Perspective of "Satellite Ecology" in the 21st Century COE Program at Gifu University

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1. OUTLINE OF THE COE PROGRAM

The research plan entitled, "Satellite Ecology," led mainly by the River Basin Research Center of Gifu University, was selected as a 21st Century COE (Center of Excellence) program in 2004. This program aims to create a comprehensive yet practical science, "Satellite Ecology," by making an attempt to integrate ecological research, remote sensing analysis, and meteorological observations and modeling analysis on the structure and function of ecosystems. The integrated science will improve our approach to environmental sciences from plot to regional and global scales. Because of the heterogeneous and variable phenomena of the structure and function of the ecosystems in both time and spatial scale, the above integration of the environmental sciences would enable us to reveal the functional structure of ecosystems of various types, including deciduous and evergreen forests, agricultural fields, and urban areas.

For the last decades, the structure and function of the ecosystems have been revealed mainly by the "ecological research" to observe the distributions of vegetation, biomass, and growth of trees at several sites. In these 30 years, "remote sensing observation" techniques, which utilizes satellite sensors to monitor environmental changes, forest and green tract distributions in urban areas, etc., has advanced dramatically. In addition, the development of meteorological observation techniques including eddy correlation flux measurement systems enables us to measure the plot scale CO_2 flux over a given forest. In recent years, the evolution of such research methods has been remarkable, and it is now possible to examine the consequences between ecosystem structure and ecophysiological behavior, their distributions and meteorological properties. Moreover, dramatic improvements in satellite sensors now enable detailed observations of the distributions of various ecosystems (forests, agricultural fields, urban areas, etc.) in regional environments and their changes over time. In addition, model simulations incorporating the ecological mechanisms and satellite-observed distribution of ecosystems have advanced to the scientific phase of examining the ecosystem functions from regional to global scales. The evolution of these research fields presents the opportunity to establish a new comprehensive and practical discipline, "Satellite Ecology." This field will attempt to integrate ecological research, remote sensing analysis, and meteorological observation and modeling analysis to comprehensively understand the ecosystem functions and further to find the conservation plans considering the co-existence of nature and us.

Satellite Ecology is a new research field found between the existing research fields or on their boundaries. At this COE, to develop and cultivate this new field of study, we plan to execute as

follows:

1) Proactively seek exchanges with many researchers in other fields of study.
2) Promote exchanges with environmental field researchers overseas.
3) Train young researchers and engineers to develop the new field.
4) Keep our doors open to the community and have dialogues with the public, responding to their inquiries, questions, and requests.
5) Attempt to address and solve the problems unique to the region where this COE is located.

2. RESEARCH PLAN

We will carry out research and education programs focusing on the ecosystems that constitute river basins (forests, agricultural fields, rivers, and urban areas). Our primary targets are the central region of the Honshu Island of Japan, centering around Gifu Prefecture's mountain-ringed and plains regions, pasturelands in the vast interior of Mongolia, irrigated rice field regions in Indonesia, etc. Gifu Prefecture and its surrounding areas will be the most emphasized site for our research program, and we will analyze and assess the functions, spatial distributions and transitions of various ecosystems involved in a river basin. In addition, we will examine the impact of changes in land utilization patterns due to human activities on the surrounding ecosystems.

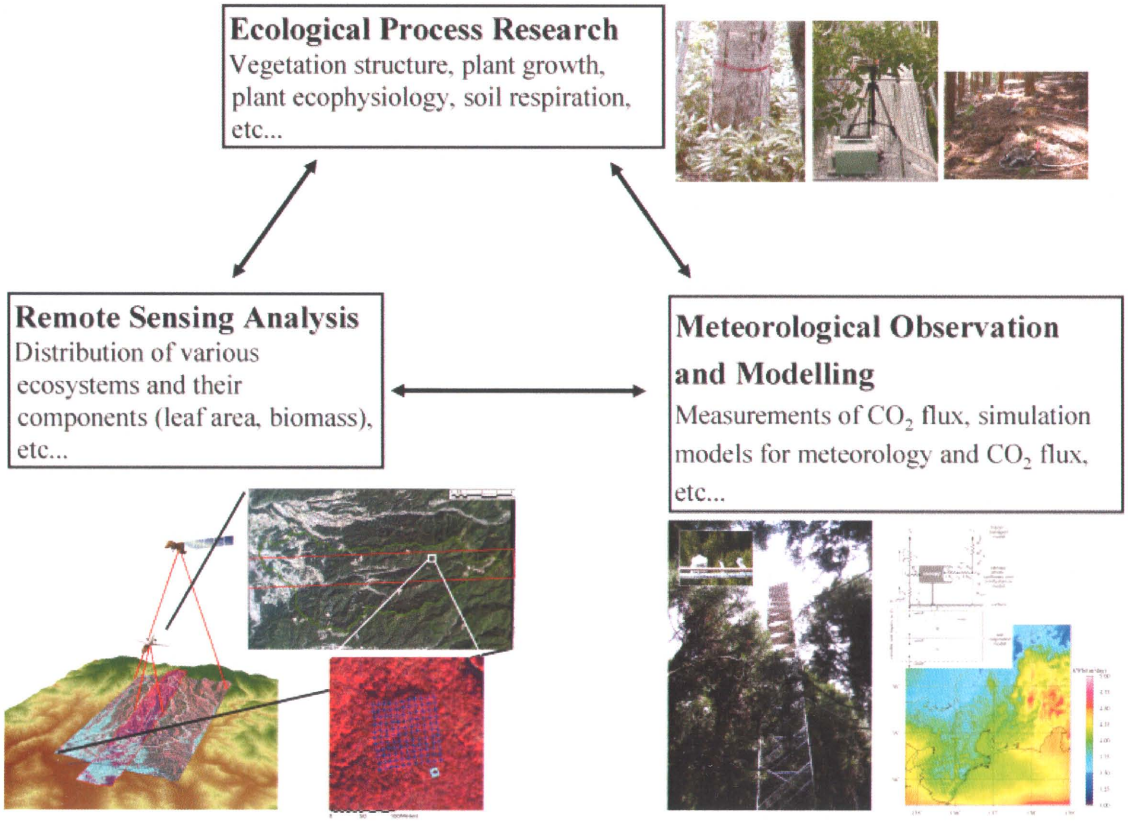
An ecosystem is established by the interactions among its components: living organisms (plants, soil microorganisms, etc.), materials (carbon, nitrogen, etc.) and energy flow. The physical and biological processes that exist in these material cycles and energy flows are called "ecological processes." To elucidate the roles of ecosystems in shaping the Earth's environment and the impact of human activities on ecosystems, it is essential to carry out comprehensive analysis of the ecophysiological characteristics of ecosystem behavior performed by plants and soil microorganisms, the spatial distributions and seasonal factors of biomass, and the impact (or interactions) of the living organisms' activities (photosynthesis, respiration, growth, input of organic matter into the soil, etc.) on the atmosphere, soil and water systems.

To measure and assess the functions of ecosystems, the spatial distribution of the impact of human activities, and temporal shift on a regional scale, observation using remote sensing is an essential tool. There are currently several tens of sensors available for such research. Such advanced tools allow us to assess the material dynamics in the atmosphere and soil and the physiological functions (photosynthesis and transpiration) of vegetation. Aiming to provide the most reliable observation, we will carefully select our targeted area and timing in order to obtain detailed information on the ecosystem behavior and its mechanisms in the area, and we will analyze the data collected by remote sensing with the highest precision.

It often turns out that the spatial and temporal resolutions of data obtained by ecological research and remote sensing do not agree as each has specific technical characteristics. Modeling analysis enables an integrated assessment and future prediction by consolidating information from studies with different spatial and temporal resolutions. Connecting such phenomena with different spatial and temporal resolution is referred to as scaling. Such models are constructed by integrating

the components that comprise the ecosystem, such as the ecophysiological characteristics of living organisms, the chemical composition of the atmosphere / soilsphere / hydrosphere, climate conditions and etc.

"Satellite Ecology", an integrated study for ecosystem structure and function.



3. EDUCATION

We aim to establish the novel academic field of comprehensive ecology. Further, we aim to train young researchers who are equipped with interdisciplinary capabilities in science and who are able to help solve social problems by working in concert with collaborating researchers overseas and government and corporate administrators and managers who are in charge of environmental issues.

1) Basic education for the research fields of Ecological process /Remote sensing /Ecosystem modeling

The researchers and post-doctoral fellows who participate in this program will receive basic education in the fields of ecology, remote sensing, and hydrometeorology to learn both the ecological reserach and remote sensing methods. These scientists will gain the ability to utilize interdisciplinary approaches to create novel ideas. Moreover, we will develop young researchers who will learn the basic methods of Satellite Ecology and formulate a new field of study. In these courses of study we will build an educational system for students and researchers at distant

universities, and release information pertaining to basic education and actual research science in Satellite Ecology.

2) Establishing a new discipline, "Satellite Ecology"

The mission of our COE program Satellite Ecology is to suggest how to optimize the relationship between human beings and nature. To meet this objective, it is essential that a diverse group of people, such as administrators in charge of environmental issues in governments, managers in charge of environmental issues in corporations, and citizens, team up to press ahead with practical studies in the field and laboratory. Since continuing to produce meaningful research data, sustaining education, and achieving acceptance by society are all essential for the development of a new discipline, we believe that the young researchers receiving a basic education at this COE will play a significant role in future environmental studies.

3) Continuing education/environmental education

We will provide open lectures to the general public and offer basic education to the staff of various non-profit organizations for environmental issues, governmental administrators in charge of the environment, teachers in junior and senior high schools, corporate supervisors in charge of environmental management, etc. We expect to play a central role in environmental research and education in Japan in the years ahead by developing sophisticated continuing education programs and opening the door to society, including providing practical education utilizing the outdoor fields for study.