Sustainable Future among Water, People, and Living Things

Integrated Sciences for Sustainable Human-Aqua Environment "Aqua Science"

Research project to create a new study “Aqua Sciense”

水共生学
Sustainable Human-Aqua Environment

https://mizu-kyosei.net/

Greetings from the Representative

Research Area:
Integrated Sciences for Sustainable Human-Aqua Environment (Aqua Science)

Water is the primary source of life, and the ecosystems of forests, farmlands, rivers, and basins from rivers to the sea are home to various living creatures. Humans also benefit from various water functions, including water infrastructure, agriculture, forestry, fishery resources, faith, culture, recreation, cityscapes, and harbors.

However, due to climate change in recent years, heavy rain and other water-related disasters have frequently occurred in many areas of Japan. Additionally, water shortages and water risks have become major issues that are directly related to poverty and education problems worldwide.

Under these circumstances, achieving a society in which water, humans, and living organisms coexist sustainably is extremely important issue for modern society.

Conventional research examining the hydrological cycle that is mainly in the field of natural science has tended to focus on general phenomena with a high emphasis on universality on a global scale. However, for water crises and water risk issues, it is necessary to conduct research that is tailored to the local and environmental conditions. Additionally, in the modern era where human activities have become a major factor in water crises and water risks, a new discipline that encompasses multiple academic fields and integrates information from the natural sciences with knowledge from the humanities and social sciences is required. This is what we are creating with the Integrated Sciences for Sustainable Human-Aqua Environment (Aqua Science).

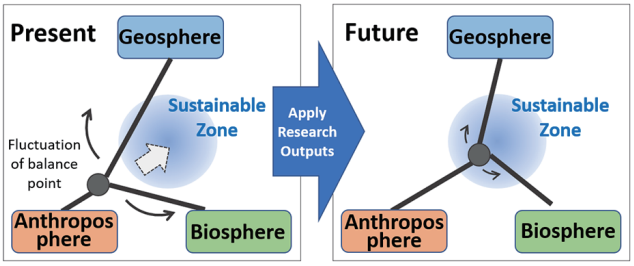
Aqua Science views the water environment as a “water cycle system” that constantly fluctuates according to the interplay among the three spheres that include the biosphere, the anthroposphere, and the geosphere. This concept proposes a future vision (ideal image of future) that conforms to the local environment to allow the system to be maintained within a sustainable range.

We are convinced that Aqua Science methods, in which different disciplines work together to solve problems, can be applied to solve various issues facing the world today.

Representative:
Kunio Araya (Chief Professor, Faculty of Social and Cultural Studies, Kyushu University)

Purpose of This Research Area

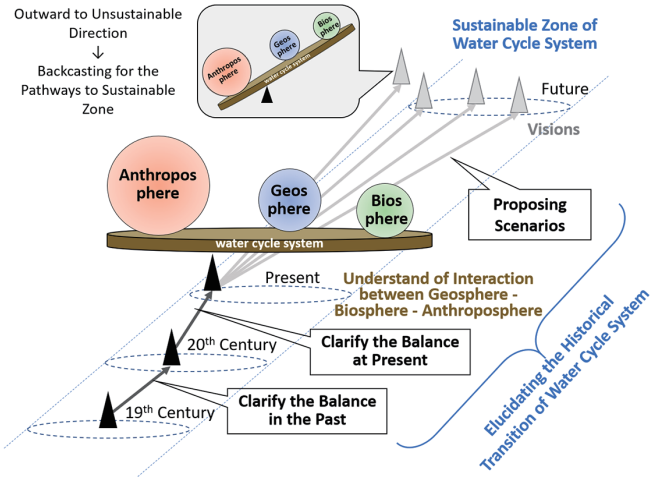
The hydrosphere environment that is essential for life is constantly subject to “fluctuations” caused by various internal and external factors such as climate change, ecosystem transition, and changes in social conditions related to water. As the range of these “fluctuations” increases, human society and ecosystems are significantly affected by frequent weather disasters, water resource conflicts, and biodiversity loss. Reducing these water crises and risks and establishing a society in which water, humans, and creatures can coexist in a sustainable manner are internationally important issues. In this research area, we consider the hydrosphere environment as a “water cycle system” established by the interaction of the geosphere, biosphere, and anthroposphere. We aim to create a new academic field, the Integrated Sciences for Sustainable Human-Aqua Environment (Aqua Science), with the primary objectives of elucidating the historical transition and current dynamics of the balance among these three spheres while exploring approaches to solve social issues related to the water environment that are in line with local conditions and proposing a vision for the future.



▲ The Goal of Aqua Science

Content of This Research Project

There are four research plans under three research groups targeting the geosphere (A), anthroposphere (B), and biosphere (C) in this research area. Planned research A01 aims to create information to understand the interactions among the geosphere, biosphere, and anthroposphere dynamically from the viewpoint of the water cycle based on the measurement and analysis of information regarding water and the surrounding environment and to develop an information translation approach necessary for utilizing the information in other planned research. Planned research B02 aims to dynamically clarify the fluctuation of the water cycle system from the past to the present from the viewpoint of social culture and history and to extract the socio-cultural factors that should be protected or modified to create a desirable symbiotic water society. Planned research B03 aims to empirically analyze from the standpoint of economics what types of water use methods are suitable for achieving healthy and prosperous lives in regions where water resources are scarce and water infrastructure is poor and what types of management measures and systems are necessary to conserve and improve the aquatic environment to explore the ideal form of sustainable water resource governance. Planned research C01 will assess the health of the basin ecosystem system by investigating the characteristics of the ecosystem and biodiversity that form the basis of the “basin sphere” where the natural environment surrounding water and human society and culture coexist to explore methods to conserve, restore, and sustainably use the water cycle system in ecosystems.



▲ Conceptual Diagram of Aqua Science

Expected Research Achievements and Scientific Significance

The creation of Aqua Science is expected to provide concrete measures to reduce water crises and water risks and ultimately make the water cycle system sustainable. Additionally, the Aqua Science approach in which different disciplines work together to solve problems can be applied to the analysis of other problems and risks facing the world today and to the creation of visions that lead to solutions. Furthermore, the promotion of this research area, including publicly offered research, will lead to the development of young researchers, the formation of a researcher network, and the discovery of new research themes.

Overview of Planned Research Groups

The main goals of Aqua Science studies are to view the water cycle system as a field of interaction among the geosphere, anthroposphere, and biosphere and to carry out the following three approaches.

1. To dynamically elucidate the present balance and historical changes of the focal point in the water cycle system under the actual conditions of each region based on data obtained from the geosphere, anthroposphere, and biosphere.
2. To propose a vision of the future of the region and certain routes to that vision based on the research results obtained.
3. To establish a reciprocal relationship between academia and the field to achieve a sustainable water cycle system in cooperation with stakeholders.

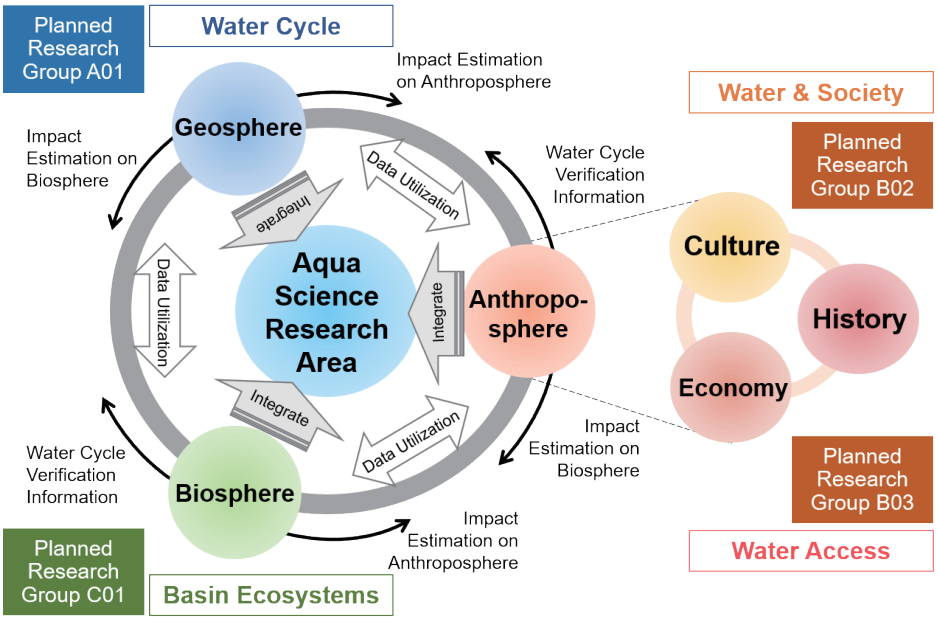
To achieve these three goals, this project involved the following research groups:

(1) The general research group
(2) Four planned research groups that included A. Geosphere (A01), B. Anthroposphere (B02, B03), and C. Biosphere (C01)
(3) A cross-academic team
(4) Publicly-offered research groups

(2) The research teams will be organized into four planned research groups based on three research items targeting the geosphere (A), anthroposphere (B), and biosphere (C). While the geosphere (A) and biosphere (C) are assigned one research group, two research groups will be established for research examining the anthroposphere (B). This is due to the observation that anthropospheric activities significantly impact the current state of the water cycle system, and it is necessary to analyze these activities from multiple perspectives.

To promote the field while maintaining organic coordination among the research groups, the research period was divided into two phases that included the first half (from the first to the third year) and the second half (from the fourth to the final year). In each phase, the roles of each research group and the coordination methods among the groups will be reconfigured. In the first half of the project, each planned research group will dynamically capture the “fluctuations” in the water cycle system from the past to the present and clarify how the equilibrium in the system has evolved. During this process, the datasets obtained from each sphere will be utilized reciprocally. For example, annual rings of wood excavated at archaeological sites, past newspaper articles, and folklore information will be provided to the planned research A01 in an attempt to improve the accuracy of the simulation, and concurrently, the simulation data will be utilized in the humanities as well as for ecological studies. Furthermore, based on microscale findings from the humanities and ecology, we propose parameters and datasets that need to be focused on by other planned research groups and thus promote joint research in collaboration with other groups. Each planned research group will be led by a representative, and three sub themes related to the overall theme will be established and structured, each with a sub thematic leader.

In the latter phase of the project, when mutual collaboration among the research groups becomes necessary, a cross-academic team (consisting mainly of the area representative, the planned research group representative, and the sub-theme leaders) will be organized beyond the existing framework of the research plans. The cross-academic team will play a central role in the creation of Aqua Science studies, including scenario development for the realization of a sustainable water cycle system and its social implementation, based on the research results obtained by each planned research group.

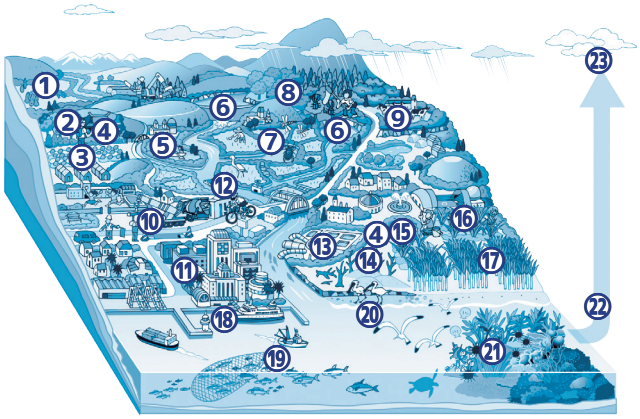


▲ Planned Research Groups of This Research Area

Water Environment

Relationship between Water, People, and Living Things

① Marsh/Salamanders
② Orchards
③ Fields, cultivated land
④ Shrine, sacred place
⑤ Leisure
⑥ Reservoir, dam
⑦ Paddy field/Aquatic insects
⑧ Satoyama, secondary forest
⑨ Dairy Farming
⑩ Water infrastructure development
⑪ Cities
⑫ River/Crucian carp
⑬ Sewage treatment plant
⑭ Pine die-off
⑮ Spring water
⑯ Pineapple fields
⑰ Sugarcane fields
⑱ Harbors
⑲ Fisheries
⑳ Tidal flats/Black-faced spoonbills
㉑ Coral reefs
㉒ Evaporation, transpiration
㉓ Clouds, rain



Crucian carp

Aquatic insects

Black-faced spoonbill

The Main Joint Fields

In this research area, several joint fields will be established in which multiple planned research groups will work together to conduct surveys, research, and social implementation.

The main joint fields are as follows:

I. Northern Kyushu (particularly Takeo City, Saga Prefecture)
II. Kushiro City and the East Hokkaido area
III. Otaru
IV. The Ryukyu Islands
V. The Mekong River basin.

The reasons for establishing the joint field are as follows.

I. The Chikugo River Basin, the largest river in Kyushu, was included. It is suitable for research examining water cycle systems from various perspectives, including river traffic, estuary development, the use of tidal flats, and frequent heavy rainfall disasters.
II. The Kushiro Marshland, the largest RAMSAR wetland in Japan, is located in this area and is becoming a grassland due to the effects of global warming and other factors. Kushiro is also the largest port in eastern Hokkaido.
III. Based on its development as a port city in Hokkaido.
IV. This is due to the observation that they are strongly affected by changes in the frequency and intensity of typhoons. Additionally, it is a remote island, and thus, there is a trade-off between securing water resources and preserving the biodiversity of aquatic environments.
V. It hosts Tonle Sap Lake, the largest freshwater lake in Southeast Asia, and is one of the leading international rivers in the region. Additionally, the river is facing a crisis of destruction of the basin ecosystem due to the increased use of fishing, domestic and industrial water, hydropower generation, and other purposes based on the development of neighboring countries.

The project also aims to model the results and experiences of these joint field studies to make them applicable to other regions.

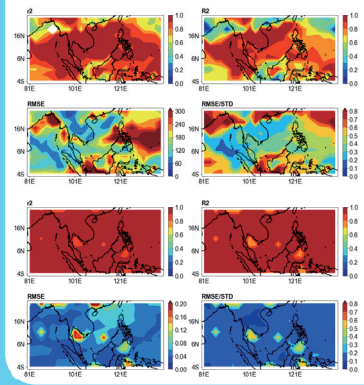
▲ The Main Joint Fields

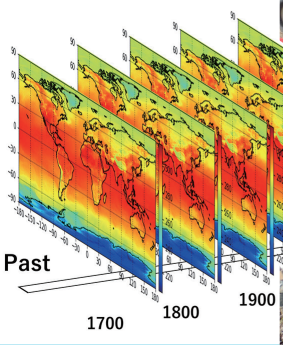
Planned Research Group A01

A01: Generation and development of information regarding water and its surrounding environment to create Aqua Science

Concept

In this planned research, we will elucidate information regarding water and its surrounding environment for the creation of Aqua Science studies, as this is the goal of this research area. This information will be the basis for dynamically clarifying the fluctuation of the water cycle due to interactions among the geosphere, biosphere, and anthroposphere from a sociocultural perspective. Specifically, we will 1) reproduce the long-term hydrological climate transition over the past 300 years and predict the future hydrological climate for the next 100 years using hydrological climate simulations, 2) measure the water surrounding the environment by remote sensing, and 3) clarify the dynamics of water and environmental substances on a watershed scale by observation and numerical modeling. This planned research aims to clarify past, present, and future water changes and the surrounding environment by conducting three additional planned research group studies. We will also develop an information translation approach to convert the spatiotemporal resolution and probabilistic characteristics of geoscience data into a form that can be efficiently utilized for research in the biosphere and anthroposphere.



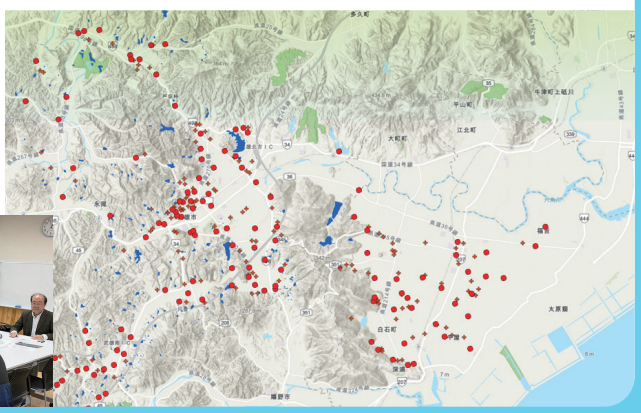


Planned Research Group B02

B02: Elucidating the society, culture, and behaviors that support a sustainable human-aqua society: determining what needs to be protected and what needs to change.

Concept

One of the keys to reducing water crises and water risks and creating a society in which the aquatic environment, humans, and living creatures coexist in a sustainable manner is to clarify the sociocultural factors that should be protected and those that should be changed in the anthroposphere, identify the major causes of fluctuations in the water cycle system, and utilize the findings to create a sustainable human-aqua society. In this planned research group, we will dynamically clarify the fluctuations in the water cycle system from the past to the present in terms of beliefs and symbolization (sub-theme 1), institutions and lifestyles (sub-theme 2), and perceptions and behaviors (sub-theme 3), and we will extract sociocultural factors that should be protected/changed to create a sustainable human-aqua society. The project will then present the social and behavioral changes that will contribute to the realization of future visions for the achievement of a sustainable human-aqua society (vision) and the formulation of a roadmap (scenario) for solving social issues in the water environment.

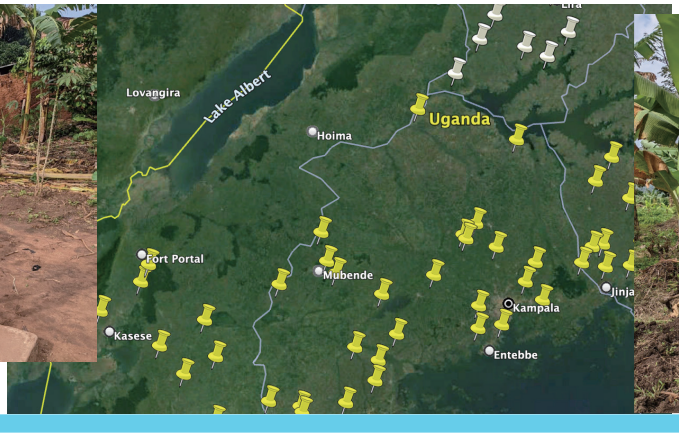


Planned Research Group B03

B03: Micro empirical analysis of sustainable water resources governance

Concept

This planned research group explored how to use water for healthy and prosperous livelihoods in areas possessing scarce water resources and poor water infrastructure and what type of conservation of the water environment, maintenance measures, and mechanisms are required to use water resources sustainably. This study empirically analyzes micro- and historical data at the household and village levels from the perspective of development economics and economic history to explore the sustainable governance of water resources. To achieve our goal, we will collect panel and historical data at the household and village levels in developing countries and combine them with simulation data detailing the spatiotemporal distribution of water resources provided by planned research group A01 to examine the relationship between water resources and human society in a new manner. Additionally, with the cooperation of the planned research group C01, this research will be conducted with an emphasis on the impact of socioeconomic activities on ecological systems, as this has rarely been considered in development economics.

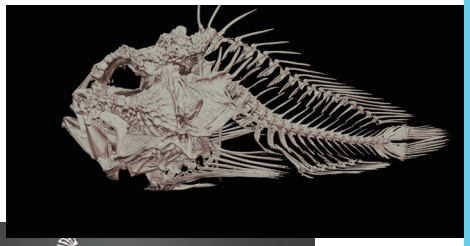


Planned Research Group C01

C01: Coexistence between humans and nature in basin ecosystems

Concept

Of the three spheres (geosphere, biosphere, and anthroposphere) that act on the “fluctuations” of the water cycle system, this study focuses on “basin ecosystems” as the aspect of the biosphere that connects the geosphere and the anthroposphere. We will visualize the network of basin ecosystems by elucidating the environmental characteristics and biodiversity and the interaction between creatures and their environment for the major ecosystems that make up the basin ecosystems (forest ecosystems, agricultural land ecosystems, and riverine to shallow sea ecosystems). By observing the dynamics of water cycle systems and basin ecosystems and evaluating the inherent multidimensional functions and resilience of basin ecosystems, we will propose scenarios for solving social issues in the water environment that are relevant to local conditions. We will also provide a future vision for achieving a new “Regional Circulation Ecosystem on Basin Sphere” and explore methods to facilitate “coexistence between humans and nature.”



Impressions from a Cambodia Excursion

Masato Furumoto (Graduate Student, Faculty/Graduate School of Agriculture, Kyoto University)

My first visit to Cambodia occurred during my first year of college (2019). This time, I had the opportunity to participate in an excursion to the Tonle Sap Lake area in March 2024. Here, I report what was particularly impressive and interesting about this trip.

The first thing that impressed me was the change in the lake's water level. When I saw Tonle Sap Lake, the largest freshwater lake in Southeast Asia, I was surprised by the size of the lake and the height of the houses built along its shores. The tour was conducted during the dry season. I knew that the water level changed with the seasons, but the changes were beyond my imagination; the flooded forest that I entered by a small boat in August was land in March (Photo 1). In the village on the lake, all life can be observed in the water; for example, churches, elementary schools, supermarkets, and other facilities are established on the water and are accessible by boat. I was also surprised at the relocation of housing from offshore to the lakeshore side of the lake to adapt to changes in water levels.

What interested me while I was there was the lake's water quality. Residents of the Tonle Sap Lake area draw water from the lake for non-drinking purposes and discharge it directly into the lake along with domestic wastewater, feces, urine, and garbage. Additionally, fuel for tourist boats, fishing boats, and wastewater from nearby factories flow directly into the lake. Moreover, it was feared that the submergence of farmland during the rainy season would cause pesticides and chemical fertilizers to leach out during the dry season, which may affect the human body and also the ecosystem. According to the interpreter, the number of fish in the lake has been decreasing in recent years, but he only cited overfishing as the cause, with no mention of water quality deterioration. He also stated that there were no particular health hazards from using lake water. However, concerns have been raised regarding the impact of water pollution on fishery resources, the health effects of using polluted lake water, and whether these effects contribute to the household economy. The lifestyle of residents is customary and may not be easy to change, but it is necessary to devise ways to control lake pollution in terms of garbage disposal and wastewater treatment methods.

▲ Photo 1

In fisheries, each household has a defined area where it can fish, and a no-fishing zone is set during the spawning season. However, overfishing by electroshock fishing and fishing in prohibited areas still seem to be practiced. Fishing against the rules is punishable by imprisonment, fines, etc, but with the number of fish decreasing, competition among fishermen may be intensifying. Near the port, we saw fishermen selling their catches to wholesalers (Photo 2). Because the wholesale price differs from one vendor to another, they sometimes decide which wholesaler to sell by asking fellow fishermen on their cell phones about the selling price or by asking people to pass on the water after they have sold.

During this excursion, we visited three floating villages along the Tonle Sap Lake, each with a different

ethnic composition. Although there are many Vietnamese in Chong Khneas, there is a mixed population of Vietnamese and Khmer, while Mechrey and Kampong Phluk have only Khmer residents and not a single Vietnamese. I was interested in the historical backgrounds of the settlements and the differences in the strength of community ties.

Another impressive sight was the presence of a garbage mountain. In Cambodia, there are no incineration facilities for garbage. Therefore, garbage from the city is collected in one place called a garbage mountain (Photo 3). I was surprised to learn that some people gathered recyclable materials and sold them to traders to earn income. Traders sell their purchased resources in Thailand and Vietnam. By working in the garbage mountain for a month, they can earn approximately twice the average monthly income of a farmer, but there is a risk of illness and injury because some of the trash is medical waste. Nevertheless, people from adults to children made a living by scavenging resources in the garbage mountain. In response to this situation, a group in a village located near the garbage mountain was working to increase vocational options such as banana paper-making, cricket farming, and pepper cultivation.

▲ Photo 3

▲ Photo 2

Rapid development in the Mekong River Basin is likely to have an increasing impact on Tonle Sap Lake. It will be necessary to analyze what kind of water usage and management system is appropriate and to explore how water can be used sustainably while taking into account the existing problems of water pollution, reduction of fishery resources, and flooded forests, and their impact on biodiversity. As these challenges are addressed, it is important to respect the wishes of people who live in harmony with the lake and carefully consider what should be protected and what should change.

From the Field of Malaria Research in Kenya

Tomoya Matsumoto (Professor, Otaru University of Commerce)

Traveling through East Africa, one encounters densely populated areas, such as Nairobi, Kigali, and Addis Ababa, located on plateaus with sufficient rainfall. The climate in these regions is relatively cool, with distinct rainy seasons, a high potential for food production, and fewer endemic disease-carrying organisms. However, only a limited number of areas offer such favorable living conditions for humans. The next most populated regions are the humid lowlands. Although water is essential for life, it also serves as a habitat for malaria-carrying mosquitoes. Many people have settled in areas with high malaria infection rates, accepting an environmental trade-off between access to water and the risk of disease. One such area is Homa Bay County, Kenya, which is the site of our research.

This project aimed to develop policy tools to encourage active infection control among residents living in malaria-affected areas. The reason we are looking at interventions for the residents is the belief that the “last mile” of malaria control cannot be achieved without the commitment of the residents themselves.

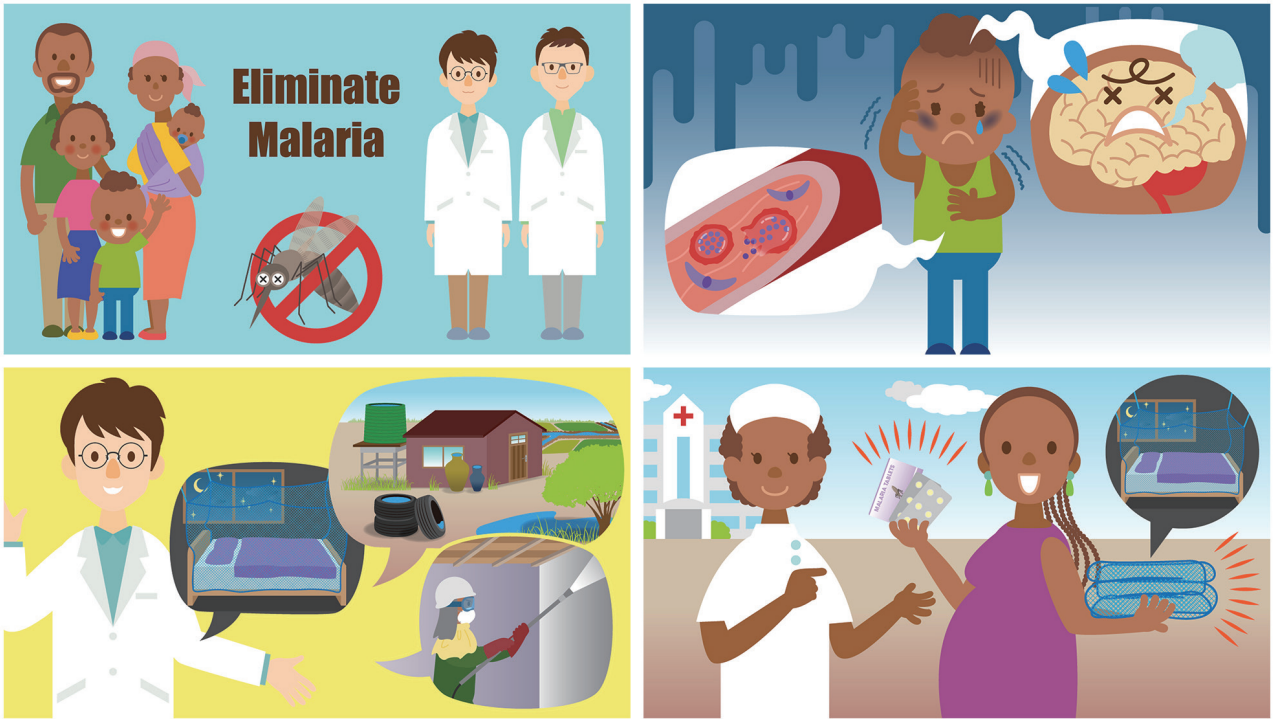
Over the past 20 years, the United Nations Millennium Development Goals and the establishment of the Global Fund, have increased funding for malaria control, leading to significant improvements in the supply of health care services. However, there are still high malaria epidemics that continue to occur in many parts of tropical Africa. The infection rate is also high in the Suba South district of Homa Bay County, with malaria-positive rates of 16.7% among all residents and 24.4% among children under 15, according to our most recent survey. One factor contributing to this high infection rate is the low motivation among some residents to prevent malaria. For example, insecticide-treated mosquito nets are highly effective in prevention; however, in the target areas, mosquito nets distributed for free are used for other purposes or are stored as new. Malaria is sometimes referred to as “the disease of poverty.” Although poverty may prevent people from affording preventative measures, it does not fully explain why free mosquito

nets are not properly used as intended. There must be other reasons for not using free mosquito nets for prevention.

"How can residents be encouraged to be proactive in malaria control?" To address this challenge, we designed a unique policy tool. This tool has two pillars. The first pillar is a knowledge intervention using educational materials on malaria developed by our research team (Figure 1). Under the guidance of medical researchers, the educational content covers malaria's characteristics, including transmission mechanisms, prevention methods, the recent focus on low-parasite-density transmission, and the risk of transmission from asymptomatic infected individuals. Residents in malaria-affected areas acquire immunity against the disease as they have been exposed to malaria parasites for a long. Such individuals with acquired immunity do not have symptoms even when they are infected. However, they can transmit malaria parasites to family members and surrounding residents. Thus, they should be protected from mosquitoes by proper preventive measures to interrupt the transmission route. Such information on asymptomatic malaria cases was new to most of the residents. Educational materials further include an explanation of the economic losses due to malaria and the benefits of prevention and early treatment, including the direct and indirect costs of treatment, lost income resulting from missed work, loss of academic performance caused by missed school days, and the potential for lost future opportunities. Malaria teaching materials that utilize findings from medicine and economics are new. This content is delivered by animated images in the local language via tablet devices. We expect that this education system can overcome several issues in awareness-raising activities in developing countries, such as the lack of human resources and the cost of training, and, hence, it can cover a larger number of the population at a reasonable cost.

The second pillar is the financial incentive system. In this project, two incentive schemes are introduced. One is a Conditional Cash Transfer (CCT) scheme, in which a small reward is given to non-infected individuals at follow-up visits, and the other is a Lottery Incentive Scheme (LIS), in which a lottery with a large reward with a small probability is given to non-infected individuals. The CCT-like incentive scheme is currently widely used to promote behavioral changes in the context of development programs targeting poor households. By contrast, LIS has few applications and is a variant of CCT that utilizes the findings of subjective probability in behavioral science. If people have a subjective probability tendency to overestimate the likelihood of events with low probabilities of occurrence, then a system in which people may win a large reward may have a greater impact on their behavior than a system in which they are only assured of a small reward. In addition, LIS has the advantage of reducing the operational costs of reward payment because the reward is paid probabilistically among candidates who meet the conditions.

In this study, a combination of the aforementioned contents was introduced in the framework of a randomized controlled trial to measure its effectiveness. Thus far, we have confirmed the following: 1) The original teaching materials have increased residents' knowledge of malaria. 2) Improved malaria knowledge promotes appropriate use of mosquito nets. 3) CCT has a positive effect on net use but no effect on RDT transmission rates. However, no LIS effect was observed on any of the indicators. Based on these results, we intend to improve the content, especially the design of the incentive schemes, to develop a more effective policy tool for social implementation.



▲ Figure 1 Educational Material Sample Images

Research and Studies on Agricultural Ponds

Satoshi Watanabe (Associate Professor, Kyushu University)
Yasuyuki Maruya (Associate Professor, Kyushu University)
Shinya Nakashita (Associate Professor, National Institute of Technology (KOSEN), Kure College)
Atsushi Okazaki (Associate Professor, Chiba University)

The core concept of the Integrated Sciences for Sustainable Human-Aqua Environment (*Aqua Science*) is the "water cycle system," which views the environment around water as a system formed by the interaction of the geosphere, the anthroposphere and the biosphere. Our research on agricultural ponds aimed to understand the balance between these three spheres. Agricultural ponds have been constructed since the Asuka Period to secure water resources for agriculture and other purposes. Many agricultural ponds were built throughout the country during the Edo Period and over time they have played an important role in the region's water resources. In addition to their importance as water resources, agricultural ponds are also important facilities in terms of human aspects, such as the formation of the landscape around the agricultural pond, recreation, such as swimming and fishing, and the biosphere, such as providing a habitat for animals and plants.

The environment surrounding agricultural ponds has changed significantly in recent years. The intensification and increased frequency of heavy rainfall have altered the water cycle around agricultural ponds, whereas declining populations and changes in agricultural practices have led to a shortage of people to maintain and manage agricultural ponds. A notable example of these changes was the collapse of several agricultural ponds during torrential rains that hit western Japan in 2018. In this case, several agricultural ponds collapsed. There were also casualties that raised public awareness of the risks posed by agricultural ponds. Most agricultural ponds are managed by local people, who benefit from them. Owing to population decline and depopulation, the number of people responsible for managing these ponds has been rapidly decreasing, and the decline in management capacity is becoming an issue in many parts of the country. In particular, in areas where urbanization and the conversion of rice fields to other crops are progressing, the demand for agricultural water is decreasing, interest in ponds in the area is also decreasing, and the number of agricultural ponds with uncertain management situations is increasing. To eliminate the risk of flooding from agricultural ponds, it is possible to consider abandoning the agricultural ponds by filling them in or cutting the embankment to remove their water storage functions. However, as noted above, many agricultural ponds have existed for many years, and sudden changes in the aquatic environment that would result from their abandonment are likely to have a significant impact on the local ecosystem. In addition, in recent years, it has been suggested that agricultural ponds and other freshwater bodies have the potential to contribute to the reduction of carbon dioxide emissions by storing carbon, and that they could be used for flood control by exploiting their water storage effect. Given these agricultural pond functions, we could not conclude that they should be eliminated.

▲ Measuring water quality with analytical equipment at an agricultural pond

While there is growing interest in the positive and negative aspects of agricultural ponds, there are still many unknowns about the reality of agricultural ponds. One of the main reasons for this is that Japan has an enormous number of agricultural ponds, estimated at 150, 000 (according to the Ministry of Agriculture, Forestry, and Fisheries). In addition, as the interest in agricultural ponds wanes, it becomes more difficult to pass on knowledge regarding agricultural pond maintenance and management that has been passed down in local communities over time, making research more difficult. With this in mind, the Agricultural pond Research Team of the Aqua Science is conducting a survey of agricultural ponds in the cities of Takeo in Saga Prefecture, Saijo in Ehime Prefecture, Higashi-Hiroshima in Hiroshima Prefecture, and Hirosaki in Aomori Prefecture. In addition to analyzing aspects of the geosphere, such as water circulation and water quality, through continuous monitoring using monitoring equipment and chemical analysis of water samples. We are also analyzing aspects of the anthroposphere, such as the current state of maintenance and management of agricultural ponds, through questionnaires and interviews with managers, and analyzing aspects of the biosphere, such as the presence or absence of aquatic plants through remote sensing, and the presence or absence of organisms through environmental DNA.

To understand the interactions between the geosphere, anthroposphere, and biosphere surrounding agricultural ponds, it is necessary to analyze them from a variety of perspectives. For example, there are many cases where a local shrine is located near the agricultural pond, and there are also many cases where the agricultural pond is related to the local culture. We would like to address the various issues surrounding agricultural ponds from a variety of perspectives, taking advantage of the strengths of Aqua Science, which involves researchers from different academic backgrounds.

Spring Water, People, and *Kami-sama* (Spirit) in the Okinawa Islands

Nahoko Shimada (External Researcher, Research Institute for Humanity and Nature)

Is it a sacred place or a watering hole? When visiting the springs of the Okinawan Islands, I cannot see the boundary between the watering holes full of life and the sacred places that are objects of faith. For example, Yozagar in Itoman City is a spring with abundant water, and farmers draw water into tanks on their light trucks. A washing place and a swimming pool for children have been built here, and a waterwheel used to be installed in order to squeeze the juice out of the sugarcane; therefore, this has always been an indispensable water source for people's daily lives. Looking toward the water outlet, there are three shrines labeled "Old Spring," "Great Spring," and "Gushing Spring," each with an incense burner. There was incense left behind, as if it had been worshipped recently. Nearby, there was a sign that read, "This is a sacred place. Let's keep it clean. Neighborhood association leader." It is not only a place of water for daily life, but also a sacred place. Not only here, but almost all of the springs I saw in Okinawa were also sacred places.

▲ Yozagar in Itoman City

Places where spring water and sacred sites combine can be found throughout Japan. Spring water is commonly found in shrines. However, they are classed as sacred water and are not used to wash clothes or for children to play in. In this way, it can be said that the characteristic of Okinawan spring water is the integration of water that supports people's daily lives and water that is an object of faith. Another characteristic is that even if people stop using water because of the spread of the water supply or the depletion of spring water, they do not stop believing in water. The wells that are no longer used have become "*Ogami-ido* (the well to worship)" and continue to live on as sacred places.

▲ Spring water in Ginoza Village

While researching the current status of spring water in Okinawa and the relationship between water use and faith, I had the opportunity to interview Tomoko Gushi, author of "*Okinawa Spring Water Travels*" in March 2023. As a radio personality for a program on Radio Okinawa, she visited more than 400 springs in the prefecture and interviewed those who used them. After the program, she launched the "*Spring Water Fun Club*" to collect and disseminate information on spring water in Okinawa, hold study sessions, and create playing cards and maps of spring water. She was a key person who could not be ignored when learning about spring water in Okinawa, but that was not the only reason I wanted to meet her. In her book, she described the scenery of people who use spring water in their daily lives. For example, an old lady who climbed a steep cliff up and down in sandals to fetch water told a story about how good it felt to bathe in the water while fetching it. One man said that he went to drink spring water at night to become sober. And the story of "*mizumori*," a ceremony in which people drink spring water from each other's villages at their weddings. The book contains sentences that bring these scenes to life. It also describes how people interact with spring water, influence each other, and how they have changed over time. I wanted to ask her about the relationship between people and spring water deliberately, as she had long observed spring water through the five senses, which are difficult to read from data such as water volume and water quality. And I would like to include "*kami-sama* (spirit)" in this discussion.

"Fluctuation," as defined in Aqua Science, is clearly visible in the spring water in Okinawa. Water pollution, decreased water quantity, and water depletion. How do people deal with spring water in Okinawa when it "fluctuates"? How does faith relate to this? What can we do from now on? I would like to think about this while listening to the stories of people like her who are involved with spring water on a daily basis.

3D Digital Biological Specimens as a Visualization of Biodiversity

Yuichi Kano (Researcher, Kyushu Open University)

Hegel, a 19th century philosopher, advocated the concept of the spiral development of things. According to Hegel, things seem to return to their origins after they have gone through a series of changes and evolutions, but in terms of dimensions, they develop in a spiral around a single axis.

Against the axis of "representing the form and behavior of living organisms," we have progressed from handwriting, to film cameras, to video cameras, to digital cameras and to CT scans. As the next step, the author has developed a method called "biophotogrammetry," which uses photogrammetry to capture the external three-dimensional morphology of living organisms. Photogrammetry is a method of constructing external shapes and colors by capturing numerous photographs of a subject from various angles. Although photogrammetry has been used for the 3D modeling of terrain using drones, it has not been widely applied to biological specimens because of their soft nature. If any part of the specimen moved during the photography, it would be impossible to build an accurate 3D model. The author, therefore, solved this issue by a simple method of hanging and rotating the biological specimens in mid-air and taking photographs from various angles while moving. It was suspended and rotated to photograph it from various angles while minimizing movement.

3D models created using this method are expected to be applicable in various fields. In biological taxonomy, digital preservation that does not degrade has advantages such as backup of physical specimens and easy online access (preservation of physical specimens is fundamental). Furthermore, there is growing interest in applying this technology to virtual reality (VR), augmented reality (AR) and the metaverse, particularly in the entertainment industry, which has made numerous inquiries about its use.

Now I mention the spiral development of things, but how will things progress in the future? Perhaps the next step in evolution is the digital representation of living organisms in four dimensions (3D+move). The key is the identification of moving parts using CT scans and AI-driven deep learning to simulate the movements of living organisms. With this development, I predict that digital preservation of specimens and the metaverse will become more realistic.

▲ Snapshot of the 3D model of a gazami crab

"Biophotogrammetry" advocacy paper:
https://doi.org/10.3897/rio.8.e86985
3D Digital Biological Specimens archive:
https://sketchfab.com/ffishAsia-and-floraZia/models

Report: Habitat Survey of Swinhoe's Rail

This is a report on a bird survey conducted by Toshio Sadakuni (Kushiro City Museum) from August 9 to 15, 2023, in Kushiro Marsh, a joint field.

Among birds, rails are particularly difficult to study and their ecology remains largely unknown. One reason for this difficulty is that they walk in marshlands where reeds and sedges thrive and their main activity occurs at night, making them difficult to observe. Another reason for the lack of progress is that marshlands can become a bottomless swamp if one makes a wrong move.

Swinhoe's Rail, one of the species surveyed, was thought to be a winter bird in Japan (migrating to Japan to spend the winter), but in recent years, it has been found breeding in Japan. In ornithology, the replacement of wintering birds with breeding birds has been a major discovery.

Swinhoe's Rail inhabits a narrow range in Far Eastern Russia and Asia. In Japan, the species has been recorded from Hokkaido to Okinawa; however, its breeding grounds are limited to Hokkaido. It is especially abundant on the Pacific Ocean side and in the eastern Hokkaido region, and the Kushiro Marsh is one of its largest habitats.

The Museum is working to explore new habitats in Hokkaido, including the Kushiro Marsh, and elucidate their ecology. In regard to Swinhoe's Rail little is known about its basic ecology, therefore it is necessary to investigate their nuptial morphology, brood-rearing period, calls of both sexes, and migratory routes. Among the common rails, Swinhoe's Rail is categorized as Vulnerable (VU) on the IUCN Red List because of its narrow habitat preferences and small populations. We will continue our research in order to inform as many people as possible about the existence of rails, including Swinhoe's Rail.

▲ Swinhoe's Rail observed during a survey in Kushiro Marsh (photo by Chieko Ishige)

▲ Canoeing up the marshland river to search for the habitat of Swinhoe's Rail

(Toshio Sadakuni)

In October 2023, Atsushi Tominaga (Professor, University of the Ryukyus) co-authored a paper published in *Nature*. The decline of amphibians, which depend on aquatic environments for reproduction and growth, suggests a challenge that Aqua Science should address.

Luedtke, J. A., Chanson, J., Neam, K., Hobin, L., Maciel, A. O., Catenazzi, A., Borzée, A., Hamidy, A., Aowphol, A., Jean, Á., Sosa-Bartuano, A., Fong, G. A., de Silva, A., Fouquet, A., Angulo, A., Kidov, A. A., Muñoz Saravia, A., Diesmos, A. C., Tominaga, A., … Stuart, S. N. (2023). Ongoing declines for the world's amphibians in the face of emerging threats. *Nature*, 622, 308–314.
https://doi.org/10.1038/s41586-023-06578-4

Introduction of the Paper

A paper showing a continuing decline in amphibian species by analyzing assessments of IUCN Red List species has been published in *Nature*. This study calculated and evaluated the Red List Index (RLI), an index based on the degree of change in rank between the first and second surveys of Red List species, and made comparisons among taxonomic groups. Globally, the study showed that amphibians have been in continuous decline, with the highest percentage of threatened species among vertebrates (approximately 40%). While infectious diseases were the main cause of the decline until 2004, climate change was the major factor in the following 20 years, followed by habitat destruction. In Japan, habitat destruction is a major factor contributing to this decline.

(Atsushi Tominaga)

Figure 1: Okinawa ishikawa's frog (*Odorrana ishikawae*), an Okinawa Prefectural Natural Monument and a nationally rare species of wild fauna and flora that is found only in the northern part of Okinawa Island (Yanbaru)

Figure 2: Abe's salamander (*Hynobius abei*), a nationally rare species of wild fauna and flora

Achievements

- Nagai Shin, Taku M. Saitoh, Ayumi Kotani, Tomoaki Miura, Hiromi Nakagawa, Chifuyu Katsumata, Hiroshi Morimoto, Hideyuki Onishi "Perspective and review: how to develop our understanding of temporal changes in the relationship between people and the landscape under societal and climate change in Northeast Asia?" *Frontiers in Environmental Science*, 12, 2024
- K Ichikawa, JQ Zhu, J Noda, R Sakemi, K Yufu and K Matsuura,"Ship-borne wave gauge using GNSS interferometric reflectometry" *Coastal Engineering Journal*, 2024
- Seiji Miyazono, Hideaki Miyahira, Takumi Hanaoka, Ryohei Nakao, Yoshihisa Akamatsu "Environmental DNA based biomonitoring for hatchery-raised fish in riverine habitats before and after recordable flood event" *Journal of Freshwater Ecology,* 39, 2024
- Tomoya Matsumoto, Masaru Nagashima, Wataru Kagaya, James Kongere, Jesse Gitaka, Akira Kaneko "Evaluation of a financial incentive intervention on malaria prevalence among the residents in Lake Victoria basin, Kenya: study protocol for a cluster-randomized controlled trial" *Trials*, 25, 2024
- Yuichiro Fujioka "Classification of Daily Food Sets in an Agro-Pastoral Society in North-Central Namibia: A Comparison of Cluster Analysis and Two-Way Indicator Species Analysis." *African Study Monographs Supplementary Issue*, 61, 187-203, 2023
- Masaru Nagashima & Chikako Yamauchi "Female Education and Brideprice: Evidence from Primary Education Reform in Uganda" *The World Bank Economic Review*, 37(4), 599-619, 2023
- Kajisa, K. and Vu, T. T. "The importance of farm management training for the African rice Green Revolution: experimental evidence from rainfed lowland areas in Mozambique" *Food Policy*, 114, 1-14, 2023
- Haruki Karube, Kunio Araya, Ken-Ichi Odagiri, Etsuko Moritsuka and Tadashi Kitano "A New Species of the Genus Hydaticus (Coleoptera: Dytsicidae) from Yambaru Area, Northern Okinawa Island, Ryukyu Archipelago." *Japanese Journal of Systematic Entomology*, 29(1), 138-143, 2023
- Utsumi, N., Kim H., "Observed influence of anthropogenic climate change on tropical cyclone heavy rainfall", *Nature climate change*, 12, 436-440, 2022
- Masaomi Kimura, Satoru Kobayashi, Marie Mitsuyasu, Wenpeng Xie, Toshiaki Iida "Simulation model of water temperature variation in dual-purpose canals considering return flow from upstream paddy fields" *Irrigation and Drainage*, 71(S1), 138-154, 2022

Integration of Academic Fields for Aqua Science

Geosphere

Hydrology
Climatology
Environmental Hydraulics
Water Resources Engineering
Coastal Engineering
Regional Environmental Engineering
Atmospheric and Hydrospheric Science
Disaster Prevention Engineering
Remote Sensing
Water and Material Cycles
:

Biosphere

Zoology
Entomology
Botany
Ecology
Systematics
Biogeography
Molecular biology
Evolutionary biology
Biodiversity Sciences
Conservation Biology
:

Anthroposphere

Historical Sciences
Sociology
Geography
Cultural Anthropology
Social Anthropology
Folklore
Linguistics
Religious Studies
Agricultural Hydrology
Area Studies
:

Economics
Development Economics
Agricultural Economics
Health Economics
Economic History
Tropical Medicine
Epidemiology
Parasitology
Policy Studies
Archeology
:

Aqua Science

Publisher: Office for Study of Sustainable Human-Aqua Environment
Design: Nanae Matsuo
Illustrations in page 16: Chiharu Hayashi, China Masuoka, Kozue Nakahara

Address: Office for Study of Sustainable Human-Aqua Environment
Faculty of Social and Cultural Studies, Kyushu University
744 Motooka Nishi-ku, Fukuoka, Japan 819-0395
E-mail: info@mizu-kyosei.net
U R L : https://mizu-kyosei.net/english/

This leaflet is funded by Grants-in-Aid for Scientific Research KAKENHI, Grant-in-Aid for Scientific Transformative Research Areas (A) “Integrated Sciences for Sustainable Human-Aqua Environment.” (Project number: JP21H05177)