1. A local commercial building code in Japan. *[Note: Specifications - Ceiling Height. Reprinted from Office Leasing in Japan | Mori Building Co., Ltd. - MORI Building, n.d., Retrieved December 15, 2023, from https://www.mori.co.jp/en/office/japan/spec/ceil_roppongihillsmt.html. Copyright Mori Building Co., Ltd. 2024 All Rights Reserved. Reprinted with permission.]*

4. Average coefficients of determination (R^2) for the optimized models

Table S3 shows the average R^2 for the optimized models in all 3 control trials and the experimental trial, as well as the average R^2 by different grid value-model combinations.

Table S3. The average coefficients of determination (R^2) for the optimized models in all 3 control trials and the experimental trial, along with the average R^2 by different grid value-model combinations.

Trial	NLC cluster	Average R^2	Grid value-model combination (w/ repetition count)	Average R^2 by different grid value-model combination
Experimental trial	Suburban/rural	0.4471	N/A- Gradient Boosting Regression (330)	0.4471
	Urban	0.5422	N/A- Linear Regression (9)	0.5327
			N/A- Gradient Boosting Regression (321)	0.5424
Control trial #1	Suburban/rural	0.4120	N/A- Linear Regression (330)	-
	Urban	0.5315	N/A- Linear Regression (330)	-
Control trial #2	-	0.5547	N/A- Multi-layer	0.5482

			Perceptron Regressor (8)	
			N/A- Gradient Boosting Regression (322)	0.5548
Control trial #3	-	0.5372	N/A- Linear Regression (330)	-

5. WSF3D building stock reference

Figure S2 shows the spatial distribution of WSF3D building stock, using as the reference to evaluate BSEEF building stock prediction results.

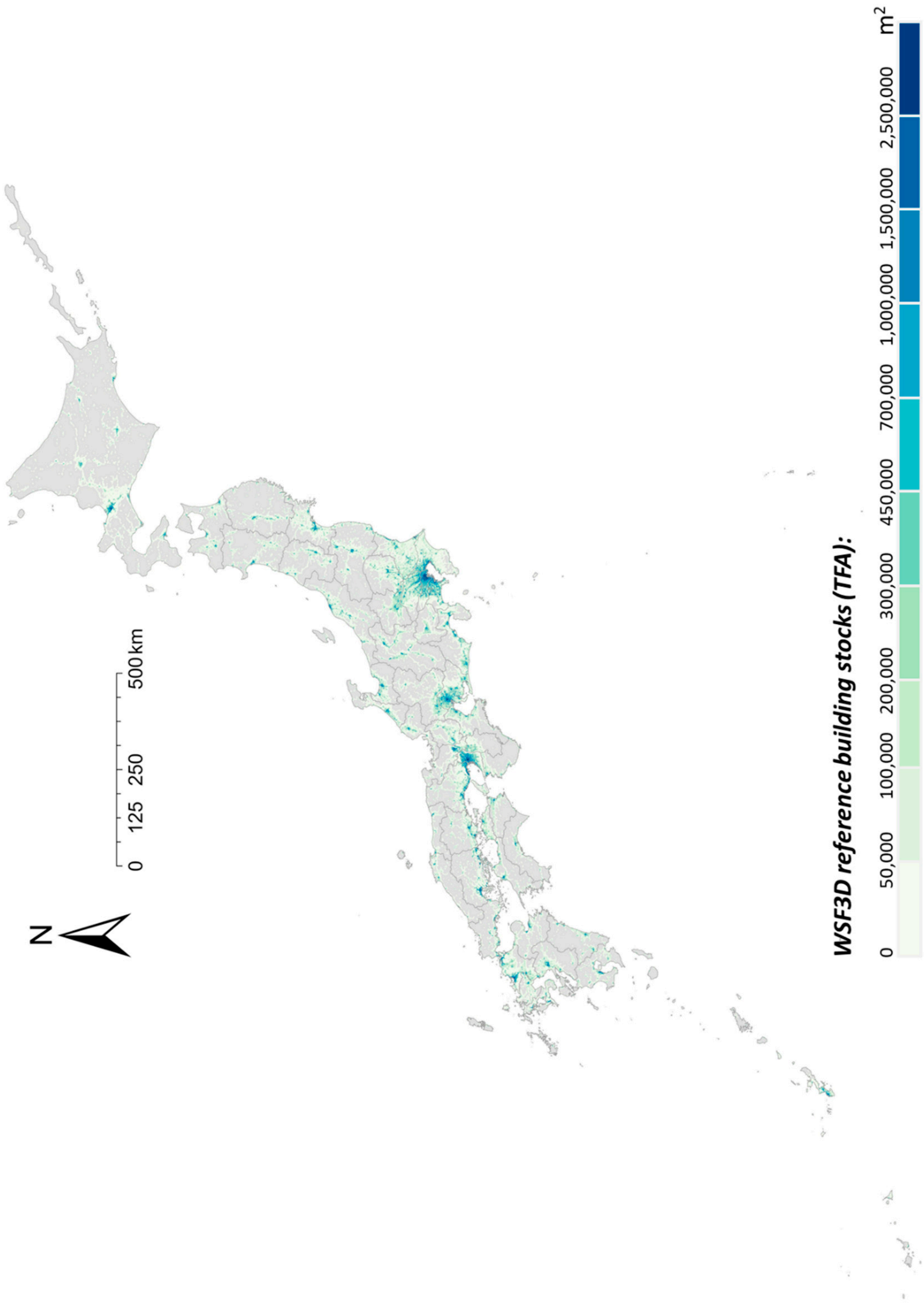

Figure S2. The spatial distribution of WSF3D building stock. *[Note to Editorial Office: We created this figure for this article; it is not based on any previously published figures.]*

6. Spatial relationship between NTL and building stock reference

Figure S3 shows a bivariate map which plots NTL and building stock reference simultaneously. In some areas, mismatch between NTL and building stock exists, as there were illuminated areas that lacked buildings, which may have contributed to the overestimation.

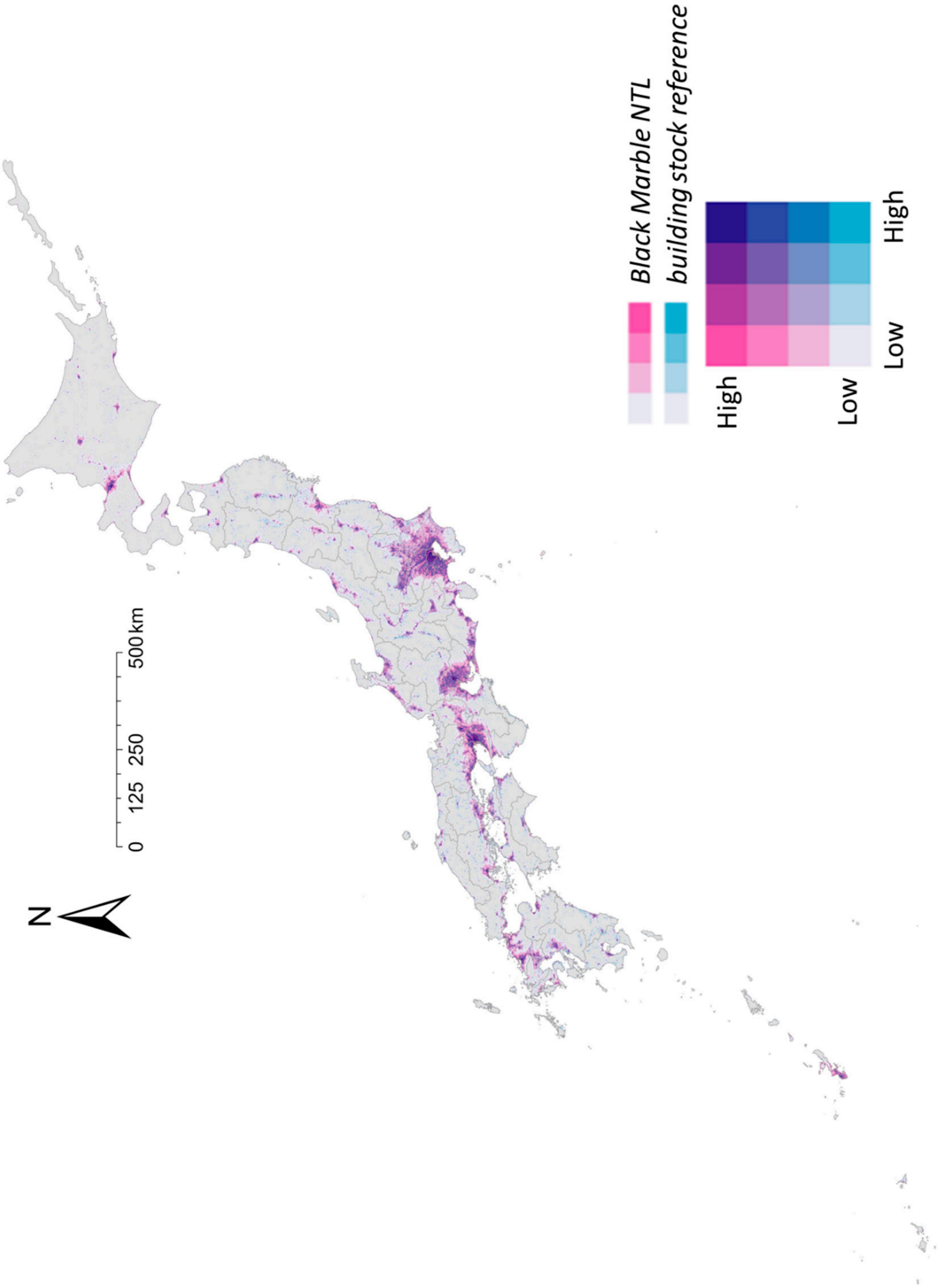

Figure S3. The bivariate demonstration of the spatial distribution relationship between NTL and building stock reference. *[Note to Editorial Office: We created this figure for this article; it is not based on any previously published figures.]*