Zero Build Forum'20

International Virtual Forum on Zero Energy Buildings

What is the Economic Value of Green?

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What is the Economic Value of Green?

-Incentives on Zero Energy Buildings Construction in the Market -

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Outline:

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  - Discussion 1: Low-carbon society and "***Zero-Energy Building***"
- **II. Economic Premium of Green in "*Property Market*".**
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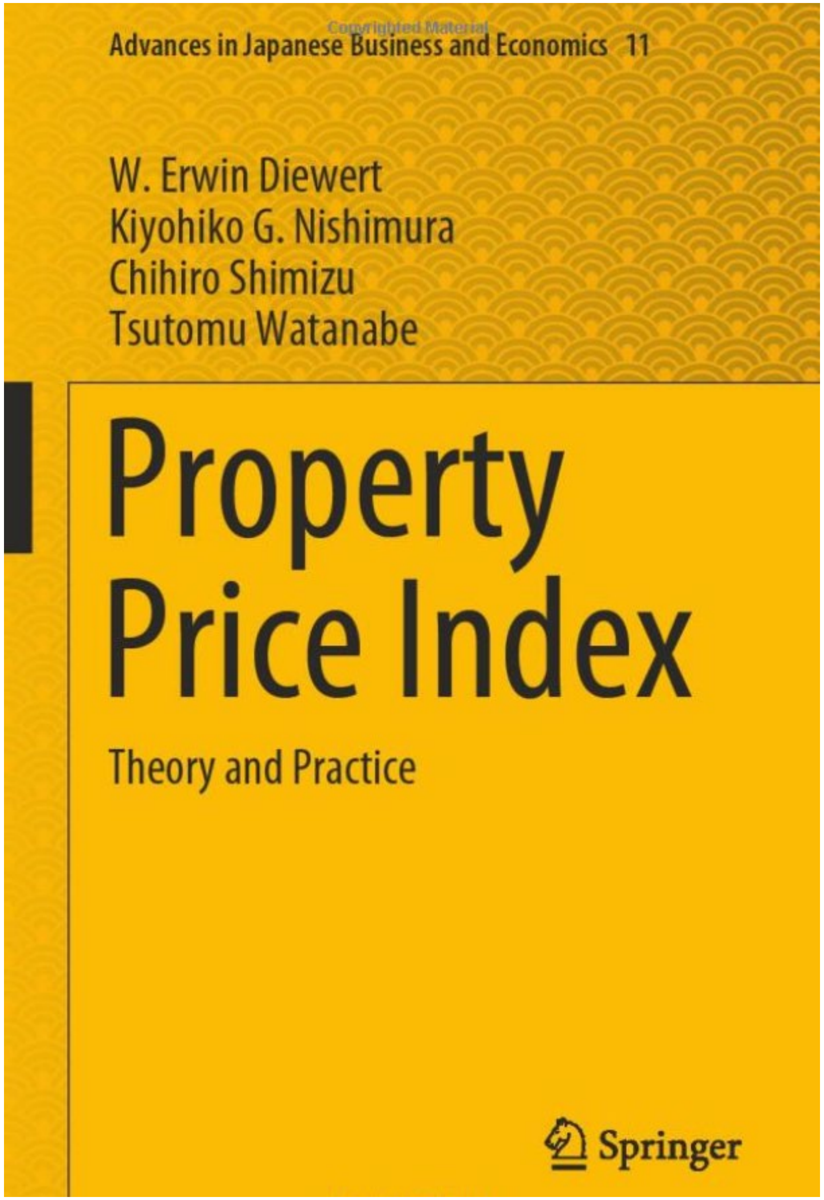
- **III. "*Sustainability*" in Property Market.**
  - Discussion 6: Resilience from "***Earthquake***".
  - Discussion 7: Adaptation to "***Climate Change***": Flood Risk.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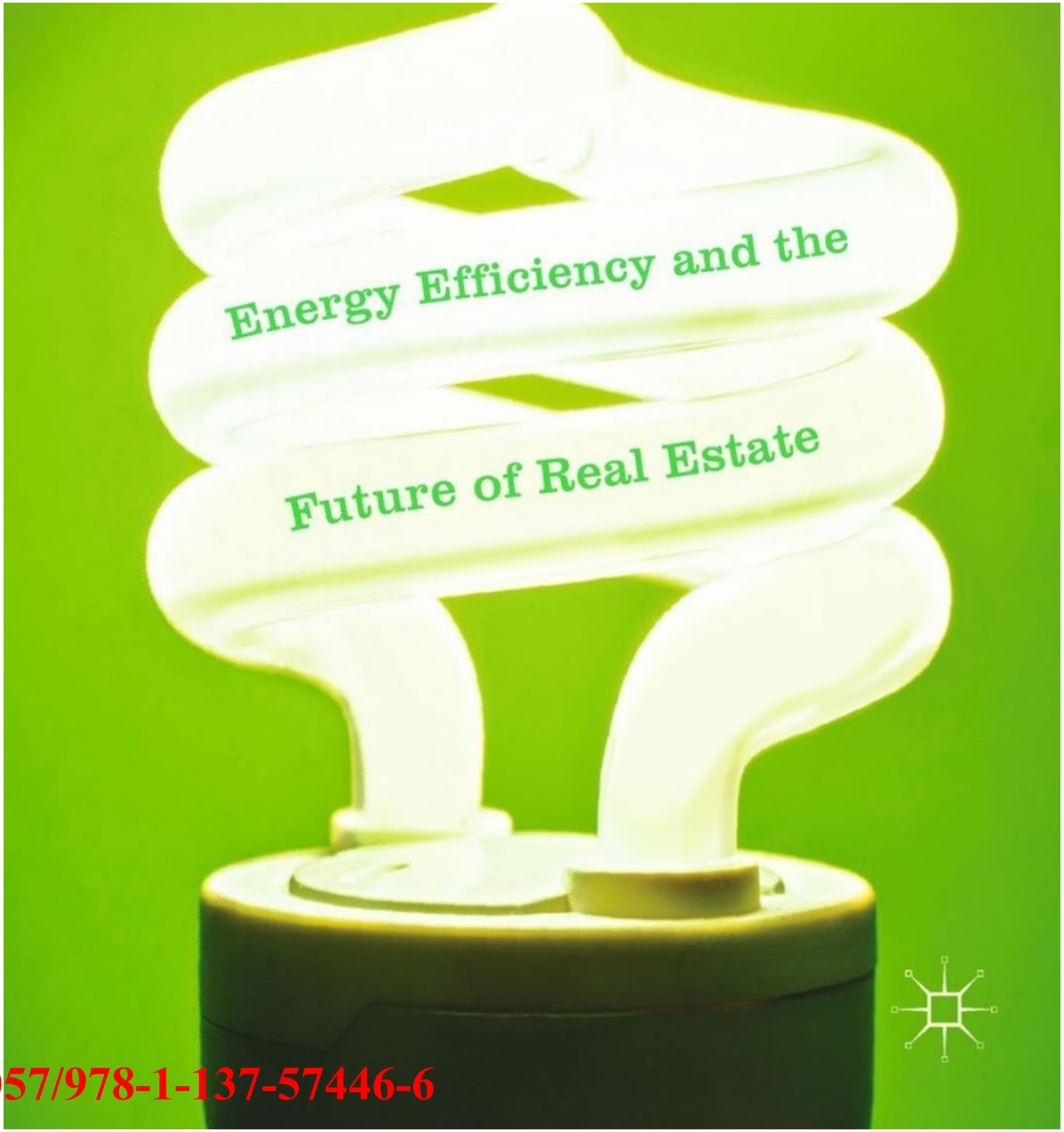

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I. Sustainability in "*Building*" or "*Property Value*".

Discussion 1: Low-carbon society and "Zero-Energy Building"

- It is anticipated that, henceforth, increasingly proactive efforts will be undertaken on a global scale aimed at achieving a **low-carbon society**.
- Japan stated a position opposing the extension of the ***Kyoto Protocol*** in 2012. One of the likely reasons is the impact of the nuclear accident caused by the ***Great East Japan Earthquake*** in March 2011 has necessitated a major shift in energy policy.
- However, having stated this position does not mean the country can avoid the low-carbon society-focused international framework that will likely develop henceforth. Instead, addressing this problem will become an issue of increasing importance.

Why Should We Focus on "*Green*" or "*Zero Energy*" Building"?

- In aiming to achieve a low-carbon society, the role that should be played by the ***property market*** is by no means a small one.
- Initiatives on a global scale toward the realization of low-carbon societies are expected to be carried out increasingly actively in the future; in this situation, the interest in "***green***" or "***Zero-energy***" buildings continues to rise.
- "***Green***" buildings are buildings that, compared with conventional buildings, are equipped with performance to constrain the amount of carbon-based compounds generated through economic and other daily activities that take place within the building.
- Through the spread of buildings equipped with this type of performance, real estate owners and users are trying to fulfill a part of their responsibility toward the realization of low-carbon societies; thus, these buildings are very important in terms of the social and economic activities of companies and individuals.

Responsible Property Investment: UNEP FI .

- McNamara, P(2007), Sustainable Property Investment-Intelligent decision making for a profitable future, RICS Conference, 12th June 2007,London.

- *The buildings and construction sector accounts for nearly 40 percent of total energy-related CO2 emissions and 36 percent of final energy use worldwide.*
- *Global building floor area is expected to double by 2050, driving energy demand and related GHG emissions for* ***construction****.*
- *Yet* ***the building sector*** *offers the largest cost-effective GHG mitigation potential, with net cost savings and economic gains possible through implementation of existing technologies, policies and building designs.*
- **UNEP FI's work on property investing is undertaken by the Property Working Group (PWG).**

Aim of the Property Working Group

- Drive innovation in ***Responsible Property Investment*** (RPI) by facilitating access to relevant information and best practice and collaboratively develop the necessary tools to enable **property investors and professionals** to systematically apply and integrate **ESG criteria** into investment and lending decisions.
- Promote and encourage RPI by collecting and providing evidence to show how it can protect or increase financial performance throughout the "***lifecycle of buildings***" while simultaneously reducing detrimental environmental and social impacts. → "***Sustainability***".
- Collaborate with **policy-makers and the real estate investment community** on developing and establishing the appropriate policy and regulatory frameworks for RPI practices to grow.

II. Economic Premium of Green in “*Property*” Market.

Sustainability research in real estate

- **Sustainability research in real estate has reached a critical juncture.** (Miller, Spivey, Florance, 2008, Fuerst and McAllister, 2011, Eichholtz, Kok and Quigley, 2010, 2011, Reichardt, Fuerst and Zietz, 2012, Fuerst and Shimizu, 2016, Yoshida, Onishi and Shimizu , 2017).

- These studies are also characterized by important limitations : *specific sectors, in specific countries and over specific timeframes*

- What is "***Sustainability***" or "***Resilience***" in Real Estate Market?

- ***Whether or not a property is "environmentally friendly" or "sustainable" could become a major investment risk.***

Why Should We Focus on "Green" or "Zero Energy" Building"?

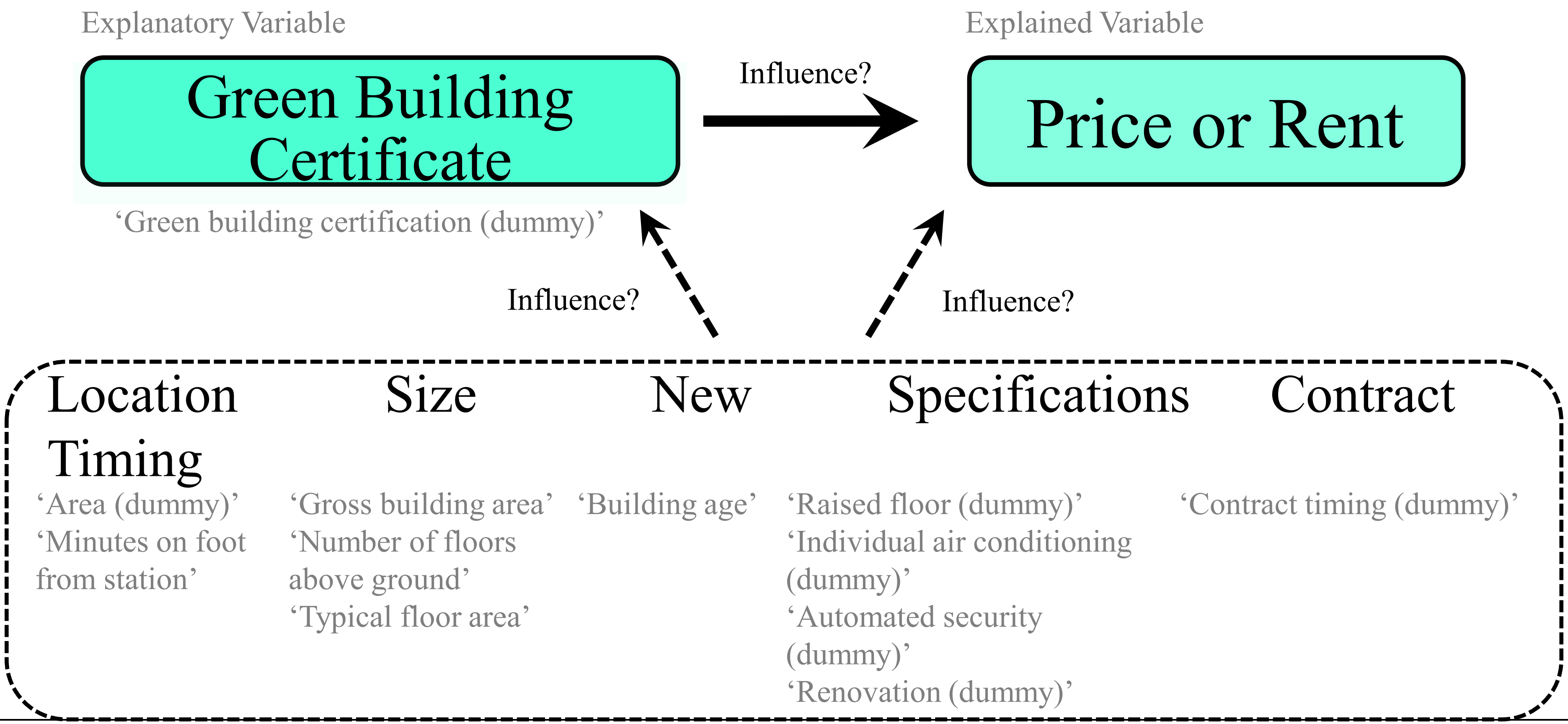
- 1. The world economy has undergone a major *structural adjustment* by GFC & Covid 19; and
- 2. Property investment have learned a number of things as a result of the financial crisis: *We have to select property very carefully for investing.*
  - Shimizu, C. (2010), "What Have We Learned from the Property Bubble?," RIPESS Working Paper No. 35.
- 3. *Whether or not a property is "environmentally friendly" or "sustainable" could become a* ***major investment risk****.*
  - Shimizu, C. (2010), "Will Green Buildings Be Appropriately Valued by the Market?," ?," RIPESS Working Paper No. 35.
- 4. *Covid 19 creates a new social order*. That also requires new demands on the building: Avoid congestion, reduce contact opportunities, and keep space between people.

Discussion 2: Investment Value of "Green Buildings"

- **Economic Premium reflect users' expectations of cost-saving effects**: even if they have to pay a higher rent, there would be no significant additional burden due to a decrease in environment-related expenses.
- Thus, when we examine investments in green buildings, **we need to consider direct benefits**, such as the ability to increase rents and other prices due to cost-saving effects, separately from other issues.
- **Constructing green buildings requires making a large initial investment** in order to provide the intended green features.

Is *Green Building Certificate* the Factor of *High Property Value*?

• If buildings with Green Building Certificate tend to share other characteristics such as the size or age of the buildings, then it may be difficult to identify whether the difference in pricr/rent was caused by Green Building Certificate or other factors.



Hedonic Analysis (1)

Explicit Correlation between Product Attributes and Price

- **Hedonic Approach**

  A method to estimate the price of a product by using the statistical technique of regression analysis. The price is considered as derived from various attributes and functions of the product. This is a quantitative analysis which gives an explicit correlation between product attributes and price.

- **All Buildings are Unique in Location, Size, Age, Facilities and Functions**

  The price/rent is determined as a result of various factors.

- **With Hedonic Approach…**

  We can measure the influence of ***Green Building Certificate*** on Price/ Rent after removing other influences such as location, size, age and facilities of the building.

Method: Hedonic model: Case of *Condominium*

$$P_{(i,j,t)} = f(G_i, X_{(i,j)}, NE_k, HH_{(i,j)})$$

$P_{(i,j,t)}$: New condominium price of condominium i and dwelling j at time t (1: asking price, 2: transaction price)

G_i : Green label of condominium i

$X_{(i,j)}$: Building characteristics of condominium i & dwelling j

NE_k : Location characteristics of region k

$HH_{(i,j)}$: Buyer characteristics of condominium i and dwelling j

(Quasi) cross-sectional hedonic model with robust S.E., time fixed effects and buyer characteristics

Estimation of Coefficient using Regression Model

- **Regression Model**

This regression model explains the contract rent by size, age, quality/facilities and contract timing of the office building.

log (contract rent) = β_0 + $\beta_1$log (gross building area) + β_2 (number of floors above ground) + $\beta_3$log (typical floor area) **…Size**

+ β_4 (building age) + β_5 (renovation dummy) **…New/Old**

+ β_6 (raised floor dummy) + β_7 (individual air conditioning dummy)

+ β_8 (automated security dummy) + **β_9** (Green Building Certificate dummy) **…Quality and Facilities**

+ β_{10} (minutes on foot) + $\Sigma_j\beta_{11j}$ (area dummy<59 area>)$_j$ **…Location**

+ $\Sigma_k\beta_{12k}$ (timing of contract signing dummy<8 quarterly>)$_k$ **…Timing of Contract Signing**

+ μ **…Variance**

- **Estimation of Coefficient**

The estimated coefficient (β_0 - β_{12}) must have the minimum variance (μ) between the rent estimated from the model and the actual rent. (Estimation by the least-squares method.)

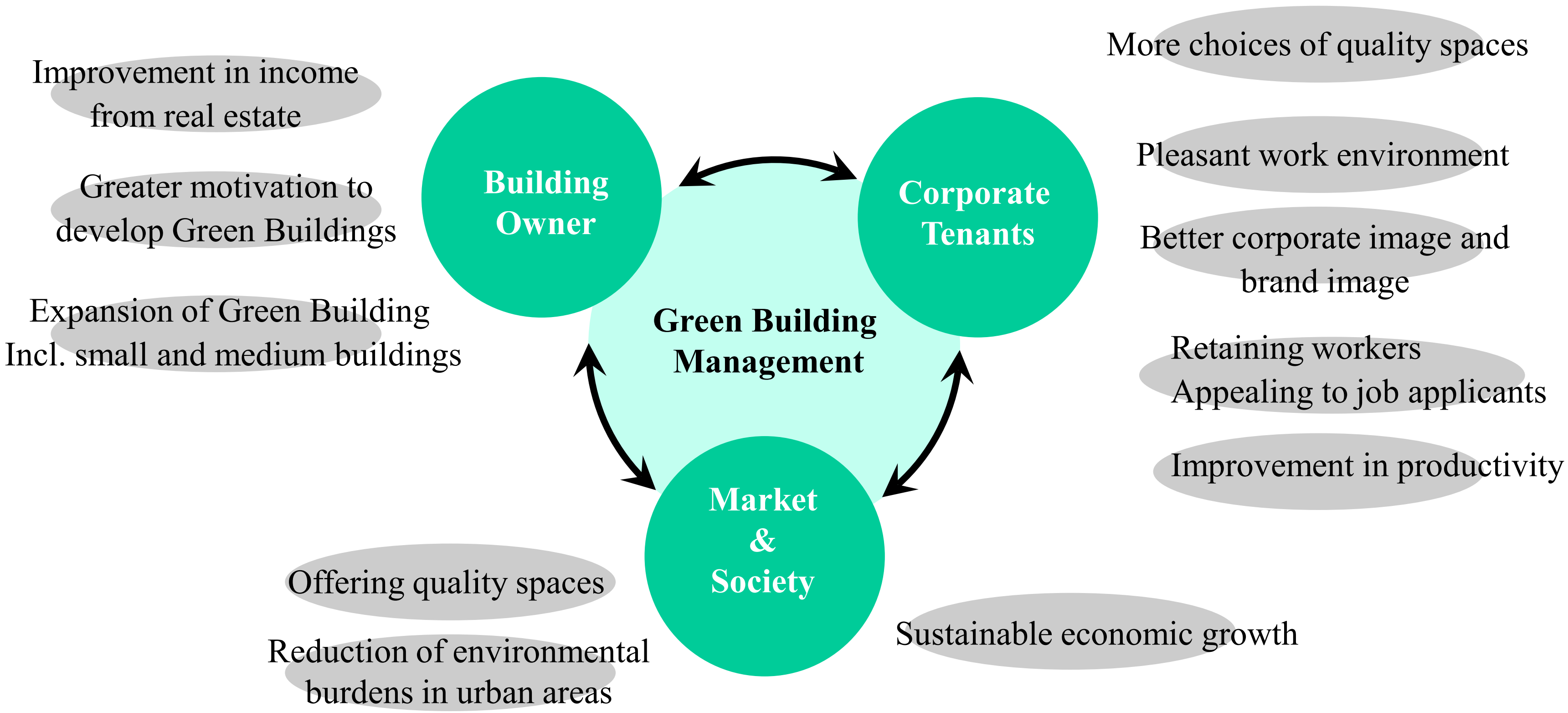
- **Coefficient of Green Building Certificate Dummy β_9**

This represents the influence of Green Building Certificate on Contract Rent of New Lease

The natural log is used as the explained variable (contract rent) in this analysis, meaning the coefficient of the explanatory variables represent the percent change of the contract rent for every one unit increase of the explanatory variable.

If We Make Clear the Economic Value of Green Building Management…

• Green Building Management will benefit all the stakeholders in the real estate industry including building owners, tenants, market and society and contribute to creating a positive spiral.



Discussion 3: Green Building Certificate.

- Against the background of this growing momentum, *green label systems* have been attracting attention as they lead to improvements in the environmental performance of actual products, services, and assets and to the realization of maintaining and improving the sustainability of society as a whole.
  - Green labels such as **BREEAM, LEED, CASBEE**, and so on.
  - **What kind of significance do these green labels have if one tries to convert them into investment values?**
  - In addition, there is variation across different countries in terms of the standards that have been established.
  - Currently, the property investment market is moving in the direction of globalization, and I believe it is necessary to move toward the **harmonization of these international standards.**

Green Label

- In the real estate field, since the publication of BREEAM in the United Kingdom in 1990 as the world's first environmental value assessment system, several other assessment systems have been published, including LEED in the United States (from 1996) and HQE in France (from 1996).
- In addition, a pension fund group in Europe founded GRESB to assess real estate companies and consider the sustainability between investment periods.
- In Japan, environmental value assessment systems have also been introduced for many J-REITs, and they can be seen spreading around the world. Since the introduction of CASBEE in Japan in 2001.

Initiatives to spread and utilize green labels

- The United States :
  - Acquisition of LEED obligatory when constructing or renovating federal government-related buildings.
  - In many local governments have imposed benchmarks from Energy Star and reporting obligations.
- The United Kingdom :
  - Since 2008, practically all buildings must be certified by the Energy Performance Certification (EPC) when they are being purchased, sold, constructed, or leased; from 2018, it will become illegal to lease real estate whose energy efficiency does not reach a certain level.

Initiatives to spread and utilize green labels

- In Japan, it is mandatory to report greenhouse gas emissions above a certain scale based on the laws :
  - The revised Act on the Rational Use of Energy (2009)
  - The Tokyo Metropolitan Ordinance on Environmental Preservation (2008)
  - In April 2016, Japan enforced the Act on the Improvement of the Energy Consumption Performance of Buildings and imposed the obligation of large-scale nonresidential buildings to conform to energy consumption performance standards
- Conversely, although Japan has established incentives toward displaying the energy performance of existing buildings, it does not have an enforceable mechanism like the United Kingdom.

Determinants of *slow adoption* and *acceptance* in Japan

- A social system incorporating environmental consideration, including in its real estate market, has already come into existence.
  - 1950s, environmental pollution
    - The same social problems that China is currently experiencing
  - 1970's, the oil shock
    - Japan has pursued a policy calling for energy conservation.
  - Further environmental considerations *would not necessarily* lead to market differentiation.
  - Buildings constructed to high specifications in recent years are implicitly meeting or exceeding environmental standards *even without green labeling*.
  - Earthquake-proofing is given the highest priority.

To make green buildings more widely accepted

- We think it would be an important policy issue to consider how we could improve the environmental functionalities of such pre-existing buildings.
  - Many older buildings are neither seismically secure nor match the standards of green buildings.

- It is important to present reliable analytical results on the extent of the *economic value* for certifying pre-existing buildings in the market as green.

Types of Green Labels

Environmental standard	Country	Year of introduction	Developer/ provider	Feature
BREEAM (BRE Environmental Assessment Method)	U.K.	1990	BRE (Building Research Establishment), ECD (Energy and Environment)	This system sets forth individual assessment standards for a wide range of subjects, from buildings, such as offices, commercial facilities, stand-alone houses, collective housing, schools, distribution facilities (warehouses) and courthouses, to communities. Although they are assessed differently, common standards are (1) energy efficiency (carbon dioxide emission), (2) water use efficiency, (3) materials used inside the building, (4) indoor environment (comfort and health for workers), (5) environment available on site, (6) accessibility, (7) management status, (8) contamination status, and (9) impact on the local ecology. Having started with assessments in the planning and development stages, this system has evolved to cover the management stage as well.
LEED (Leadership in Energy and Environmental Design)	U.S.A.	1996	U.S. Green Building Council	The basic concept is the same as for BREEAM. Initially intended for application in the design and development stages, this system is now comprehensive, also covering the management stage. Evaluation standards are (1) energy efficiency, (2) water use efficiency, (3) resource use efficiency and externality, (4) design, (5) respect for the landscape, and (6) environmental quality.
CASBEE (Comprehensive Assessment System for Built Environment Efficiency)	Japan	2001	IBEC (Institute for Building Environment and Energy Conservation)	The basic concept is the same as for BREEAM. Providing basic tools for design, development, existing buildings, and repair, this system sets forth standards for a wide range of subjects, from buildings to city planning. Although evaluation standards are much the same as under BREEAM and LEED, this system is unique in that buildings are assessed in terms of BEE (Building Environment Efficiency), comprised of their environmental quality (Q) and environmental load (L).
IPD: Environmental Code	U.K.	2007	IPD (Investment Property Databank)	While BREEAM, CASBEE, and LEED are focused on the potential functions of buildings, the Environmental Code focuses on their actual use status. Assessment standards are (1) energy efficiency, (2) water use efficiency, (3) waste disposal efficiency, (4) accessibility, (5) equipment, (6) indoor environment, and (7) adaptation to changes in the global environment.
IPD/IPF: Sustainable Property Index	U.K.	2009	IPD (Investment Property Databank), IPF (Investment Property Forum)	Information affecting investment performance was drawn from the IPD Environmental Code and converted into an investment performance index. The extracted assessment standards are (1) building quality, (2) accessibility, (3) energy efficiency, (4) water use efficiency, (5) waste disposal efficiency, and (6) flooding risk.

Source: http://www.breeam.org/ for BREEM; http://www.usgbc.org/DisplayPage.aspx?CategoryID=19 for LEED; http://www.ibec.or.jp/CASBEE/ for CASBEE; http://www.ipdoccupiers.com/Default.aspx?TabId=1632 for the IPD Environmental Code; http://www.ipd.com/Default.aspx?tabid=2215 for the IPD/IPF Sustainable Property Index.

Green Label

		LEED	Energy Star	BREEAM	EPCs	HQE	GRESB	greenstar
Used in this study		-	-	-	-	-	-	-
Development		U.S.Green Building Council (US)	U.S. Environmental Protection Agency (US)	Building Reserch Establishment (UK)	UK Government (UK)	HQE Association (France)	GRESB (Netherlands)	Green Building Council of Australia (Australia)
Since		1998	1995	1990	2006	1996	2010	2003
Target		Buildings	Buildings	Buildings	Buildings	Buildings	Firm	Buildings
Focus		Comprehensive	Energy Efficiency	Comprehensive	Energy Efficiency	Comprehensive	Comprehensive	Comprehensive
Output		4 ranks	Enegy Star ≧75	5 ranks	8 ranks	4 ranks	4 quadrants	6 ranks
Evaluation items	Building and equipment performance	○	-	○	○	○	-	○
	Operation	○	○	○	-	-	○	○
	Water	○	-	○	-	○	○	○
	Material	○	-	○	-	○	-	○
	Indoor environment	○	-	○	-	○	○	○
	Site and Ecosystem	○	-	○	-	○	-	○
	Transport	○	-	○	-	-	-	○
	Waste	○	-	○	-	○	-	○
	Pollution	○	-	○	-	○	-	○
	Other	-	-	Manegement, Performance verification	-	-	Organization, Disclosure, Risk assessment, Green lease	Management, Innovation

Green Label

		NABERS	CASBEE	CASBEE for real estate	DBJ Green Building Cetificate	SMBC Sustainable Building Assessment	BELS
Used in this study		-	○	○	○	○	-
Development		Australian Government (Australia)	Ministry of Land, Infrastructure, Transport and Tourism (Japan)	Ministry of Land, Infrastructure, Transport and Tourism (Japan)	Development Bank of Japan (Japan)	Sumitomo Mitsui Bank Corporation (Japan)	Ministry of Land, Infrastructure, Transport and Tourism (Japan)
Since		1990	2004	2012	2011	2011	2014
Target		Buildings	Buildings	Buildings	Buildings	Buildings	Buildings
Focus		Energy Efficiency	Comprehensive	Comprehensive	Comprehensive	Comprehensive	Energy Efficiency
Output		5 ranks	5 ranks	4 ranks	5 ranks	6 ranks	5 ranks
Evaluation items	Building and equipment performance	-	○	○	○	○	○
	Operation	○	-	○	-	○	-
	Water	○	○	○	○	○	-
	Material	-	○	○	-	○	-
	Indoor environment	○	○	○	○	○	-
	Site and Ecosystem	-	○	○	○	○	-
	Transport	-	○	○	○	○	-
	Waste	○	-	-	○	○	-
	Pollution	-	○	-	-	○	-
	Other	-	Earthquake resistance, Handicapped accessible	Earthquake resistance, Useful life, Disaster risk	Environment risk, Crime prevention, Tenant relation	Risk management, Management policy, Innovation	-

Discussion 4: Economic Premium in “*Residential*” Market.

- The residential sector has attracted a much smaller number of academic studies in this topic area, despite its large size and obvious relevance for both the general economy and ***sustainable development***.
- The reasons for this lack of empirical evidence are not clear. Larger fragmentation of investors and a lower fraction of professional or institutional investment in the market driving the ***discourse around 'green value'*** may be a contributing factor.
- Housing markets are highly regulated and prone to inefficiencies in many countries.

Previous Researches 1

- Dian and Miranowski (1989): showed that increasing energy efficiency increases housing prices.
- Banfi et al. (2005) : 13% higher rent for buildings that have adopted energy-saving measures.
- Fuerst et al (2012) : 14% premium of the highest band of the Energy Performance Certificate over the lowest band.
- Earlier, et al (2011): significant premiums for more energy-efficient buildings.

Previous Researches 2

- Zheng and Kahn (2008) and Zheng, Kahn and Deng (2012): significant price premia for 'green' properties in the Chinese housing market.
- Deng, Li and Quigley (2012): substantial economic returns to green buildings in Singapore.

- Kok and Kahn (2012) as well as Hyland et al (2013): similar conclusions for the Californian and the Irish housing market respectively.

- **Fuerst, F and C. Shimizu (2016) , The Rise of Eco-Labels in the Japanese Housing Market," *Journal of Japanese and International Economy*, 39, 108-122.**

Case of Tokyo Condominium Market: Fuerst and Shimizu (2016).

- Tokyo Metropolitan Government's Green Labeling System for Condominiums.
- Green Labeling System for Condominiums (2002, revised in 2005 & 2010), mandatory for new construction and major refurbishment to organize and publish information based on a) building insulation, b) energy efficiency & performance, c) lifespan extension (durability) and d) greening (plants etc.) of the building.
- The evaluation results for the respective items **are expressed as a number of star symbols**, max: ★ ★ ★ .

Estimation Models:

Model.1

$$\log P_{(i,j,t)} = a_0 + a_1 T_{(i,j)} + \boxed{a_2 G_i} + a_3 \boxed{G_i T_{(i,j)}} + \sum_m a_4^m X^m_{(i,j)} + \sum_n a_5^n NE_k^n + \sum_t a_6^t D_t + \varepsilon_{(i,j)}$$

Model.2

$$\log P_{(i,j,t)} = a_0 + a_1 T_{(i,j)} + \boxed{a_2 G_i} + a_3 \boxed{G_i T_{(i,j)}} + \sum_m a_3^m X^m_{(i,j)} + \sum_n a_4^n NE_k^n + \sum_s a_5^s HH^s_{(i,j)} + \sum_t a_6^t D_t + \varepsilon_{(i,j)} + \sum_t \boxed{a_7^t G_i D_t} + \varepsilon_{(i,j)}$$

Model.3

$$\log P_{(i,j,t)} = a_0 + a_1 T_{(i,j)} + \boxed{a_2 G_i} + a_3 \boxed{G_i T_{(i,j)}} + \sum_m a_3^m X^m_{(i,j)} + \sum_n a_4^n NE_k^n + \sum_s a_5^s \boxed{HH^s_{(i,j)}} + \sum_t a_6^t D_t + \varepsilon_{(i,j)} + \sum_t \boxed{a_7^t G_i D_t} + \varepsilon_{(i,j)}$$

Estimation result, *Base Model*: Model 1

	(1) baseline OLS	(2) Robust reg
	lp	lp
Transaction price discount	-0.0347***	-0.0316***
	(-27.87)	(-26.54)
Green asking price premium	0.0609***	0.0586***
	(18.66)	(18.31)
Green transaction price discount^2	-0.00918*	-0.00948**

Transaction Based Premium 0.0609－0.00918＝0.05172

Estimation result considering *Time Effect* : Model 2

	Model 2: log(price)
Regressor	**Coefficient**
green2005	**0.045****
green2006	**0.0487*****
green2007	**0.0596*****
green2008	**0.0844*****
green2009	**0.096*****
green2010	**0.0438*****
tgreen2005	**-0.0486****
tgreen2006	**-0.003**
tgreen2007	**0.010**
tgreen2008	**-0.034****
tgreen2009	**-0.029****
tgreen2010	**0.008**
Property & condo attributes	Yes
Developer fixed effects	Yes
Location controls	Yes
Management fixed effects	Yes
Buyer characteristics	Yes
Time fixed effects	Yes
N	**48,740**
R^2	**0.814**

Estimated Result considering *Household's Characteristics:* Model 3.

	(1) baseline OLS	(2) Robust reg	(3) Income Q1	(4) Income Q2	(5) Income Q3	(6) Income Q4
	lp	lp	lp	lp	lp	lp
Transaction price discount	-0.0347***	-0.0316***	-0.0359***	-0.0354***	-0.0337***	-0.0343***
	(-27.87)	(-26.54)	(-11.72)	(-15.94)	(-16.16)	(-13.37)
Green asking price premium	0.0609***	0.0586***	0.0408***	0.0398***	0.0702***	0.0777***
	(18.66)	(18.31)	(3.63)	(6.74)	(13.12)	(12.45)
Green transaction price discount^2	-0.00918*	-0.00948**	-0.0158	-0.00692	-0.00936	-0.00975
			0.025	0.03288	0.06084	0.06795

"*Green premium*" in *Residential* Market in Tokyo.

- Compared to non-labelled properties, labelled buildings commanded a premium of 6.09% for the base asking price and 5.19% for the base transaction price (6.09% - 0.9%).
- Premium appears to *rise over time* (exception: 2010).
- Green asking price premia are found to *progress with increasing incomes of buyers* (from 4% to nearly 8%).

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- The average price premium observed in recorded transaction prices is mainly driven by households with above-average incomes paid for green-labelled properties.

Discussion 5: Economic Premium in "*Commercial*" Market.

Possible Cause 1: Social Consciousness

- Socially conscious *consumers* pay premia
  - Aroul and Hansz, 2012; Dastrup et al., 2012; Bruegge, Carrion-Flores, and Pope, 2016; Fuerst and Shimizu, 2016
- Socially conscious *firms* pay premia
  - Eichholtz, Kok, and Quigley, 2010; Miller et al., 2008; Pivo and Fisher, 2010; Fuerst and McAllister, 2011a; Devine and Kok, 2015; Eichholtz, Kok, and Quigley, 2016

Possible Cause 2: Energy Cost Savings

- The cost efficiency of a building can be associated with a high price
  - Laquatra, 1986; Dian and Miranowski, 1989; Gilmer, 1989; Brounen and Kok, 2011; Deng et al., 2012; Aydin, Brounen, and Kok, 2016

Possible Cause 3: Building Cost Add-On

- Developers may increase prices for extra costs
  - Yoshida and Shimizu, 2012; Dippold, Mutl, and Zietz, 2014

Empirical Strategy in Yoshida, Ohnishi and Shimizu(2017)

- (1) $$\ln Z_{\boldsymbol{ijt}} = \alpha G_i + \boldsymbol{X}_{\boldsymbol{i}}'\boldsymbol{\beta} + \delta_t + \lambda_j + \varepsilon_{ijt},$$
  - $\ln Z_{\boldsymbol{ijt}}$ denotes either **electricity usage** (total kwh for the past year) or water usage (m3 for the past year) of building i located in submarket j in month t
  - G_i denotes a dummy variable for green building labels,
  - $\boldsymbol{X}_{\boldsymbol{i}}$ denotes building characteristics: gross building area, the number of stories, age, time to the nearest station, management fee, maintenance costs, and capital expenditures, and dummy variables for recent renovation, a zone AC system, a card-key system.
  - δ_t denotes month fixed effects,
  - λ_j denotes 50 submarket fixed effects, and
- (2) $$\ln R_{ijt} = \alpha G_i + \boldsymbol{X}_{\boldsymbol{i}}'\boldsymbol{\beta} + \boldsymbol{Z}_{\boldsymbol{i}}'\boldsymbol{\gamma} + \delta_t + \lambda_j + \mu_{ijt},$$
  - $\ln R_{ijt}$ denotes the natural logarithm of the rent contracted at quarter-year t for office space i located in submarket j,
  - $\boldsymbol{Z}_{\boldsymbol{i}}$ denotes a vector of building-level energy usage variables,
  - δ_t denotes quarter-year fixed effects,
  - λ_j denotes submarket fixed effects, and

Result of Energy Usage Regressions

Dependent Variable:	Log electricity usage	Log water usage
Green label dummy	-0.101**	-0.189**
	(0.050)	(0.074)
Zone air conditioning dummy	-0.123***	-0.123***
	(0.042)	(0.045)
Card-key system dummy	-0.267***	-0.443***
	(0.044)	(0.058)
Building renovation dummy	-0.143***	-0.258***
	(0.035)	(0.049)
Occupancy rate	0.003***	0.005***
	(0.001)	(0.001)
Gas usage dummy	0.197***	-0.173***
	(0.035)	(0.045)
Constant	3.820***	-1.444***
	(0.158)	(0.212)
Other Variables (size, age, etc.)	Yes	Yes
Submarket & month fixed effects	Yes	Yes
Observations	2,126	1,132
Adjusted R^2	0.433	0.589

Findings 1

Sustainability features are effective in reducing of electricity and water consumption

- Observed features: a zone air conditioning system, a card-key security system, and a recent building renovation.
- Unobserved features: Green labels

→Green building features contribute to the actual reduction of the consumption of electricity and water.

- A contribution because sustainability features do not guarantee actual reductions
- One of a few studies about the actual energy consumption

Result of Log Rent Regression

	(1)	(2)	(3)	(4)	(5)	(6)
Green label dummy	0.217**	0.236*	0.030	0.010	0.060	0.096
	(0.089)	(0.124)	(0.103)	(0.111)	(0.092)	(0.097)
Zone air conditioning dummy	0.079	0.038	-0.247***	-0.157*	-0.184**	-0.212
	(0.055)	(0.121)	(0.087)	(0.091)	(0.087)	(0.135)
Card-key system dummy	-0.004	0.095	0.080	-0.040	0.168	0.189
	(0.081)	(0.125)	(0.108)	(0.100)	(0.111)	(0.134)
Building renovation dummy	0.045	0.095	0.031	0.205	0.014	0.018
	(0.053)	(0.083)	(0.140)	(0.150)	(0.111)	(0.134)
Log maintenance costs		-0.034				-0.046
		(0.067)				(0.170)
Log repair costs		0.059**				-0.018
		(0.028)				(0.057)
Log electricity usage			-0.209**		-0.309***	-0.305***
			(0.099)		(0.102)	(0.112)
Log water usage				0.098	0.159**	0.170**
				(0.068)	(0.065)	(0.070)
Constant	8.103***	7.571***	8.733***	8.528***	8.985***	9.571***
	(0.258)	(0.565)	(0.715)	(0.619)	(0.571)	(0.826)
Other variables (size, age, etc.)	YES	YES	YES	YES	YES	YES
Submarket fixed effects	YES	YES	YES	YES	YES	YES
Quarter-year fixed effects	YES	YES	YES	YES	YES	YES
Observations	480	332	165	162	162	158
Adjusted R-squared	0.758	0.775	0.779	0.769	0.801	0.805

Findings 2

A rent premium is associated with material benefits in energy and water costs

- When the usage of electricity and water is omitted in a rent estimation equation, green labels have a significant positive effect on office rents.
- When the usage of electricity and water is included, their coefficients are statistically significant but the coefficient on green labels becomes insignificant

→ Green labels indirectly affect office rents through *electricity* and *water usage*, but they do not have a direct effect

"*Green premium*" in *Commercial* Market in Tokyo.

- One of a few studies on the actual use of energy and water.
- Green building characteristics are ***effective*** in reducing electricity and water consumption.
- Green building characteristics have an ***indirect effect*** on rents through electricity and water consumption, but not a direct effect.

III. "*Sustainability*" in Property Market.

"*Sustainability*" of Property

- **ESG risk→*Sustainability***

- On March 11, Japan was struck by a major earthquake. Among other things, this generated awareness of the fact that, **in order to sustain property values, it is necessary to adopt strong measures not only in terms of earthquake-proofing, but also with respect to water damage, soil liquefaction, etc.**

- In future, with regard to property investment, there is a need to manage investment value ***sustainability* and *safety*** in a real sense, in a way that includes ***environmental* risks**.


IPD
An MSCI Brand
Global Estate Measurement
Code for Occupiers
Tenth Edition
September 2013

across an estate - as well as against external peer group organisations.

Environmental Health-Check

A summary of the key topics and questions covered in the Health-Check are set out below, along with the overall rating table (to the right).

Score	Rating
0-20	Very Poor Health
21-40	Poor Health
41-60	Average Health
61 to 80	Good Health
81+	Excellent Health

General

- Environmental Management Systems
- Responsible individual

Score /10

Energy

- Metering
- Lighting
- Temperature Controls

Score /26

Water

- Efficient Fittings
- Metering
- Leak Detection

Score /17

Waste

- Waste Management Planning
- Recycling & Segregation
- Sustainable Product Sourcing

Score /20

Transport

- Green Travel Planning
- Cycling Facilities
- Food miles

Score /8

Equipment and Appliances

- Refrigerants
- NOx Emissions
- Light Pollution

Score /8

Health and Well-Being

- HVAC maintenance
- Water Testing
- Noise monitoring

Score /9

Adaptation to Climate Change

- Flood Risk
- Business continuity

Score /2

Large-scale disaster.

- **MSCI-IPD Occupiers: Environment Code**
- **Environment Code**

- **Core Measures:**
- i)Energy, ii)Water, iii)Waste

- **Qualitative Measure:**
- iv)Transport, v)Equipment and Appliances, vi)Health and well-Being, vii)**Adaptation to Climate Change.**

- **+ Large Scale Disaster:**
  - **Earthquake, Flood and Energy consumption**

"*Sustainability*" or "*Resilience*" in Real Estate Market.

- **Stage 01. Earthquake**
- **Stage 02. ESG regulation**
  - Zero Energy Building
- **Stage 03. Adaptation to Climate Change**
  - Flood Risk

Great Kanto Earthquake, 1923

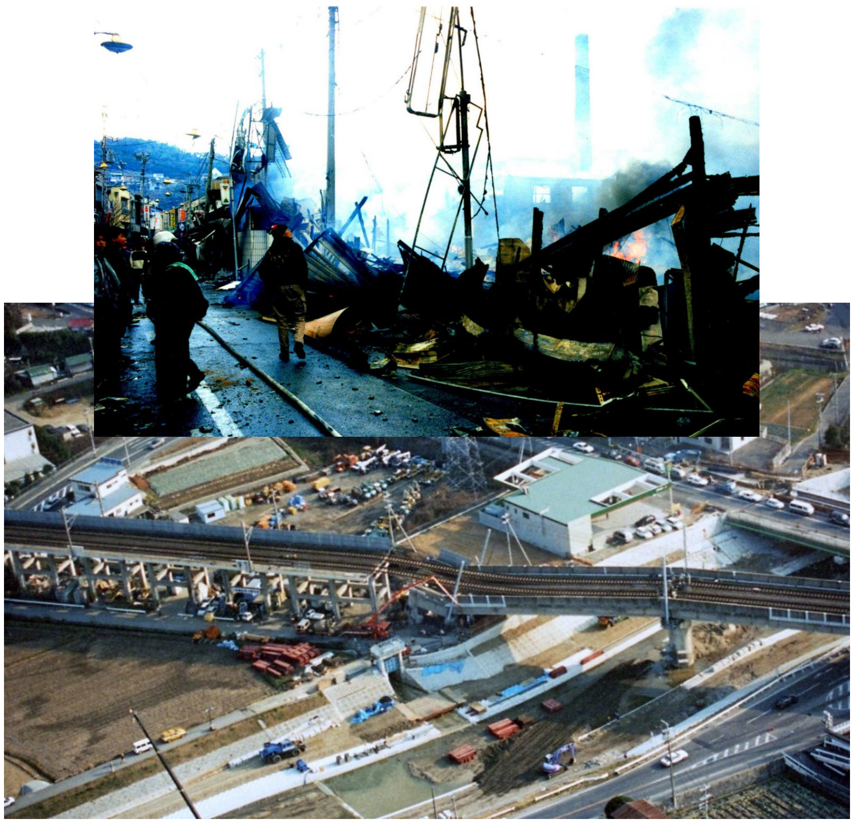
- The *Kanto earthquake* occurred on September 1, 1923, mainly in the southern Kanto region(Tokyo). It killed 105,000 people.






Great Hanshin-Awaji Earthquake, 1995

- On January 17, 1995, a major earthquake struck near the city of Kobe, Japan, killing more than 6,432 and making more than 45,000 people homeless.



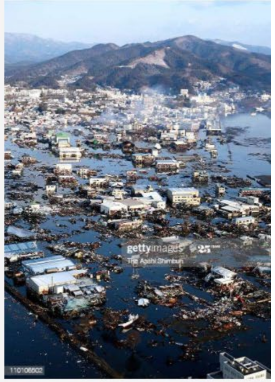
Damage to Kobe City Hall

Damage to wooden building

Damage to reinforced concrete building

Great East Japan Earthquake,2011

- The Great East Japan Earthquake is a disaster caused by the 2011 off the Pacific coast of Tohoku Earthquake that occurred on March 11, 2011, and the accompanying accident at the Fukushima Daiichi Nuclear Power Station. Due to the *tsunami* and *fire*, more than 22,000 people were killed or missing in 12 prefectures.



Discussion 6: Resilience from "*Earthquake*".

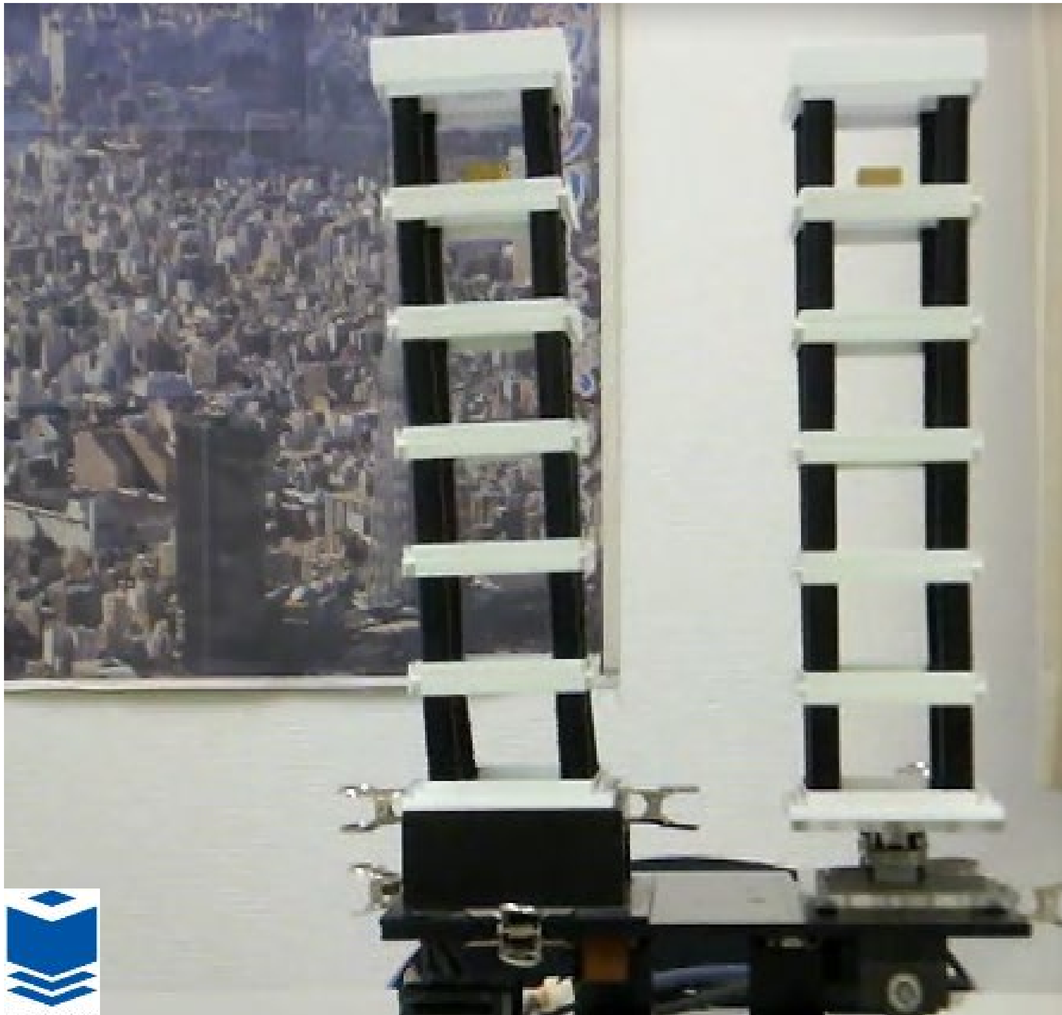
- 1894 The "Wooden Seismic House Guidelines" is made.
- 1920 "*Urban Building Law*" Enforcement The first national law on architecture.

- **Great Kanto Earthquake, 1923**
- **1924 Amendment of "Urban Building Law" Added "Horizontal seismic intensity to 0.1 or more" clause.**

- 1950 "*Urban Building Law*" abolished. Enforcement of "*Building Standard Law*".
  - Introduced long-term and short-term concepts in the Building Standards Act.
- **1970 Amendment of "Building Standard Law" Strengthened the necessary bearing wall.**
- 1980 Amendment of "Building Standard Law"
- **1981 Amendment of "Building Standard Law" (New seismic design method).**

- **Great Hanshin-Awaji Earthquake, 1995**
- **2000 Amendment of "Building Standard Law" The concept of performance regulation is introduced, and the limit strength calculation method is recognized as a structural calculation method in addition to the conventional calculation of allowable stress.**

Seismic Isolation Building : Private Sector/ Starts, Co.



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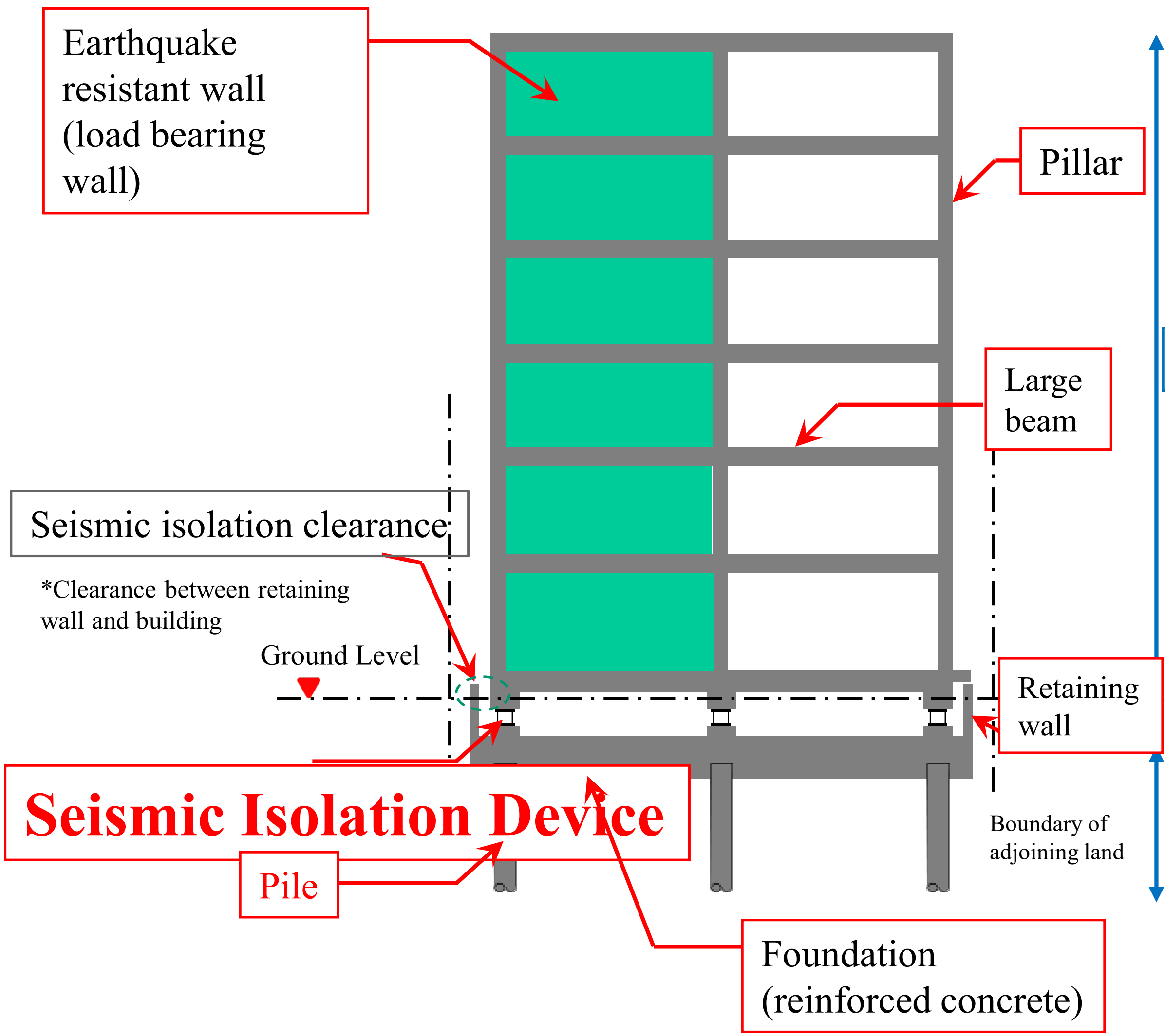
Difference in shaking with seismically isolated and general quake-resistant buildings

- In the case of a large earthquake, as quake-resistant structures are connected to the ground, the shaking is transferred as is through to the building.
- **In seismically isolated buildings, a seismic base isolation device is inserted between the structure and the ground, which breaks the connection and therefore the shaking which is transferred to the building from a large-scale earthquake is abated by 1/4 to 1/3.**
- **Seismic isolation, as compared to general quake-resistant buildings also suppress the shaking intensity felt at higher floors.**

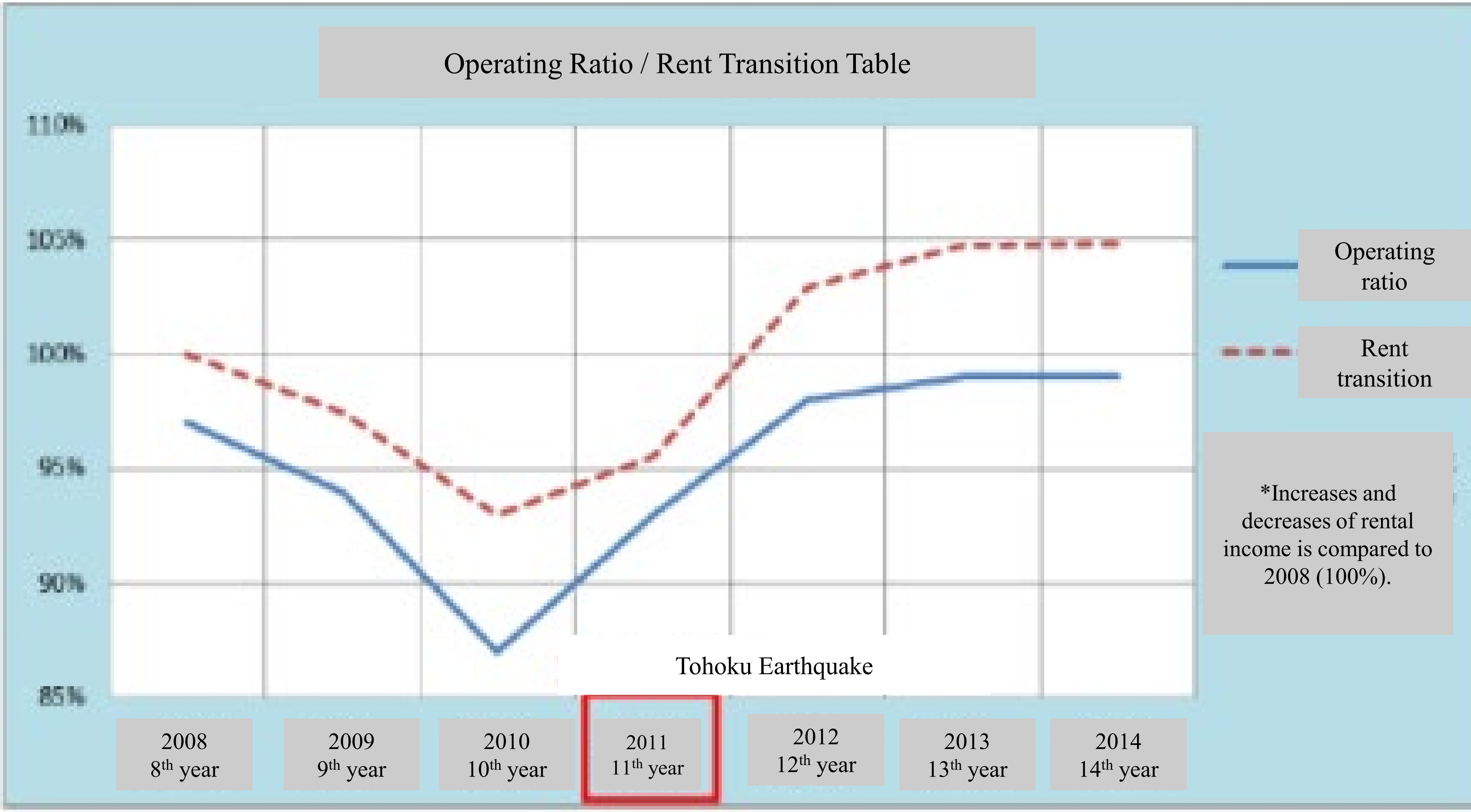
Seismic Isolation Building

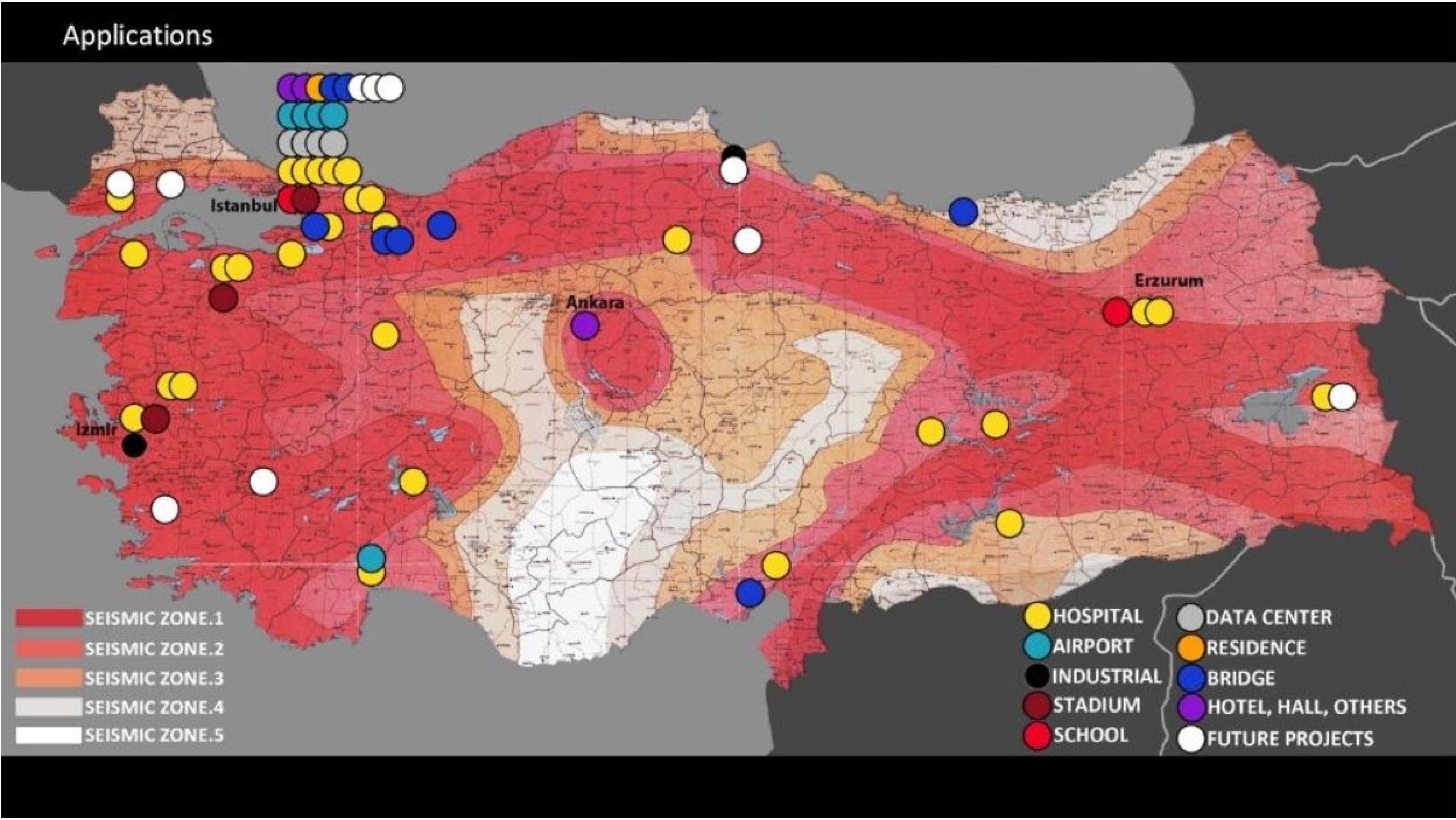


Outline diagram of seismic isolation (cross-sectional)

- As seismically isolated structures have a seismic base isolation device installed, a dedicated pit is a necessity.
- In the case of a large-scale earthquake, horizontal movements of 20-30cm occur, meaning a retaining wall or clearance is necessary.

Example of the effectiveness of the seismic isolation





Source: Istanbul Institute of Technology

Discussion 7: Adaptation to "*Climate Change*": Flood Risk: *Kumamoto* heavy rain, 2020.

- The total number of houses damaged by heavy rain was 592, and the total number of houses was 8,256 including the inundation above and below the floor and the partial damage.


熊本豪雨、死者22人に 心肺停止18人、不明...
news.yahoo.co.jp


熊本豪雨の被災地支援クラウドファンディング ...
mainichi.jp


熊本豪雨、死者６０人に 大雨特別警報から１週...
kumanichi.com


早く助けて」「短時間で一気に水が」 熊本・未...
nishinippon.co.jp


目を覚ましたら家に水... 「暴れ川」氾濫、未明の...
mainichi.jp


熊本豪雨の死者22人に 18人心肺停止、11人不...
r.nikkei.com


熊本豪雨で考える日本のダム。川辺川ダムが...
news.yahoo.co.jp


熊本豪雨、芦北町などで２人死亡...球磨村の特養で...
yomiuri.co.jp


熊本豪雨で1人死亡、15人心肺停止 老人ホーム浸...
nikkei.com


熊本・鹿児島大雨、２人が心肺停止...２０万...
yomiuri.co.jp


熊本豪雨15人心肺停止、9人不明 球磨川氾濫...
fukuishimbun.co.jp


まとめ「熊本豪雨」｜【西日本新聞ニュ...
nishinippon.co.jp


どうか無事でいて」 降り続く雨の中、懸...
tokyo-np.co.jp

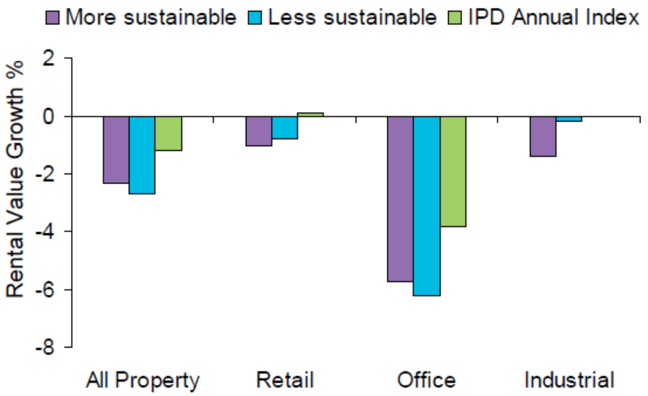

熊本豪雨、死者２２人に 心肺停止１８人...
chugoku-np.co.jp

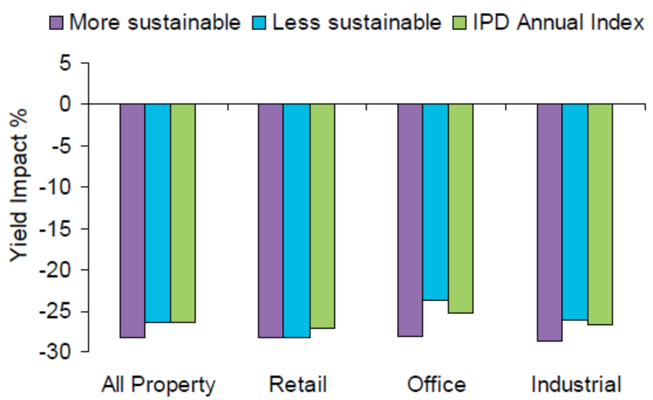

熊本豪雨、死者２５人...
nippon.com


熊本豪雨 死者49人、不明11人に 浸水61...
mainichi.jp

IPD/IPF Sustainable Property Index (ISPI) UK

- To identify the more sustainable properties in the market, ISPI asks landlords 20 or so questions, easily answerable, based on the 6 categories of:
- -Building quality
- -Building accessibility
- -Energy efficiency
- -Water efficiency
- -Waste management
- **-Flood risk.**





SLR(Sea Level Rise) and flood

・An IPCC report on climate change impact specifies salinization, flood and erosion as environmental disasters that have already materialized as a result of SLR, whereas impacts on health, heritage, freshwater availability, biodiversity, agriculture and fisheries are expected in the near future (Hoegh-Guldberg et al., 2018, p. 57)

・Among salinization, flood and erosion, flood is both the most relevant and well-discussed topic when it comes to **the price implications of SLR to real estate market**.

Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J.Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou, 2018: Impacts of 1.5ºC Global Warming on Natural and Human Systems. In: Global Warming of 1.5° C. An IPCC Special Report on the impacts of global warming of 1.5° C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I.Gomis, E. Lonnoy, T.Maycock, M.Tignor, and T. Waterfield (eds.)]. In Press.

SLR and flood

・Coastal flood, rather than river flood, has been the primary concern of researchers.

・Coastal flood is triggered by direct inundation, as well as by storm surge and other water related disasters whose effect is amplified by the higher sea level (Michael, 2007; Warren-Myers et al., 2018)

Michael, J. A. (2007). Episodic flooding and the cost of sea-level rise. *Ecological Economics, 63*(1), 149-159. doi:10.1016/j.ecolecon.2006.10.009

Warren-Myers, G., Aschwanden, G., Fuerst, F., & Krause, A. (2018). Estimating the Potential Risks of Sea Level Rise for Public and Private Property Ownership, Occupation and Management. *Risks, 6*(2), 37. doi:10.3390/risks6020037

SLR flood and coastal damages

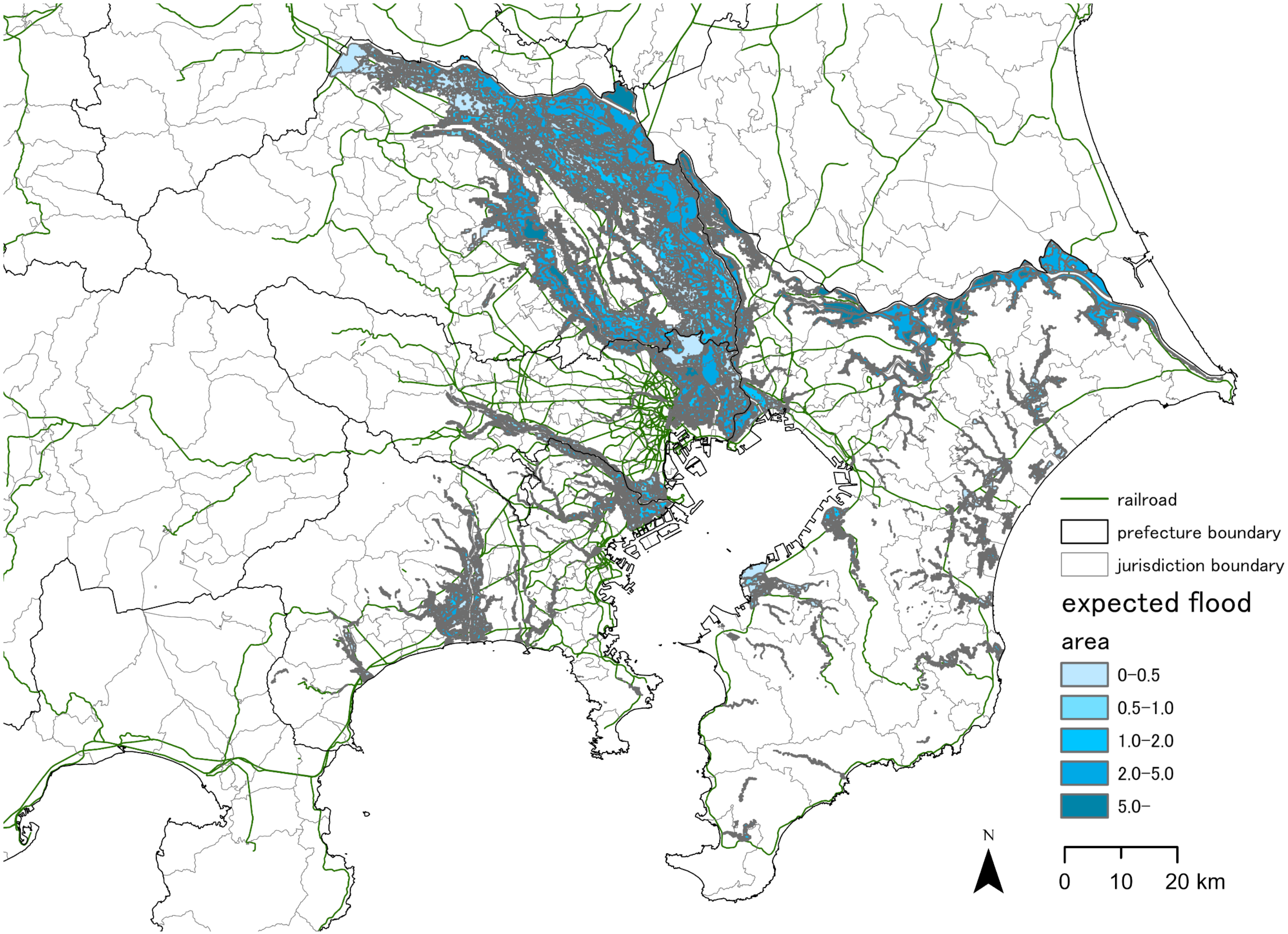
・There has been an accumulation of research aimed at revealing general implications of SLR flood to coastal cities.

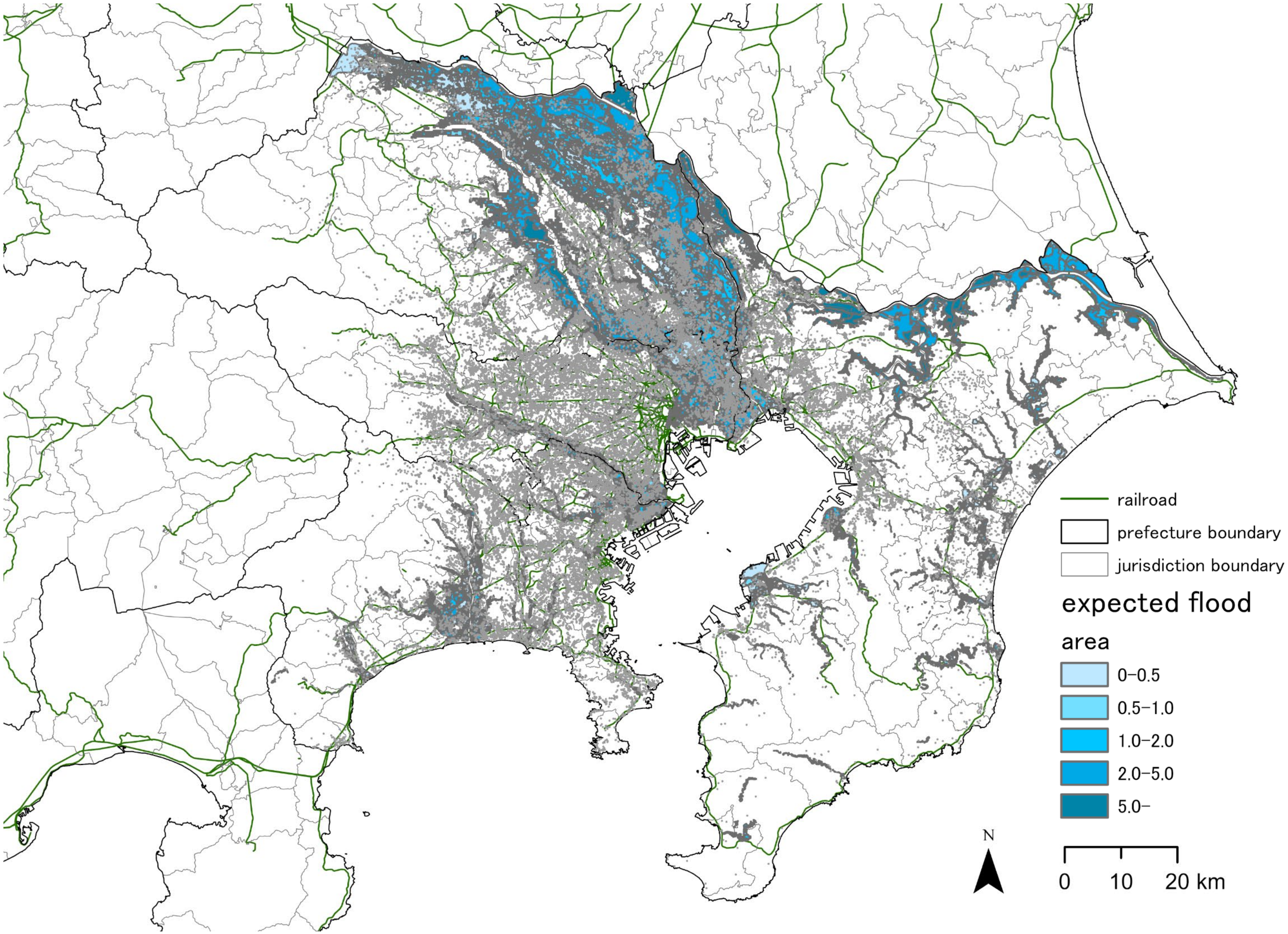
・Neumann et al. (2015), Hallegatte et al. (2013) and Brown et al. (2018) are among such research to quantify population, land and assets that are exposed to SLR-induced coastal flood.

Brown, S., Nicholls, R. J., Goodwin, P., Haigh, I. D., Lincke, D., Vafeidis, A. T., & Hinkel, J. (2018). Quantifying Land and People Exposed to Sea-Level Rise with no Mitigation and 1.5∘C and 2.0∘C Rise in Global Temperatures to Year 2300. *Earth's Future, 6,* 583-600. https://doi.org/10.1002/2017EF000738

Hallegatte, S., Green, C., Nicholls, R. J., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature Climate Change, 3*(9), 802-806. doi:10.1038/nclimate1979

Neumann B, Vafeidis AT, Zimmermann J, Nicholls RJ (2015). Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding - A Global Assessment. *PLoS ONE 10*(3): e0118571. doi:10.1371/journal.pone.0118571


railroad
prefecture boundary
jurisdiction boundary
expected flood
area
0–0.5
0.5–1.0
1.0–2.0
2.0–5.0
5.0–
N
0
10
20 km


railroad
prefecture boundary
jurisdiction boundary
expected flood
area
0–0.5
0.5–1.0
1.0–2.0
2.0–5.0
5.0–
N
0
10
20 km

Hedonic Regression with Expected Flood Risk in Tokyo detached house market

Variable	dependent var: ln(price)			dependent var: ln(price per area)		
	Coef.	Robust S.E.	t	Coef.	Robust S.E.	t
ln(parcel area)	0.140	0.004	36.21***	0.140	0.004	36.21***
ln(building area)	0.669	0.013	51.49***	-0.331	0.013	-25.5***
ln(building age)	-0.134	0.001	-168.3***	-0.134	0.001	-168.3***
ln(dist. to the nearest station)	-0.110	0.001	-97.18***	-0.110	0.001	-97.18***
ln(dist. to CBD)	-0.424	0.002	-242.79***	-0.424	0.002	-242.79***
below 1LDK dummy	0.054	0.009	6.02***	0.054	0.009	6.02***
2LDK to 3DK dummy	0.064	0.004	18.17***	0.064	0.004	18.17***
3LDK to 4DK dummy	0.062	0.002	34.48***	0.062	0.002	34.48***
above 4LDK dummy		(baseline)			(baseline)	
wooden structure dummy	-0.155	0.008	-19.5***	-0.155	0.008	-19.5***
planning regulation area dummy	0.293	0.004	77.78***	0.293	0.004	77.78***
expected flood 0		(baseline)			(baseline)	
expected flood 0-0.5	-0.136	0.002	-55.14***	-0.136	0.002	-55.14***
expected flood 0.5-1.0	-0.105	0.003	-39.68***	-0.105	0.003	-39.68***
expected flood 1.0-2.0	-0.123	0.002	-53.58***	-0.123	0.002	-53.58***
expected flood 2.0-5.0	-0.172	0.003	-68.64***	-0.172	0.003	-68.64***
expected flood 5.0- [m]	-0.208	0.017	-12.51***	-0.208	0.017	-12.51***
const.	18.530	0.060	310.79***	18.530	0.060	310.79***
R-squared		0.5975			0.5897	
RMSE		0.27587			0.27587	
max VIF		1.96			1.96	
mean VIF		1.21			1.21	

Notes. statistical significance, *** 0.1%, ** 1%, * 5%; Coef. = Coefficient; S.E. = Standard Error

Conclusions:

- We humans have common serious problems such as ***global warming*** and ***climate change***.
- The construction sector has a large role to play in addressing this problem.
- In addition, we are at increased risk of encountering a major disaster; ***Earthquakes***, ***heavy rains***, ***wildfires***, etc.
- Many friends have been killed by such disasters. The evolution of building technology can save many future lives.
- We can improve our building technology by cooperating internationally.

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