Sustainable Science related to Global Climate Change Issues

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What is “Sustainability”? 

- So many definitions!
- Our definition
- Balance between sub-systems
Linkages among three systems

Global system
- Climate system
- Energy and Resources
- Ecosystem

Human system
- Security/Safety
- Lifestyle
- Health
- Norms and values

Social system
- Politics
- Economy
- Industry
- Technology

Resource-circulating society

Low-Carbon Society

Global warming

Complex Problem

Mass production, consumption, destruction

infectious diseases
natural disaster
Knowledge Innovation for Global Sustainability

To link various research networks: Network of Networks (NNs)

Low carbon society

Resource-circulating society

Nature-coexistent society

Cultural diversity

Poverty alleviation and human security

Integrated Knowledge

Education, Human Resources Development

Social change

Developed countries

G8 nations, WEF, ...

Global Sustainability

Society with diversity

Support

Policy recommendation
What is the present situation?

- Explosion of information and knowledge
- Difficult to find a “right solution”
- Integration of knowledge is critical
How to develop a new methodology

- Structuring Knowledge
- Text mining with ontology
- Mapping knowledge
- Networking knowledge
UT: Network Structure in R&D Projects

Aiming at examining how collaboration networks are formed among Japanese universities, public research institutes, and industries to create innovation.
Mapping Researches of Climate Change
IR3S Flagship Research Project

How much anthropogenic GHG emission? Emission sources?

What kind of policies are required?

How much GHG reduction & adaptation is possible by technology?

Risk can be avoided by adaptation?

Future climate? Sea-level rise?

How much Human and ecosystem put at risk by climate change?

Amount of anthropogenic GHG emission? Emission sources?

What kind of policies are required?

How much GHG reduction & adaptation is possible by technology?

Risk can be avoided by adaptation?

Future climate? Sea-level rise?

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UT Integrated Research System for Sustainability Science (IR3S)

Research Network Alliance for Sustainability Science
Establishing Strategy for Global Sustainability in the 21st Century through collaboration amongst international research networks

**UT IR3S**
- Management HQ
- Network of networks for Sustainability Science Promotion Office
- Flagship projects Todai, Kyoto, Osaka, Hokkaido, Ibaraki universities
- Long-term scenario for sustainable society Todai, NIES

**Research networks for Sustainability Science**
- Tyndall Centre
  - Lead: East Anglia University
- CIRPS
  - Lead: Rome University
- SRC
  - Lead: Stockholm University
- GLP
  - Lead: Copenhagen University
- AAAS
  - Lead: Harvard University

**Collaboration in Asia**
- United Nations University
- Universities/institutes in China
- Universities/institutes in India
- Universities/institutes in Southeast Asia

**Contributions to**
- G8, CBD, FCCC, etc.
Interdisciplinary Initiative for Global Sustainability (TIGS)

- Energy
- Urban-rural environment
- Environmental Risk
- Technologies
- Food and water

Integration of Research Output
Structuring Knowledge

Collaboration
- Industrial, government, and international organization
- Domestic research groups
- Overseas research institutes
- Alliance for Global Sustainability (AGS)
- UT’s branches in other countries

Organization
- Sustainability Education Programs
- Proposal
- Vision proposal

Knowledge of the University of Tokyo

Flagship Projects
Sustainable Energy Research

- Systemization Approach
- “Tripple 50”
  - Efficiency 50%
  - Non-fossil energy 50%
  - Self-Sufficiency 50%
- Bio-energy due to rice
  - “I-ne-I-ne” Project
- Small wind-power
Corn (USA)

Sugar Cane (Brazil)

Rice (Monsoon Asia)

Materials for Bio-diesel

Sustainable!
Energy Analysis

- **Output for Bio ethanol**
  - Corn (US)
  - Sugar cane (Brazil)
  - Rice (Asia)

- **Input of Oils**
  - Production
  - Cultivation

- **Energy Analysis**
  - Suger

- **Bars**
  - Production
  - Cultivation
Materials for bioethanol

- **What** – High-yielding rice cultivars as energy crops
- **Where** – Lowland paddy field abandoned to avoid overproduction
- **How** – Low-input sustainable production for whole crop utilization
INEI NE Nippon Project

Innovation in New Energy with INE in Nippon

Objective of the INEI NE Nippon Project is to construct sustainable Japanese society through production and utilization of bioethanol from whole crop of rice plants.
Oil-Dependent Japan Tries Turning Rice Into Fuel

Some Farmers Plant High-Yield Variety For Ethanol Factory

BY YUKA HAYASHI

NIIGATA, Japan—For decades, Yasuji Tsukada has meticulously tended his terraced rice paddies to grow top-quality rice for Japan's demanding consumers.

Now the 66-year-old farmer faces a new challenge: Grow a new type of rice but spend as little money and labor as possible and ignore its taste and appearance.

Mr. Tsukada is among 360 farmers in this renowned rice-growing region in central Japan who are on the forefront of an effort to develop a new type of biofuel. A group of Japanese farmer cooperatives, with some government funding, started a project last year to turn rice into ethanol, a fuel that can be mixed with gasoline to power automobiles.

The cooperative's supporters, such as Mr. Tsukada, want to see the conversion of rice to biofuel, but he is eager to diversify its sources of energy.

While the country imports most of its raw materials and food, it is self-sufficient in rice production, and even has a surplus. A change in the Japanese diet has significantly reduced rice consumption over the past decades, but government subsidies and farmers' persistence have kept rice farming popular.

Wheat warehouse buildings are brimming with rice and the countryside dotted with rice paddies left fallow.

Japanese farmers and Morita, a professor of agriculture at the University of Tokyo, estimates Japan could make up to one million kiloliters (264 million gallons) of rice-based ethanol annually—equivalent to 1.7% of its gasoline consumption by planting rice fields. The initial production will be tiny, but the new ethanol plant in Niigata will make just 1,000 kiloliters of ethanol per year. The output will be mixed with gasoline and sold at local farmer cooperatives' pumps.

Backers of the experiment say large-scale Japanese rice—fuel production wouldn't push up prices, as has been seen elsewhere in the diversion of corn and sugarcane for ethanol production.

As global biofuel output increases—rising annually by the equivalent of roughly 300,000 barrels per day of oil—researchers are looking to develop biofuels that use nonfood crops, such as switchgrass and jatropha, to avoid further driving up food prices. But because Japanese rice is expensive—a result of high production costs and government price controls—little is exported, and the market is largely self-contained.

Prof. Morita says biofuel rice would contribute to the environment and food security in Japan by adding greenery to the rural landscape and helping paddies in good condition for possible future reclamation to food production.

But the same things that give the Japanese rice market—notably high costs and inefficiencies—could pose problems for large-scale rice ethanol production. Most farms are small, family-run operations with just a few hectares of land. (A hectare is 2.47 acres.) And many rice paddies are divided into small lots or laid out in terraces on the sides of mountains, making automation difficult.

Mr. Tsukada had already stopped growing rice for consumption on about three hectares of his 30-hectare farm to qualify for government subsidies. He tried to grow soybeans but the land is too wet and the quality and size of the crops have been less than satisfactory. So when the local farmers cooperative suggested planting rice for ethanol last year, Mr. Tsukada, who works his land with his wife and son, was happy to give it a try.

After a relatively successful fall harvest, Mr. Tsukada has allocated more land to the special rice. He planted the seedlings last month. "They've told us over and over again to switch to soybeans and start growing vegetables," says Mr. Tsukada. "But I'm a rice farmer and I'd rather stick with rice if I can."

Mr. Tsukada has started growing Hokusuri 133 rice, a high-yielding breed that was developed as animal feed. Its stalks grow tall and thick and its output could be as much as 70% higher than the average Japanese rice plant. The biofuel factory in Niigata will use the rice grains to produce alcohol and will polish its production machinery using rice hulks.

Mr. Tsukada sold his fuel crop at 20 yen per kilogram last year, compared with 230 yen for high-grade food rice. This pays just a small portion of his production cost. For now, temporary incentives and subsidies cover some of the balance, but he thinks he will still come out behind.

I'd be happy to keep growing biofuel rice," says Mr. Tsukada. "I only wish they will give us a better price."
Potential of bioethanol from rice

- **100 million kL** from whole crop of high-yielding rice plants grown in abandoned lowland paddy field
- **200 million kL** from rice straw and husk produced in conventional rice production
- Japanese small-scale model for area
- Evaluation from economical, environmental and social viewpoints
High Performance 1kW Small Horizontal-axis Wind Turbine: “Air Dolphin”

- Light and strong **full-carbon** blades to attain high response
- Multi-stagger design to achieve **high start-up** at low wind speed region

**swing rudder system for yaw control**
The tail wing is hinged free to swing flexible under random wind direction change.

An Innovation for Low Noise: "Silent Disrupter Blade“ inspired by the wings of ow

Robust Body with No Screw: inspired by traditional japanese crafts

( Pic by Zephyr Co. )
**Experimental studies**

**Truck Tests**
A data acquisition system on the vehicle collects all the operational data of the wind turbine.

**Round Robin Testing**
Demo. sites:
Spain, China, Bulgaria, Scotland, Italy, Japan

**Fig. Power Performance of Airdolphin by track test**

Feature compared to Large WT

- High performance under wide wind speed range (Fig.)
- A broad range of needs with wide application possibilities
  - Low/Middle wind velocity
  - Less constrain by landscape
  - Low noise
  - Stand-alone use in remote places
  - Simple construction

Fig. Power Generating Capability of the Airdolphin Mark-Zero
Summary

- A concept of “Sustainability” is presented.
- Structuring Knowledge is being promoted.
- Network of networks (Globarization with diversity)
- Sustainable Energy Strategy
  - Systemization
  - Bio-energy Compatibility with Climate
    - Emphasis on Monsoon Asia
  - Small and Distributed