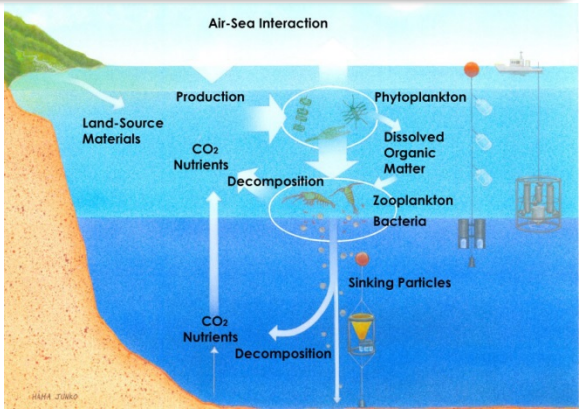
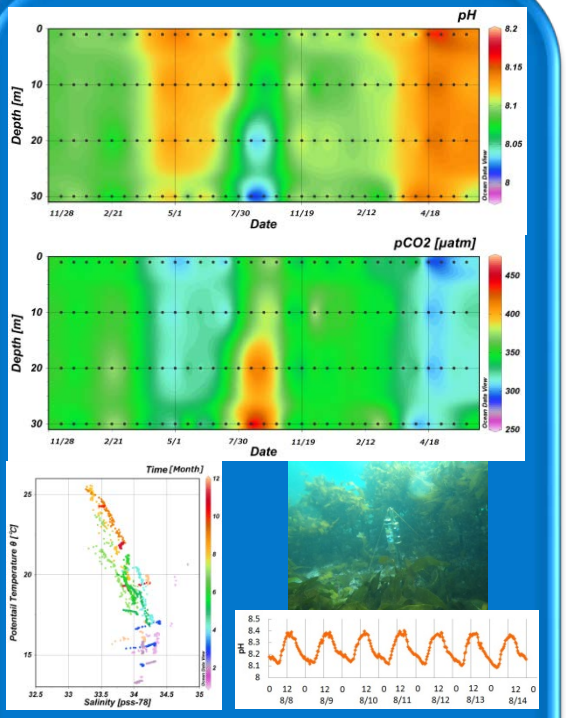
Microbial Processes and Carbon Cycle in the Ocean

Prof. Dr. Takeo Hama (thama@biol.tsukuba.ac.jp)

Biogeochemical cycle of bioelements in the ocean drived by microorganisms plays a crucial role in determining and maintaining the global environment. We are studying the relation between microbial processes and carbon cycle by flowing the organic matter flow in the ocean such as production, transformation, transport and decomposition.

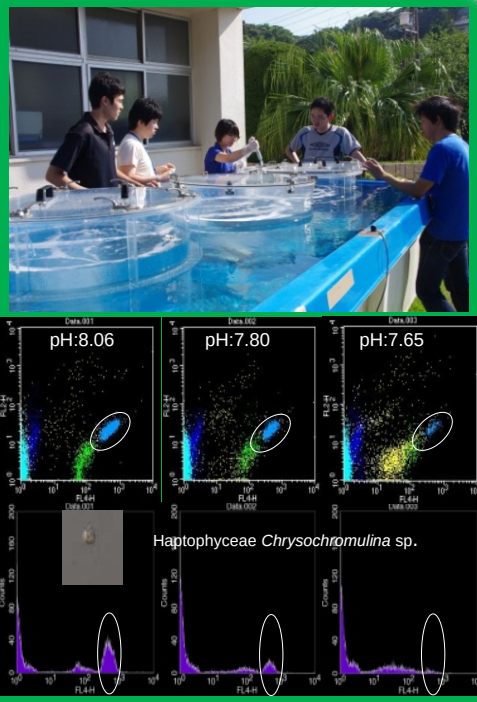


Ocean acidification in coastal waters



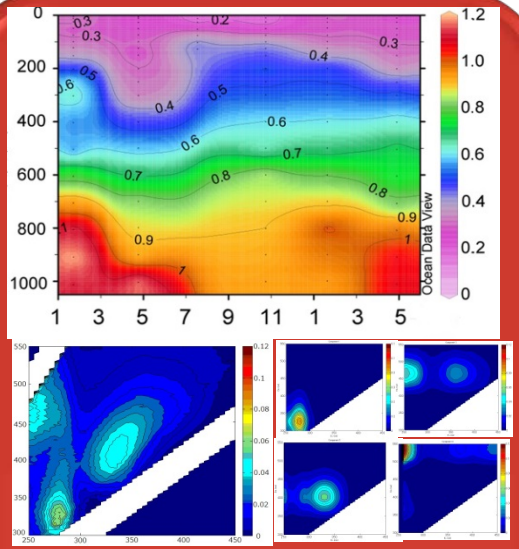
The carbonate system in the coastal waters varies with wide rage reflecting the biological activity

Microbial response to ocean acidification



Some phytoplankton groups are sensitive to ocean acidification and likely reduce their biomass under the future ocean

Bacterial production of refractory dissolved organic matter



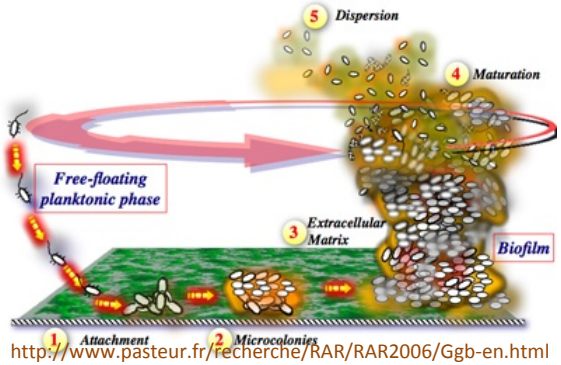
Bacteria are “producer” of refractory dissolved organic matter which accumulates huge amount of carbon into the ocean

Nomura Laboratory

Research

Biofilms

The aggregation of microbial in enviroment



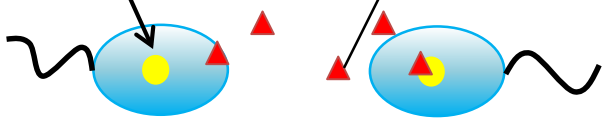
http://www.pasteur.fr/recherche/RAR/RAR2006/Ggb-en.html

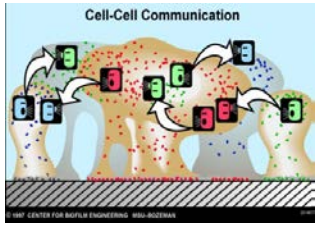
Yawata Y *et al*., 2008 . Appl Environ Microbiol
Tashiro Y *et al*., 2009. J Bacteriol
Tashiro Y *et al*., 2010. Appl Environ Microbiol
Inaba T *et al*., 2013 . Appl Environ Microbiol

Cell-cell communication

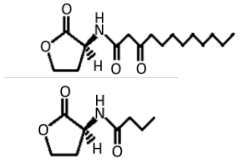
The conversation of microbial

Specific receptor Signaling molecule





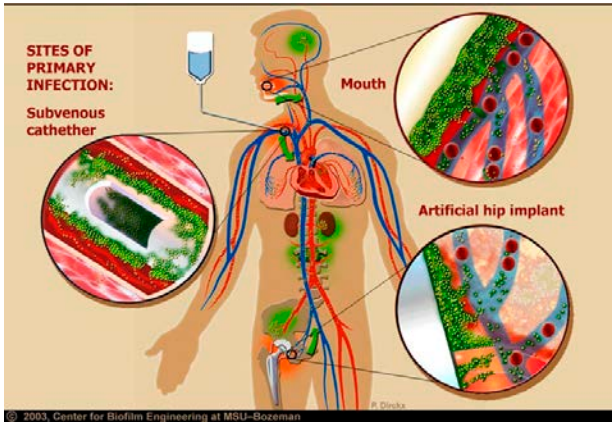
Example of signaling molecule



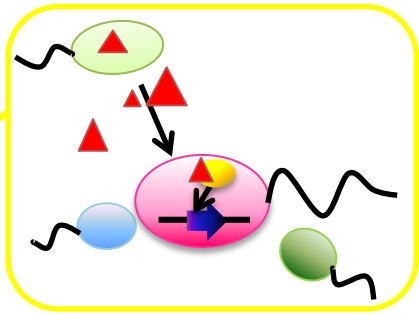
Toyofuku M *et al*., 2007. J Bacteriol
Toyofuku M *et al*., 2008. J Bacteriol
Tashiro Y *et al*., 2008. J Bacteriol
Toyofuku M *et al*., 2013. Environ Microbiol

Applications

Medical treatment of infection disease



Activate waste water treatment ability by species specific regulation



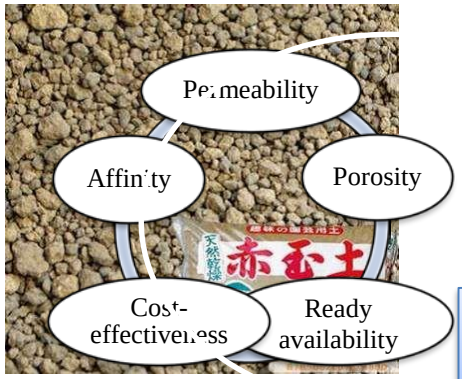
JST/ALCAproject: Development of Innovative Regulatory Techniques of Biofilms for production of clean energy

Bio-Resource Process Engineering Lab-
Wastewater Treatment and Biomass Conversion

Prof. Dr. Zhenya Zhang

Adsorbents Development
(Heavy metals, ammonium, phosphate, etc)

Ding *et al.*, Chem Eng J 236 (2014) 17-28.
Yang *et al.*, Chem Eng J 220 (2013) 367-374.
Zhao *et al.*, J Colloid Interf Sci 393 (2013) 264-270.
Ding *et al.*, Water Res 47 (2013) 2563-2571.
Ding *et al.*, ACS Appl Mater Interf 5 (2013) 10151-10158.
Chen *et al.*, J Hazard Mater 186 (2011) 863-868.



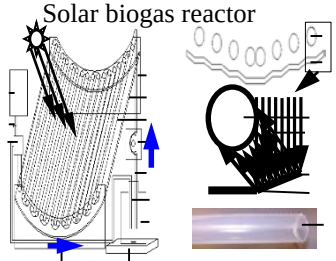
Electrochemical and Biological Nitrogen Removal

Lei *et al.*, Bioresour Technol 128 (2013) 774-778.
Zhao *et al.*, J Hazard Mater 192 (2011)1033-1039.
Li *et al.*, Bioresour Technol 101 (2010) 6553-6557.
Zhang *et al.*, J Hazard Mater 163 (2009) 1090-1095
Li *et al.*, J Hazard Mater 171 (2009) 724-730.

Heavy Metals Immobilization and Waste Reclamation
(Using hydrothermal treatment)

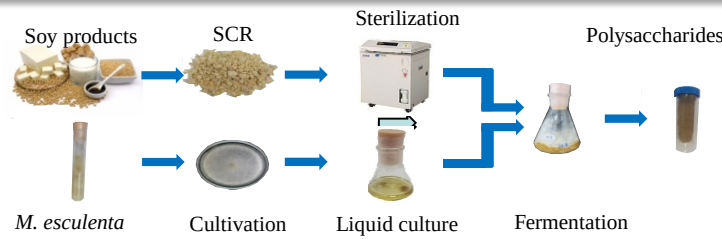
Shi *et al.*, Bioresour Technol 137 (2013) 18-24.
Shi *et al.*, Bioresour Technol 149 (2013) 496-502.

Biogas Production from Organic Solid Wastes
(Sewage sludge, animal manure, and crop residues)



Liu *et al.*,. Water Res 47 (2013)4986-4992.
Liu *et al.*, Int J Hydrogen Energ 38 (2013) 7246-7252
Liu *et al.*, Bioresour Technol 137 (2013) 57-62.
Lin *et al.*, Appl Microbiol Biotechnol 97 (2013) 10575-10583.
Wang *et al.*, Bioresour Technol 111 (2012) 70-75.

Functional Food Material Production and Conversion
(Using solid wastes from food processing industries)



Shi *et al.*, Carbohyd Polym 95 (2013) 200-206.
Li *et al.*, Ind Crop Prod 50 (2013) 666-672.
Shi *et al.*, Food Bioprocess Technol 6 (2013) 1856-1867.
Shi *et al.*, Int J Food Sci Technol 47 (2012) 1215-1221.

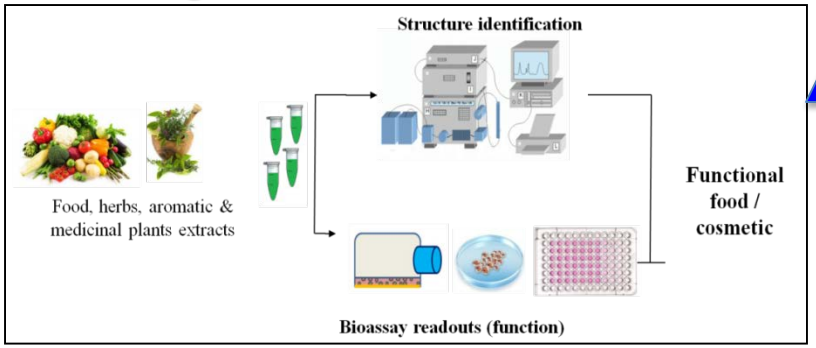
Project Info: Ammonia recovery from organic wastes and realization of dry anaerobic biogasification with mitigation of ammonia inhibition (JSPS Grants-in-Aid for Scientific Research (B) No. 25281048)

Food Functionality Lab.

Prof. Hiroko ISODA

isoda.hiroko.ga@u.tsukuba.ac.jp

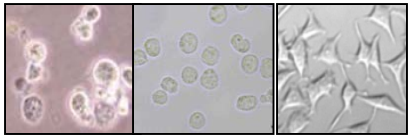
Screening of bio-resource health benefits



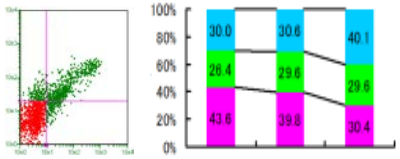
Our team developed through the last decade several functional bioassay based on mammalian cells readouts for the screening of health benefit of different bio-resource and identification of their main bio-active compounds.

We joined chemistry, cell culture , molecular biology, animal experiments, and "omics" including genomics, proteomics, and metabolomics techniques to provide the scientific evidence of the health benefits of functional foods and cosmetics

Cell differentiation induction research



[K562 cells] [HL60 cells] [PC12 cells]



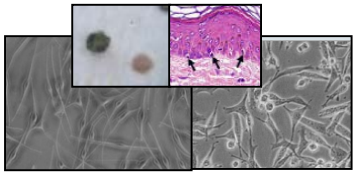
Screening of plant extracts, and their functional compounds on cell differentiation or stem cell-like behavior in:

- neuronal cells, leukemia cells, pigment cells

to elucidate the mechanism of nerve cells function and the anti-cancer effects of these plants or compounds.

▪ *Tsolmon et al. Mol. Nutr. Food Res,* 55, S93-S102,2011

Pigment cell research

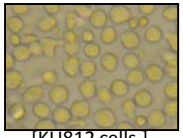


[Melanocytes] [Melanoma cells]

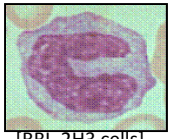
Excessive melanin can gives us freckles or may indicate skin cancer such as melanoma. We conduct research at the molecular biology level on the use of natural compounds that regulate melanin biosynthesis to maintain skin homeostasis.

▪ *Villareal et al., J Dermatol Sci 67, 26-36, 2012*

Anti-allergy research



[KU812 cells]

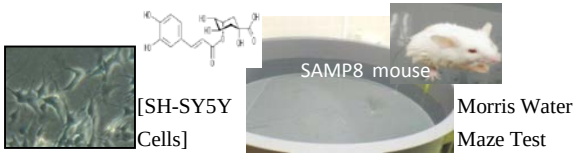


[RBL-2H3 cells]

In our laboratory, we evaluate the anti-allergic activity of natural compounds and extracts using rat and human basophilic cell lines (mast cells) as *in vitro* model to reproduce cell immune response to natural compounds.

▪ *Isoda et al., J. Agric. Food Chem., 60, 7851−7858, 2012*

Anti-aging research

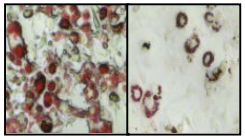


[SH-SY5Y Cells] Morris Water Maze Test

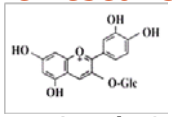
Over the last decades, ageing, energy imbalance and senescence are affecting more and more people worldwide.. In our laboratory, we are screening functional substances that have protective effects against oxidative stress and promote ATP production in neuronal cells. *In vivo* experiments are performed to validate the results in senescence-accelerated mouse

▪ *Sasaki et al., Behavioural Brain Res., 238:86-94, 2012*

Metabolic syndrome research



[3T3-L1 cells]



Cyanidin-3-glucoside

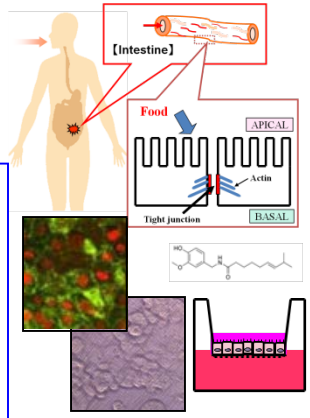
Metabolic syndrome has become one of the major public-health challenges worldwide.

Diabetes, hyperlipidemia, hypertension, obesity, and insulin resistance, are the main risk factors that increase cardiovascular and heart disease and other health problems.

In our laboratory, we are screening botanicals that may have positive effect against metabolic syndrome using 3T3-L1 cells and obese mice models.

▪ *Zar Kalai et al., ECAM Journal, 2013 in press.*

Intestinal barrier function and absorption research



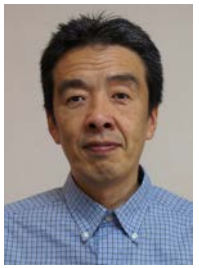
Caco-2 cell monolayer in transwell inserts

The tight junction of epithelial cells play an important role in intestinal barrier function and has a significant role in food absorption.

Research has shown that the tight-junction permeability is regulated by the absorption of various nutrients. We are conducting research determining the molecular structure of tight junctions and their interactions with the cell cytoskeleton in response to stimulus such as capsaicin, etc.

▪ *Han et al., Cytotechnology, 2013*

Onda Lab.



Interdisciplinary Study on Environmental Transfer of Radionuclides from the Fukushima Daiichi NPP Accident

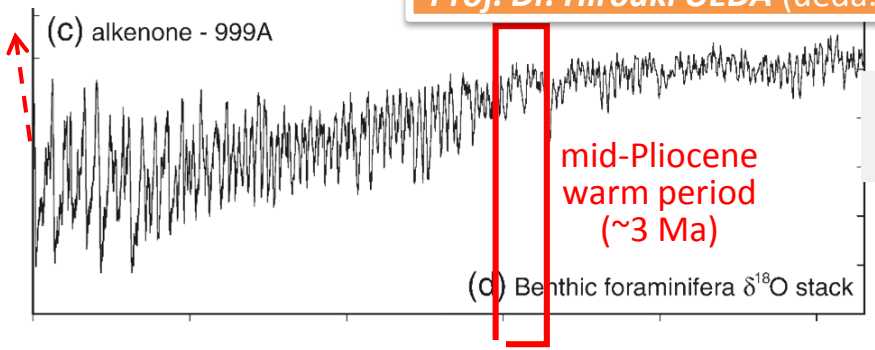
We launched a interdisciplinary team, which consists of related but different study fields with geoenvironmental researchers as a core, to understand current contamination status and to construct a model for transfer and diffusion processes of radionuclides. With this interdisciplinary study on environmental transfer of radionuclides from the Fukushima Daiichi NPP Accident, we aim at strengthening academic levels of geoenvironmental sciences of our country, which in turn will contribute to the post-accident decision making.

onda@geoenv.tsukuba.ac.jp

Paleoclimate Modeling

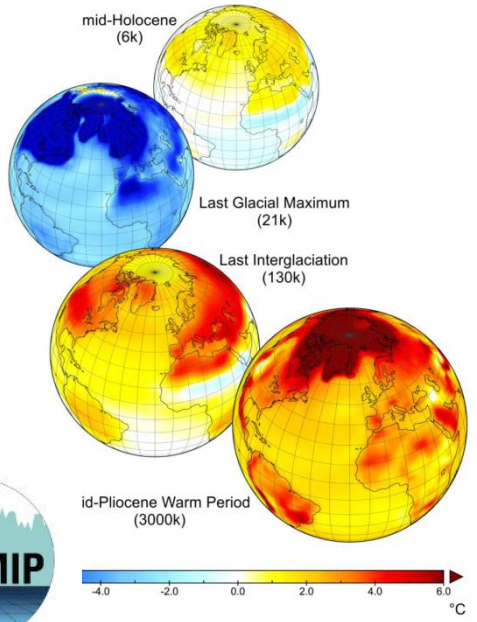
Prof. Dr. Hiroaki UEDA (ueda.hiroaki.gm@u.tsukuba.ac.jp)

Present-day global warming



✓ How can we constrain the Earth's climate sensitivity?

Information from the past climate changes



PRISM

PlioMIP

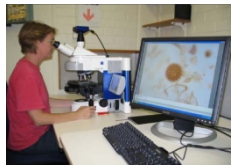
Proxies

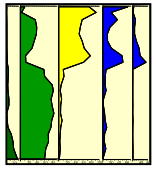
Pollen

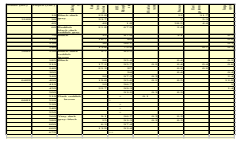
Fossil Leaves

Fossil Wood

Data

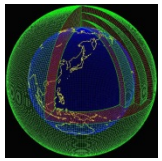




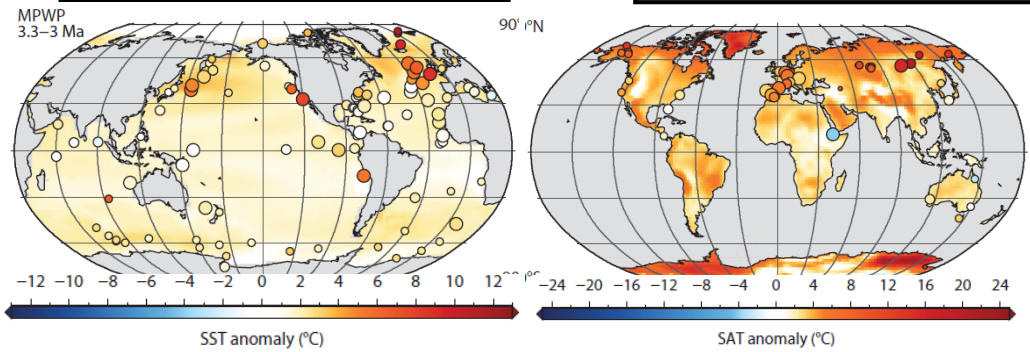


Models

✓The same models used in future climate projections



We can evaluate skills of climate models to simulate climate change forced by external forcings.



Earth's climate properties can be detected by comparing the observed climate change, archived paleoclimate data, paleoclimate-modeling and future climate projections.

ueda.hiroaki.gm@u.tsukuba.ac.jp

Salzmann, U. and coauthors (including Y. Kamae and **H. Ueda**), 2013: Challenges in quantifying Pliocene terrestrial warming revealed by data-model discord. *Nature Climate Change*, **3**, 969-974.

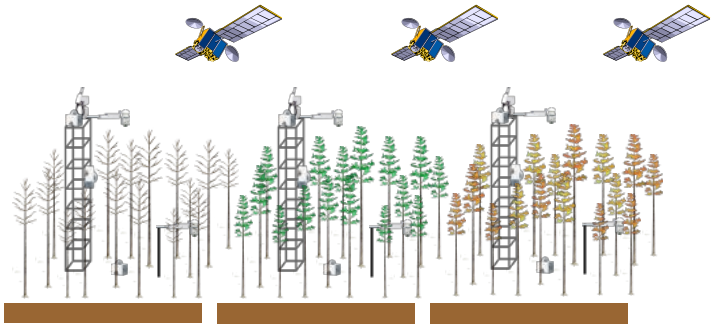
Kenlo Nishida Nasahara, Ph. D.

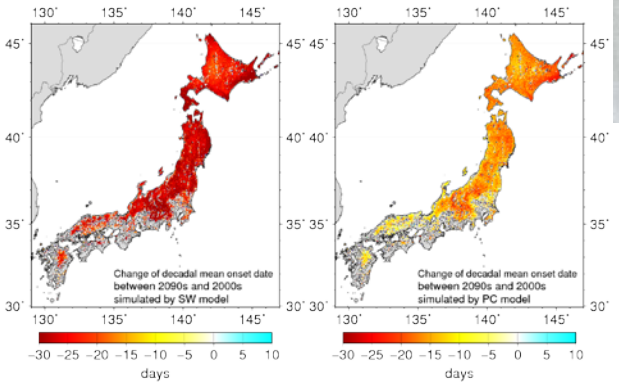
Associate Professor, Environmental Remote Sensing

PEN (Phenological Eyes Network) (Leader)

… Synthetic observation of ecosystem by both satellites & ground

… More than 30 sites (Japan, UK, USA, etc.)





Preiction of spring leaf flush in the future
in response to climate change

UK-Japan project (Leader)

… Collaboration between U Tsukuba & U Edinburgh (Prof. John Grace)

… Grant awarded by both governments,
celebrating 150 yrs of diplomatic relations.

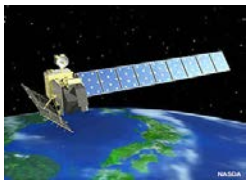
JAXA missions (Leader)

… Leader of “Ecology Research Group” of Japan Aerospace Exploration Agency (JAXA)

… PI of new Eaeth-observation satellites in JAXA: GCOM-C & ALOS-2

筑波大学 University of Tsukuba

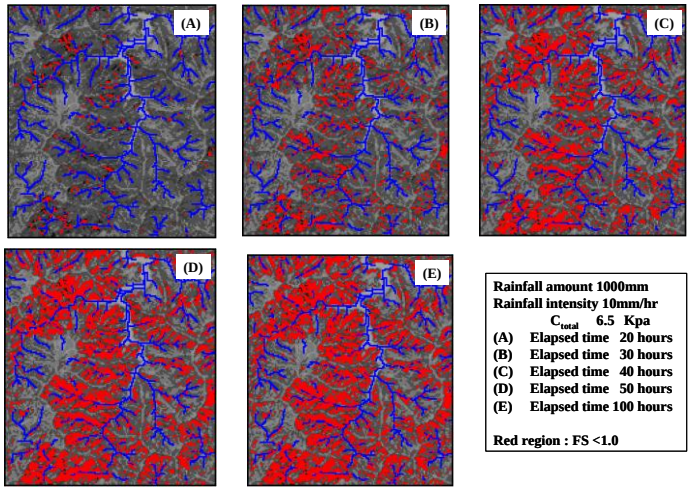
JAXA 宇宙航空研究開発機構 Japan Aerospace Exploration Agency



Water and sediment dynamics in mountain watersheds

Norifumi HOTTA, Watershed Management Lab., University of Tsukuba

Japan, a mountainous country, suffers from frequent sediment disasters. For better mitigation, our laboratory is studying the causes, mechanics, and processes of water cycling and sediment-related phenomena, such as landslides, erosion, debris flows, and sedimentation using field observations, flume tests, and numerical simulations.



Related publications:

Hotta et al. (2013) Influence of fine sediment on the fluidity of debris flows. Journal of Mountain Science, 10, 233-238.

Hotta (2012) Basal interstitial water pressure in laboratory debris flows over a rigid bed in an open channel. Nat. Hazards Earth Syst. Sci., 12, 2499-2505.

Shuin, Hotta et al. (2012) Estimating the effects of heavy rainfall conditions on shallow landslides using a distributed landslide conceptual model. Physics and Chemistry of the Earth, 49, 44-51.

Hotta et al. (2010) Changes in groundwater level dynamics after low-impact forest harvesting in steep, small watersheds. Journal of Hydrology, 385, 120-131.

Koi , Hotta et al. (2008) Prolonged impact of earthquake-induced landslides on sediment yield in a mountain watershed: the Tanzawa region, Japan. Geomorphology, 101, 692-702.

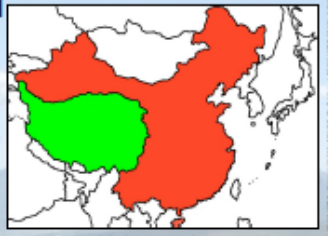
Carbon cycling research in Qinghai Tibetan Plateau
Our challenges in one of the highest and fragile ecosystem

by HIROTA Lab. (Terrestrial Ecosystem Ecology)

Why "Qinghai Tibetan Plateau (QTP)?"

The QTP is an ideal field to study recent two global environmental issues,
climate warming & biodiversity crisis, due to...

1. **having quite high Biodiversity**
2. **big grassland with sink ability for CO_2**
3. **heavy impact of grazing and land-use change**
4. **low temperature with high altitude**

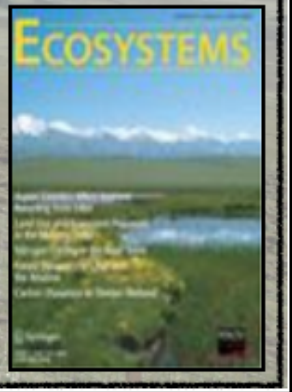


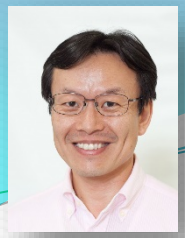
Main three topics

- **Carbon pool and fluxes in alpine wetland, meadow and grassland**
  (Hirota et al. 2009, in *JPE*, Hirota et al. 2007 in *Liminol.*, 2006 in *Ecosys.*),
- **Grazing impact on carbon dynamics and vegetation**
  (Hirota et al. 2005 in *Atmos. Environ.*etc.)
- **Relationship between biodiversity and ecosystem functions, such as productivity**
  (Hirota & Tang 2012 *BSJ-review*, Hirota et al. 2010 *JPR*.)

HOT Outcome from COLD QTP

1. **Alpine wetland in the QTP has important role as sink for CO_2 and source of CH_4, and is very fragile ecosystem to grazing impact.**
2. **Mountain grassland also has sink for CO_2 (not strong) and its ability is easy to change by grazing and land-use change impact.**
3. **Spatial variation in CO_2 flux and pool within a grassland ecosystem and it can be explained by biodiversity**



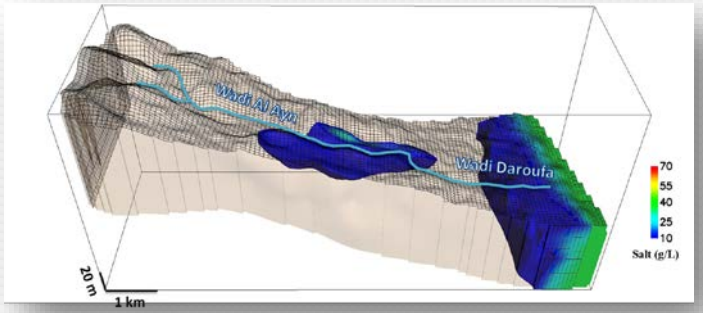


Hydrology & Water Resources Lab

Prof. Dr. Maki TSUJIMURA

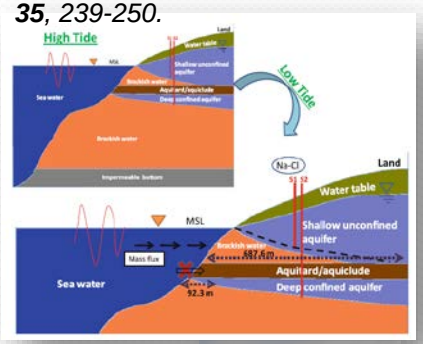
mktsuji@geoenv.tsukuba.ac.jp http://www.envr.tsukuba.ac.jp/~mktsuji/engl.htm

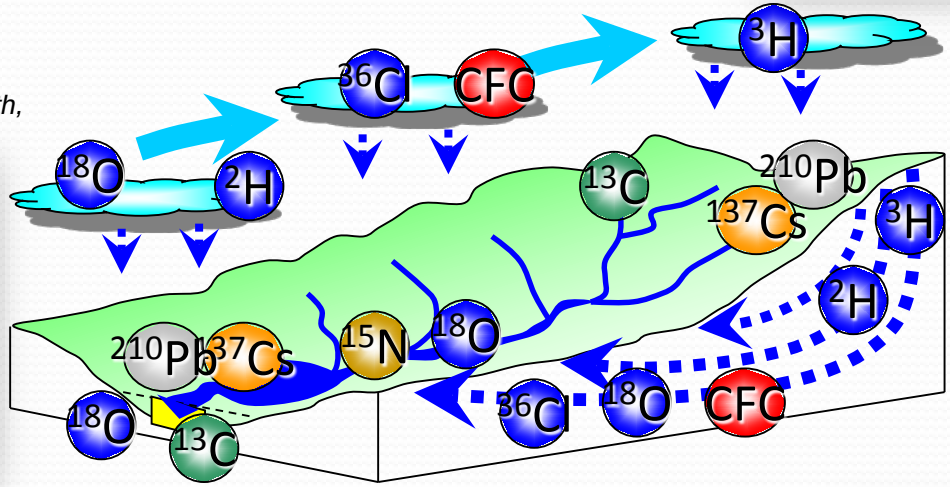
- *Main Topics*
  - Source, Path, and Age of Hydrological Cycle??
    - Where and how does water come from?
    - How old is the water?
    - Multi Tracers of Isotopes, Solutions, CFCs/SF_6 Gas



How does tide affect on a coastal groundwater?

*Kumar,Tsujimura et al., (2013) Environmental Geochemistry & Health, **35**, 239-250.*





How does salinized water contaminate fresh groundwater in a coastal watershed in Tunisia?

*Chekirbane, Tsujimura, et al., (2013) Hydrological Sciences Journal, **58**(5), 1097-1110.*

How does bedrock groundwater contribute to river runoff?

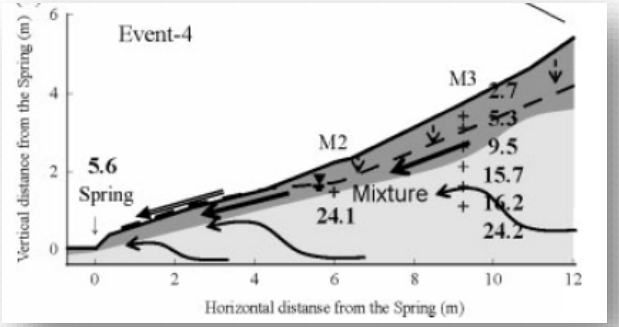
*Iwagami, Tsujimura, Onda et al., (2010) Hydrological Processes, **24**, 2771-2783.*

How does river water recharge groundwater in Ulaanbaatar, Mongolia?

*Tsujimura, Ikeda et al., (2013) Sciences in Cold and Arid Regions, **5**(1), 126-132.*

How is groundwater recharged in a grassland, eastern Mongolia?

*Tsujimura, Abe et al., (2007) Journal of Hydrology, **333**, 47-57.*



Environmental Chemical Ecology

Biological Interaction Between Plants and Microorganisms in the Rhizosphere

Keiko YAMAJI, Associate Prof.

Research Content

We clarify chemical interaction between plants and microorganisms in the rhizosphere, especially under severe environmental conditions; heavy-metal stress and Al stress. *Via* chemical and histochemical analysis as well as field works, we reveal possible mechanisms between plants and microorganisms, considering utilization of the interaction for environmental problems. Recently, we also examine effect of radio-Cs absorption in plants and microbes.

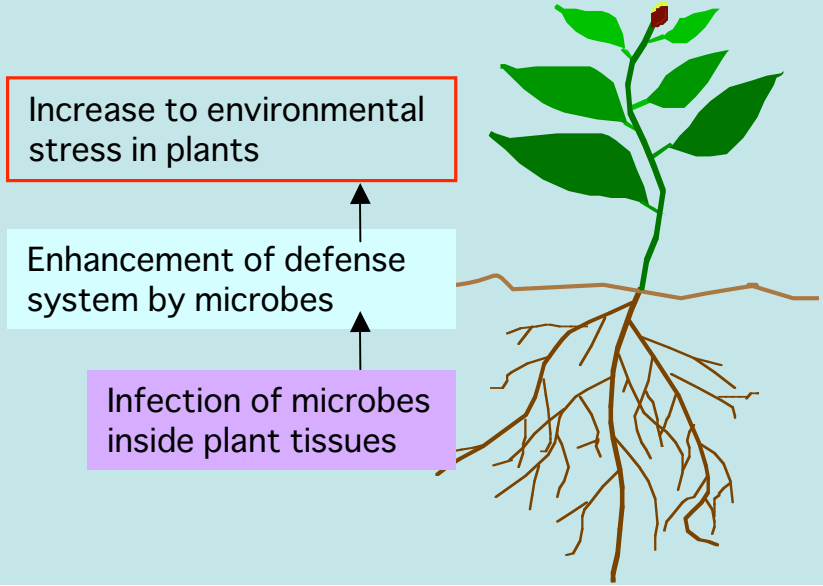
Cooperative Research Institutes

*Forestry and Forest Products Research Institute

*Kyoto University

*Yamagata University

*Hokkaido University

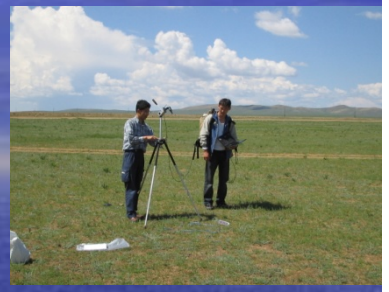


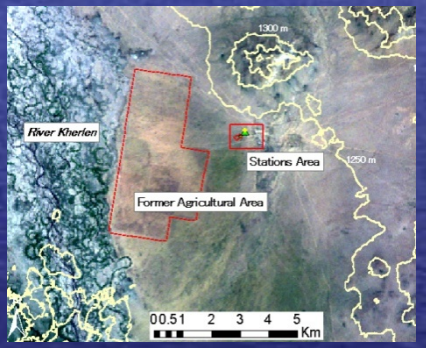
杉田 倫明 教授

生命環境科学系（地球科学）
オフィス：総合研究棟A304

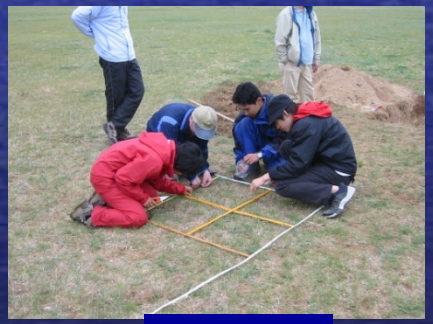
- 専門
  - 水文学、境界層気象学，生態水文学
  - 地表面付近の水、熱、CO_2動態と環境
- 対象
  - 水と土壌・植生・大気，そして人間活動
  - 地球上どこでも
    - これまで： 北米、つくば、スウェーデン、タイ、中国
    - 現在： モンゴル、エジプト，霞ヶ浦
  - 過去から現在，そして未来へ
- 方法
  - 観測・解析＆モデル
  - 新しい機械・方法（観測、リモセン、GIS、モデルなど）と地道な観測の融合

GPSによる動物行動調査

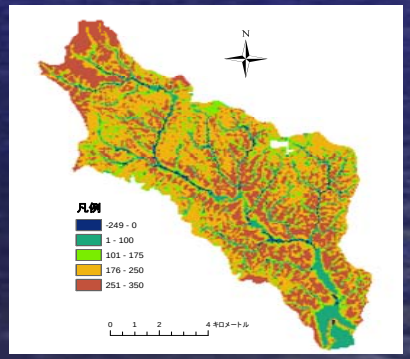




リモセンとGIS



植生調査



水文モデル

微気象・フラックス・水文要素の測定

ラジオゾンデによる大気境界層観測

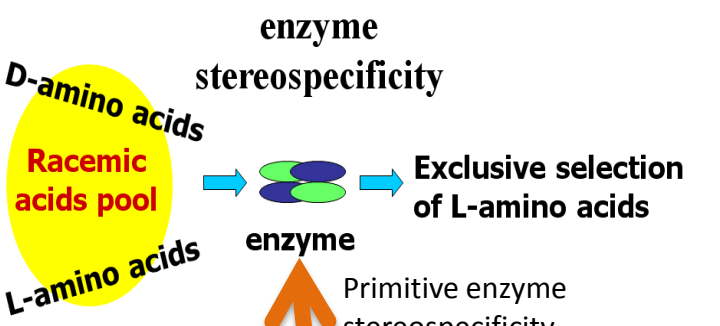
Evolutionary Biochemistry Lab by Shimada A., assistant professor (ashimada@envr.tsukuba.ac.jp)

Research goal

Resolution of mechanism of enzyme stereoselectivity making life-birth possible in early earth

The study for origins of life

Birth of life in early earth is the greatest mystery. Chiral homogeneity is the most essential to create life. It is enzyme stereoselectivity that could undertake an absolutely vital role in it in contemporary biological world. Researches of extant enzyme stereospecificity holds a key to solving this difficult problem.



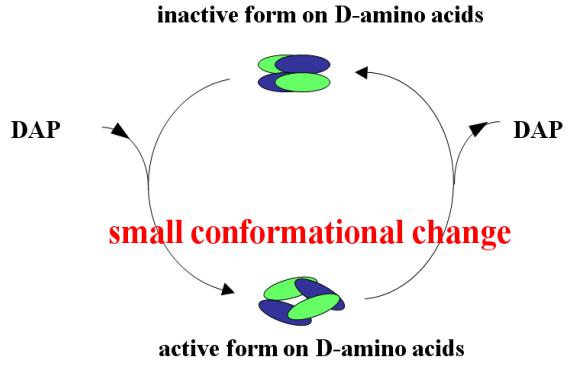
Primitive enzyme stereospecificity was established at the first step of birth of life.

early earth

Birth of Life

Present study

Tryptophanase in concentrate diammonium hydrogen phosphate (DAP) solution



Tryptophanase has no activity on D-amino acids because of its absolute stereospecificity, but becomes active to them in highly-concentrated ammonium phosphate solution (DAP). It is considered its small conformational change triggers the activity. This result indicates the stereospecificity is flexible against conventional enzymology. The study of this interesting stereoselectivity-conversion is important to unfold a mechanism of enzyme stereospecificity, which produces a famous technical term of no homochirality - no life.

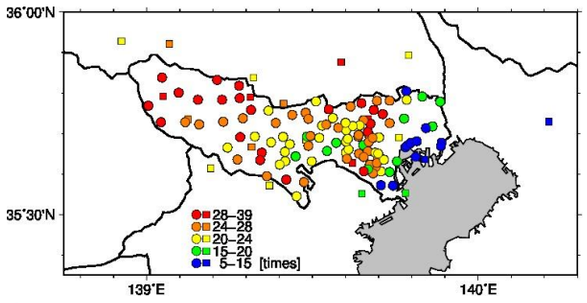
Urban Climate and Modeling Laboratory

Prof. Kusaka (kusaka@ccs.tsukuba.ac.jp)

Urban Climate

Our laboratory's research is focused on the urban heat island phenomenon and related themes. The impact of urbanization has been examined by observation and numerical simulation.

The number of Heavy rainfall days in Tokyo

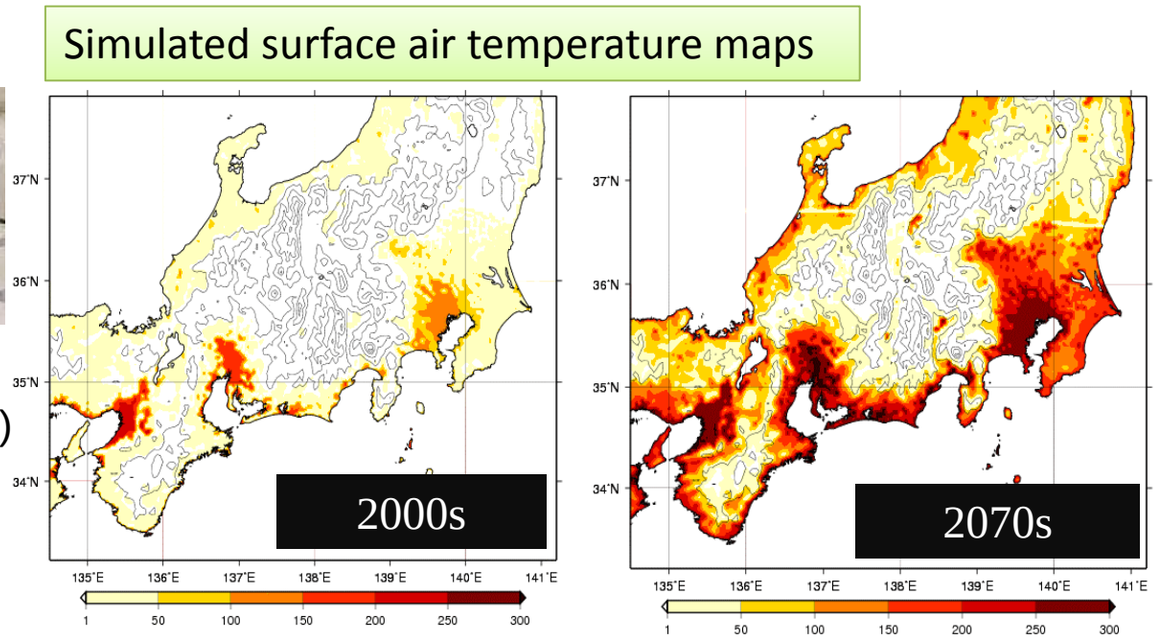


Regional Climate Projection by the WRF model running on the Supercomputer

Our research group conducts various urban climate (future) projections using regional climate model WRF.

T2K supercomputer
Cray, 684 node (16 cores)

Simulated surface air temperature maps



Numerical Modeling

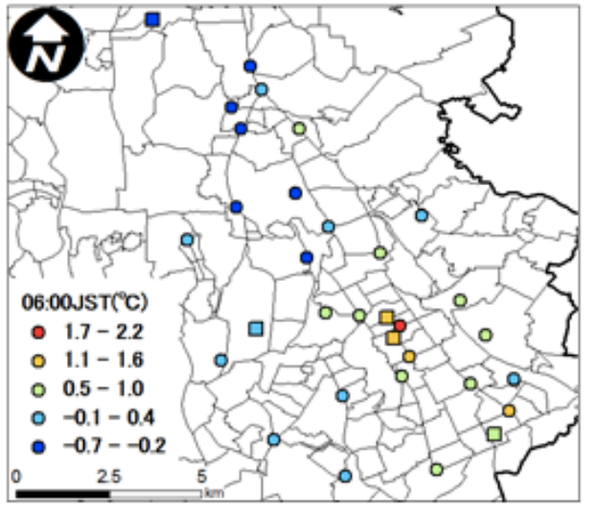
We have been developing our own numerical models (a new LES model, a new Urban Canopy model, a new local circulation model). Improving the WRF model has been also performed in our group.

Observation

We have been observing several boundary layer phenomena such as the urban heat island, convective thermal, or local wind.

Observation sites

Observed Surface air temperature map in Tsukuba city



Socio-Environmental System Laboratory

Yoshiro HIGANO, *Professor*
higano@jsrsai.envr.tsukuba.ac.jp

Helmut YABAR, *Associate Professor*
yabar@jsrsai.envr.tsukuba.ac.jp

Takeshi MIZUNOYA, *Associate Professor*
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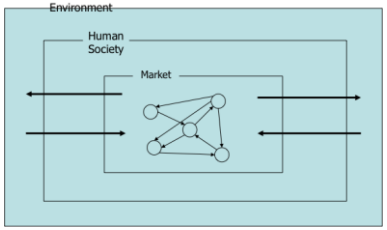
Socio-Environmental System Laboratory conducts various researches on evaluating remediation technologies, assessing their dissemination and proposing socio-environmental policies. Our features of research are to exploit computer simulation, by which we are practicing various assessments through system dynamics modeling on socio-economic system, natural environmental system and their interactive relations. This enables us comprehensive and multilateral assessments quantitatively.

The Feature of Social and Environmental System Engineering

- Analyzing of Interaction between the Socio-Economic and Environmental System
- Many-sided Evaluation of Policy Measures and Technologies
- Policy-oriented Environmental Science for Decision-making Process



Solution Process of Environmental Problems

- Cause Elucidation
- Measure Planning
  - R&D for Environmental Technologies
  -Environmental Policy Planning (Regulation, Taxation System...)
- Prior Evaluation
- Optimal Selection of the Tech. and Policy Measure
- Implementation of Measures

Recent Themes

- Methodology to Derive the Optimal Rate of Environmental Tax
- Introduction of the Optimal Environmental Tax System
- Impact Analysis of Environmental Tax
- Water Environmental Policy for Improvement of Lake Water Quality
- Integrated River Basin Management Policy
- A Practical Use Policy of Biomass System for Sustainable Development and Environmental Improvement