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Citizen Science in the Digital Age

- Engaging Civil Society in Social Science and Humanities Research -

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With the rapid spread of information technology, the term “co-creation” has come into frequent use. Citizen science, collaboration between citizens and scientists, is also an important initiative for jointly shaping society. As one example, citizen science in the natural sciences is highly regarded worldwide. On the other hand, citizen science in the humanities and social sciences can be considered to still be in its infancy.

What role can citizen science play in the field of humanities and social science research, in which the subject of study is ourselves rather than natural phenomena? At a conference jointly organized by NIRA, DIJ, and DWIH Tokyo[1], researchers from Japan and overseas discussed the following points in relation to citizen science.

Citizen science has the potential to bring new possibilities to the development of research in the humanities and social sciences. Citizen science itself has the potential to develop by not only obtaining data from citizens, but by utilizing the intelligence and insight of citizens in the solution of social issues. In order to manifest these potentials, it will be necessary to design protocols for citizen participation, involve universities that support citizen science, and build data provision and management systems based on the perspectives of data ownership and the protection of personal information. In addition, the data platforms provided today by giant IT companies should be regarded not as enemies that fence in data, but rather as tools for sharing data with citizens. The era of big data will be the era of designing the data that one wants to use.

1. Introduction *

With the rapid spread of information technology, the term "co-creation" has come into frequent use. Citizen science, collaboration between citizens and scientists, is also an important initiative for jointly shaping society. Examples include the American ornithology project "e-Bird," in which birdwatchers from around the world participated, and the major project "Galaxy Zoo," a citizen astronomy initiative. In the Galaxy Zoo project, a vast amount of astronomical observation data was divided between citizens. As a result, classification progressed in a short period of time, leading to a major discovery - a new form of galaxy. In Japan also, the "Bumblebee Census," which utilized citizen science methods, is highly regarded.

As this indicates, citizen science, especially in the natural sciences, is displaying great vigor across national borders. Behind this is the global trend toward making research data more open. The activity of citizens in collecting and analyzing big data is a mechanism for excavating data, adding value, and returning it to society. Based on these trends, government agencies in Japan, the United States, and Europe are also providing policy support for citizen science. In Japan, the promotion of citizen science was proposed as one factor in the enhancement of the foundations of science and technology innovation in the 5th Science and Technology Basic Plan (FY2016 to FY2020).

On the other hand, citizen science in the humanities and social sciences can be considered to still be in its infancy. What role can citizen science play in the field of humanities and social science research, in which the subject of study is ourselves rather than natural phenomena? "Citizen Science in the Digital Age - Engaging civil society in social science and humanities research," a conference focusing on the possibilities of and the issues facing citizen science in the fields of the humanities and social sciences was held in Tokyo in Fall 2019. The conference was jointly organized by NIRA, the German Institute for Japanese Studies (DIJ), and the German Center for Research and Innovation (DWIH Tokyo), and saw vigorous discussion of the issues by experts active at the forefront of citizen science in Japan and overseas. What are the significance and merits of citizen science in the humanities and social sciences, and how will we form points of contact with citizens? How should responsible collaborative research proceed? This paper will discuss these issues while also looking at concrete examples.

* NIRA would like to take this opportunity to express its gratitude to all presenters and participants who attended this conference, in addition to the German Institute for Japanese Studies (DIJ) and the German Center for Research and Innovation (DWIH Tokyo) for their full support in planning and preparation. This paper was compiled by Atsushi Inoue, a NIRA research coordinator and research fellow, based on the discussions held at the conference.

[Topic] What is Citizen Science?

Citizen science refers to the involvement of members of the general public who are not professional scientists in scientific research. The approach has multiple origins and encompasses a wide range of concepts, but has become entrenched as the concept of engaging the capabilities of citizens to assist in research, and the generation of research results by citizens and scientists working together. The direct aim of citizen science is to gather public knowledge and promote research, but it also possesses significant roles as a form of outreach enabling broad dissemination of research results and as an aspect of educational activities. The term "citizen science" itself is comparatively new, only having been in active use in Europe and the United States for between 20 and 30 years, since the 1990s. Citizens have, however, conducted scientific research, including astronomical observation and observation of nature, since the time of Aristotle. Eventually, in the 19th century, the professionalization of "scientists" generated a difference between the position of professionals and amateurs as a social structure. Hence "citizen science," was born as an attempt to involve citizens in scientific research.

2. "Three Keys" Essential for the Promotion of Citizen Science

In Europe and the United States, a trend can be seen towards the taking up of advanced initiatives in the area of citizen science, based on the concepts of increasing scientific literacy and promoting science communication. This is a policy-based approach to science and technology, one that seeks to further "democratize" science. The push to advance citizen science is accelerating through initiatives such as the European Commission's formulation, in 2013, of the significant goal of integrating five million citizen scientists in five years, and the establishment in Germany of the "Citizen Science Platform."

One of the conference's keynote speeches, offered by German sociologist Dr. Martina Franzen, (a Postdoctoral Research Fellow at the Institute for Advanced Studies in the Humanities), presented three challenges that represent the key to working with the public in the humanities and social sciences.

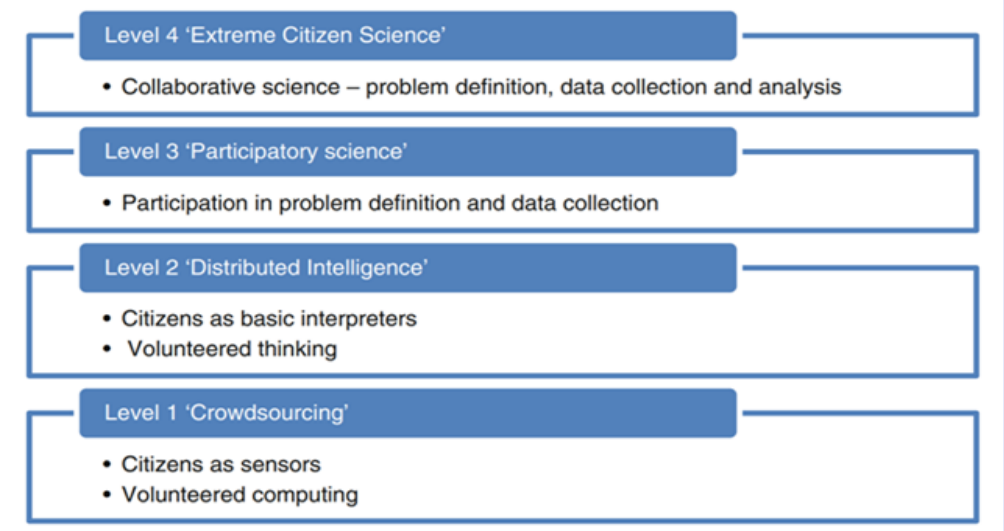
How Do We Set the *Level* of Citizen Involvement?

The first point is the issue of how to set the level of involvement of citizens. According to the classification of citizen science proposed by Professor Muki Haklay of University College London (UCL), citizen involvement increases from Level 1 to Level 4. As shown in Figure 1, Level 4 is "extreme citizen science," in which citizens and scientists work together to produce collaborative results, from the definition of the problem to data collection and analysis. As

indicated by the fact that Levels 3 and 4 include the element of "problem definition," it can be considered that rather than simply providing assistance in research work, citizens will participate from the stage of discussing the research theme to be taken up. There are also mechanisms for involvement by providing support for research funding.

However, the current situation is that the majority of conventional citizen science activities are limited to Level 1, in which citizens play the role of "sensors." Professor Haklay points out that "In many cases, citizens are still incorporated as only part of the research process." What do we ask for as a citizen's task? If the requirements of the task are low, the degree of participation tends to increase. However, Dr. Franzen indicated that we should first discuss the direction we are aiming towards in citizen science. Against the background of the availability of a range of citizen science methods, will citizens be responsible for supporting the process of acquiring new knowledge, or is the goal to democratize science by means of citizen science and thus change society? These are points that must be considered.

Figure 1 Levels of citizen science



(Source) Haklay, M. (2013)[2], Figure 2

How Can Participation by a Large Number of Citizens Be Ensured?

The next issue is how can a large number of citizens be reached, and can sufficient numbers be ensured? Citizen science often involves participation without remuneration. Many citizen scientists have a main occupation, and have limited time to spare. Motivation is also essential to continued participation in citizen science activities. In fields that readily connect to individual interests, such as astronomy, biology, and archeology, it is possible to expect citizen participation as part of a hobby. But there are, presumably, few people who would spend their days on social issues such as budget deficits and social security. In other words, in the case of the humanities and social sciences, we must more effectively reach out to citizens. However, Dr.

Franzen pointed out that when we talk about "citizens," we are not talking about a homogeneous "everyone." Citizens with a high level of education and those who possess financial means display a greater tendency to participate in citizen science; depending on the topic, gender also plays a role in participation.

In addition to clear targeting, another point that we must be aware of is the problem of the "digital divide." While the threshold to participation in citizen science has been significantly reduced by the introduction of IT, there is a gap between people who do and do not use information and communication technologies. The older the person, the more pronounced this tendency, but older people also actively engage in volunteer activities. Dr. Franzen informed us that in Germany also, measures are being debated as to how to involve the elderly in citizen science.

Research Design and Organizational Challenges

The third point is research design and organizational challenges. In the field of the humanities, it is relatively easy to conduct research based on big data. In this respect, the humanities can be considered similar to the natural sciences. However, in the social sciences, the fact that we ourselves are the subject of research is one that must be negotiated with extreme sensitivity. The movements of planets and insects, or the letters that make up words, do not change with human observation, but in the case of the social sciences, the fact of observation can affect the behavior of both subjects and observers. For example, a shopkeeper who is aware of an observer may behave in a more service-oriented manner than usual. Another example is provided by a past survey conducted in order to investigate the actual status of begging, in which citizens recorded the number of beggars that they saw while commuting; in this survey, there were cases in which the citizens acting as observers arbitrarily changed their commuting routes in order to observe more beggars. Protocol design is an important factor in ensuring that research is not biased by the subjectivity of the citizens involved.

Dr. Franzen also mentioned points to consider when dealing with sensitive personal information. The "Mass Observation" conducted in England in 1937 is famous as a large-scale social research study in which citizens engaged in social observation by keeping a diary of events around them; as in this case, social science data is often closely related to issues of privacy. It is clear that information management systems are required, but there is also the issue of how to balance "individual dignity" and "public interest." In advancing citizen science in the social sciences, it is also necessary for participants in research to understand the purpose of the citizen science: citizen science for research or citizen science for public policy — for example, are they researching issues such as homelessness or attempting to solve them?

3. New Trends in Citizen Science

Information Technology Boosts Citizen Science

How do IT professionals view modern citizen science? Professor Masaru Kitsuregawa, Director-General of the National Institute of Informatics, has been for many years one of the leaders in Japanese citizen science as a pioneer in database research. In his keynote speech, Professor Kitsuregawa offered examples of the collection and utilization of big data by citizens, and, as his latest initiative, a case study of a project that seeks to collaborate with artificial intelligence (AI).

Professor Kitsuregawa first discussed, as representative examples of citizen participation-type projects, the outcomes of joint projects conducted with the global environmental data integration and analysis system DIAS. In one case, butterfly monitoring in Tokyo was carried out by three people: a conservation ecology researcher, an IT researcher, and an individual recruited from among members of the PAL System Consumers' Cooperative Union to act as a butterfly investigator. In this project, when the butterfly investigator found a butterfly, they uploaded basic information such as time, date and location, in addition to the captured image. The collected data was managed and edited by the ecologist and published on the website "Ikimoni". Approximately 50,000 data can be searched by species name, region, and image, and are employed in conservation activities as an important source of data for understanding biodiversity. Professor Kitsuregawa informed us that the participants were delighted at the surprise discovery of a species that had been thought extinct.

Professor Kitsuregawa also introduced "Stork Citizen Science" as an example of the realization of increased sophistication in data collection applications. The survey was conducted on a nationwide scale, with numerous members of the public ranging in age from their teens to their 80s participating. The project has produced new findings, such as the fact that Toyooka in Hyogo Prefecture is a major stork habitat. Because storks also travel to South Korea and China, the project's activities are expanding beyond the borders of Japan.

Monitoring activities in which citizens play a role as "sensors" as described above can be said to be the "classical approach" to citizen science. In the field of the natural sciences, the introduction of IT has spurred remarkable development in terms of factors such as increased efficiency and scale, even as the history of traditional citizen science is woven within the framework.

Reviving Big Data That Slumbers in the Past

The "Minna de Honkoku" project was developed with Assistant Professor Yuta Hashimoto of the National Museum of Japanese History and Associate Professor Yasuyuki Kano of The University of Tokyo's Earthquake Research Institute as the central figures, and with the cooperation of institutions and groups including the abovementioned institutions and the Kyoto University's Research Group for Historical Earthquakes. This project was introduced by Professor Kitsuregawa as an example of the humanities and social sciences transcending the boundaries between sciences and non-sciences. "Honkoku (transcription)" in this case refers to realizing the printing of "*kuzushi-ji*," or cursive characters, which were handwritten in historical materials such as ancient documents and records. This is to say that the project represented an attempt to utilize big data slumbering in the past. Specifically, the project was conducted for the purpose of elucidating past natural disasters, and took historical materials related to earthquakes as its focus. More than 5,000 registered participants took part, and more than six million characters, from approximately 500 historical

sources, were recorded in a text database. The accuracy achieved was over 98%, an adequate level of quality to allow the details of the materials to be grasped.

What is surprising is that many of the participants were "amateurs" who were attempting to decipher ancient texts for the first time. What allowed these inexperienced individuals to participate was the provision of the "Kuzushi Character Learning Support Application KuLA," developed chiefly by Osaka University's Graduate School of Letters, as learning content for beginners, and the support provided in interpretation by an AI trained using the "Kuzushi Character Data Set" published by the National Institute of Japanese Literature and other institutions. Two types of automatic cursive script recognition software have also been independently developed by the Center for Open Data in the Humanities (CODH) and Toppan Printing Co., Ltd. In addition, participants corrected each other on the Web to improve accuracy (an approach similar to that used by Wikipedia). In the case of the above-mentioned monitoring survey, training to classify insects and plants was provided in a game format as preparation for citizens to act as investigators.

Looking back on these activities, Professor Kitsuregawa says, "Having intellectual curiosity is the most important factor in propelling citizen science; it is a powerful driving force." It is no exaggeration to say that the public's eagerness to learn supports society.

Data Transcribed by Citizens Can Provide the "Fuel" for AI

As seen above, citizen science methods such as collecting or classifying data through the efforts of individuals are considered to represent "classical" citizen science, and their product is the result of the learning realized by each citizen involved. Based on this, "data as fuel for AI," assisting AI in learning, has become a new trend.

There has been, in fact, a continuation of the development of the automatic cursive character recognition AI. In 2019, CODH, the National Institute of Informatics (NII), and the National Institute of Japanese Literature held a competition on Kaggle. Kaggle is a platform that connects approximately 400,000 machine learning engineers and data scientists around the world, and holds competitions offering prizes to the developers of the best analytical models for issues presented by governments and companies. The development of the cursive script recognition method was accelerated by means of this worldwide competition. The "Cursive Character Data Set" was improved and provided for use as a learning material for the AI in the competition; the greater the amount of learning materials that an AI learns, the more accurate the AI analysis will be. Therefore, it is expected that the transcribed data provided by the "Minna de Honkoku" project will provide learning materials for AI.

Professor Kitsuregawa says, "Data is the fuel that powers AI." Up to the present in citizen science, the collected data was mainly handed over to experts and used as research materials. The destination for data has changed significantly – to AI. Citizen science can be expected to contribute to the initial introduction of machine learning to all fields in the future.

Everyone Is an Amateur and Everyone Is a Citizen

While tracing the trends in citizen science using examples, Professor Kitsuregawa once again asked "Who is the citizen in citizen science?" As learning advances, academic fields are becoming increasingly specialized and subdivided. This tendency is the same in both the natural sciences and the humanities / social sciences. Giving consideration to the fact that a single individual was once able to be expert in a wide range of fields, there are certain negative aspects to this, but it is also the case that this is an era in which experts are now also "amateurs" outside their specialized field, and at the same time, everyone is an expert in something. Professor Kitsuregawa pointed out that the line between professional scientists and citizens in citizen science is also fading. We are all "citizens."

Barry Barish, who won the Nobel Prize in Physics in 2017 for his achievements in the observation of gravity waves, is fresh in the memory as a person who was not in the "exact center" of a specialized field realizing a remarkable achievement. While his co-winners Rainer Weiss and Kip Thorne are experts in gravitational waves, Barish was originally a developer of accelerators that detect elementary particles. Gravitational waves fell outside his area of specialization. However, as the director of the American observatory LIGO, which succeeded in observing gravity waves, his skill as a manager in promoting big science was highly regarded, leading to his receipt of the award. In citizen science today also, the abilities of citizens are attracting attention from considerations of the management and coordination of such projects.

New Challenges in Citizen Science

A project called "Time Machine" has been commenced in Europe. This is a major project seeking to digitize and map the 2,000-year history of Europe and design a large-scale simulator. Professor Kitsuregawa believes that the background to this project is an awareness among European citizens that the tragic history of the past should not be repeated. Curiosity is not the only driving force in citizen science.

In recent years, a range of problems associated with the aging of the population have become apparent in Japan; worldwide, we face numerous issues, such as the SDGs and the problem of marine plastics. These problems cannot be solved by experts in one field alone. Already, in Japan, there is a movement to solicit funds, inspire interest, and attract participants through crowdfunding in order to clarify the actual state of microplastic pollution in Sagami Bay. Professor Kitsuregawa emphasized that citizen scientists are required for precisely such difficult issues that must be solved by society as a whole. How do we bring together the intelligence and insight of individual "citizens" to produce the maximum effect? Today, with the dramatic improvement in information technology, citizen science is entering an era in which it faces a new challenge – breaking the mold of the past.

4. Citizen Science in the Digital Age: Possibilities and Challenges

Following the keynote speeches in the first half, Dr. Shohei Yonemoto (Visiting Professor, The University of Tokyo), Mr. Kazuhiro Hayashi (Senior Research Fellow, National

Institute of Science & Technology Policy, Ministry of Education, Culture, Sports, Science & Technology), Dr. Tsutomu Watanabe (Professor, Graduate School of Economics, University of Tokyo), and keynote speakers Dr. Franzen and Professor Kitsuregawa took the stage as panelists in a panel session. To begin, moderator Dr. Noriyuki Yanagawa (Executive Vice President, NIRA / Professor, Graduate School of Economics, The University of Tokyo) raised the question of the possibilities of, and the challenges faced by, citizen science in a data-driven society.

Advances in technology have made it possible for us to obtain a wide variety of information and data. As discussed in the keynote speeches, it is not necessary for the individual providing the data to be an expert; the fact that the data becomes richer with the participation of citizens in the research is a tremendous merit of citizen science. In addition, the ways in which citizens are able to participate in research have diversified, allowing more opportunities for citizen researchers to be involved in domains that were previously restricted to professional researchers, such as the setting of research agendas and the analysis of data, rather than simply providing information. The improvement in the quality of research realized through the incorporation of the ideas of citizens is another major factor in the appeal of citizen science.

At the same time, science is displaying a tendency towards inflation. Just as in the natural sciences, the deployment of big data is advancing in humanities and social science fields. It is considered that the ability to perform analyses using abundant data will affect outcomes, and thus that private companies engaged in data businesses, as exemplified by GAFA, will have a significant influence on the development of science. Amid these changes, it will be essential for us to identify the significance of, and the possibilities for, the involvement of citizens in advancing science.

At this juncture, Dr. Yanagawa directed considerations towards how to expand the nature and concept of research, how to increase the possibilities for citizen science in humanities and social science research, and how to build systems enabling citizens to be responsible for research as topics for discussion.

Universities Will Play the Role of Marketing "Research as a Product"

Dr. Yonemoto proposed that universities in the 21st century might provide services that meet the desires of members of the general public who wish to savor the enjoyment and frustrations of research. Western modernity was the process of opening the luxuries previously monopolized by aristocrats to the masses in the form of consumer goods. Scientific research is one of these. The utility of scientific research was recognized in the latter half of the 19th century; research was consolidated into universities and research institutes for purposes of national defense and the development of industrial products, and thus became specialized. During the Cold War in the latter half of the 20th century in particular, universities and research institutes grew to become huge. However, Dr. Yonemoto pointed out that in the 21st century, these huge universities are no longer functional, and may move in the direction of a distribution of functions. In the process, Dr. Yonemoto predicts that services that open research to the public and allows them to enjoy the intellectual satisfaction and experience the frustration of research will appear.

The concept here is that universities will sell "research as a product," similarly to the way in which a travel agency sells overseas travel packages, and the university specialists will provide the necessary equipment and information and fulfill the function of guiding research.

Many of the research themes chosen by citizens are close to their daily lives, such as the environment, education, food, health, welfare, culture, local history, and relations with neighboring countries, or are political themes. If platforms are made available for the publication of the research results produced by such citizens and knowledge is accumulated in an effective manner, it will become a public good that can be used in policy proposals and policy evaluation. This should also provide a stimulus to current social sciences.

Dr. Yonemoto asserted that as a direction for a post-industrial society, a society in which citizens can expect a lifespan of 100 years, the collection and analysis of materials and the presentation of new perspectives based on each individual's urgent awareness of problems is one of the most mature forms of political participation.

Towards an Era in Which Collaborative Citizen Science Produces Significant Outcomes

Mr. Hayashi indicated that the concept of citizen science has changed due to digitalization, and that collaborative citizen science is the direction of the future. Traditionally, communication between science and society has been one-way. Research funds were distributed to scientists through taxes from citizens, and those scientists worked to communicate with citizens following the completion of their research. There was little interaction between the two during the research process. Under these circumstances, citizen science had considerable significance as an activity in which citizens monitor scientists who possess an overwhelming volume of information on themes such as pollution and nuclear power.

However, ICT has made it easier to communicate in both directions, and the ways that citizens are able to be involved in scientific research have become more diverse. For example, the involvement of citizens at the stage of setting research agendas is a new sign. In Europe, a program called "Citizen and Multi-Actor Consultation on Horizon 2020" (CIMULACT) is being implemented to mobilize approximately 1,000 citizens in order to draw a picture of society in the future, following which there will be discussion as to what type of research themes should be set. In Japan also, the "Future Society Creation Project," which has been conducted by the Japan Science and Technology Agency (JST) since fiscal 2017, incorporates a process of soliciting research themes from citizens.

The sourcing of research support through crowdfunding is also a characteristic of recent years. This is one of the ultimate forms of citizen science, given that citizens are involved in agenda-setting even prior to the commencement of the research. Mr. Hayashi pointed out that the digital transformation has made it easier for citizens to get involved in science, and this represents a game changer with respect to funding. Moreover, "independent scientists," who are neither professional scientists nor amateurs, have emerged in recent years. These scientists are financially independent, obtain research funds using their specializations (IT skills, etc.), use the funds to conduct the research they wish to do, and later write academic papers.

Citizen science has been practiced for years, but the digital transformation has made the points of contact between scientists and citizens truly diverse. There are cases in Japan in which results with significant impact have been produced by pursuing research in collaboration with citizens. We need to recognize the potential of conducting collaborative scientific research with citizens and link it to the development of science.

New Approaches to Protection of Personal Information and Data Acquisition in Citizen Science

Dr. Watanabe pointed out that the question of how to lower the hurdles around the protection of personal information and data acquisition is the key to promoting citizen science in social sciences fields. The protection of personal information is essential in pursuing research in the social sciences. For example, when using consumer purchasing information such as loyalty card information, the citizens who generate the data often have a desire not to have their information seen outside the context of the research. Professional scientists and companies are able to establish rules and protect personal information under these rules, but it is difficult for amateur scientists to proceed with research with similar boundaries. How to protect personal information in citizen science is a new and difficult issue.

The cost of acquiring data is also an important issue. The lack of a necessity to expend funds would be the best condition for the expansion of citizen science. However, the reality is that data has economic value and good quality data is not available for free. How to compensate the providers of data, and how to reduce costs? It will be necessary to devise ways to lower the hurdles surrounding the use of data by citizens.

Dr. Watanabe suggested that these issues might be resolved based on agreements among citizens. For example, the problems of the protection of personal information and the cost of data acquisition could be surmounted by an agreement among citizens to the effect that the information obtained in a certain area would be available to the residents of that area. If both the researcher and the subjects of the research were residents, information would not be given out to the outside. It should be comparatively easy to obtain agreement regarding the provision of personal information and data in research conducted by citizens with other citizens as the subjects. Finding solutions in the context of citizen science will be an important perspective for the development of citizen science.

The Rise of Giant Platform Companies and Citizen Science

Professor Kitsuregawa discussed the significance of citizen science and the direction to be aimed for based on the relationship with platformers. With the rise of giant platform companies such as the companies making up GAFA, throughout the world discussion is proceeding in relation to data ownership, legislation is being framed in this area, and data is being utilized based on the concept of data ownership. How to regulate intangible digital goods is a new and difficult question, but Professor Kitsuregawa believes that when the principle of "FAT (fairness, accountability, and transparency)" is established, platformers will no longer be

"enemies" that fence data in, but will rather fulfill the role of a public good, providing data to citizens. In order to move in that direction, it will be necessary to foster a sense of ethics in relation to data throughout society and to work effectively with platformers. Citizen science also has an educational significance in fostering an ethical sense of science and data, and the role it will play will be great.

Dr. Watanabe also pointed out that the relationship between GAFA's data business and citizen science should be viewed from the perspective of complementarity rather than competition. GAFA uses AI to examine human behavior in detail, but in order for AI to function, it is necessary to impart objective functions unknowingly formed by human individuals, such as "What do humans want to do" and "When do humans feel the happiest?" However, Dr. Watanabe indicated that determining what these objective functions are is the most difficult thing for AI specialists. What humans are intending is something that can be seen when they look back at themselves and carefully observe the people around them. Dr. Watanabe emphasized that it will be of great significance to carry out research that clarifies such principles of human behavior as citizen science projects.

Professor Kitsuregawa pointed out that we must not forget to be aware of precisely what data we possess which GAFA does not possess. For example, Japan has a population of 80,000 people aged over 100 years old, and information concerning these people is valuable not only to Japan but to the world. Long-term follow-up data, as exemplified by cohort studies[3], is also valuable data that platform companies do not possess. The effective use of such data and its linkage with daily life and the development of the social sciences is the direction that citizen science should aim for.

Furthermore, Dr. Kitsuregawa emphasized that as information technology evolves, the future era will not be one in which we use data that someone already possesses, but will rather be an era of data design, in which one creates the data that one wants. In the area of citizen science also, there will be citizens who create and study their own data. It will be important to establish an environment allowing such activities to be carried out with peace of mind, and it will be necessary to formulate laws that protect data and to build systems for international cooperation.

Expansion of the Concept of Citizen Science in a Data-Driven Society

The question, "Citizen science in the traditional Japanese context has dealt with controversial themes such as nuclear power and pollution. Will it be possible for citizen science in the humanities and social sciences to treat subjects like these about which opinions are divided, or will they be excluded?" came from the audience. Dr. Yanagawa proposed that rather than rejecting the traditional concept of citizen science, the concept could be expanded by incorporating the perspective of data analysis. Even in the case of topics on which opinions are divided, if value judgments are formulated and conclusions reached only after considering and analyzing the data, the discussion will be more constructive than in situations in which there is no data. In a data-driven society, it will be important for anyone to be able to use and analyze

data and to have open discussions based on the results. In this way, Dr. Yanagawa indicated a direction for citizen science in the digital age.

5. Conclusion

The discussions at the conference made it clear that citizen science has the potential to play a major role in deepening our understanding not only of natural phenomena but also of social phenomena, and in generating new knowledge. It was indicated that there are certain conditions for this. First, citizen participation is not limited to data collection. It will be important to possess a citizen-collaboration perspective that utilizes the knowledge possessed by citizens at various stages of the research process, such as data analysis and the communication of results, rather than limiting citizens to merely collecting data. Second, it will be necessary to strengthen the motivation for citizen participation, because less citizen participation will lead to the termination or the failure of the research. Means of increasing the incentive for citizen participation that might be considered include the use of digital tools in order to create environments enabling research on themes that stimulate the citizens' intellectual curiosity. Third, ensuring quality in addition to quantity will be an important issue. It will be necessary to establish protocols for citizen participation, establish systems for the protection of personal information and the provision and management of data, and to realize responsible collaborative research conducted by citizens and scientists. It was also pointed out that the rise of giant IT companies that provide data platforms does not compete with citizen science. Rather, there is considerable leeway for citizen science to supplement these platforms; citizen science has access to data that platform companies do not possess, and there are numerous research themes that should be conducted in order to enable AI to effectively analyze big data. At the same time, platformers might become providers of data to citizens. It was pointed out that the creation of frameworks and systems to actively build complementary relationships of this type will also be indispensable to the development of citizen science.

Finally, based on the discussions at the conference, we would like to conclude with a few words about the role that citizen science can play in the current COVID-19 pandemic, which poses a major threat to global health, economy and society. One of the greatest challenges in ending the pandemic is our inability to accurately track the movements of infected people until infection are detected. In order to realize accurate tracking, it will be necessary to collect highly confidential personal information, including information on individual movements and health status. The consent of citizens is essential to making this possible. If citizens not only provide data, but are also able to participate in the visualization and analysis of data and knowledge creation, and if a framework can be established enabling them to jointly own the data, it should be easier to obtain their support. It is also worth considering not only making calls for the voluntary provision of data, but also providing some kind of economic incentive for citizens to share data, enabling us to advance citizen science on a policy-directed basis.

When societies have faced crises in the past, there is a long history of citizens coming

together to overcome those crises. The COVID-19 pandemic is one such threat. However, we still cannot say that information from citizens has been appropriately aggregated and has led to changes in the behavior of the government and of citizens. It is no exaggeration to say that the success of COVID-19 measures will ultimately depend on the active involvement of citizens. To that end, it will be important not only to unilaterally convey information on the effects of COVID-19 to citizens, but also to invigorate the activities of citizens and scientists towards thinking about the measures we should take in relation to the pandemic, and citizen science will play an extremely important role in this. Efforts will be required to facilitate ongoing two-way communication between citizens and scientists.

Note

[1] Citizen Science in the Digital Age - Engaging civil society in social science and humanities research - (Held in September 2019)

[2] Citizen science and volunteered geographic information – overview and typology of participation. In D. Sui, S. Elwood, & M. Goodchild (Eds.), *Volunteered Geographic Information, Public Participation, and Crowdsourced Production of Geographic Knowledge*. Berlin: Springer.

[3] Cohort study: Studies that bring together a large number of subjects who are not at the present time (or were not at some point in the past) infected with the disease to be studied, and which, through long-term observation and tracking, investigate whether the presence or absence of certain factors may cause or prevent the disease.
(Reference) National Cancer Center Hospital Cancer Information Service Glossary: "Cohort Study"
https://ganjoho.jp/public/qa_links/dictionary/dic01/cohort_study.html

The conference was the scene of lively discussion

◆Program

Welcome
Dorothea Mahnke (DWIH Tokyo)

Introduction
Reiko Kanda (NIRA)

Keynote Speech 1:
"Same but Different – Citizen Science in the Social Sciences and Humanities."
Martina Franzen (Institute for Advanced Studies in the Humanities)

Keynote Speech 2:
"Data-driven Society and the Citizen Science"
Masaru Kitsuregawa (National Institute of Informatics/ University of Tokyo)

Panel Discussion
Panelists:
Martina Franzen (Institute for Advanced Studies in the Humanities)
Masaru Kitsuregawa (National Institute of Informatics/ University of Tokyo)
Kazuhiro Hayashi (National Institute of Science and Technology Policy)
Shohei Yonemoto (University of Tokyo)
Tsutomu Watanabe (University of Tokyo)

Moderator:
Noriyuki Yanagawa (University of Tokyo and NIRA)

Concluding Remarks
Franz Waldenberger (DIJ Tokyo)

Martina Franzen

Dr.Martina Franzen is Postdoctoral Research Fellow at the Institute for Advanced Study in the Humanities (KWI). She received her PhD from the faculty of sociology at the University of Bielefeld in 2010. She engaged in research as Research Fellow and Principal Investigator at Bielefeld University, Faculty of Sociology from 2009-2014 and as Postdoctoral Research Fellow and Principal Investigator in the research group science policy studies at the WZB Berlin Social Science Center from 2014-2019. She moved to KWI in 2019. Her research focuses on science communication, medialization of science, digitalization and datafication of scientific knowledge production, citizen science, valuation studies, and sociological theory of society. Of her many publications, the latest are "Changing science-society relations in the digital age: the citizen science movement and its broader implications." (Handbook on Science and Public Policy, 2019, pp.336-356) and "Zum Wandel der wissenschaftlichen Wissen-sproduktion durch Big Data: Welche Rolle spielt Citizen Science? " ("How the data deluge is changing scientific knowledge production: What role does Citizen Science play? ") (in Österreichische Zeitschrift für Soziologie, 44, 15-35, 2019).

Masaru Kitsuregawa

Dr. Masaru Kitsuregawa is the Director General, National Institute of Informatics and Professor, Institute of Industrial Science, The University of Tokyo. He is a pioneer of database research. He led the Ministry of Education, Culture, Sports, Science and Technology's "Info-plosion" project (2005-2010), and headed the Cabinet Office's Funding Program for World Leading Innovative R&D on Science and Technology (2010-2014), which focused on ultra-large databases. A specialist in the field of data engineering, he completed the Doctoral Program of The University of Tokyo's Graduate School of Information Engineering, and holds a Ph.D.in engineering. After holding positions including Director of The University of Tokyo's Earth Observation Data Integration & Fusion Research Initiative, he became Director General of the National Institute of Informatics in 2013. He also holds the position of professor in The University of Tokyo's Institute of Industrial Science, and was President of the Information Processing Society of Japan (2013-2015). Professor Kitsuregawa is the recipient of numerous honors, including ACM SIGMOD Edgar F Codd Innovation Award, the Medal of Honor with Purple Ribbon and Chevalier de la Legion d'honneur.

Kazuhiro Hayashi

Mr. Kazuhiro Hayashi is Senior Research Fellow, National Institute of Science & Technology Policy, Ministry of Education, Culture, Sports, Science & Technology. He is involved in policy science re-search, and attempts to educate the scientific community regarding the importance of reform in the area of the circulation of scientific data. Making use of his knowledge of chemistry and his IT skills, he contributed to the pioneering digitization and commercialization of the journal of the Chemical Society of Japan. He is an expert member of the working party on Open Science for G7 Science and Technology Ministry meeting, and the Cabinet Office in Japan. At

Japan Open Science Summit in June 2018, he planned and hosted a session of Citizen Science as a chair to foresee the future of collaborative re-searches. He is also helping Young Academy of Science Council of Japan (SCJ) to utilize Citizen Science for their research, being a specially appointed member of SCJ.

Shohei Yonemoto

Mr. Shohei Yonemoto is Visiting Professor at University of Tokyo. He studies the history as well as the philosophy of science, including bioethics, and global environmental issues. He graduated from the Department of Science, University of Kyoto. He joined Mitsubishi Kasei Institute of Life Science and became as President of the Center of Life Science and Society. He worked as Adjunct Professor of the Research Center for Advanced Science and Technology, the University of Tokyo. He has authored "Biopolitics" (in Japanese; Chuko Shinsho 2006) and others.

Tsutomu Watanabe

Dr. Tsutomu Watanabe is Professor of Economics and Dean of the Graduate School of Economics, The University of Tokyo. Before joining The University of Tokyo in October 2011, he was professor at Hitotsubashi University (1999–2011) and senior economist at the Bank of Japan (1982–1999). He has held visiting positions at various universities, including Kyoto University, Bocconi University, and Columbia University. He received his Ph.D. in economics from Harvard University in 1992. His main research area is monetary policy and inflation dynamics. He has developed the Nikkei-UTokyo Daily Price Index® with Kota Watanabe, and is principal founder of Nowcast Inc.

Noriyuki Yanagawa

Dr. Noriyuki Yanagawa is Executive Vice President, NIRA and Professor of Graduate School of Economics, The University of Tokyo. His research focuses on Contract theory, Financial Contracts, and Law and Economics. He received his Ph.D. from the Graduate School of Economics, University of Tokyo. Before joining the Faculty of Economics at the University of Tokyo as Associate Professor in 1996, he was Assistant Professor at Keio University. He became Professor of the University of Tokyo in 2011. He is also a member of the Prime Minister's Council on Economic and Fiscal Policy and the Director of the Fintech Research Forum at the Center for Advanced Research in Finance, the University of Tokyo.