Methodological Gaps for adaptation to climate change in East Asia

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Introduction

◆Climate change caused by human activities will continue for centuries. Need at least several decades until a mitigation take effect. Need to put adaptation together immediately.

◆Top-down approach

Impact assessment based on accurate predictions of climate models. The current mainstream. Assess potential impacts of **climate change** by global climate models and downscaling in a region by regional climate models or statistical methods.

◆Bottom-up Approach

Assessment of potential vulnerabilities of resources (water, food, energy, health, ecosystem) . Climate change is one of many factors. Emphasis on risk assessment and disaster management. Focused on adaptation and mitigation measures to reduce vulnerability (Pielke Sr. et al., 2009). Robust adaptive strategies for "possible scenario" instead of “accurate prediction for optimization"

→ Complement mainstream top-down approach

Research Program on Climate Change Adaptation (RECCA) *2010-2015*

Vulnerability and adaptation to climate change in water hazard assessed using regional climate scenarios in the Tokyo region

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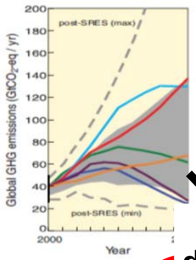
Research Program on Climate Change Adaptation (RECCA)

Vulnerability and adaptation to climate change in water hazard assessed using regional climate scenarios in the Tokyo region

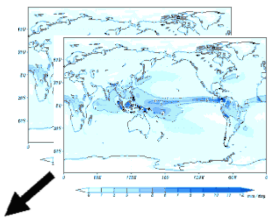
Theme 1

Development of regional climate simulation using LULC change scenarios

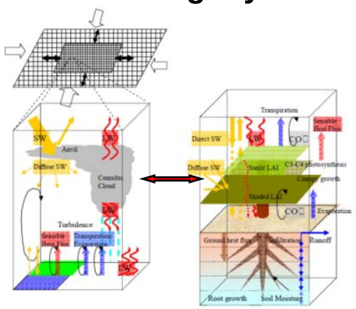
Socio-economic scenarios



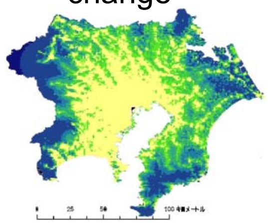
GCMs



Dynamical downscaling by **RCM**



Land use/Land cover change



Urban solid structure & Artificial Heat Release

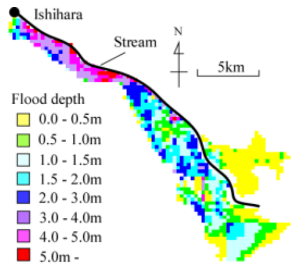
Contribute to **sustainable Social development** in metropolis

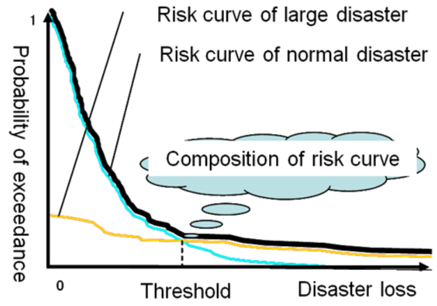
Theme 3

Development of adaptation simulation based on water-related vulnerability

Vulnerability assessment based on Socio-Economic and Physical Perspectives

Water-related hazard and risk assessment

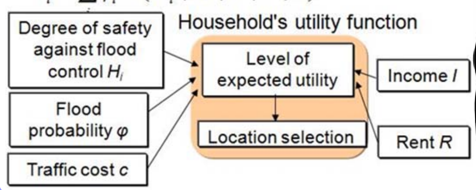




Adaptation simulation by Computable Urban Economic (CUE) model

Land use simulation which selects location to maximize household

$$V_i = \sum \phi_i^j V(H_i^j, R^j, I^j, c^j, \ldots)$$



Meeting with local government

Downscaling

◆Users of climate scenarios produced by global climate models with coarse grid-spacing have been dissatisfied with the inadequate mismatch of spatial scale.

◆**Downscaling** technique is used to obtain the local /regional climate scenarios.

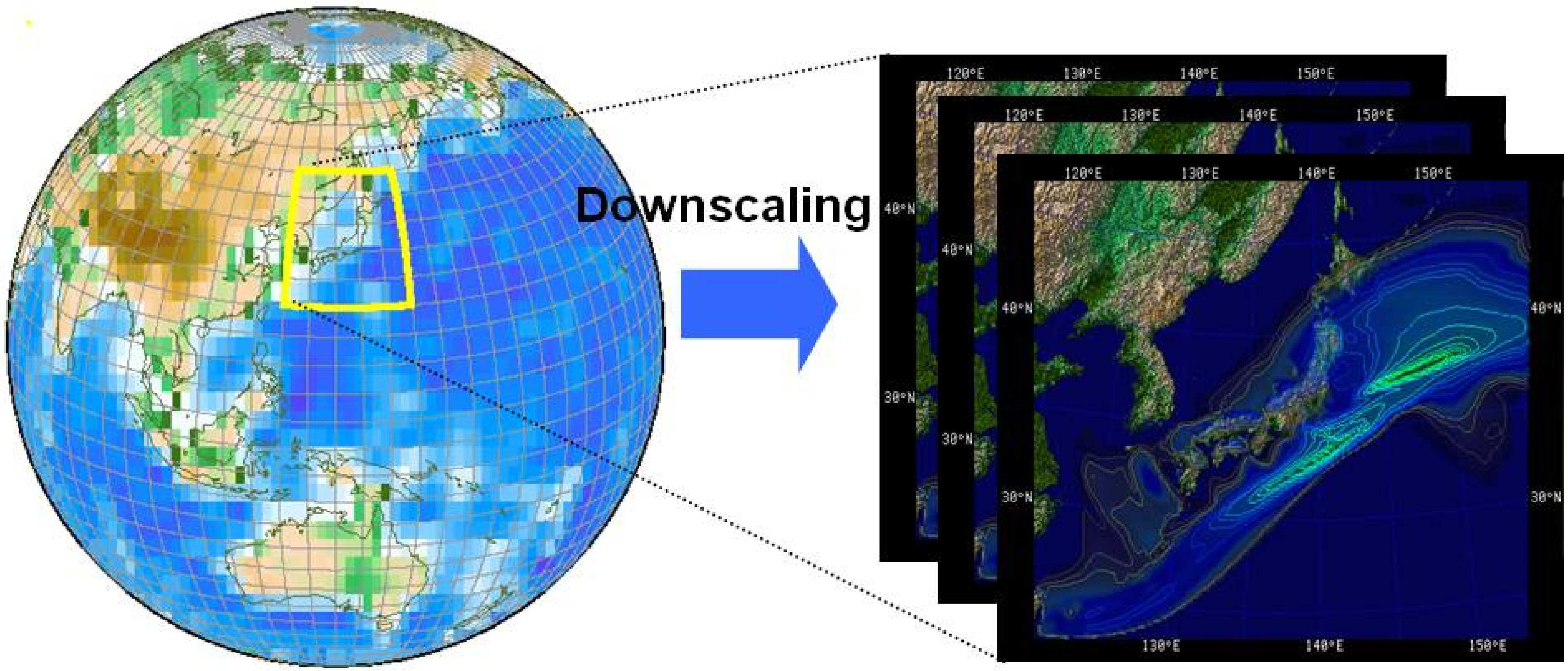
Especially in regions of complex topography, coastlines, and in regions with highly heterogeneous land surface covers where those results are highly sensitive to fine spatial scale climate processes.

◆ **Downscaling** can provide added value for variables and locations of interest. But those are different by region, and grid scale and physics parameterization interacting with each other.

Structural uncertainty : Different physics parameterization
Parametric uncertainty : Physics schemes have empirical parameters

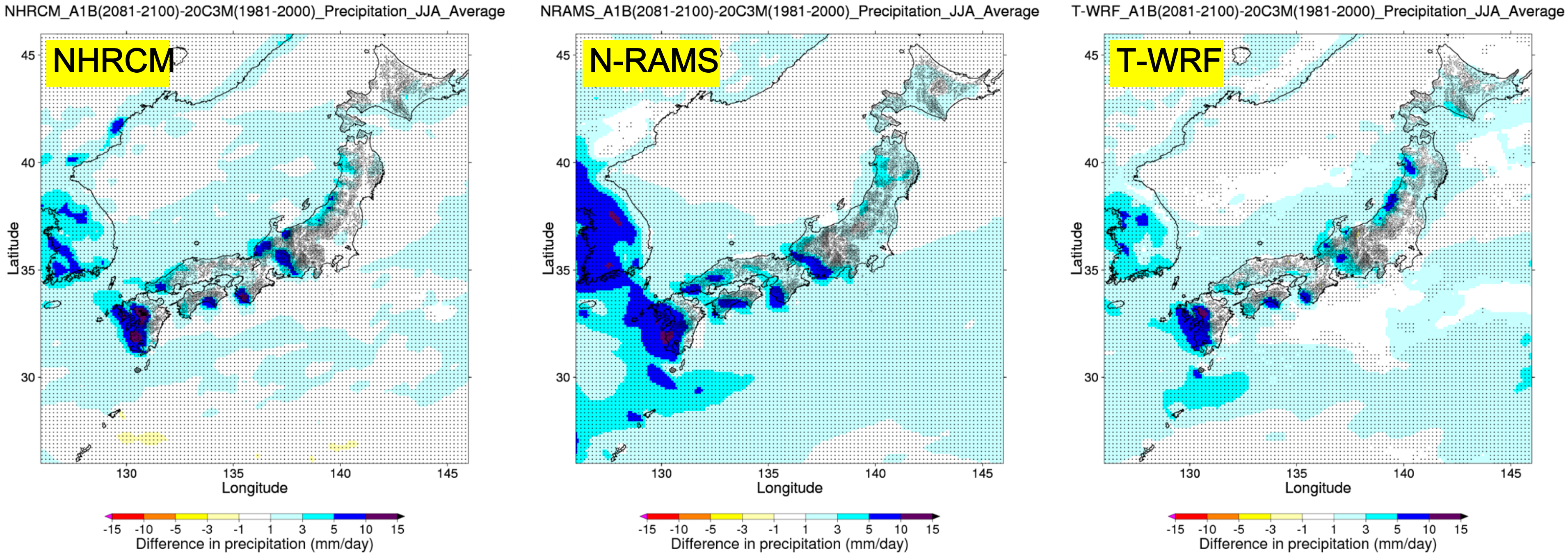
Multi-model ensemble experiment

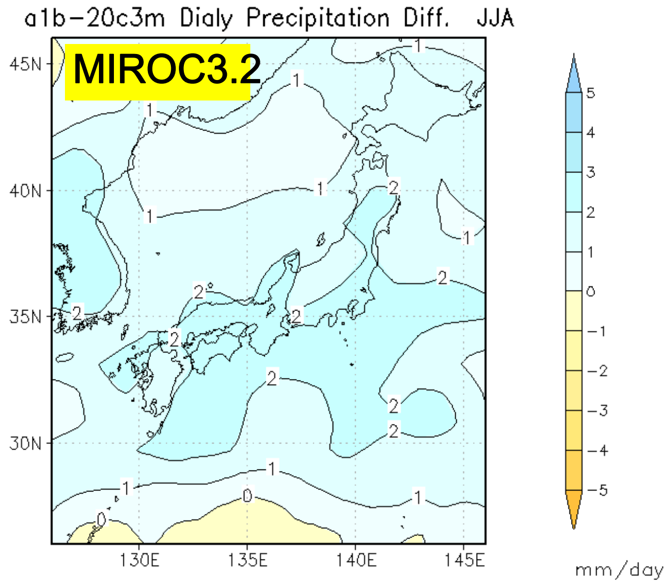
- Ensemble downscaling experiment by multi-regional climate models to investigate the range of structural uncertainty



Future scenario of regional precip.

a) NHRCM JJA b) NRAMS JJA c) T-WRF JJA





➢Future changes in JJA mean daily Precip.:

・ Precip. increases are noticeable in the west and south sides of the mountainous regions where precipitation amounts are large in the recent climate.

・ Relationship between precip. changes and topography is unclear in GCM simulations.
Downscaling added values

Tsunematsu, Dairaku, Hirano, JGR, 2013

Method for flood risk assessment (risk curve)

✓On the basis of past flood data from 1976 to 2008, we created flood risk curves for each prefecture

Frequency-Damage method (F-D method)

We estimated annual flood damage at each prefecture based on product between number of damaged housing units and average damage per housing unit per year

Annual damage $L = (F \times N) \times (D \times E)$ (1)

L; Annual damage

F; Ratio of damaged housing units per year (Number of damaged housing unit/Total number of housing unit)

D; Ratio of average damage per year (Average damage per damaged housing unit /Average property per housing unit)

E; Average property per housing unit during the study period (1976-2008)

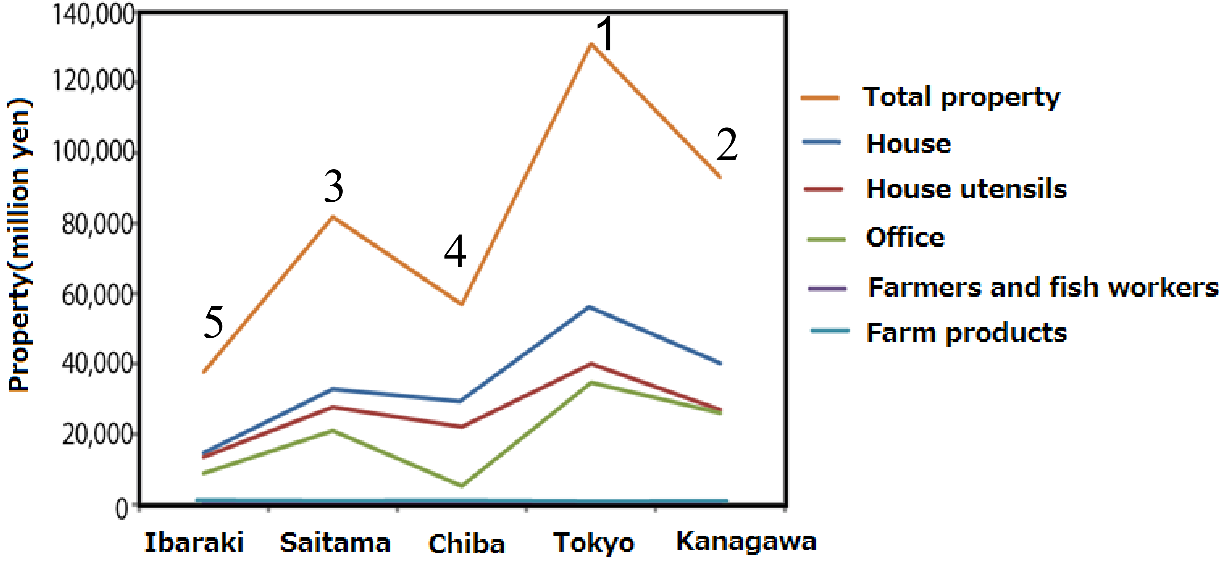
N; Average number of housing unit during the study period (1976-2008)

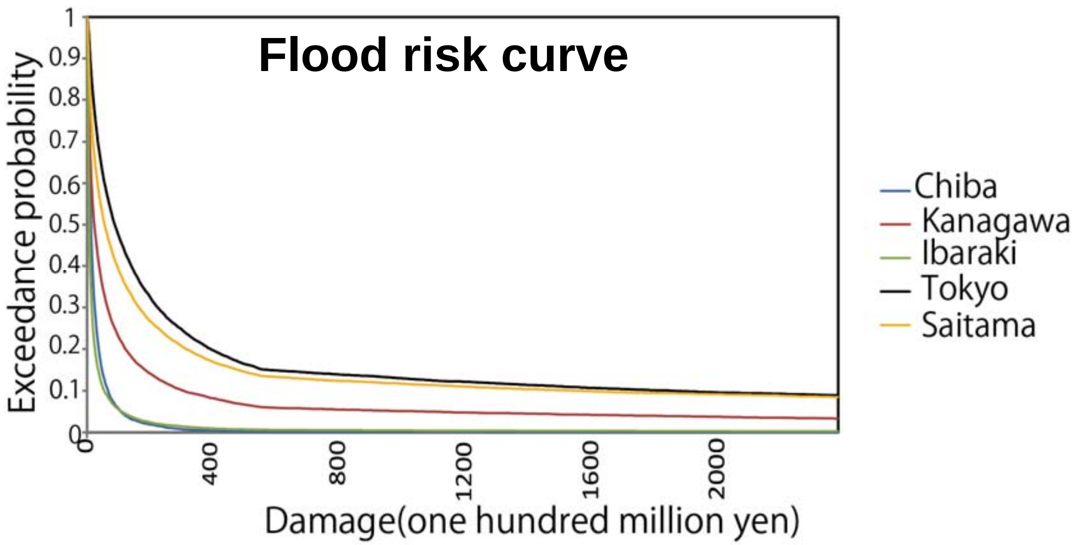
・ To evaluate statistically, we generated random numbers of F and D for 10,000 years, using Monte-Carlo Simulation.

Dairaku and Hirano, AJHE, 2013
Hirano and Dairaku, Impacts World 2013

General property and Flood risk curves for each prefecture

General property





✓Total property is high in Tokyo and Kanagawa, low in Ibaraki and Chiba.

✓Higher(lower) flood risk seems to relate with higher(lower)property. However, it is not always the case.
 Total property of Saitama is lower than that in Tokyo, while the flood risk is comparable.

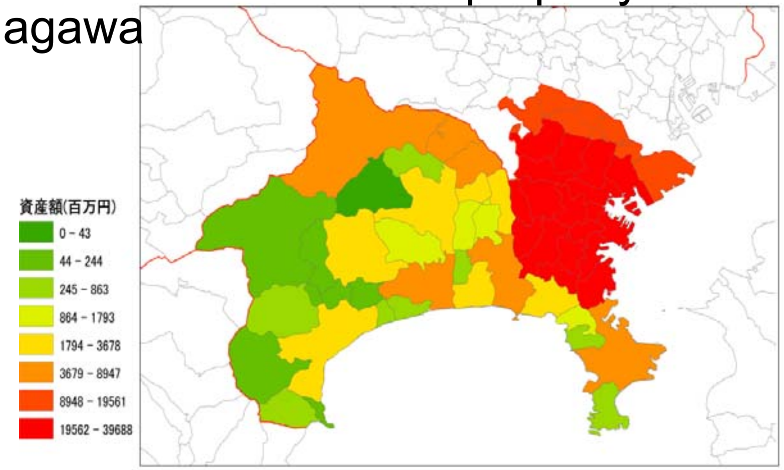
→ To explain possible causes of these, it is effective to investigate detail spatial distribution of property and flood risk.

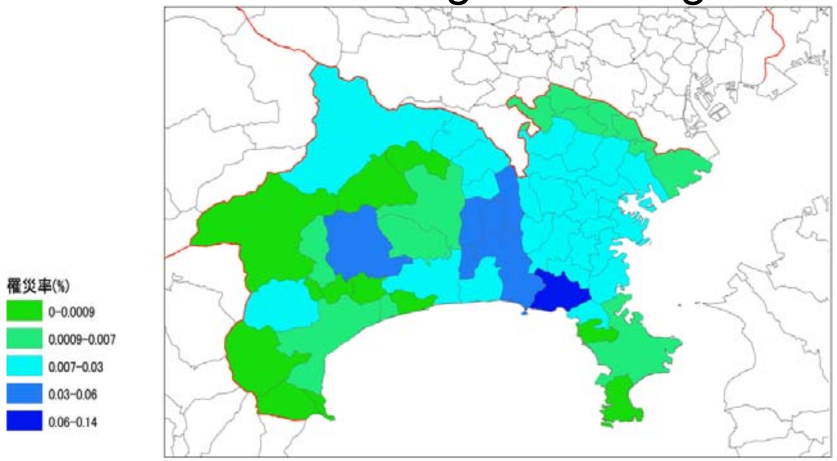
Dairaku and Hirano, AJHE, 2013
Hirano and Dairaku, Impacts World 2013

Spatial distribution of general property and ratio of damaged housing units

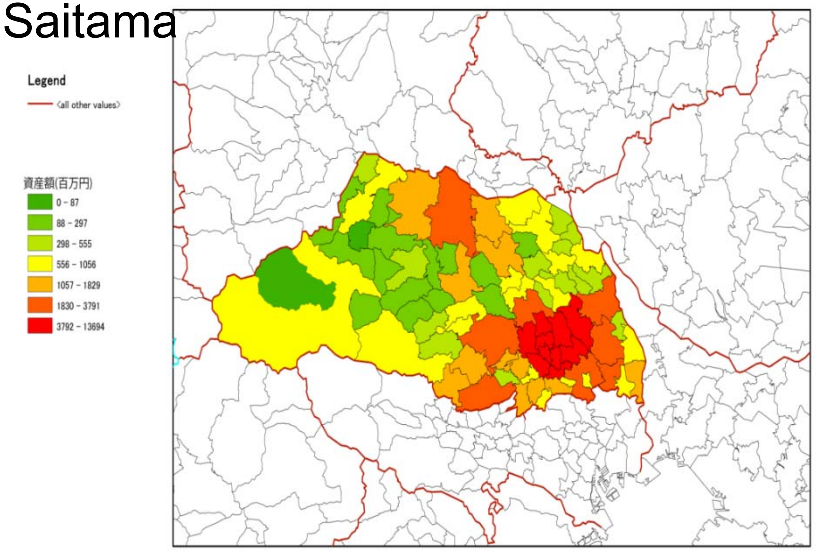
General property | Ratio of damaged housing units

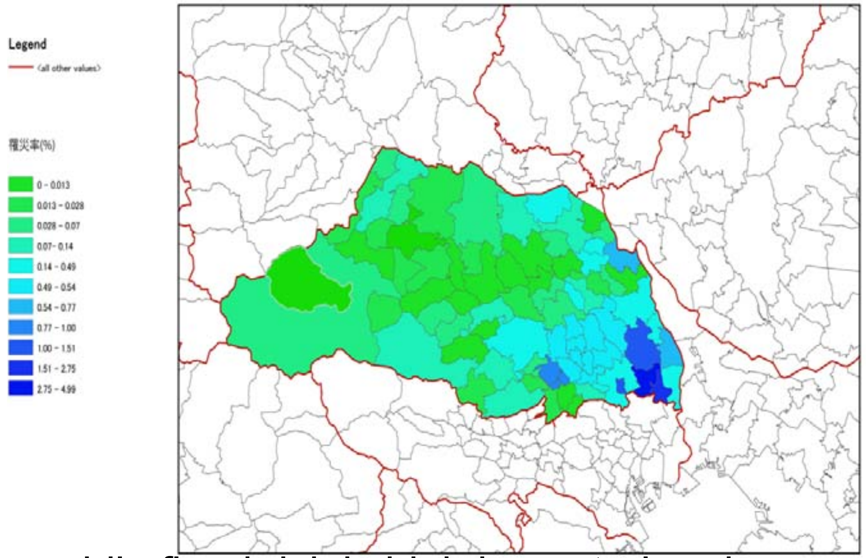
Kanagawa





Saitama



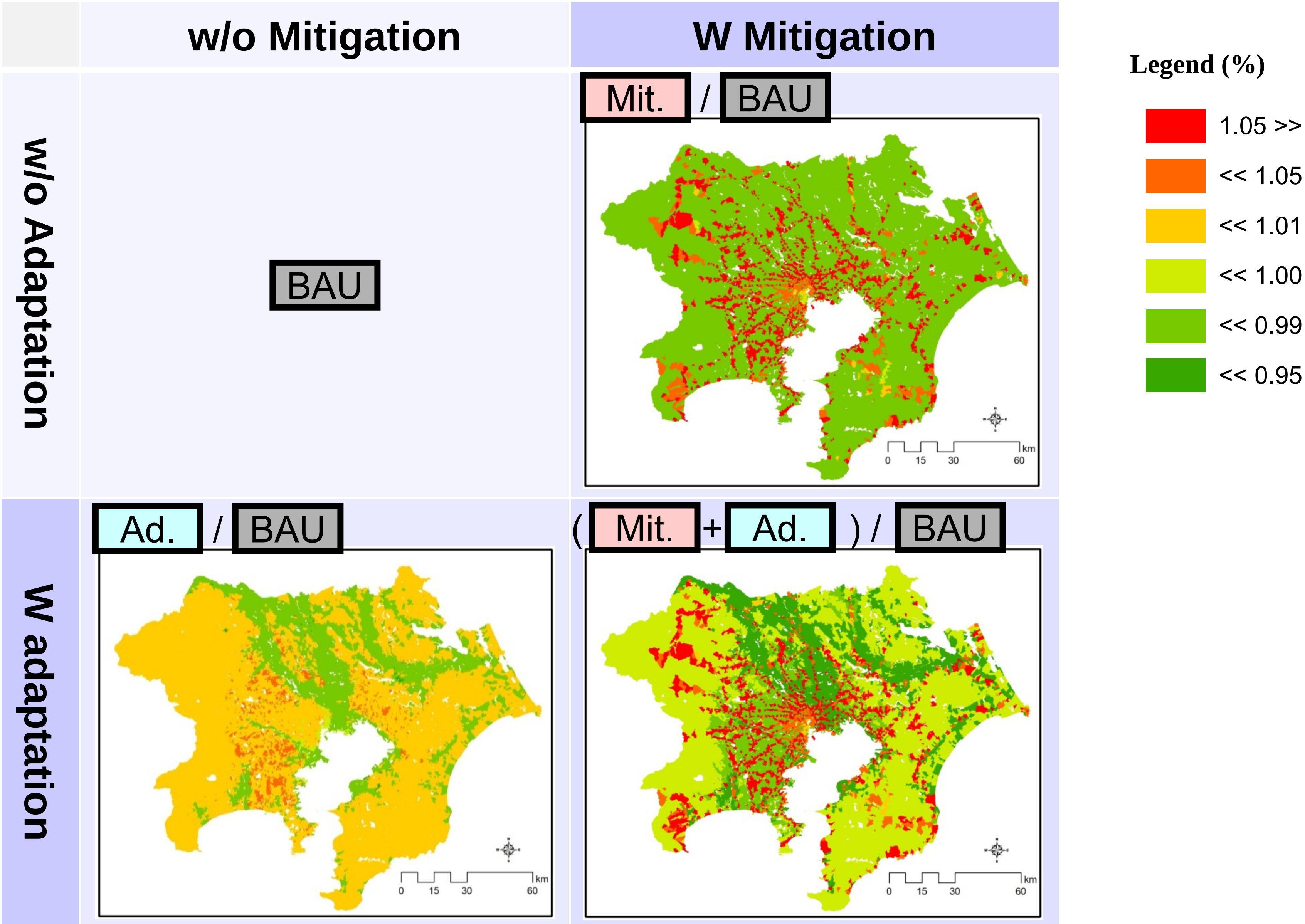


✓Kanagawa: Property is high in northeastern area, while flood risk is high in central and southern area (Inconsistent).

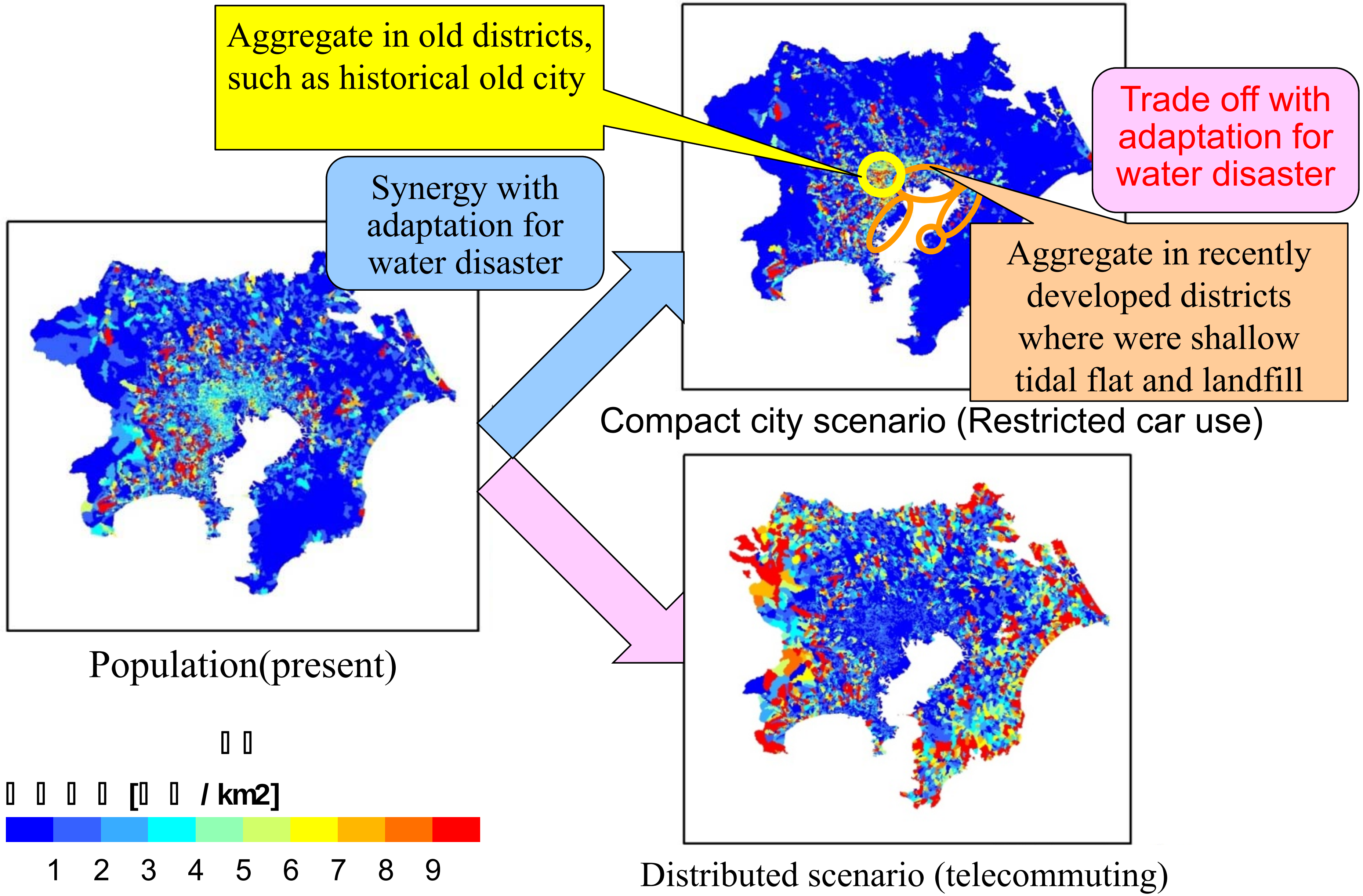
✓Saitama: Both property and flood risk are high in southeastern area (Consistent).

Dairaku and Hirano, AJHE, 2013
Hirano and Dairaku, Impacts World 2013

Change of population density



Land use scenarios calculated by NIES model (Provisional)



Summary for adaptation to climate change

- ◆Climate scenarios by global climate models has inadequate mismatch of spatial scale.
- ◆Downscaling can add values.
- ◆ Assessment of water disaster potential using regional climate scenarios
- ◆Develop statistical water hazard/risk assessment method and adaptation simulation technologies for climate change adaptation in the field of land use

Contribute to adaptation strategies related to disaster prevention and environmental protection at local level.
Provide scientific knowledge/tool for sustainable development and resilient society by adapting to climate change

Methodological Gaps for adaptation to climate change

- Downscaling can add values to fill inadequate spatial scale gaps. "Garbage in, garbage out"

- Probabilistic quantification of structural and parametric uncertainties is necessary for impact/adaptation/vulnerability (IAV) assessment.

- Regional socio-economic scenarios that is consistent with the global scenarios.

- Interactions between multi-sectors (synergy/trade off)

- Impact assessment of high-impact low probability events (Domino/Cascading risk: e.g., supply-chain)