Biogeochemical cycle of bioelements in the ocean driven 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.

Microbial Processes and Carbon Cycle in the Ocean

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

Ocean acidification in coastal waters

Microbial response to ocean acidification

Bacterial production of refractory dissolved organic matter

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

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

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 environment

Cell-cell communication
The conversation of microbial

Applications
Medical treatment of infection disease

Activate waste water treatment ability by species specific regulation

Research

Biofilms
The aggregation of microbial in environment

Cell-cell communication
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Medical treatment of infection disease

Activate waste water treatment ability by species specific regulation


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

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

JST/ALCA project: 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)

Zhao et al., J Colloid Interf Sci 393 (2013) 264-270.

Electrochemical and Biological Nitrogen Removal

Zhao et al., J Hazard Mater 192 (2011) 1033-1039.

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

Biogas plant developed in the project field, Shanghai

Zhao et al., J Colloid Interf Sci 393 (2013) 264-270.

Heavy Metals Immobilization and Waste Reclamation
(Using hydrothermal treatment)


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

Soy products
SCR
Sterilization
Polysaccharides

M. esculenta
Cultivation
Liquid culture
Fermentation

Shi et al., Carbohydr 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.

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)
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.

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

Present-day global warming

mid-Pliocene warm period (~3 Ma)

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

Information from the past climate changes

✓ The same models used in future climate projections

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

Fossil Leaves

Pollen

Fossil Wood

Proxies

Data

Models

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

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.)

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 Earth-observation satellites in JAXA: GCOM-C & ALOS-2
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:
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 CO₂
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 CO₂ and source of CH₄,
   and is very fragile ecosystem to grazing impact.

2. Mountain grassland also has sink for CO₂ (not strong) and its ability is easy
   to change by grazing and land-use change impact.

3. Spatial variation in CO₂ flux and pool within a grassland ecosystem and it
   can be explained by biodiversity
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?

How does bedrock groundwater contribute to river runoff?

How does river water recharge groundwater in Ulaanbaatar, Mongolia?

How is groundwater recharged in a grassland, eastern Mongolia?
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

Increase to environmental stress in plants

Enhancement of defense system by microbes

Infection of microbes inside plant tissues
杉田 倫明
教授

専門
- 水文学、境界層気象学、生態水文学
- 地表面付近の水、熱、CO₂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
Birth of Life

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.

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.
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

Urban Climate and Modeling Laboratory
Prof. Kusaka (kusaka@ccs.tsukuba.ac.jp)

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

2000s

2070s

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.

Observed Surface air temperature map in Tsukuba city

Observation sites
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  mizu@jsrsai.envr.tsukuba.ac.jp

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

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.