

Lakes as Sources and Sinks: Social and Ecological Dynamics Affecting Downstream/Pollution-Accumulating Lakes

A downstream and pollution-accumulating lake (DPA lake) is an inland body of water that is both an active source of water for humans, agriculture and industry and a sink for upstream waste. This project investigates present and likely future (50-100 years) problems in DPA lake environments in the context of global environmental sustainability and regional development. It will propose a set of indices related to DPA lakes from which solutions or mitigations can be based, and which will guide the design of ideal governance of human-watershed systems.

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Project overview

Water quality of downstream and pollution-accumulating (DPA) lakes is particularly vulnerable to degradation (Fig. 1). The number of DPA lakes is expected to increase in the world, particularly in and near the metropolitan cities that have poor water resources. The purposes of this study are to predict and discuss the problems specific to such lakes in the next 100 years, to propose appropriate governance techniques, and to design a human society that has a rich sense of futurability. Lake Kasumigaura northeast of Tokyo is a representative DPA lake (Photo 1).

We will test two working hypotheses. First, we hypothesize that increases in water use will accelerate accumulation of pollutants in the lake, which in turn will reduce availability of water. In order to test this hypothesis, we will construct a numerical model capable of simulating hydrological and biogeochemical cycles in the lake and watershed. This model will show both subsystems with short turnover times, such as precipitation and specific river and lake dynamics, and those such as groundwater and sedimentary processes with long turnover times and which are also affected by various stakeholders around the water environment (Fig. 2). The model will be used to indicate nutrient cycles in the watershed and to predict changes in water quantity. We will apply sustainability indices to DPA lakes in order to evaluate the watersheds in light of environmental factors and human development.



Photo 1 Lake Kasumigaura at the time of an outbreak of Koi Herpes Virus (KHV) disease

Secondly, we hypothesize that decreases in both the diversity of water use and human population in the watershed area will reduce the resilience of the lake, and thus the viability of the regional human-nature system. We will investigate water and lake uses and their change through time in order to test this hypothesis. Several lakes in Asian countries such as China and Indonesia will be considered as DPA lakes. We will conduct inter-lake comparisons based on indices that describe economic and environmental constraints such as global carbon limitation and population decline and aging.

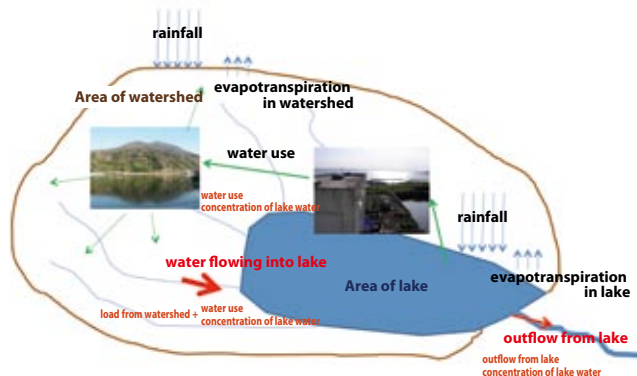


Figure 1 Hydrological (black) and nutrient (brown) cycles in a DPA lake

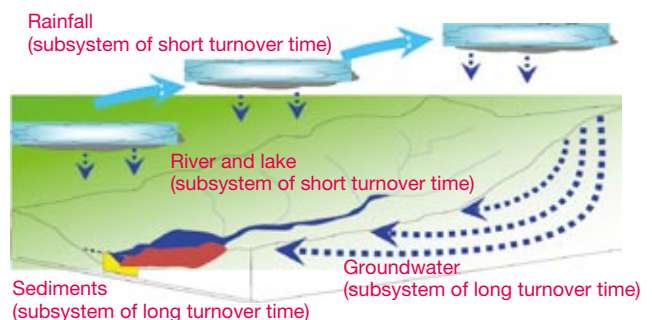


Figure 2 Subsystems of short and long turnover times

Coastal Area Capability Enhancement in Southeast Asia

Coastal area ecosystems are very complex, containing some of the highest levels of biodiversity and primary productivity on earth, but they are also subject to intensive human use and easily degraded. This project uses advanced methods of ecological and social analysis to develop a comprehensive account of how people in several areas of Southeast Asia use coastal resources. It will promote dialogue of how rational and appropriate measures to for social and ecological sustainability can be established.

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Purpose of the project

This study investigates the biodiversity and productivity of Southeast Asian coastal ecosystems, their vulnerability in relation to human activities, and assesses how social practices and ecological processes can be better aligned. We reconsider the existing regime of resource management, centering on “optimal” production (or maximum sustainable yield), and propose the concept of “area capability” as a framework for assessing ecosystem-livelihood linkages in complex and uncertain future environments.

Research approaches

The study is developed in three components:

1) Ecosystem mechanisms and dynamism

Specimens, including organisms, water, sand, soil and suspended materials, are collected from marine, mangrove and terrestrial ecosystems, entered into a Geographical Information System (GIS) and subjected to stable isotope analysis in order to evaluate ecosystem features and food-web structures and geographical ranges. Mitochondrial DNA sequence analyses and AFLP analyses of the organism specimens will describe genetic biodiversity and clarify the reproducible units of each species within the ecosystems. Chemical analyses will be performed in order to estimate pollution of land and waters. Biomass is evaluated by several methods, including through satellite image analysis and acoustic estimations.

2) Local livelihoods and adaptive management

Anthropological, social and economic research methods are used to describe the relationship between human action and ecosystem structure and services. Such data and analyses will be used to establish dialogue between project members and local people, and to amplify, concentrate or improve data collection and methods of evaluation as necessary.

3) Environmental governance and local community development

Household interviews and observation surveys are used to gather data on local livelihoods, ethnicity, kinship, employment and educational backgrounds, and use of ecosystems. Logbook surveys will be conducted in order to collect data relating to fishing and other key ecosystem-related livelihood activities. Conjoint and contingent valuation method analyses describe different viewpoints



Photo 1 Mangrove Reforestation and Fisheries Stock Enhancement Project site at Batang Bay, Panay Island, Philippines



Photo 2 Set-Net at Rayong area in Thailand

regarding ecosystem services and values. The key elements necessary for consensus building are clarified, and appropriate policies are proposed.

Expected outcomes

This project will establish a robust database of ecological and social data that can be subject to extensive scientific analysis. By facilitating public access to the database and to information regarding key resource problems in coastal Southeast Asia, many people directly involved in coastal resource management will be able to discuss their understanding of the problems they face, and exchange ideas regarding potential solutions. The idea of “area capability”, a synthesis of coastal ecosystem- and livelihood-resilience under uncertain and complex environmental conditions, will be proposed for popular and academic debate.

Designing Agriculture in the Era of Petroleum Scarcity

How to feed the world in the 21st century? While increased food productions due to advancement of agricultural technology might pose an optimistic view to the world-wide food supply, energy resources such as petroleum is predicted to be inevitably depleted. This project will better understand human capabilities and agricultural capacities of maintaining food productions in the coming era of petroleum scarcity and will design how to transform our modern petroleum-dependent society into a future low-carbon society.

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Purpose of the project

The use of non-solar energy revolutionized all phases of agriculture, including irrigation, cultivation, harvesting, processing of harvested produce, transportation, and storage, thereby boosting labor and land productivity and supporting rapid increase in human population to its current level of approximately 6.8 billion. Contemporary agrisystems depend on petroleum-based sources of energy, but increasing petroleum scarcity is likely in the 21st century. Petroleum-based production systems are also considered incompatible with a low-carbon society. While there has been intensive debate of different scenarios of petroleum depletion and low-carbon society, there is less discussion of their significance to food production and consumption. This project therefore will reappraise and suggest the re-design of agriculture and food production systems to suit the coming era of petroleum scarcity and low-carbon society, and to create diagrams that promote such systems in specific communities.

Research approaches

We hypothesize that increasing scarcity of petroleum will lead to transformation throughout agricultural production and food consumption systems. Our research therefore will take the following two approaches:

Agricultural approach

Based on an exhaustive analysis of existing literature, we assume that changes in energy supply will lead to bottlenecks in food production. Project research will verify the effectiveness of non-carbon intensive agricultural substitutes, such as organic compost for chemical

fertilizers, mixed cropping of susceptible-resistant varieties for pesticides, and biogas and/or bioethanol for agricultural machinery fuel. We propose to develop fertilizer-effect testing methods for converting organic wastes into fertilizer, and to examine optimal materials and varieties for these alternatives, such as high-yield varieties with low-fertilizer tolerance. Crop testing will be conducted in active commercial fields in Kyoto, Ayabe and Fukuchiyama cities, and will allow direct information exchange between farmers and scientists.

Social action approach

The project will also contribute to popular discussion of agriculture and food issues through a series of lectures and science cafes in both urban and rural areas. These discussions will be designed so as to include academics, farmers, gardeners and the general public, and so to deepen consideration of the everyday and longer-term motivations and goals of these different communities and of possible alternative scenarios. Specific models, such as the German 'kleingarten', can be discussed, as can methods for re-claiming the cultural significance of food.

Expected outcomes

Based on our field studies and structured discussions, we will design regional, low-carbon agricultural schemes in selected regions. In the process we will enhance popular consideration of the significance of agriculture and food in everyday life and contribute to the deeper discussion of the sources of energy that maintain human life.

Annual nitrogen (N) budget in Japan (2000)

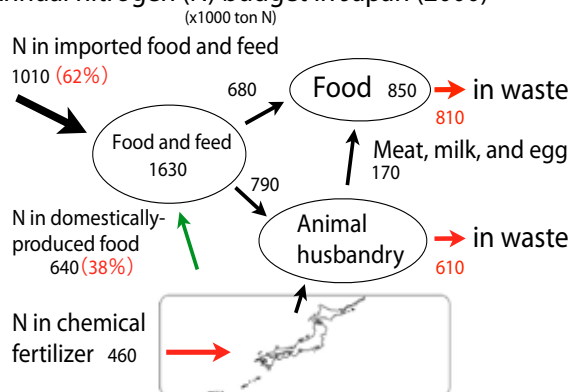


Figure 1 Nitrogen budget in Japan in 2000



Photo 1 Rice-production fields in Udom Xai Province, in northern Laos

Both highland swidden (background) and lowland riverine paddy (foreground) cultivations play significant roles in rice production. These paddies yield 3 - 4 tons of unhusked grains without any external inputs, compared to 6 tons in Japan, with use of machinery, irrigation, chemical fertilizer and pesticides. The Laos system is therefore a model for low-input, high-return agriculture.



Photo 2 Animal husbandry in Japan largely depends on imported feeds, such as corn, soybean, wheat grains and hay

Cycling manure back to fields could provide additional soil nutrients and reduce eutrophication in water sources.

The History of Human-Water Interactions in East Asian Livelihood Complexes

This project will describe a regional environmental history of human-water relationships within a set of livelihood complexes found in four areas of the Loess Plateau. The area has a long history of human inhabitation, and several distinct livelihood complexes can be identified, as can a long sequence of both natural and anthropogenic environmental transformations. In particular, the availability and use of water has been a determining environmental factor throughout the history of the Loess Plateau, with great impact on human livelihood complexes. As many people continue to live in arid environments and are likely to experience even greater water scarcity in the coming decades, accurate understanding of the linked patterns of human and environmental change is necessary.

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Project overview

The objectives of this research are to describe the history of human-water relationships within a set of livelihood complexes in four areas of the Loess Plateau and to design a framework of practical countermeasures to solve environmental problems that emanate from the Plateau. In integrating environmental history arid-land forest science and environmental law and governance, we will link environmental and social dynamics in past, present and future.

Research methods

Project research takes place within the following dimensions:

Disciplinary dimension

Project research relies on the insights and methods of several academic disciplines, including environmental history, afforestation science, and environmental law and policy. In combination, they will allow us to construct a detailed map of Loess Plateau environmental history, with particular detail regarding changes in plant ecology in relation to past and present human development in the area.

Time dimension

Project research pays particular attention to different

forms of environmental knowledge, from traditional to futuristic, the ways in which this knowledge has changed through time, and the significance of different knowledge systems and change in specific environments.

Regional dimension

Yanan, Wuding Hu, Fen He, and Datong have been selected as case study sites. Research at these sites will allow a series of inter-comparison studies. As a whole, this inductive structure will produce a regional synthesis of human-water interactions on which practical countermeasures to environmental problems can be based.

Expected outcomes

We will construct a state-of-the-art map of environmental history of the Loess Plateau. An integration of environmental history, afforestation science, and environmental law and policy is expected to contribute to a design-oriented, problem-solving approach to global environmental problems. Project research will be of special relevance to the current policy for converting farmland to forest and grasslands (*i.e.*, the Grain-for-Green Project), and in mitigating transboundary environmental problems that extend from the Loess Plateau to the Bohai Sea through the Yellow River.



Photo A Loess Plateau landscape

Water- and Food-Sheds in the Noto Peninsula: New Scales of Analysis in Global Environmental Studies

This project uses innovative technological and conceptual tools to describe interlinked human and biophysical phenomena in the Noto Peninsula, Japan. Research will combine stable isotope analysis and other fine-scale methods of biophysical system description with intermediate landscape-scale analysis, especially of water- and food-sheds. The project also includes description of the human cultural practices linked to key landscape processes. In total, the project develops in-depth description of the human-terrestrial-aquatic systems found in Noto, and also contributes to the establishment of the field of peninsula studies.

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Project overview

This project investigates the nature-society relationships in the Noto Peninsula, Japan. Jutting into the Sea of Japan from central Honshu, Noto Peninsula presents unique biophysical conditions and cultural-ecological history, but shares many economic and demographic features found throughout rural Japan. This project takes water- and food-sheds as central units of analysis. Comparative study of several shed-areas will allow description of the factors affecting hydrological and biogeochemical cycles in the peninsula. Research will describe biodiversity and hydrology in particular, and describe how they are affected by human action, institutions and structures. This description is linked to social features, especially demography, primary industry (agriculture, forestry, fishing and aquaculture), development, settlement, and cultural phenomena that may be associated with continued community life and sense of wellbeing. Circuits of food production and consumption are therefore of particular interest.

Research methods and organization

Key research objectives are the following:

- 1) Extensive field and stable-isotope analysis of hydrological and biogeochemical cycles, especially in relation to biodiversity;
- 2) Detailed description of the circuits of food production and consumption, with particular emphasis on local foodsheds, and their relationship to hydrology, biogeochemistry and biodiversity as well as to local health;
- 3) Description of local customs, festivals and lifestyle of residents and the relation between transportation systems and social transition.

In combining innovative technological and conceptual tools to describe interlinked human and biophysical phenomena in the Noto Peninsula, this project also contributes to the establishment of peninsula studies as an important field for future human-environmental inquiry.

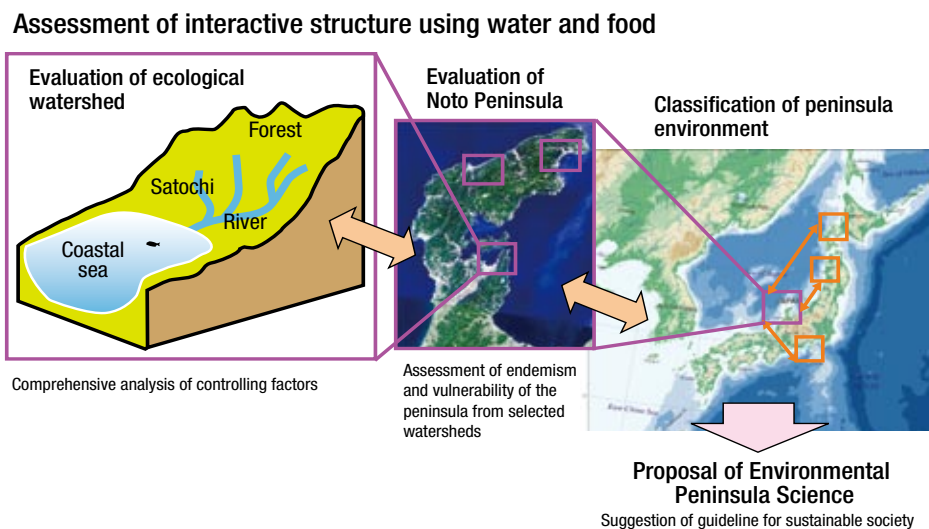


Figure Schematics of the evaluation method for the peninsula

An ecological watershed is the basic unit.

Historical Adaptation to Climate Change in Japan: Integrating Palaeoclimatological Data and Archaeological Evidence

How will climate change affect regional precipitation patterns? How ought human societies react to current changes of climate? This project takes a historical approach to such questions. Using high-resolution palaeoclimatological records, such as tree-ring oxygen isotope data, project researchers examine a number of regional signatures of climate variability during the past two millennia. Integrating such data with the extensive existing historical and archaeological evidence in and around the Japanese Archipelago will provide new insights into how past societies reacted to climate variability, and give clues as to how present and future societies can become tolerant of dynamic climate systems.

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Research purpose

Society-climate relationships have been poorly understood, largely due to the lack of detailed palaeoclimate data. This project will therefore precisely reconstruct climate variability in several regions and historical periods in Japan. Historical and archaeological investigations will allow better understanding of the nature and characteristics of societies that are tolerant (or vulnerable) to climate changes. In integrating palaeoclimatological and historical data and synthesizing findings from several case studies, the objective of this project is to describe general social characteristics or modes associated with tolerance to environmental change.

Strength of the research method

High spatiotemporal resolution palaeoclimate data of tree-ring cellulose oxygen isotopic ratios plays the key role in this project. Recent technical developments allow accurate reconstruction of past climate variability in yearly or monthly timescales. Such high resolution datasets bring remarkable advantages. They allow correlation of specific palaeographic evidence with concrete climate events such as drought and flood. Specific climate events and cycles can also be accurately linked to human historical

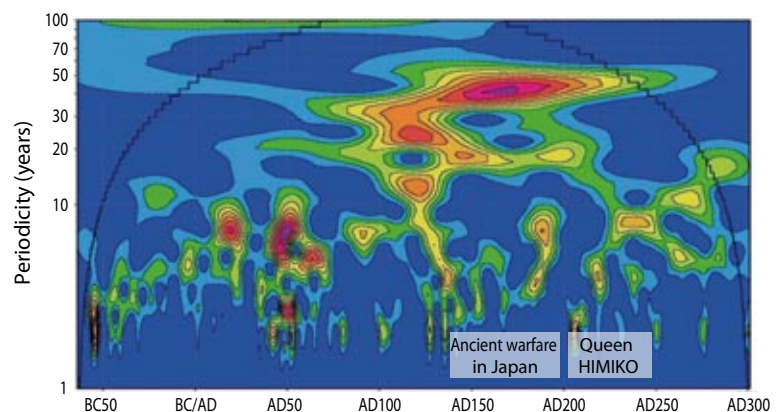
data in order to deepen understanding of past social vulnerabilities and changes.

Expected outcomes

Palaeoclimatological data obtained in this project will substantially improve understanding of Japanese history; it also will improve the validity of climate prediction models. Though there are different causes of past and current climate change, there may be similarities in how societies react to such change and an association between societies that are tolerant, or vulnerable, to local environmental changes and those that are tolerant or vulnerable to climate change. In this light, our analysis of climate-society relationships is expected to deepen our understanding of the capabilities of a human society to react to global environmental changes.



Photo Taking tree-ring samples from a live tree



Figure

This figure describes past cycles ('periodicity') of summer rainfall variability in central Japan, which is derived from a tree-ring isotope data gained from an ancient buried tree sample. Periodicity (in years) is shown on the vertical axis. Colours indicate intensity of periodicity (long wavelength colour = dominant periodicity). The figure therefore indicates that the dominant periodicity of summer rainfall variability changed significantly with time between 100 BC - 300 AD. The data allows us to hypothesize that multi-decadal variability affected historical events such as the period of ancient warfare in Wa (mid-late 2nd century AD) and subsequent appearance of the shaman Queen Himiko (late 2nd - mid 3rd century BC) of Yamataikoku, who was known for her rain-making rituals, and predictions of floods (cf. Records of Wei).

The Effect of Local Governance on Incentive Programs for Forest Ecosystem Service Conservation

This project examines forest degradation and possible recovery in two states of Malaysia. It examines the scope of deforestation and its effect on forest ecosystem services, and the potential of several international incentive mechanisms, such as carbon and biodiversity offsets, for reducing emissions of greenhouse gases from deforestation and forest degradation, protecting the pristine forests, slowing deforestation and securing forest ecosystem services. We will investigate local community response to the incentive mechanisms in order to describe how local governance systems can facilitate optimal and sustainable use of forest ecosystem services.

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Objectives of the study

This project examines the process of deforestation in two states of Malaysia. It documents the background spatio-temporal dynamics associated with forest degradation and deforestation. It also examines the local governance structures that can maintain the ecosystem services and natural resources provided by tropical forests. With this goal, we adopt two approaches to the question of forest governance. First, we examine local governance and the extent to which local people respond to locally-adopted initiatives. Second, we examine the effect of forest protection/development measures adopted by state and federal administrations. Comparative analysis of the two approaches will allow description of the best opportunities in forest preservation policy, and the challenges that remain to be addressed.

Methodology and approach

Field monitoring study takes place in Peninsular Malaysia, and East Malaysia (Sabah or Sarawak), all of which have experienced significant deforestation and are now targeted for reforestation. The key research areas are summarized as below:

- 1) Predictions of spatio-temporal changes in forest degradation and deforestation, and their associated

environmental risk:

- Analysis of landcover changes in the field sites.
 - Prediction and risk analysis of the socio-economic backgrounds of deforestation and land degradation processes.
 - Simulations focusing on future possible changes in, and optimization of, ecosystem services in the target areas.
- 2) Studies on the responses of local people to the soft-landing approach and introduction of an incentive mechanism:
- Survey on the reaction and response of local people to forest degradation.
 - Survey on how local and global incentive mechanisms would be accepted and used by local people.
 - Development of region-custom plans for sustainable use of natural resources.
 - Analysis of the compliance of incentive mechanisms to domestic and international laws.

Significance

The proposed study will thus contribute interdisciplinary evaluation of contemporary schemes to enhance biodiversity, and of the significance of local actors in long-term governance of forest ecosystems.

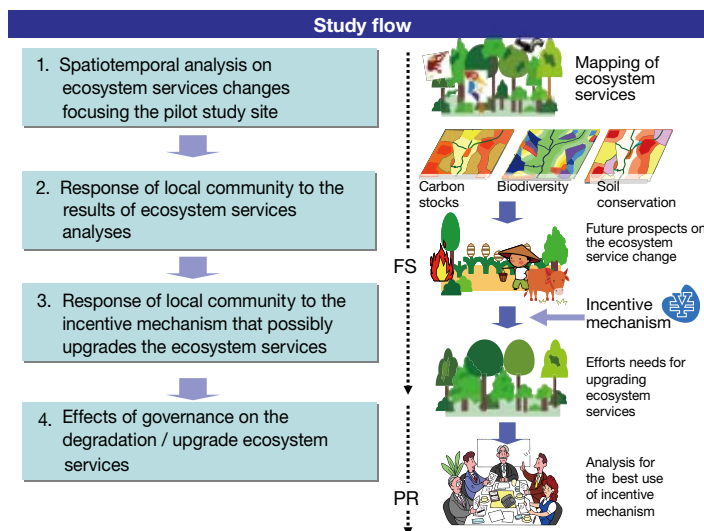


Figure 1 Flow of the study (FS: Feasibility Study; PR: Pre-Research)

Desertification and Livelihood in Semi-Arid Afro-Eurasia

Semi-arid Afro-Eurasia is one of the front-lines of desertification. Numerous nomadic and agricultural peoples inhabit the area, employing various husbandry practices and livelihood strategies. Difficulties in preventing desertification stem from poverty of the local communities that live on limited natural resources in the area, hence countermeasures to this environmental problem could be elicited from people's livelihood and be designed through glocal and human-scale actions therein. We will elucidate the interrelations between people's livelihood and desertification, and livelihood strategies for socio-ecological adaptation to desertification and suggest practical and feasible approaches to cope with the problem.

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Research backgrounds and objectives

Semi-arid Afro-Eurasia has been exposed to climatic, ecological and socio-economic changes with significant uncertainties. The area, one of the front-lines of desertification, appears to suffer from a vicious cycle of poverty and land degradation. The difficulty in successfully addressing complex socio-economic and environmental problems since ratification of the United Nations Convention to Combat Desertification (UNCCD) imply the need to re-examine approaches employed to date. The objectives of our project are therefore to: 1) deepen our understanding of human-environment interrelations and livelihood strategies relevant for socio-ecological adaptation to desertification; 2) re-examine current practices for desertification prevention and development assistance; and 3) suggest practical and feasible approaches to cope with desertification.

Research methods

Our study areas encompass the Sahel region of West Africa (Burkina Faso and Niger), southern Africa (Namibia), and semi-arid India. Each of these areas has distinct socio-economic and ecological contexts that modulate livelihood activities, threats to livelihood, and potential adaptation strategies. Inter-area comparison studies play an integral

role in identifying the common and region-specific features of the zone under study.

Socio-economic and ecological analyses will permit re-examination of current techniques used to prevent desertification and to promote development. Analysis of indigenous practices that have supported livelihoods and minimized desertification through time will allow project researchers to develop complementary countermeasures. Our recent innovation and development of a "fallow band system" in Niger has been proven useful in controlling wind erosion and concurrently promoting yield increase by 30 – 50% without the inputs of additional labour and materials (Fig. 1). We will use this system as an innovation tracer and/or pilot program in order to identify some channels of information and technique dissemination and to evaluate local adaptation and innovation.

We will also conduct action research in the field of indigenous technology- and technique-transfer, especially in the Sahel (Fig. 2). Noting that "indigenous" techniques are location-specific, we expect to observe hybridizations as specific techniques are adapted for local systems. Analysis of this process of hybridization should reveal some deeper aspects of livelihood dynamics.

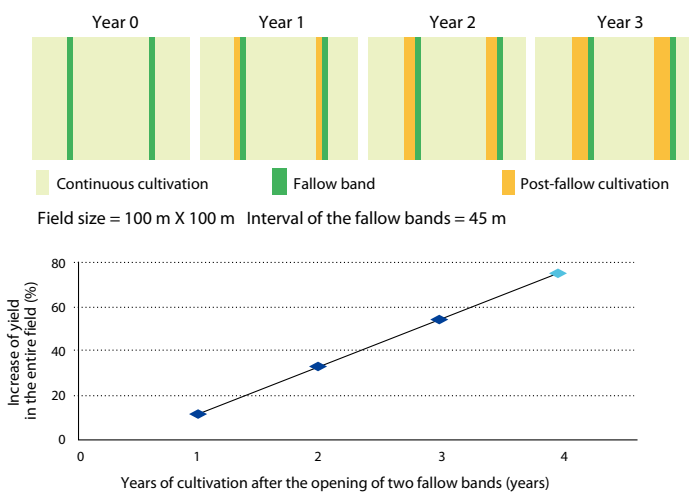


Figure 1 Fallow band system and yield increase

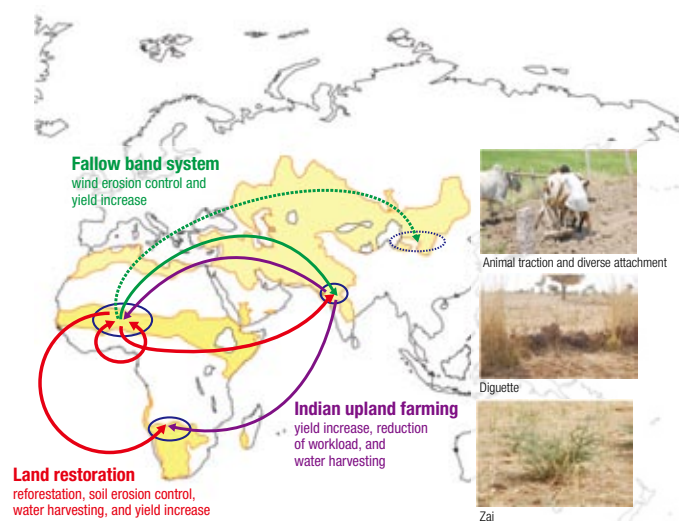


Figure 2 Action research for technology transfer

Environmental Change and Immunological Adaptation in the Mekong River Region

This study examines human immunological change and adaptation in relation to development and environmental change. The emerging field of environmental immunology provides the conceptual and methodological framework, as this field addresses the impact of environmental factors, such as exposure to pollution, nutritional stress, and infectious disease pathogens, on the human immune system. Field work will take place at selected sites in Vietnam, Cambodia, and Southern Laos, where people are often dependent on agricultural and aquatic resources and particularly susceptible to impacts of current environmental change.

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NGO: Action for Mangrove Reforestation

Project overview

The immune system is the human body's basic adaptive mechanism to changing environmental conditions, but recent environmental change occurs at a pace far beyond the body's capacity to adapt. This FS focuses on peoples dependent on Mekong River agricultural and aquatic resources, as their livelihoods are often directly affected by development in the region. Rich in natural and human resources, the Mekong region has attracted considerable investment and achieved remarkable economic growth in recent years. Poverty is still prevalent in the region, however, and environmental degradation associated with development often negatively affects traditional agricultural- and fisheries-based livelihoods. Japan's 2009 Official Development Assistance (ODA) program, "A Decade for a Green Mekong", highlights the need for environmentally-sound "green development" in the region, especially in relation to biodiversity and preservation of forests. Innovative approaches are needed.

Field research will describe food-nutritional status, which is undergoing rapid change, in relation to human resistance ("host defense") to disease. Environmental immunology provides the conceptual and methodological framework, as it links human physiological condition and health status to development and environmental change in

the Mekong River region; this study will therefore advance description of "sustainable development", especially in relation to human wellbeing.

Research structure

The central objective of the research is to document human immune response to recent development in the Mekong Delta of Vietnam, the Tonle Sap Lake area of Cambodia, and southern Laos. Water environments and dynamics are privileged, as hydrologic dynamics and water availability, access and quality are determinant in the region. Multi-dimensional field studies will describe: 1) the impact of upstream environmental change on fish-, coral- and mangrove ecology, as well as on agricultural, fishery and forestry resources; 2) kinetics of water levels, especially flood, in the study sites; 3) individual and community nutritional and immunological status through anthropometric measurements, diet records, and biochemical-immunological analysis of blood and urine. The incidence of infectious disease, including dengue fever, forest-, wet-rice- and coastal-malaria, as well as Mekong schistosomiasis and paragonimosis, will be tracked, as will immunological response to chemical pollutants.

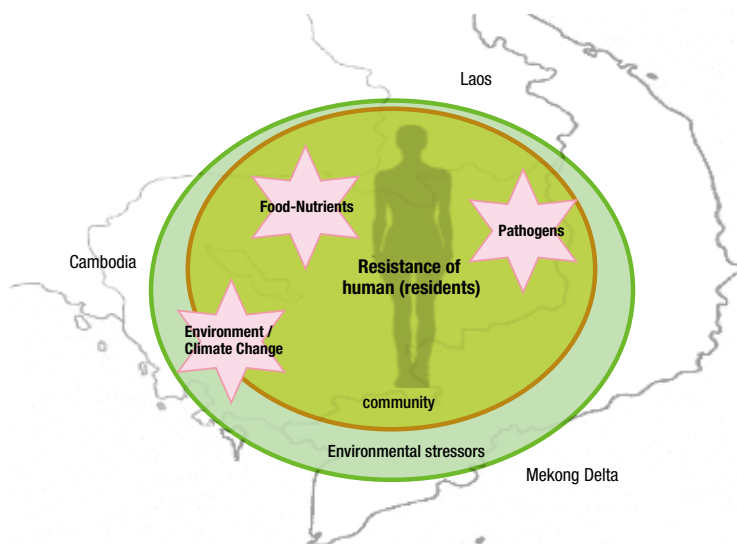


Figure 1 Key concept of the project

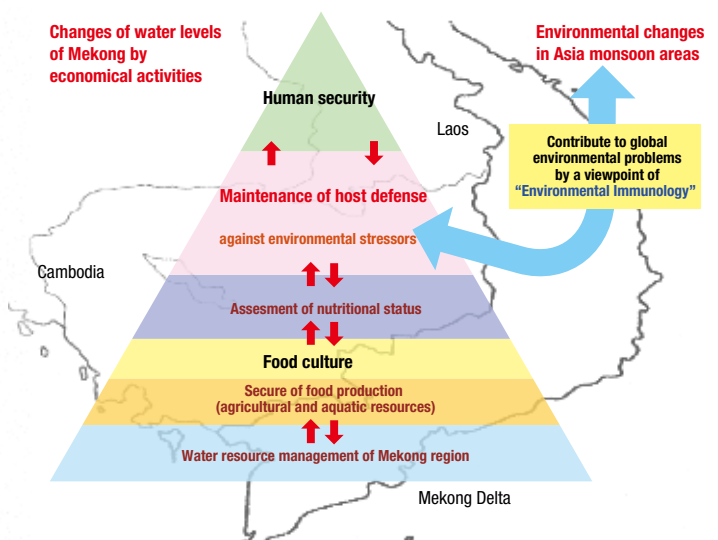


Figure 2 Research framework



A mangrove forest cleared to provide timber for the paper mill
Sumatra, Indonesia
ABE Ken-ichi

Color of a City
Ankara, Turkey
From above, a city is unified with the Earth's color
MATSUNAGA Kohei

