UTokyo FOCUS
The University of Tokyo

FUTURE SOCIETY INITIATIVE

Society 5.0 and the University of Tokyo

東京大学
THE UNIVERSITY OF TOKYO

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UTokyo FOCUS
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bringing together all the university's activities in one location.
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Introduction

This magazine highlights some of the efforts being made by the University of Tokyo to bring about a better future for all. The Future Society Initiative (FSI), established in 2017, registers ongoing research projects that contribute to the United Nations Sustainable Development Goals (SDGs). The FSI hopes to encourage interdisciplinary collaboration between projects where there are natural synergies.

The 17 SDGs, laid out by the United Nations in 2015, offer a guideline to achieving a more equitable and fair society for all humanity by 2030. The SDGs cover a wide range of issues, from hunger and poverty to health and well-being, from clean energy to clean water, and from innovation to peace. There are a great many challenges to overcome before we can achieve the lofty targets they assign us, but at the University of Tokyo we regard the SDGs as a framework to bring together disparate activities intended to bring about a better future.

Most would agree that an equitable society, where all can enjoy the fruits of progress, is a good idea. In Japan, we call this brighter future Society 5.0, as the fifth stage of human development after the hunter-gatherer, agrarian, industrial and information societies. Society 5.0 is a knowledge-intensive society powered by the combination of artificial intelligence and big data with information and communications technology. Society 5.0 offers a future where the barriers of distance and ability, borders and language have no meaning, and all can take part in society on their own terms.

But technology alone cannot solve all our problems. The humanities and social sciences are essential guides to the problems we choose to tackle, and architects of the future we choose to create together. Diverse viewpoints on the challenges we face are essential. Japan is already experiencing many of the issues that will soon affect other societies around the world. We must listen to the ideas and experiences of people from all backgrounds, and from all countries, to find the solutions we need.

We hope you will find inspiration in these pages as you read about the University of Tokyo and the FSI's efforts to realize the brighter future offered by Society 5.0.

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The Future Society Initiative: Towards a better future

Makoto Gonokami

President, The University of Tokyo

The University of Tokyo celebrated its 140th anniversary last April. Science and technology have advanced greatly in those 140 years. They have greatly empowered humanity and vastly expanded the scope of its activity. Entering this new century, the speed at which science and technology advance has accelerated even more, changing human society in many ways.

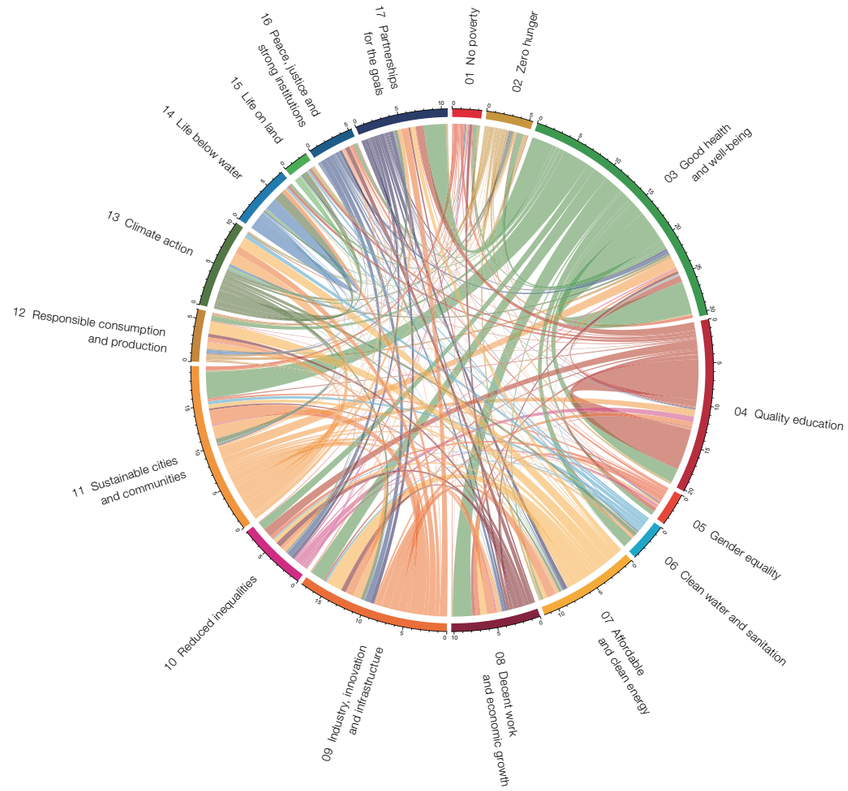
Today, new technologies to analyze and use the vast quantity of data accumulated on the internet are advancing rapidly. This digital revolution is changing society in far-reaching ways, making it possible to connect geographically distant resources and bringing about a disruptive and qualitative change in the economic and social mechanisms of human society. We hope that these new technologies will bring a range of benefits, including improving productivity across a wide range of industries, decreasing disparity between rural and urban areas, and improving social participation among the elderly. This is in line with “leaving no one behind” stated in the United Nations’ Sustainable Development Goals. New technology can lead to the realization of an inclusive society where diversity is valued and everyone can achieve their full potential.

It is important to establish suitable social systems and economic mechanisms so that people can accept these new technologies and actively choose to participate in their spread throughout society. Establishing such mechanisms will require the collaboration and shared knowledge of many diverse peoples. The University of Tokyo contributes to the linkage of technological advancement, social systems and economic mechanisms through the creation of new value in partnership with society, making use of the great breadth of our research and depth of accumulated learning.

We need a common goal shared by many if we are to work together with diverse peoples to direct these actions towards creating a better future society. The University of Tokyo has focused on the SDGs as a tool for deepening collaborations within and outside the university. In July 2017, the university established the Future Society Initiative (FSI) as the flagship organization to coordinate this activity directly under leadership of the university president. Initially, the FSI has registered research projects that contribute to the realization of the SDGs, and is promoting those projects across the university and to society as a whole. Already over 180 projects have been registered with the FSI, as you can see in the image to the right. This magazine showcases a small selection of those projects.

I hope that this magazine will convey some of the FSI’s exciting activities to a wider audience, and will lead to new connections and partners working together to bring about a better society for all.

FSI projects at a glance



Researchers at the University of Tokyo have so far registered a total of 180 projects representing a cross section of disciplines for the Future Society Initiative (FSI). Each project has one of 17 Sustainable Development Goals (SDGs) picked by the researchers as its main theme, while they have assigned one or more of the other goals as subthemes.

Masahiro Sugiyama, associate professor at UTokyo’s Policy Alternatives Research Institute, used the programming language R to create a chart that tells you at a glance what goals these projects cover and how they are connected with each other.

The chart shows that UTokyo research covers all of the 17 SDGs. It also reveals the largest portion of the FSI projects are related to health, education and industry, reflecting the main concerns of the Japanese public.

Certain goals tied to the projects also have strong connections to each other. For example, health and cities are closely connected, while climate and energy are also strongly linked.

Sugiyama points out that the chart has its limitations. “It does not show how certain projects try to achieve some goals while they may sacrifice others,” he said. “But it presents a general picture of the university’s research in relation to SDGs.”

In the following pages, we present the breadth of research at the University of Tokyo
by highlighting some of the projects registered under the Future Society Initiative.
Public health is a common theme underlying a large share of FSI projects.
We take an in-depth look at researchers who are actively tackling challenges on this front around the globe.
We also showcase six projects spanning the sciences and humanities,
from changing diets in African cities to rare-earth sources
from the ocean floor to bringing humanities into the digital age.

CONTENTS

Out of the lab, into the field

Raiding rat nets across the Gobi Desert.
Treating drinking water with ultraviolet LEDs in Asia.
Mapping viruses with mobile phones in West Africa.
Researchers often work in places where resources and technical know-how are severely lacking.
Their common goal: to bring the fruits of their labor to communities grappling with a public health crisis.

Researcher Chizu Sanjoba in the field in Mongolia.

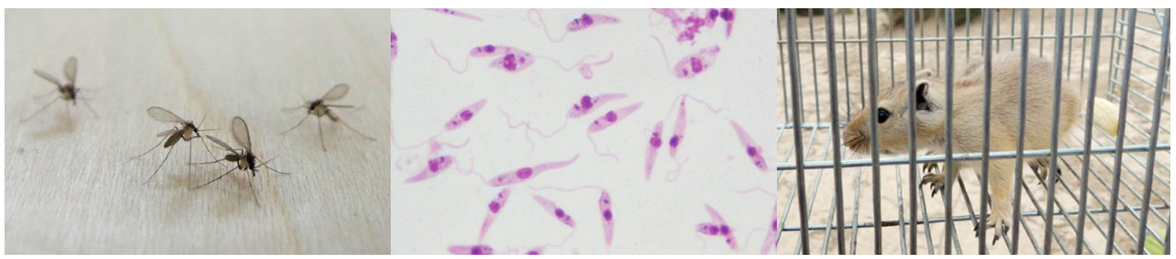
Children in a Bangladeshi village gather around a trap to catch sand flies.

Chizu Sanjoba, an assistant professor at the Graduate School of Agricultural and Life Sciences, is an expert on parasitic diseases, particularly leishmaniasis. Leishmaniasis is an infection caused by *Leishmania* parasites, and spread through the bites of infected sand flies. The infection causes skin sores or extreme swelling of internal organs such as the liver and spleen.

One of 20 or so neglected tropical diseases designated by the World Health Organization, leishmaniasis affects people in poverty the hardest, due to their living conditions, which brings them into close contact with insects, livestock and other disease-carrying animals.

Since the disease's transmission cycles are complicated and different from area to area, Sanjoba argues that adopting the "One Health" approach, where research and interventions cover not only humans but also the animals and environments that surround them, is crucial.

"There are about 20 *Leishmania* parasites that cause leishmaniasis," Sanjoba said. "There are at least 90 known species of sand flies that transmit the parasites. And then come animals that host the disease, from dogs to rodents to cattle. So there is a myriad of combinations of these. We need to devise a different control strategy in every country, while finding common knowledge we can share everywhere. This is not something that just one lab can do; we need to work with experts in various different disciplines."



Left: An image of sand flies, which transmit *Leishmania* parasites. Center: A microscopic image of *Leishmania* parasites.
Right: Great gerbil trapped by the researchers.

Hunting down great gerbils

Sanjoba's research has taken her to many remote places in countries ranging from Turkey to Sri Lanka to Bangladesh, but one experience that sticks in her mind is a trip she took to Mongolia, where she tracked down desert rodents called great gerbils, which were thought to be a key pathogen carrier.

An international group of researchers including Sanjoba suspected that Mongolian people, many of whom are nomads, became infected with leishmaniasis after coming into contact with the gerbils. To prove this, they chartered three vans, hired a local driver and a cook, and hit the desert of the Gobi.

Adopting the "One Health" approach, where research and interventions cover not only humans but also animals and environments that surround them, is crucial

For a month, the researchers went hunting for one gerbil nest after another, setting up traps to catch the rodents. Then they examined the animals in a makeshift "clean bench" inside a tent to check if the creatures were indeed infested with *Leishmania* parasites.

"We couldn't take a bath for the entire month, we lined up behind horses to drink water when we found an oasis, and we stayed together in a tent and avoided going out at night so we would not be attacked by wolves," she recalled.

Their research did prove that the gerbils carried the parasites.

What distresses Sanjoba, however, is meeting children in a village hit with leishmaniasis during a research trip one year, and then finding upon her return there the following year that they have died. She has also seen patients with clear signs of malaria who refuse to get their blood tested to see if they have the disease.

That's why Sanjoba now considers education part of her work. She recently created, with the help of friends, a short animation film to teach Bangladeshi people the importance of using bed nets to avoid getting bitten by sand flies. She chose animation as her tool because many of those affected cannot read.

Water pollution along the Mekong

A desire to find real-life solutions also drives Kumiko Oguma, an associate professor of environmental engineering at the Research Center for Advanced Science and Technology. She has worked with communities in Southeast Asia since 2000, when, as a graduate student at UTokyo, she traveled along the Mekong River to study how human waste such as feces and urine released into the river upstream tainted the drinking water of people living downstream.

“I was shocked to learn that people without a water supply system had no option but to drink groundwater no matter how contaminated it was”

“I was shocked to learn that people without a water supply system had no option but to drink groundwater no matter how contaminated it was,” Oguma said. “Even when there was water supply, the tap water was often tainted with bacteria. Yet people had no option but to drink that water. It’s important for researchers to get detailed data about water contamination and write papers about it, but that alone does not make you feel you are helping local people. I had always wondered what I could do for the locals, beyond regular research activities.”

Oguma is now developing a compact water-disinfection device equipped with an ultraviolet light emitting diode (UV-LED).

Ultraviolet light is widely used at water treatment plants in many countries including Japan to kill a variety of bacteria, viruses and parasites, but all facilities use mercury lamps to emit the light. It was not until around 2010 that LED emitting germicidal UV light became commercially available, according to Oguma.

The high costs of UV-LED make it difficult for the technology to be widely available in developing countries right now, but Oguma says UV-LED water-disinfection devices could become a viable solution once their prices come down.

Oguma explains that the technology has several advantages over mercury UV lamps. For one, it is totally mercury-free and more compact than mercury lamps. The LEDs begin functioning the moment their power is turned on, unlike mercury lamps, which take about 15 minutes to stabilize and start working.

In addition, the wavelength of UV emitted by the LEDs can be adjusted to target specific kinds of germs.

In some parts of the world people don’t have access to tap water, and even when they do, their water is often contaminated with germs. Clockwise from top left: A street in Jakarta after a flood; residents washing clothes in the suburbs of Kathmandu where water supply is limited; samples of tap water in Vietnam containing *E. coli* bacteria; water tanks in Vietnam; a receptacle to collect rainwater in Sri Lanka.

The technology could even prove useful in remote communities in Japan, where the population is rapidly aging and shrinking and where centralized large-scale water-treatment facilities may become unsustainable.

Oguma is currently doing a pilot test of home-based UV-LED devices in one mountainous community. The devices could also be useful at evacuation centers in disaster-affected areas or on remote islands, she said.

Using mobile-phone data

Ryosuke Shibasaki, professor at the Center for Spatial Information Science (CSIS), has explored the use of mobile-phone data to monitor the spread of deadly epidemics.

For a project commissioned by the International Telecommunication Union, a United Nations agency, Shibasaki and his team of researchers visited the West African country of Sierra Leone about five times over a one-year period starting in late 2015, after the country was declared Ebola virus-free following the 2014 outbreak.

The purpose of his work there was to create a system that allows the country’s government to track and map people’s movements from one city to another based on anonymized mobile-phone call records and other “spatial” data — such as satellite images — so if there is another outbreak, the government can predict how the virus will spread and make quick decisions.

A meeting in Sierra Leone.

A nurses’ study group in Nepal.

“Understanding people’s mobility is very important,” said Shibasaki, who has also worked with the governments of Liberia and Guinea, countries neighboring Sierra Leone and both severely hit by the Ebola virus.

“And there is a lot of data out there because everyone, including those in the poorest communities, use mobile phones, which are part of their civil infrastructure.”

Hiroyuki Miyazaki, a project assistant professor also at CSIS, is studying how to technologically empower nurses in Nepal as part of the EpiNurse project, an international, multi-institution initiative headed by University of Kochi professor and disaster nursing expert Sakiko Kanbara.

The project, launched after Nepal experienced a magnitude-7.8 earthquake in April 2015, aims to build a smartphone-based network where nurses can easily share information about the health conditions of local residents and the kinds of medical assistance needed.

Miyazaki said that through the project, he wants to help develop skills and resources so nurses can improve their capacity to work effectively in their local area.

“Many local nurses rushed to help with disaster relief in the wake of the quake, but some of them lost their jobs because their pro bono work outside the hospitals was not well-understood,” Miyazaki said. “By making their efforts more visible to the public, I want to keep them from losing jobs so they can keep on playing a key role in their communities in periods of disaster or even during normal times.”

Assistant Professor
Chizu Sanjoba
Graduate School of Agricultural and Life Sciences

Associate Professor
Kumiko Oguma
Research Center for Advanced Science and Technology

Professor
Ryosuke Shibasaki
Center for Spatial Information Science

Project Assistant Professor
Hiroyuki Miyazaki
Center for Spatial Information Science

It’s who you are that counts

Have you ever forgotten a password, left your purse at home or even suffered identity fraud? These problems may share a solution, which Rie Shigetomi Yamaguchi, project associate professor at the Graduate School of Information Science and Technology, calls lifestyle authentication. It’s a way to prove who you are, and make payments, log into apps or devices, and use a new range of personalized services with a simple tap of your smartphone.

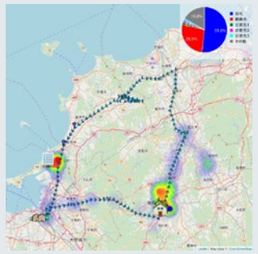
Lifestyle authentication could also be the most effective way to prevent criminals from impersonating you online or in real life. It’s an idea to improve upon unsecure methods such as fingerprints, passwords or the nuisance of multistage verification, and to provide this without any hassle to users.

As you go about your day, smartphones and other connected devices record information about you and your activities. The data is vast and unique to you, so is extremely hard to fake.

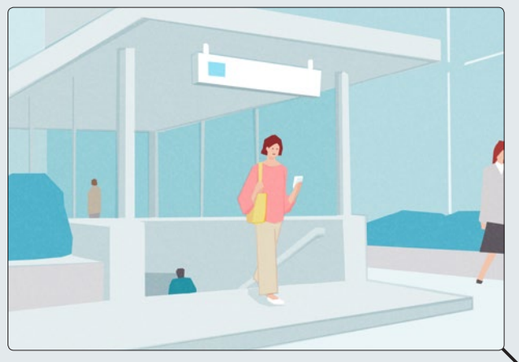
So how does it work? When service providers request your identity, they compare your device’s record with a secure long-term record of past information, which is made available with your prior consent. Sophisticated analytic techniques determine if your short-term data matches patterns of behavior apparent in your long-term data to verify that you are who you claim to be.

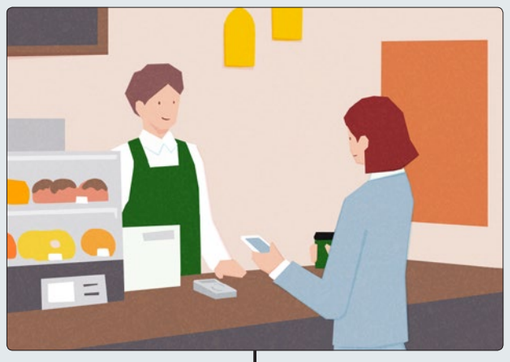
The greater the information you collect, the more accurate the records become, which makes the system increasingly secure. Services can also use your data to better anticipate your needs, for example giving you personalized service even on your first visit to an unfamiliar store.

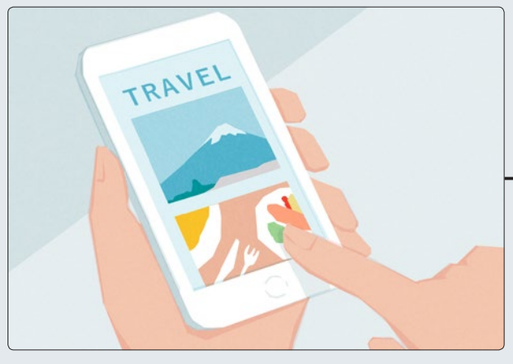
Great for those particular about their coffee!



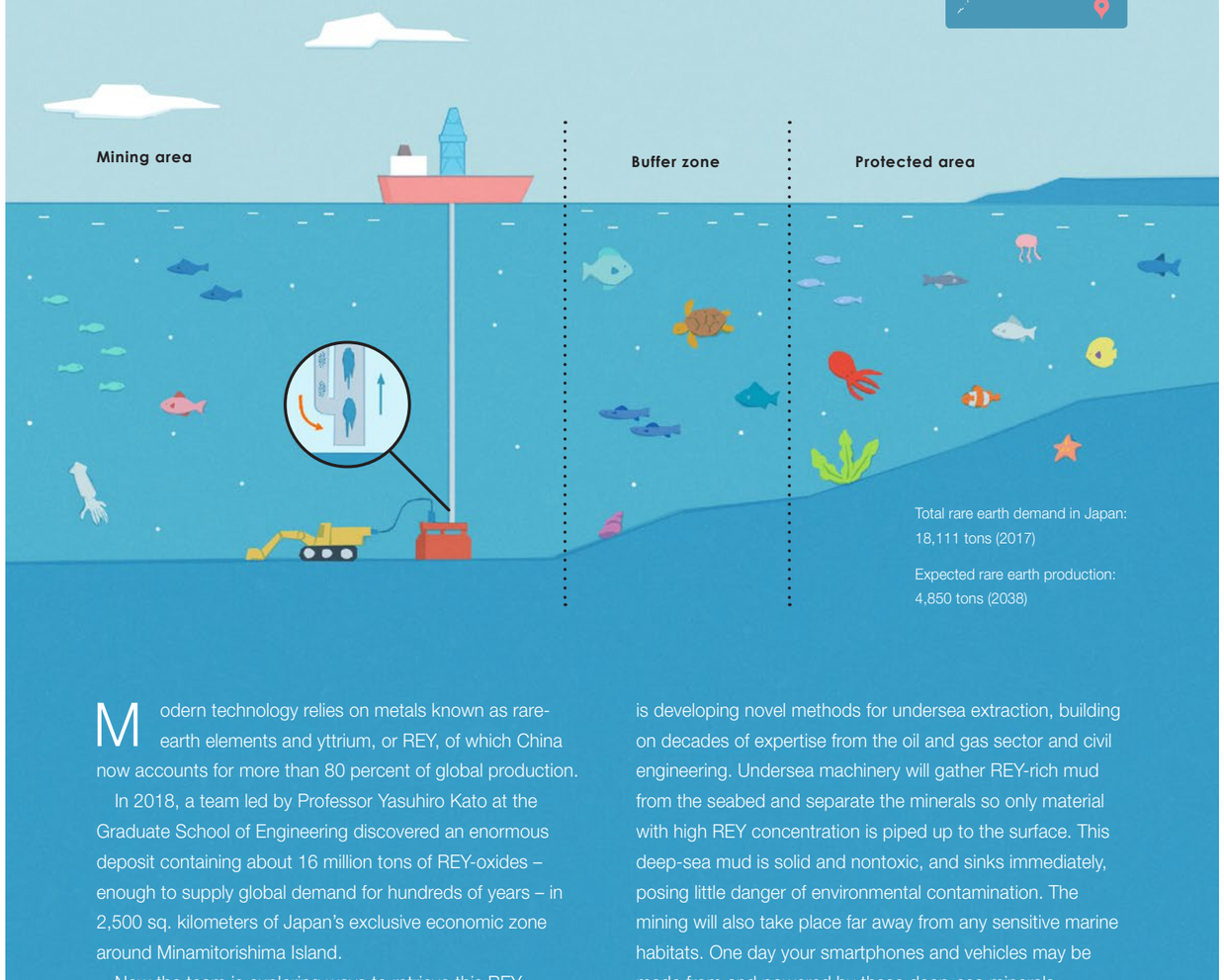
This map shows an example individual’s typical journey and frequently visited places. The pattern this data forms is part of the digital fingerprint used to secure your digital life with lifestyle authentication.







Muddy work for a greener future



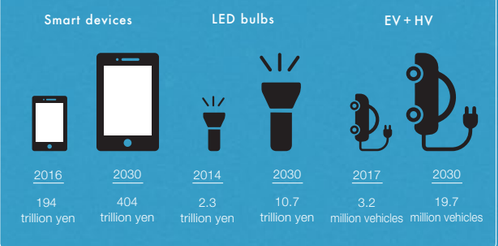
Modern technology relies on metals known as rare-earth elements and yttrium, or REY, of which China now accounts for more than 80 percent of global production.

In 2018, a team led by Professor Yasuhiro Kato at the Graduate School of Engineering discovered an enormous deposit containing about 16 million tons of REY-oxides – enough to supply global demand for hundreds of years – in 2,500 sq. kilometers of Japan’s exclusive economic zone around Minamitorishima Island.

Now the team is exploring ways to retrieve this REY-rich mud to secure supplies of the metals for all kinds of manufacturers and increase Japan’s resource independence. Green industries utilizing domestic REY resources would flourish and boost the economy, and reduce demand for fossil fuels. The deposit has strong green credentials as it contains negligible amounts of hazardous or radioactive substances, far less than current land sources of REY. The ongoing project to extract the elements from the seafloor attracts Japan’s corporations and government.

However, it faces a significant challenge: The REY-rich mud lies more than 5 kilometers below sea level. No resource has ever been mined from such depths. A UTokyo-led consortium is developing novel methods for undersea extraction, building on decades of expertise from the oil and gas sector and civil engineering. Undersea machinery will gather REY-rich mud from the seabed and separate the minerals so only material with high REY concentration is piped up to the surface. This deep-sea mud is solid and nontoxic, and sinks immediately, posing little danger of environmental contamination. The mining will also take place far away from any sensitive marine habitats. One day your smartphones and vehicles may be made from and powered by these deep-sea minerals.

Scale of major industries using rare earths
(figures for 2030 are projections)



Changing diets change the world

Sushi from Japan, hamburgers from America, moussaka from Greece: Each country has classic national foods. But as societies change, everyday diets also change. Individual meal choices affect population health, food security, natural ecosystems and global climate.

Associate Professor Alexandros Gasparatos from the Integrated Research System for Sustainability Science (IR3S) and his students study the causes and impacts of changes in urban diets in Sub-Sahara Africa. The project started in spring 2017 and includes four growing African cities. Three University of Tokyo graduate students originally from the study countries are traveling to Accra, Ghana, and Nairobi, Kenya, to interview nearly 1,500 households in total. Research partners working jointly in Malawi and Mozambique will continue the surveys in 2019.

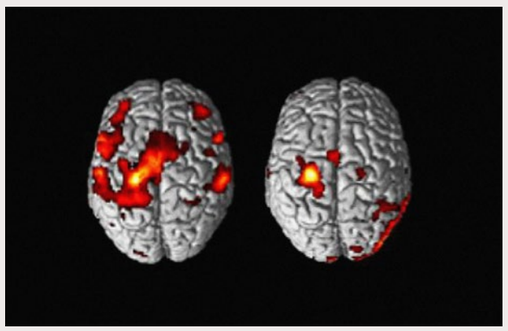
By asking locals what they eat now compared to a decade or longer ago and why, the researchers aim to predict what drove diet transitions, as well as the far-reaching impacts of current and future urban diets. With a better understanding of how and why diets are changing in these major African cities, countries can decide whether and how to incentivize certain dietary choices, or to support individuals and enhance sustainability in their growing cities.

Research is underway to study the causes and impacts of changes in urban diets in Africa.
Top: Preparing food in Nairobi. Left: A collaborating researcher interviews children in Nairobi. Right: A residential area in Nairobi.

Paralympians reveal brain's amazing adaptability

Despite their physical accomplishments, Professor Kimitaka Nakazawa at the Graduate School of Arts and Sciences is most interested in the brains of athletes, specifically Paralympians. An expert in neurorehabilitation after stroke or spinal cord injury, Nakazawa also previously worked with dancers and baseball pitchers, but he did not meet a para-athlete until 2016. The results of that American eight-time Paralympic swimming medalist's brain imaging studies were so surprising, Nakazawa has since sought out five other Paralympians, including Japanese and German track and field athletes, an American archer and a Japanese bench press weightlifter.

Nakazawa wants to observe how the brain and body adapt to neurological injuries or amputations. Preliminary results reveal that after the loss of one part of the body, the brain reorganizes itself to better control the remaining body parts. Nakazawa hopes to continue studying para-athletes, including at the 2020 Paralympic Games in Tokyo. Understanding the neurological mechanisms underlying these athletes' physical compensation methods may lead to more effective rehabilitation for stroke or injury patients and better physical training for all people.

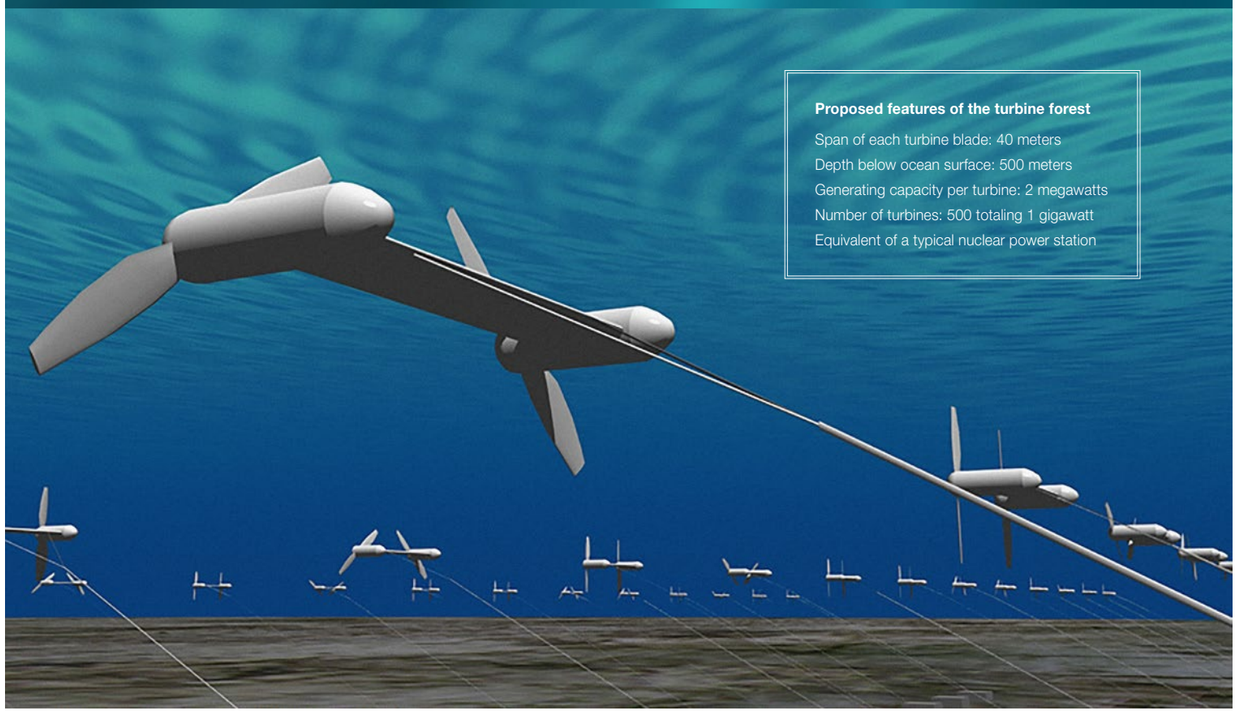


The brains of athletes with a spinal cord injury (left) show more activity, depicted here by more lighted areas, and better control of their grip strength than the brains of people without injury (right).

From ocean currents to electric currents

Their huge bulk tens of meters across loom in the murky depths of the ocean. These aren't whales or sharks, but giant submarine turbine generators. They are the dream of Professor Ken Takagi at the Graduate School of Frontier Sciences, and his team strives to make them real. Tethered to the seafloor, each turbine will cleanly generate several megawatts of electricity from nothing more than the continual push of the deep-ocean currents. Takagi is a shipbuilder by trade, but his task is to create a unique way to harness the sea to generate clean energy for Japan. Climate change and the tragic Fukushima nuclear disaster in 2011 push researchers to find alternatives to fossil-fuel and nuclear power.

Along Japan's shore runs one of the few stable ocean currents near a populated coastline. The plan is to connect an array of undersea turbines to the electricity grid, and realizing it might only be a few years away. In 2017, Takagi's dream was realized by NEDO and IHI Corp. as a prototype generator with dual 11-meter turbines generating 100 kilowatts of power. In 2019, NEDO and IHI will test an improved version of the turbine to generate electricity for residents on Kuchinoshima isle, just south of Japan's southernmost main island, Kyushu. The hope is that the next test will prove the commercial viability of this idea, and work can begin to seed the ocean floor to turn it into a forest of turbines.



Proposed features of the turbine forest

Span of each turbine blade: 40 meters
Depth below ocean surface: 500 meters
Generating capacity per turbine: 2 megawatts
Number of turbines: 500 totaling 1 gigawatt
Equivalent of a typical nuclear power station

Humanities in the digital age

Some of the volumes of the *Taisho Shinshu Daizokyo*, containing scriptures from India, China and Japan.

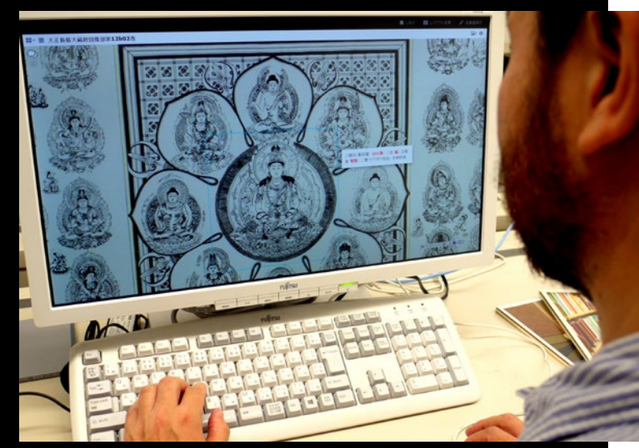
The internet and other digital technologies have become indispensable tools for people all over the world, but they are also transforming dramatically methods of academic research. These advances have raised questions on how to harness technology to store, research and disseminate the intellectual resources of humanity spanning thousands of years.

In 2012, UTokyo launched a cross-disciplinary, graduate-level program on digital humanities to help researchers, whether in the arts or sciences, tackle these challenges. Masahiro Shimoda, professor at the Graduate School of Humanities and Sociology, plays a key role, having led a project to digitalize the Buddhist scriptures *Taisho Shinshu Daizokyo*, originally published in the 1920s and '30s.

A milestone of the project, called SAT and started in 1994, was making the 100-volume collection accessible online from anywhere in the world. It has also expanded the scope of humanities research.

For example, SAT researchers found, while converting the text into digital format, that thousands of Chinese characters in the scriptures were not encoded for computers and not digitally displayable. Years of efforts by researchers alarmed by the possibility of certain components of Asian writing culture disappearing into digital oblivion eventually led to the listing of 2,800 characters on Unicode, the international encoding standard for handling text on computers. The SAT database has also accelerated international research collaborations.

UTokyo's digital humanities program brings together experts from various disciplines, including media studies and computer linguistics, to provide students with opportunities to learn and practice how to deepen and disseminate their research using digital technologies.



An image database of the *Taisho Shinshu Daizokyo* was unveiled in 2016.

Building a better future together

みんなの未来をみんなで創る

The University of Tokyo aims to become a university for the world,
and we work together with partners around the globe
and across all areas of society to build a better and more equitable future for everyone.
We hope that you will consider joining with us as we work towards our goals,
either by participating in our research and education or by supporting our activities.

東京大学は、世界のための大学になることを目指しています。
すべての人によりよく、より公平な未来を築くため、世界中の、そして社会のあらゆる分野のパートナーと協働しています。
私たちの研究や教育への参加、もしくは協力をぜひご検討ください。