Rural – Urban Systems and Industrial Ecology: Case Studies in Japan and Asia

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Outline

1. Rural – Urban Systems through Biomass Utilization in Asia
   (1) Urban-Rural Linkages through Biomass Utilization in Asia
   (2) Key Issues on Rural-Urban Systems in Asia

2. Changes in Biomass Material Flow
   (1) Biomass material flow in Vietnam’s Mekong Delta
   (2) Biofuel production in Malaysia
   (3) Biomass material flow in Japan

3. Agricultural landscape and ecosystem services in Japan
   (1) Satoyama (Japanese traditional agricultural landscape) and its ecosystem services in Japan
   (2) Changes in Satoyama and ecosystem services

4. Sustainability of Resort Industry in Japan
   (1) Resort development in the Tokyo Metropolitan Area
   (2) Redundant golf courses
   (3) Restructuring the redundant golf courses and its environmental and social impacts
While the world-wide demand for biomass such as biofuel made of corn, sugarcane and oil palm is growing, it is predicted that unused agricultural residues and abandoned arable land may increase in developing countries due to changes in diet and rural farming systems.

Biomass use matters relationship between rural and urban areas not only through material and energy exchanges, but also through history, culture, tradition and social context of each region or country.
Urban-Rural Linkages through Biomass Utilization:

Four Layers of Urban-Rural Linkage

- Energy & Resources
  - Energy Consumption
  - Diet change
  - Organic Waste
  - Fertilizer & Chemicals
  - Machines & Equipments
  - Drinking Water

- Economy & Industry
  - Secondary & Tertiary Industry
  - Oil Price Fluctuation
  - Trade Markets
  - Labor migration, informal population
  - Urbanization Sprawl
  - Globalization
  - Modern lifestyle

- Socio-Culture
  - Conservation groups
  - Pollutants/Health
  - GHGs emissions
  - Heat Island

- Ecosystem & Environment
  - Biomass Utilization
    - Home Land Planning & Biomass Policy
    - River Basin
    - Product Certification
  - Biomass Industry
    - Surplus Labor
    - Poverty
    - Tradition & Heritage
    - Regionalization/Localization
    - Aging
    - Health & Gender
    - Rural Landscape
  - Catchment Area
    - Soil degradation
    - Deforestation
    - Abandoned land
  - Biodiversity
  - Species Pool
  - Regulating Service
  - CO2 sink
  - Wildlife Habitat
  - Deforestation

Rural Areas
- Food
- Agricultural Residues
- Tree Plantation
- Fuel wood
- Forest & Timber Residues
- Energy Crop Plantation
- Agricultural Water
- Primary Industry
- Uncertainty & Seasonality
- Modernization
- Surplus Labor
- Poverty
- Tradition & Heritage
- Regionalization/Localization
- Aging
- Health & Gender
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In terms of Land Use:

**Urban Areas**
- Industrial Area
- Urban Center
- Suburb
- Transportation
- Residential

**Rural Areas**
- Power Plant
- Plantation
- Forest
- Resort
- Agricultural Land
- Channel/River/Pond/Lake
- Pasture
- School/Hospital
Four Layers of Urban-Rural Linkage

Energy & Resources

1) Food and Bioenergy
2) Waste and Bioenergy
3) Water
4) Motorization

Economy & Industry

5) Economic Growth and Industrial Structure
6) Globalization and Regionalization
7) Technology Development and Diffusion

Socio-Culture

8) Individualism and Social Integration
9) Urbanization and Symbolic Rurality
10) Rural Abandonment

Ecosystem & Environment

11) Cohesion and Fragmentation
12) Environmental Sustainability
13) Regulation and Certification
Key Issues regarding Rural-Urban Systems:

Common issues ➔ Energy and resources management, globalization and economic growth (Economy & Industry)

Key issues for Japan

- Rural abandonment, symbolic rurality, fragmentation, redundancy of rural infrastructures, accumulated large forest biomass stock and high dependency on timber and food imports

Key issues for China

- Increase in biomass waste (agricultural residues and MSW), water shortage, motorization, industrial structure and lifestyle changes, rapid urbanization and labor migration from poor rural areas

Key issues for Vietnam

- Similar to China, but almost a decade behind China. Food, waste, motorization (especially motorcycles), industrial structure, urban sprawl and basic infrastructure construction and technology diffusion
2. Changes in Biomass Material Flow

(1) Biomass material flow in Vietnam’s Mekong Delta
(2) Biofuel production in Malaysia
(3) Biomass material flow in Japan
(1) Material flow of biomass in Vietnam’s Mekong Delta
Major biomass sources in Vietnam

BIOMASS

Wood Residues
- Natural Forest
- Planted Forest
- Scattered Trees
- Wood processing by-product
- Other Wooden Wastes

Livestock
- Household Livestock
- Livestock Farm

Crop residues
- Agricultural Wastes
- Agro-industries

Municipal wastes
- Residential, commercial, market wastes
- Sludge of municipal sewer system

3 main biomass sources in Mekong Delta
Biomass energy potential in Mekong Delta

- 91% energy potential comes from agricultural residues
- 8% from firewood and forest residues
- 1% from human and animal wastes
Biomass potential and consumption projection

Rice husk and rice straw are not fully utilized

- low density characteristic
- Scattered sources

➡ Difficult to collect, handle and store
➡ High transportation cost

Insufficient handling and utilization ➡ negative impacts on the environment

Depending on the extent of urbanization, biomass-based energy supply will decrease by 3.1 – 22.2% in 2030
(2) Biofuel production in Malaysia

- Palm oil is the most produced vegetable oil in the world in terms of production – 37 million tones (Oil World, 2006)
- Malaysia and Indonesia account for 86% of global palm oil production

![Graph showing Palm Oil Production in Malaysia](image)
Roundtable on Sustainable Palm Oil (RSPO)

RSPO’s Principles and Criteria (P&C):

1. Commitment to transparency
2. Compliance with application laws and regulations
3. Commitment to long-term economic and financial viability
4. Use of appropriate best practices by growers and millers
5. Environmental responsibility and conservation of natural resources and biodiversity
6. Responsible consideration for employees and for individuals and communities affected by growers and mills
7. Responsible development of new plantings
8. Commitment to continuous improvement in key areas of activity

- RSOP certified palm oil entered market in September 2008 and close to 1.5 million tones are expected to be in the market by end 2008. The volume will reach 2 million tones by the end of 2009, which accounts for 5% of the world palm oil production.

- RSPO membership: 264 Ordinary and 92 Affiliate members (as of May 2009), accounting for 40% of palm oil production in the world.
## Volumes of RSPO certified palm oil to April 2009

<table>
<thead>
<tr>
<th>Company</th>
<th>Country</th>
<th>Mills</th>
<th>CPO (mt)</th>
<th>PK (mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Plantations Berhad</td>
<td>Malaysia</td>
<td>6</td>
<td>185,324</td>
<td>50,195</td>
</tr>
<tr>
<td>New Britain Palm Oil (NBPOL)</td>
<td>PNG</td>
<td>4</td>
<td>257,338</td>
<td>62,181</td>
</tr>
<tr>
<td>Sime Darby</td>
<td>Malaysia</td>
<td>5</td>
<td>218,636</td>
<td>52,823</td>
</tr>
<tr>
<td>Kulim Bhd</td>
<td>Malaysia</td>
<td>3</td>
<td>88,914</td>
<td>24,943</td>
</tr>
<tr>
<td>Wilmar/PPB Oil Palms</td>
<td>Malaysia</td>
<td>3</td>
<td>122,900</td>
<td>27,400</td>
</tr>
<tr>
<td>PT Musim Mas</td>
<td>Indonesia</td>
<td>2</td>
<td>135,000</td>
<td>31,250</td>
</tr>
<tr>
<td>IOI Corp</td>
<td>Malaysia</td>
<td>1</td>
<td>70,000</td>
<td>16,500</td>
</tr>
<tr>
<td>SIPEF/ Hargy Oil Palms Ltd</td>
<td>PNG</td>
<td>2</td>
<td>180,122</td>
<td>41,000</td>
</tr>
<tr>
<td>Cargill/PT Hindolie</td>
<td>Indonesia</td>
<td>2</td>
<td>51,344</td>
<td>12,122</td>
</tr>
<tr>
<td>Kuala Lumpur Kepong-KDC</td>
<td>Malaysia</td>
<td>2</td>
<td>92,000</td>
<td>22,000</td>
</tr>
<tr>
<td>PT London Sumatra</td>
<td>Indonesia</td>
<td>4</td>
<td>169,480</td>
<td>PKO</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>34</td>
<td>1,571,056</td>
<td>340,414</td>
</tr>
</tbody>
</table>
(3) Material flow of biomass and its changes in Japan

The material flow accounts for FY2002

Ministry of the Environment: Fundamental Plan for Establishing A Sound Material-Cycle Society,
### Major biomass waste emission and utilization in Japan (2005)

<table>
<thead>
<tr>
<th>Waste Type</th>
<th>Amount</th>
<th>Utilization</th>
</tr>
</thead>
</table>
| Livestock waste                   | 89 mill. t| 90% used for compost
                               |          | 10% Unused                                                                    |
| Food waste                        | 22 mill. t| 20% used for feedstuff
                               |          | 80% Unused                                                                    |
| Timber mill residues              | 5 mill. t | 90% used for energy and compost
                               |          | 10% Unused                                                                    |
| Construction wood waste           | 4.6 mill. t| 60% used for pulp and animal spreading material
                               |          | 40% Unused                                                                    |
| Sewage sludge                     | 75 mill. t| 64% used for construction material and compost
                               |          | 36% Unused                                                                    |
| Forest residues                   | 3.7 mill. t| Almost 100% Unused                                                         |
| Agricultural residues             | 13 mill. t| Used for feedstuff and compost 30%
                               |          | 70% Unused                                                                    |
Forest covers in Tokyo Metropolitan Area

Forest Cover: 44%

Coniferous woodland  Broad-leaved woodland
## Tokyo Metropolitan Area and “Big Island”

<table>
<thead>
<tr>
<th></th>
<th>Area (km²)</th>
<th>Population (1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tokyo MA</td>
<td>32,424</td>
<td>41,500</td>
</tr>
<tr>
<td>Hawaii Island</td>
<td>10,432</td>
<td>201</td>
</tr>
</tbody>
</table>
Material flow changes in secondary woodland

**Year of 1950**

**Stock**
- Available logs and timbers in Tokyo MA: 5,090,000m³
- Charcoal, firewood etc: 6,580,000m³

**Utilization**
- Total utilized volume: 11,670,000m³
  - Bundle of twigs: 1,980,000m³ (17%)
  - Firewood: 3,400,000m³ (29%)
  - Charcoal: 6,210,000m³ (53%)
  - Shiitake mushroom: 20,000m³ (0.2%)

**Year of 2000**

**Stock**
- Available logs and timbers in Tokyo MA: 3,000,000m³
- Logs for Shiitake mushroom: 15,000m³
- Import of Shiitake mushroom: 450,000m³

**Utilization**
- Total utilized volume: 630,000m³
  - Charcoal: 30,000m³ (5%)
  - Shiitake mushroom: 590,000m³ (95%)
    (From Tokyo MA: 150,000m³)

**Decrease by 95%**
- Dry mushroom: 39t
- Dry shiitake: 1,442t
- Fresh shiitake: 18,407t
- Imports as food (from China)
Shiitake Mushroom Production in Tokyo MA (2001)

Fresh Shiitake Mushroom

Dry Shiitake Mushroom
Long-term changes in logs volume for firewood, charcoal and shiitake mushroom in Japan

Source: Japanese Agency of Forestry
3. Agricultural landscape and ecosystem services in Japan

(1) Satoyama (Japanese traditional agricultural landscape) and its ecosystem services in Japan
(2) Changes in Satoyama and ecosystem services
What are *Satoyama*?

*Satoyama* ≈ Japanese term for traditional rural landscapes

- Comprises human settlements and several types of ecosystems
  - secondary forests, agricultural lands, irrigation ponds, grasslands, etc.
- Formed/developed through *prolonged interaction between* humans and ecosystems.
- Connotes a traditional way of life
  - Interaction is central to the management of the ecosystems
- More than 40 per cent of Japan’s total landmass
  - many found in rural districts
- Conceptual issues
  - Various terminologies, different definitions, no appropriate English translation
What are Satoyama and Satoumi?

Satoyama Landscape

Source: Ministry of Environment, Japan
Coppice Woods

# Ecosystem Services from *Satoyama*

<table>
<thead>
<tr>
<th>Provisioning Services</th>
<th>Regulating Services</th>
<th>Supporting Services</th>
<th>Cultural Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Rice</td>
<td>- Climate control (in Japan)</td>
<td>- Nutrient cycling</td>
<td>- Eco-tourism</td>
</tr>
<tr>
<td>- <em>Sake</em></td>
<td>- Local air quality control</td>
<td>- Groundwater supporting</td>
<td>- Traditional knowledge</td>
</tr>
<tr>
<td>- Fish</td>
<td>- Flood control</td>
<td>- Carbon storage, etc.</td>
<td>- Symbols and heritage of Japanese culture</td>
</tr>
<tr>
<td>- Wild edible plants</td>
<td>- Erosion control</td>
<td></td>
<td>- Spiritual monuments and objects (e.g. temples, mountains)</td>
</tr>
<tr>
<td>- Charcoal</td>
<td>- Landslide control</td>
<td></td>
<td>- Folklore</td>
</tr>
<tr>
<td>- Bamboo shoots</td>
<td>- Water quality control</td>
<td></td>
<td>- Festivals (<em>Matsuri</em>)</td>
</tr>
<tr>
<td><em>(takenoko)</em></td>
<td>- Water filtration</td>
<td></td>
<td>- <em>Amasan</em> (traditional female divers), etc.</td>
</tr>
<tr>
<td>- Mushrooms (e.g. <em>Matsutake, Shitake</em>)</td>
<td>- Control of wild animals Population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Genetic resources</td>
<td>- Pest control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Medicinal plants</td>
<td>- Habitat for migrating birds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Berries</td>
<td>- Pollination control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Bush meat</td>
<td>- Buffering against acid rain and dust, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Timber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Water, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crises of Satoyama

Satoyama is declining and disappearing

Drivers of change (multiple causes):

- Abandonment
- Ageing
- Depopulation and Rural-Urban migration (out-migration of younger workforce)
- Declining economic value of agro-forestry products
- Global trade
- Shifting trends in energy consumption (since energy revolution of 1950s)
- Urbanization, construction and development
- Invasive Alien Species (e.g. Black bass).
- Change in sense of commons: Unclear property rights and stronger expression of rights and interest in what was considered as commons
Depopulation and Rural Abandonment in Japan

Fading Rural Settlements:
- 4,849 rural settlements (3.4% of total settlements) have less than 9 households, and 1,403 settlements among them are expected to lose the remaining households (fading away). ¹)
- Out of 62,271 rural settlements in the depopulated regions, 442 settlements (0.7%) will be abandoned within the next decade and 2,219 settlements (3.6%) will fade away in the long run.²)

¹) Ministry of Agriculture, Forestry and Fisheries, 2006)
²) Ministry of Land, Infrastructure, Transportation and Tourism, 2007)
Consequences of Change

Function, use and value will diminish with the decline and disappearance.

- Impact on national / local economy.
  - e.g., food: self-sufficiency rate of vegetables in Japan declined from 100% in 1965 to 82% in 2003, and that of mushrooms does from 115% to 77% in the same period (Japan MAFF, 2004).
- Loss of biodiversity.
- Erosion of cultural heritage: traditional knowledge, diet culture, festivals, etc.
- Disasters (attacks by bears, destruction to food crops by monkeys).
- Increasing the gap between rural and urban areas.

Gap between fine ecological studies and studies on ecosystem services
4. Sustainability of Resort Industry in Japan

(1) Resort development in the Tokyo Metropolitan Area
(2) Redundant golf courses
(3) Alternative Management Options for Restructuring Redundant Golf Courses
Development History of Golf Courses in Japan

- Number of golf courses
- Cumulative bankruptcies
- Cumulative number of players per year

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of golf courses</th>
<th>Cumulative bankruptcies</th>
<th>Cumulative number of players per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1960</td>
<td>100</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>1963</td>
<td>200</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>1966</td>
<td>300</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>1969</td>
<td>400</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>1972</td>
<td>500</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>1975</td>
<td>600</td>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>1978</td>
<td>700</td>
<td>35</td>
<td>140</td>
</tr>
<tr>
<td>1981</td>
<td>800</td>
<td>40</td>
<td>160</td>
</tr>
<tr>
<td>1984</td>
<td>900</td>
<td>45</td>
<td>180</td>
</tr>
<tr>
<td>1987</td>
<td>1,000</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>1990</td>
<td>1,100</td>
<td>55</td>
<td>220</td>
</tr>
<tr>
<td>1993</td>
<td>1,200</td>
<td>60</td>
<td>240</td>
</tr>
<tr>
<td>1996</td>
<td>1,300</td>
<td>65</td>
<td>260</td>
</tr>
<tr>
<td>1999</td>
<td>1,400</td>
<td>70</td>
<td>280</td>
</tr>
<tr>
<td>2002</td>
<td>1,500</td>
<td>75</td>
<td>300</td>
</tr>
<tr>
<td>2005</td>
<td>1,600</td>
<td>80</td>
<td>320</td>
</tr>
</tbody>
</table>

Cumulative players, Number of golf courses, Cumulative bankruptcies.
Distribution of the existing golf courses in Japan
Expansion of golf course construction in the Tokyo MA

2008:
Over 800 courses in Tokyo MA

- Highway
- Shinkansen
- Prefectures
- Golf courses
Golf Courses in Hawaii Island

1. Big Island Country Club
2. Discovery Harbor Golf & Country Club
3. Hamakua Country Club
4. Hilo Municipal
5. Hualalai Golf Club
6. Kona Country Club Ocean Course
7. Makalei Hawaii Country Club

[Mauna Kea Resort]
8. Mauna Kea Golf Course
9. Hapuna Golf Course
10. Mauna Lani Resort North Course
11. Naniloa Country Club
12. Sea Mountain Golf Course
13. Volcano Golf & Country Club

[Waikoloa Beach Resort]
14. Waikoloa Beach Course
15. Waikoloa King Course
16. Waikoloa Village Golf Course
17. Waimea Country Club

(Source) http://golflinkshawaii.com/golf/hawaii.html
(1) Redundant Golf Courses by 2035 in Japan

Figure 4 Estimation results of redundant golf courses in Japan

(a) When the golf participation rate gradually declines
(b) When the golf participation rate remains constant in the future
Spatial Distribution of Redundant Golf Courses

Out of over 800 courses in Tokyo Metropolis, 800 courses in Tokyo Metropolis.

Accessibility: 79

Total: 302

Density: 205
Environ-

Environment: 85

Integrated level 1: Overlapped parts (bold italic figures, 59 golf courses) → □
Integrated level 2: un-overlapped parts (243 courses) → +
The closed golf course in Gunma Pref. (2008/05/27)
The closed golf course in Gunma Pref. (2008/05/27)
The abandoned clubhouse

Landslide and erosion
(3) Alternative Management Options for Restructuring Redundant Golf Courses

a) Multi-purpose space (park)

b) Cemetery

c) Biofuel feedstock plantation and storage site for biomass feedstock

d) Reforestation

e) Pasturing

f) Abandonment
<table>
<thead>
<tr>
<th>Options</th>
<th>Environmental impacts</th>
<th>Social and economic impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Multi-purpose space</td>
<td>The space can be also utilized as a nature restoration site or even a disaster control site</td>
<td>Citizens can enjoy walking, sports and other recreational activities</td>
</tr>
<tr>
<td>b) Cemetery</td>
<td>Avoid or minimize additional forest destruction associated with cemetery development</td>
<td>Resolve a deficient cemetery supply in peri-urban areas</td>
</tr>
<tr>
<td>c) Biofuel feedstock</td>
<td>A net life cycle CO$_2$ sequestration of 3.3–4.4 ton ha$^{-1}$year$^{-1}$ of CO$_2$ (Tilman et al., 2006)</td>
<td>Promote rural industry and create employment opportunities</td>
</tr>
<tr>
<td>plantation and</td>
<td>The redundant courses can supply storage space not only for feedstock of perennials, but also for other cellulosic resources like forest thinning and agricultural residues</td>
<td></td>
</tr>
<tr>
<td>storage site for biomass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>feedstock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Reforestation</td>
<td>Improve biological diversity and enhance carbon sequestration and water-retaining functions as well as restore rural landscape</td>
<td>Fields for action-based environmental education</td>
</tr>
<tr>
<td>e) Pasture</td>
<td>Pasturing can deter degradation of the land and other negative impacts caused by abandonment with relatively low cost and labour</td>
<td>Livestock production would provide economic benefit</td>
</tr>
<tr>
<td>f) Abandonment</td>
<td>Recovering to forests in the long run. Soil erosion and illegal dumping of industrial waste should be monitored</td>
<td>Damages on agricultural production by wild boars Landslide disaster potential</td>
</tr>
</tbody>
</table>
GHG Emission Estimation of Six Options

CO₂ Sequestration (t-C/course/year) vs CO₂ Emission (t-C/course/year)

- Grassland
- Woodland
- Construction
- Operation & Maintenance

Options:
- Golf course
- a) Multi-purpose space (park)
- b) Cemetery
- c) Biofuel feedstock plantation and storage
- d) Reforestation
- e) Pasturing
- f) Abandonment

**Per one course (100ha)**
Cost Analysis of Six Options

- Construction cost (Initial cost)
- Per one course (100ha)
- Operation cost
Scenario Analysis

Redundant Golf Courses in Tokyo MA (152 courses)

Maintain as golf courses

Six options

A  B  C  D  E  F

Business as usual
Generating Energy
Amenity and Comfort
Nature Restoration

Environmental
Social
Economic

Social aspect
Economic aspect
Environmental aspect
Social aspect
Four scenarios

Environmental Mitigation by Technology

Business as usual

Generating Energy

Shrink and retreat

Vitalization of rural economy and community

Nature Restoration

Amenity & Comfort

Conservation of nature and ecosystem/Cultural heritage
Restructuring scenarios

Business as Usual
Generating Energy
Amenity & Comfort
Nature restration

Golf courses
(a) Multi-purpose space (park)
(b) Cemetery
(c) Biofuel
(d) Reforestation
(e) Pasturing
(f) Abandement

(The darker options are, the more applied to the scenario)
Result of the scenario analysis

![Graph showing the relationship between Net CO2 Sequestration and Annual Cost (108 YEN). The graph includes points for Business as Usual, Amenity & Comfort, Generating Energy, and Nature Restoration.]
Summary of redundant golf courses in Japan

- This study
  - reviewed developmental history of golf courses in Japan and estimated that 152 (23%) golf courses will be redundant by the year 2035 in Tokyo MA.
  - identified 302 golf courses that are or will be soon approaching redundancy through the spatial distribution analysis.
  - described six alternative management options for restructuring the existing golf courses as a sustainable infrastructure.
  - attempted environmental and economic assessment of six management options
Acknowledgement:

This study was carried out as part of the Tenure Track Program at Waseda Institute for Advanced Study, which is supported by the program entitled “Promotion of Environmental Improvement for Independence of Young Researchers” under the Special Coordination Funds for Promoting Science and Technology provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.
Relevant journal papers and presentations:


