2nd Seminar of the UsinoVerT Chair

"Planning Green Infrastructures for Industrial Cities"

ESALQ-Piracicaba, Brazil & UniLaSalle-Rouen, France

November 27 - 28, 2025

Differential Needs and Strategies for Green Infrastructure in Urban and Rural Japan

Sadahisa Kato, MLA, Ph.D.
Tottori University of Environmental Studies, Japan

Outline

- Background and study objectives
- Key discriminators
- Green space conditions
- Key issues and strength of urban and rural areas
- Urban strategies
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- Conclusion

Background and Study Objectives

Green infrastructure (GI) provides multiple functions:
flood control, heat mitigation, species habitat, health benefits,
and cultural amenities.

However, the form, functions, and management demands of GI
differ fundamentally between cities and the countryside.

Study objectives

Develop a comparative framework

1. Characterize constraints and opportunities for GI in urban vs. rural Japan
2. Identify which types of GI should be developed, conserved, or restored in each context to maximize ecological, social, and economic benefits

Green Infrastructure (GI) Examples

Urban	Rural
• Hybrid green-grey systems (parks, green roofs, rain gardens, green parking lots) • Grey infrastructure with ecological functions (porous pavements, rainwater storage tanks)	• Secondary and planted forests that require sustainable management • Agricultural and rice fields functioning as GI for water regulation and habitat

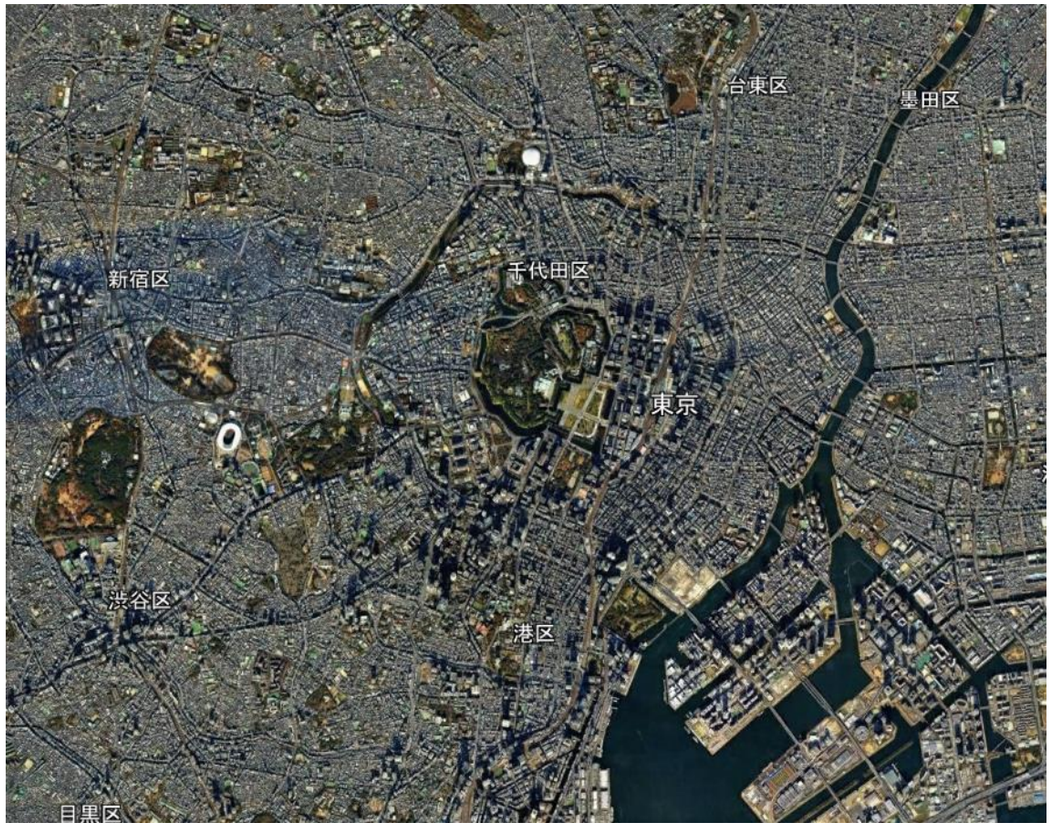
Key Discriminators

Definition/Discriminating Criteria

	Population density	Impervious surface cover	Artificial structures
Urban	High	High	Many
Rural	Low	Low	Few

Examples

Urban



Central Tokyo (high density, highly impervious, complex infrastructure)

vs.

Rural

Satoyama landscape in Yazu, Tottori (mosaic of forests, farmlands, paddy fields, and settlements)

Green Space Conditions

	Urban	Rural
Quantity	Small	Large
Quality	Medium–High	Low–Medium

Discussion Factors

	Constraints	Opportunities
Urban	• Limited space for new GI development • GI quantity: small green space per person • Pollution (air, water, noise)	• GI quality tends to be high • Greater human and financial resources • Stronger institutional capacity (funding, skilled staff)
Rural	• Labor shortages due to aging and out-migration • Weak local government finances • Abandoned farmland and poorly maintained forests	• GI quantity: large total area of green space • Extensive tracts of land available for GI-based strategies

Tailored GI Strategies (Overview)

Urban priorities	Rural priorities
• Design multifunctional, compact GI • Promote hybrid green-grey systems • Retrofit grey infrastructure with ecological functions	• Ecosystem-based adaptation to climate change • Ecosystem-based disaster risk reduction (Eco-DRR) • Biodiversity conservation • Ecotourism

Tailored Strategies for Urban Areas

Tailored strategies

Make efficient use of limited urban space and time by designing **multifunctional landscapes** (Kato and Ahern 2009)

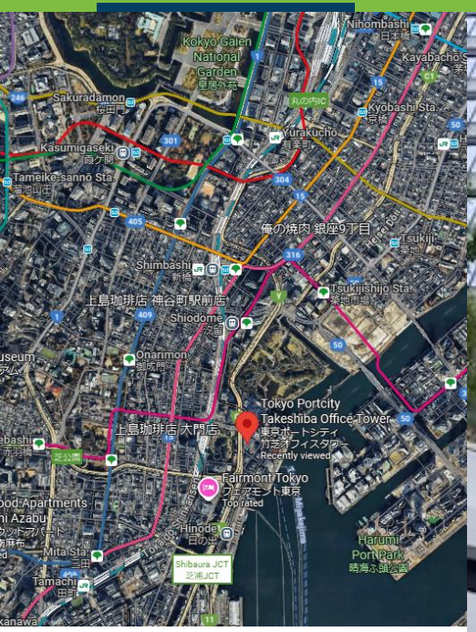
Develop **hybrid green-grey systems**: green roofs, rain gardens, porous pavements, and stormwater tanks

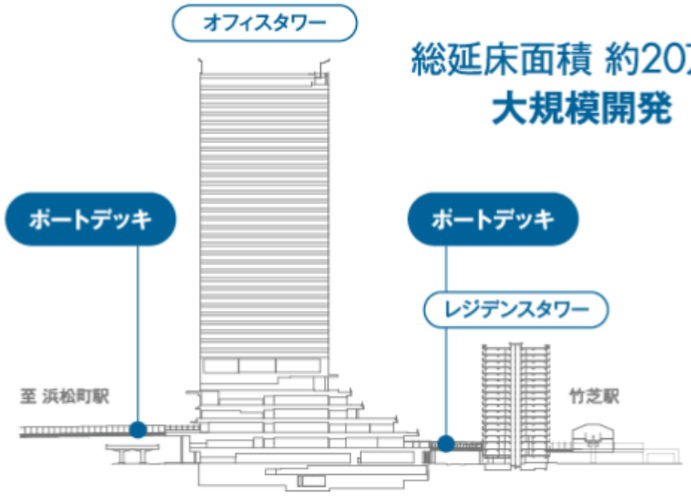
Prioritize high-impact, multifunctional **GI retrofits** in streets, station areas, and private developments; integrate green corridors to enhance connectivity

Conserve remnant natural patches and historic green spaces, and apply design guidelines that minimize ecological disruption during redevelopment

Kato and Ahern (2009) Multifunctional landscapes as a basis for sustainable landscape development.

Tokyo Portcity Takeshiba – project overview





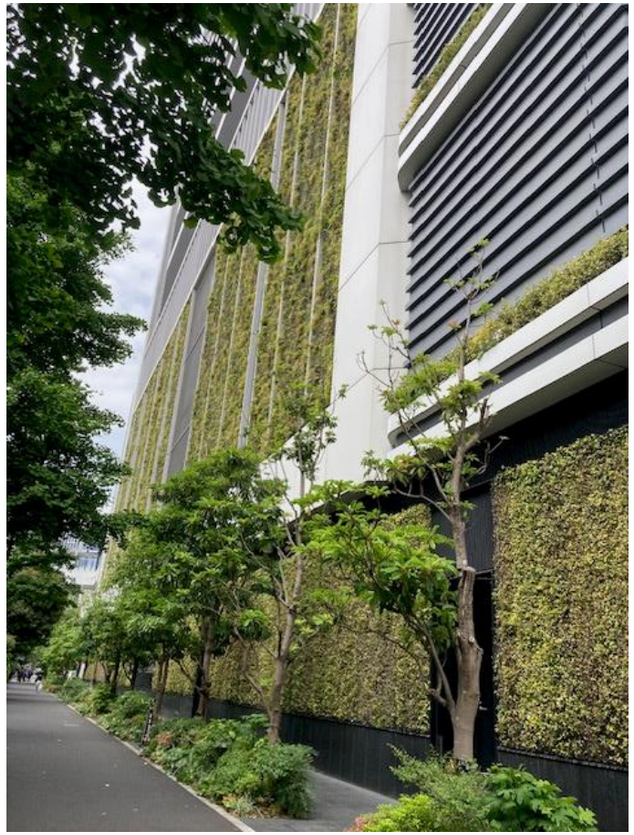
Located in an affluent business district near palace gardens and the bay

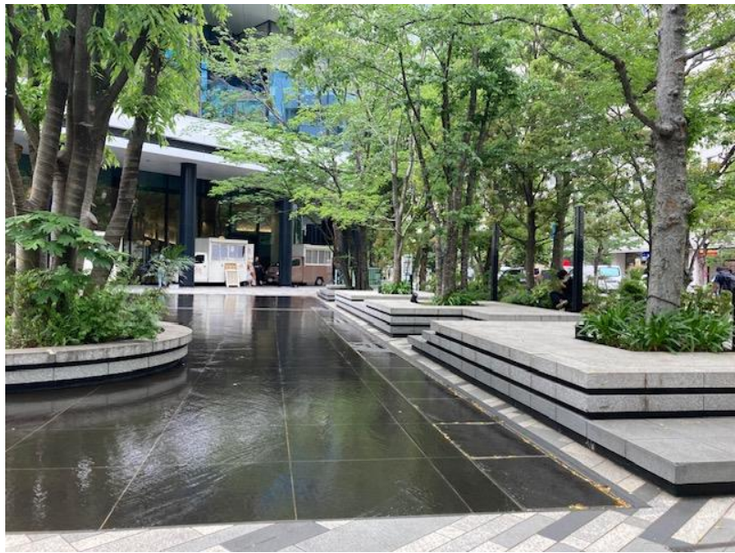
Mixed-use office bldg. w some shops (café, restaurants, bank ATM, etc.) at street level

Deck access to the residence tower, and street and deck access to two stations

Tokyo Portcity Takeshiba (street level)

Street-level GI



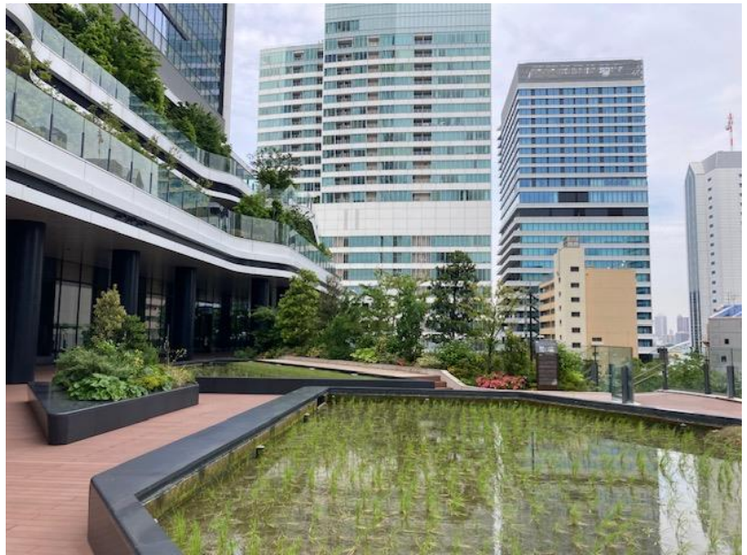


- Street trees combined with seating areas
- Large green wall along the building façade
- Rain garden for stormwater infiltration and retention
- Public plaza with trees, benches, and a shallow water film

Tokyo Portcity Takeshiba (terrace level)

UniLaSalle
Institut Polytechnique

Terrace-level GI



- Green spaces to relax and socialize
- Rice paddy field
- Bee hives for urban apiculture
- Beds of herbs and organic vegetables

Used for environmental and food education events

Chaire UsinoVerT usines & territoires

Tokyo Portcity Takeshiba – GI performance

Stormwater management

- Multi-level system (rain garden, permeable pavements, infiltration trenches/tanks, terrace greens) provides ~600 m³ of stormwater retention, detention, and infiltration
- Water recycling reduces total water use by about 4–5%
- Stepped terraces and the rain garden are used in environmental education programs

Heat mitigation

- Terraces provide ~1,700 m² of green space that offers shade and evapotranspiration; one terrace includes a water film
- A 1,200 m² green wall cools the façade: reflected solar radiation is reduced by ~30%, suppressing ground-surface temperature rise
- A 300 m² green curtain (climbing vines on wires) adds seasonal shading

Tokyo Portcity Takeshiba – GI performance

Biodiversity and well-being

- GI elements help form an ecological corridor connecting neighboring palace gardens
- Plantings emphasize local species attractive to birds and butterflies
- The overall design aims to increase productivity and reduce stress for office workers

Tailored Strategies for Rural Areas

Ecosystem-based adaptation

Ecosystem-based disaster risk reduction

Sustainable tourism and rural revitalization

Biodiversity conservation

Example: upland forest management (Kato and Huang 2021)

- Manage secondary and plantation forests to
- Reduce landslide and mudslide risk
- Conserve soil
- Enhance water retention and groundwater recharge
- Maintain cultural landscapes and heritage values

Tailored Strategies for Rural Areas

Restoration

- Reclaim fallow farmland and underused planted forests through mixed-species plantings

- Support community-based stewardship to address labor shortages and improve GI **quality**

Disaster risk reduction

- Consider contracting (relocating) the high-risk town center to safer ground
- Use surrounding farmlands and forests as natural infrastructure for flood mitigation (Watanabe and Ishida 2022)

Tree Planting on the Former Ashio Copper Mine

Historic copper smelting caused severe smoke pollution, deforestation, and wildfires, leaving ~2,400 ha barren around the smelters.

1996: NPO was formed, launched a large-scale greening project through public–private partnership

In recent years, about 190,000 volunteers participate annually in tree-planting and environmental education activities.
Environmental education for children; Environmental learning center
By 2020, ~250,000 seedlings had been planted, restoring about half of the former wasteland.

Now fall colors are back with rich wildlife

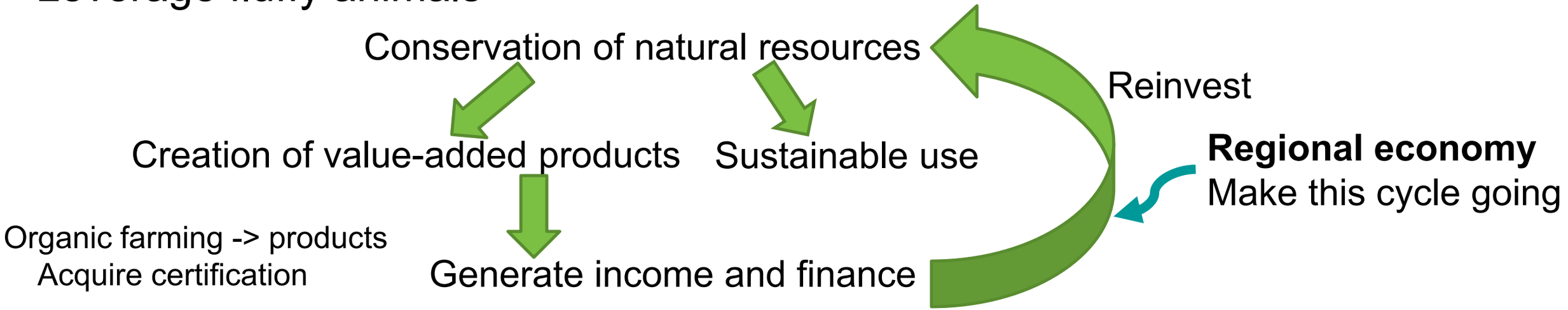
Tailored Strategies for Rural Areas

Examples

Habitat conservation X **Tourism**

Bird watching

Leverage fluffy animals



Leverage smart agriculture and **ecotourism**-oriented landscapes to diversify income, reinforce local engagement, and improve GI management

GI for Citizens and Tidal Flats / Terraced Fields

Climate change worsens natural disasters such as heavy rainfall, floods, landslides, and mudslides.

Traditional terraced rice fields act as GI by retaining sediments and reducing downstream flood damage. However, many terraces have been abandoned because of aging farmers and labor shortages.

2021 new project by sake brewers, young farmers, and the local government to conserve and restore terraced rice fields and the agricultural landscape

A new sake product uses rice from these fields; part of the revenue supports conservation of local nature, culture, and livelihoods.

The local government developed evaluation criteria for their activities and local commercial activities; 80 companies

Conclusion

GI needs, and therefore appropriate GI types, differ substantially between urban and rural areas.

In many respects, urban GI needs and solutions are the inverse of rural needs and solutions. Therefore, tailored strategies are essential.

By matching GI typologies to the specific environmental, social, and institutional contexts of urban and rural Japan, this framework informs planners and policymakers who are seeking tailored, resilient GI solutions.

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