Division of Environmental Studies

Department of Environment Systems

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Energy and Environment Laboratory	Lecturer Masaatsu AICHI	Current approaches to energy supply and consumption face problems such as climate changes and dwindling resources. The development of key technologies for saving energy, switching to renewable energy resources, and appropriate waste disposal is required. Our goal is to perform research that will contribute to the development of these technologies, especially by taking advantages of the characteristics of subsurface formations. For example, we study ways of developing a sustainable energy system, especially through hydrogeological and thermo-poro-mechanical modeling of geothermal heat pumps, geothermal power plants, and the geological sequestration of carbon dioxide. On the other hand, we also start to study how to adapt to global warming. Combining mitigation and adaptation is an attractive choice but it is not simple because one countermeasure possibly causes another environmental effects. For example, though the groundwater becomes more important water resource under changing climate, the overexploitation of groundwater possibly causes another environmental problem such as land subsidence, sea water intrusion in coastal area, so on. We try to predict and prepare for this kind of domino-like propagation to other environmental problems in advance.	water resource; groundwater; land subsidence; modeling; emergency situation	Land subsidence caused by groundwater abstraction has been one of the severe environmental problems in Asian coastal megacities. By strictly regulating the groundwater abstraction, the land subsidence in several cities in Japan ceased today. On the other hand, the groundwater becomes more important water resource under changing climate. In addition, the groundwater is considered to be an important water resource after an earthquake or flood disaster. Furthermore, the high groundwater pressure is harmful for the subsurface infrastructures. Then, the possibility to restart groundwater abstraction is becoming a matter of debate. However, it is essential to avoid the restart of land subsidence problem. Theoretically, it can be achieved by controlling the groundwater level so that the effective stress does not exceed the preconsolidation stress of subsurface formations. However, it is very difficult to find practically because of the heterogeneity in subsurface formations and the complex history of hydraulic head change in clayey layer. In this program, we try to numerically simulate the evolution of the preconsolidation stress under the historical groundwater abstraction and find a critical groundwater level in the future groundwater usage. The schedule is roughly planned as follows: 1st-2nd week: Introduction to land subsidence simulation and excursion to the land subsidence monitoring system in Tokyo.

				3rd -4th week: Simulation of the past land subsidence and proposal for the future.
Akizuki - Oshima Laboratory	Prof. Yoshito OSHIMA Asst. Prof. Makoto AKIZUKI	"Supercritical fluid" refers to a fluid in which the material's critical points of temperature and pressure are being exceeded. Dramatic physical changes are possible depending on the operating conditions of the material. In particular, the ionic content and dielectric constant of supercritical water changes extensively based on temperature and/or pressure. As a result of this, it becomes possible to select a reaction based on one's objective: from an ionic atmosphere suitable for inorganic reactions, to one implementing the dissolving of organics, which is equivalent to a non-polar solvent. Taking advantage of these properties, it is expected that this new, inexpensive, environmentally-friendly reaction medium will replace conventional organic solvents. Our laboratory has many research goals, covering a broad range of topics: Degradation of harmful waste products using the oxidation reaction in supercritical water, organic synthesis using solid catalysts, and synthesis of inorganic materials such as nanoparticles and polymers. In regards to all of these fields, by designing, analyzing, and controlling reactions based on a study of chemical reaction rate and reaction engineering, we are advancing extensive research, from fundamental research related to the chemical reaction of supercritical fluids, to the cultivation of new engineering application technologies.	Supercritical Water, Reaction Engineering; Organic Synthesis; Tunable Solvent; Catalysis	**Organic synthesis using supercritical water as an environmental technology** Supercritical water is a promising reaction medium for organic reactions because its solvent properties can be varied with the temperature and the pressure, and these properties affect reaction kinetics and mechanisms. The aim of this study is to propose a methodology which enables to control the reaction rate and the selectivity of organic synthesis reactions only with the change of temperature and pressure of supercritical water.
Environmental Chemical Energy Engineering Laboratory	Assoc. Prof. Junichiro OTOMO	Development of environmental-benign energy devices and systems is a crucial issue in terms of energy saving and reduction of CO2 emission. The research in Otomo laboratory focuses on electrochemical reaction, catalytic reaction and ionic conduction in solid electrolytes with the objective of integrating the elemental technologies into new chemical energy conversion devices and systems such as fuel cells, hydrogen production and energy storage systems. The integration of physicochemical phenomena with different scales is necessary to construct novel energy	Chemical looping, reversible fuel cell; hydrogen; energy storage; technology assessment	Hydrogen production and energy storage systems are key technologies in terms of future energy systems combined with renewable energy. Chemical-looping (CL) and reversible fuel cell (r-FC) technologies are efficient energy conversion systems, and they attract attention as next generation energy supply and storage systems. To advance the systems, their technology assessments are required as well as experimental studies. In this project, the assessment of environmental impact and relevant

		devices and systems. Thus, we are investigating the physicochemical (or electrochemical) phenomena through the perspective in molecular-scale, mesoscopic scale and macroscopic scale to solve some energy problems.		experiment for CL or r-FC system will be investigated based on physicochemical properties of component materials and reactions with relevant experiments of CL and r-FC.
Marine Environment Systems Laboratory (Tabeta lab)	Prof. Shigeru TABETA	To continue enjoying the blessings of ecosystem, preserving various functions of ecosystem, restoring deteriorated ecosystem, and creating a favorable new one are crucial. We aim to analyze and evaluate marine environment systems from the viewpoints of physical processes, ecosystems, and social systems considering the interaction of land, coastal zones, and oceans. The life of human being cannot stand without a variety of ecosystem services. To continue enjoying the blessings of ecosystem, preserving various functions of ecosystem, restoring deteriorated ecosystem, and creating favorable new one are crucial. We aim to analyze and evaluate the impact of human activities on ecosystem as well as to develop technologies to preserve/restore/manage the ecosystem. Main areas of our research are the modeling and simulations of marine ecosystem and material cycles, the environmental impact assessment of ocean and coastal developments, the restoration and management of coastal environment and fisheries, and so on.	coastal fisheries; marine ecosystem model; fisheries simulator	To realize sustainable fishery and sound ecosystem in coastal region, implementation of effective fishery management practices is required, as well as development of an assessment system. For example, more efficient and sustainable fishing operations need to be determined considering both the resource and economic conditions. We have been developed a fishery simulator for bottom otter trawling in Japanese coastal region, which is based on two models: a fish behavioral model that predicts the spatiotemporal variability of fish biomass and population size, and a fishing operations model that predicts the fishing activities of trawling boats. We are also collecting field data to improve the models utilizing fishing boats in the actual operations. In this project, data analysis and/or computational simulations will be conducted to assess coastal ecosystem and fishery management.

Geosphere Environment Systems Laboratory	Prof. Tomochika TOKUNAGA	Underground geosphere environment has been extensively used to support highly developed human society; e.g., extraction of energy resources and groundwater, waste disposal, construction of tunnels and underground spaces. Because of these activities, environmental problems which affect the sustainability of our society have emerged. The target of our laboratory is to understand and predict the change of geosphere environment caused by human activities, and to develop necessary engineering measures to attain sustainable use of geosphere environment. Current research topics include, studying and evaluating geosphere environmental changes caused by energy resources development and proposing necessary technological measures for sustainable resources development, securing stable and safe freshwater resources and development of efficient management schemes, and modeling long-term fluid flow and material transport processes through geosphere and its application to waste disposal and energy resources exploration	Groundwater; watershed; water and nitrogen cycle; field survey	The increased production of reactive nitrogen promotes the growth of food production, and thanks to this innovation, world human population has increased rapidly. However, the increase of anthropogenic usage of nitrogen leads to many environmental problems such as eutrophication, global acidification, and global climate change. One of the main reasons of groundwater pollution caused by nitrate-nitrogen is considered to be the use of fertilizers in agriculture, and groundwater quality management is becoming a serious issue in Japan. On the other hand, groundwater watershed does not necessarily follow topographical watershed, thus, it is necessary to comprehensively understand how groundwater flows, and how nitrogen compounds behave in geosphere and hydrosphere to manage the environment. In this study, field survey, water sampling, chemical and isotopic analysis, GIS-based mapping, and numerical modeling techniques will be applied to study hydrogeological system and behavior of nitrogen compounds in the upper reach of the Tsurumi river to provide scientific basis for proposing the possible management plan to conserve the water quality and the local environment.