Recommendations

Recommendations Concerning an Approach to Open Science That Will Contribute to Open Innovation

July 6, 2016

Committee on Open Science
Science Council of Japan

The original was written in Japanese and SCJ provides English version for non-Japanese readers. The appendix is not included in this version. The translation of this document was supported by the National Institute of Informatics (NII), Japan.

These recommendations constitute a public announcement of the results of deliberations by the Science Council of Japan's Study Committee on Open Science.

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Summary

1. Background of preparation

In 2010 the Science Council of Japan recommended the establishment of a “comprehensive scientific journal consortium” for the purposes of resolving issues relating to scientific journals, while in 2015 it issued “Recommendations for the 5th Science and Technology Basic Plan.” In response to subsequent developments, such as studies conducted by Cabinet Office’s Expert Panel on Open Science based on Global Perspectives, this Committee was launched with a focus on crafting a vision for “openness in research data” and “data sharing.”

2. Details of studies

(1) What to do about guidelines for “openness in research data”

Here, “openness in research data” does not mean making all data open. Instead, it just means that data required for the purposes of contributing to open innovation be shared to a greater extent than it is now. Guidelines will be necessary to determine what kind of data be made open and what kind of data be kept closed, and these guidelines should include descriptions of the data envisioned as being covered, the establishment of embargos, and so on.

(2) How to ensure that incentives for openness are offered

To promote openness, research incentives will be required. In addition to convenience in the preparation of academic papers, essential incentives will include (a) the acceleration of research activities through the reuse of research results, (b) virtual observatory and/or laboratory using databases and analytical tools, (c) acquisition of research resources, (d) interdisciplinary integration, and (e) social implementation. In particular, the basis for incentives will be the provision, through the establishment of databases, of a research data infrastructure that enables the resources from other fields to be utilized.

(3) How to allocate the cost of achieving open science

The cost of promoting open science includes data production costs, data distribution costs, standardization-related costs incurred by engineers for distribution, and data storage costs. Therefore, to make openness continuous, a balance must be achieved between these costs and the benefits from utilization of data through openness.

(4) The issues of division of labor in research and the careers of researchers

As a result of sophistication of research, the traditional system of research, whereby a single researcher performs all process, i.e. produces, distributes, and utilizes data, has been joined by one in which the data producers who conduct experiments or measurements to produce data, the data distributors (data curators) who organize, standardize, etc. data formats, and the data users who analyze open data each have their own separate roles. However, a problem is that in this system, unlike data users, who can make research achievements in the form of academic papers and patents, data producers and data curators find it difficult to establish

careers as researchers.

(5) The possibilities of open science

The Committee conducted a questionnaire survey of scientific associations relating to each of sections I, II, and III. The majority of the scientific associations that responded have already made academic papers as well as digital data such as data and databases relating to academic papers public. Furthermore, at approximately half of them, the establishment of common measurement criteria for each data item means that there is also data that could become even more valuable.

3. Recommendations

(1) Establishment of a research data infrastructure that allows the management of and ensures the openness of interdisciplinary research data

The ICT progress in research environments has resulted in an explosive increase in research data. Not only that, but the data has become more complex, and issues are who should bear the costs and how to ensure cybersecurity. There is also the issue of taking steps to adequate privacy safeguard when research data concerning people is shared. This is a particularly important issue in fields such as life science, the humanities, and social science.

Cabinet Office and MEXT should swiftly and strategically establish a research data infrastructure for resolving these issues, in order to achieve open innovation by accelerating research activity through greater openness in research data and by promoting interdisciplinary integration and social implementation. It will be important to establish a highly efficient and reliable cloud-based data storage system, which is research data infrastructure offering high-speed, safe, and flexible data access,.

Also required is a mechanism for establishing and administering research data repositories, based on data strategies for open/closed data in each research community. Furthermore, because it is burdensome for small research organizations to store research data as a means of preventing research misconduct, in their case it would be preferable to establish a nonpublic, registration-based joint repository service. This joint repository service would need to offer a mechanism for allowing low-cost data storage. For example, cold storage could be employed for data that is accessed infrequently.

(2) Establishment of data strategies by research communities

Each research community should work on devising an open/closed strategy and guidelines that include predictions of the data that will be covered, the establishment of embargos, the determination of the scope of data openness, the inclusion of tools for analyzing data, and so on. What will be especially important during this process will be to ascertain and select the data to be covered. Therefore, from the perspective of costs, the key point will be to establish clear criteria for the selection of data. A mechanism for establishing and administering data repositories based on the open/closed data strategies determined by research communities will be included in the research data infrastructure described in Recommendation (1) above.

(3) Career design for data producers and data curators

Data producers and data creators cannot make research achievements in the form of academic papers or patents, which are the conventional way of assessing a researcher’s performance. Overseas, several incentive and evaluation mechanisms are being explored as means of solving this problem. They include the introduction of badges for contribution to copyright holders and naming the data producers and data curators who have provided data for academic papers. Japan should also be aggressive in adopting these kinds of incentives and evaluation methods so that data producers and data curators are able to forge careers as researchers, and MEXT should act systematically and organizationally to that end.

Contents

1. Background of preparation

Due to advances in science and technology, scientific research is undergoing a paradigm shift. One part of this trend is "open science." Such organizations as Expert Panel on Open Science based on Global Perspectives, Cabinet Office [1][2] and Council for Science and Technology's Subdivision on Technology's Science Information Committee, the Ministry of Education, Culture, Sports, Science and Technology's (MEXT) [3] noted domestic and international trends in relation to open science. The Science Council of Japan has launched the Committee on Open Science (hereinafter referred to as the "Committee") for the purpose of exploring action that should be taken by science community in Japan.

Open science comprises two main categories: "open access," which relates to the online perusal of scientific papers, and "open data," which relates to the use of data. Regarding the former, open access, in 2010 the Science Council of Japan recommended the establishment of a "comprehensive scientific journal consortium" for the purposes of resolving issues relating to scientific Journals [4], while in 2015 it issued "Recommendations for the 5th Science and Technology Basic Plan" [5]. The latter document emphasized the importance of establishing a scientific information infrastructure for storing research data in order to accelerate the deepening of scientific and academic fields, enhance international competitiveness, and deliver innovation on a sustainable basis.

In view of such developments, the Committee has focused on achieving "openness in research data" and "data sharing," which form part of the field of open data within open science. Furthermore, in the run-up to the compilation of these recommendations, the Committee has also disseminated information to Cabinet Office's Follow up Expert Panel on Open Science and at the "Data Sharing—Catalysts for the Development of Science—Toward the Promotion of Data-Driven Science," which was hosted by the Japan Science and Technology Agency.

2. Organization of the issues in open science

(1)Domestic and international trends

We have made a research on previous cases, including overseas trends, from various organizations and fields, including Cabinet Office, MEXT, ICSU-WDS (World Data System), life science, materials, microorganisms, astronomy, social science, and humanities to organize the issues in open science.

- Overseas trends

In 2013 an international consortium, the Research Data Alliance (RDA), was launched for the purposes of exploring ways of resolving numerous issues in order to smoothly promote data sharing. The RDA aims to get researchers and engineers to establish international standards on a voluntary basis. In March 2016 the RDA held its 7th conference in Tokyo, the first time the conference had been held in Asia.

Furthermore, in December 2015, the ICSU-IAP-ISSC-TWAS[1] working group issued a joint statement on open data [6] containing 10 guidelines for individuals and organizations, such as scientists, research institutes, and publishers, that should be responsible for open data.

The ICSU-WDS was established in 2008 for the purposes of supporting the long-term preservation and provision of quality-controlled scientific data. Since 2010, its International Program Office (WDS-IPO) has been situated in the National Institute of Information and Communications Technology (NICT).

In addition, common infrastructures for open science are being established in Europe (EUDAT), the USA (OSF: Open Science Framework), and so on.

- Domestic trends

Cabinet Office's Council for Science, Technology and Innovation (CSTI) has emphasized the importance of open science and has been conducting follow-up activities on an ongoing basis.

Furthermore, with regard to the establishment of a scientific information infrastructure, MEXT's Council for Science and Technology's Subdivision on Technology's Science Information Committee has pointed to the importance of support from the national government for utilizing the vast quantities of research data obtained from projects and bodies such as the Data Integration Analysis System Program (DIAS-P), the National Bioscience Data Center (NBDC), and the Center of Innovation Program (COI).

Japan Science and Technology Agency (JST) is also studying on research data sharing, but its focus is on the administration of the J-STAGE open access platform.

- Questionnaire surveys of scientific associations

The Committee conducted a questionnaire survey of scientific associations relating to each of sections I, II, and III. Specifically, Section I sent questionnaires mainly to the scientific association federation, the Section II sent questionnaires mainly to scientific associations to which committee members are connected, and the Section III sent questionnaires to scientific associations that are members of the liaison council for science- and engineering-related scientific associations. We would like to take this opportunity to extend our deepest gratitude to each scientific association. We also received separate responses from the scientific associations that are members of the scientific association federation, so we are unable to calculate the response rate.

The majority of the scientific associations that responded have already made academic papers as well as data and databases relating to academic papers public. Furthermore, at approximately half of them, while individual researchers possess data, common measurement criteria for each data item means that there is also data that could become even more valuable.

[1] ICSU: International Council for Science, IAP: Inter Academy Partnership, ISSC: International Social Science Council, TWAS: World Academy of Sciences

In addition, it is unfortunate that the scientific associations that responded were not very aware of the existence of the Cabinet Office report [1]. Moreover, only around 10% had organized an event on the theme of open science during the past five years. However, we found that almost half of the scientific associations were adding the free expression of opinions concerning open science and had a high level of interest in the topic.

The results of the survey indicated that activities by scientific associations to achieve open science have still to get underway, but that they are aware of the existence of valuable data and the importance of utilizing it.

(2)The data covered and the meaning of "open"

As Figure 1 shows, the Committee decided to study "openness in research data" and "data sharing."

Cabinet Office's Expert Panel on Open Science based on Global Perspectives is only studying on digital data. After hearing the views of various research institutes and conducting a questionnaire survey of scientific associations, it became clear that research data also includes "wet data," i.e. non-digital data such as old books and compounds. However, as targets for openness, it is difficult to handle actual materials across different fields, so this time all we have done is acknowledge their existence.

Furthermore, open science tends to be regarded as meaning that all research data is made open. The questionnaire survey of scientific associations also revealed that scientific associations are concerned that making all data public would lead to a reduction in their membership. However, after hearing the opinions of research institutes, it has become clear that openness does not mean make all data open. Instead, what it really means is to ask that data which can contribute to open innovation should be made more open than it is now. To that end, however, strategies and guidelines for making data open/closed will be essential. Open/closed guidelines would include descriptions of the data envisioned as being covered, embargos, the scope of openness of the data, tools for analyzing data, and so on.

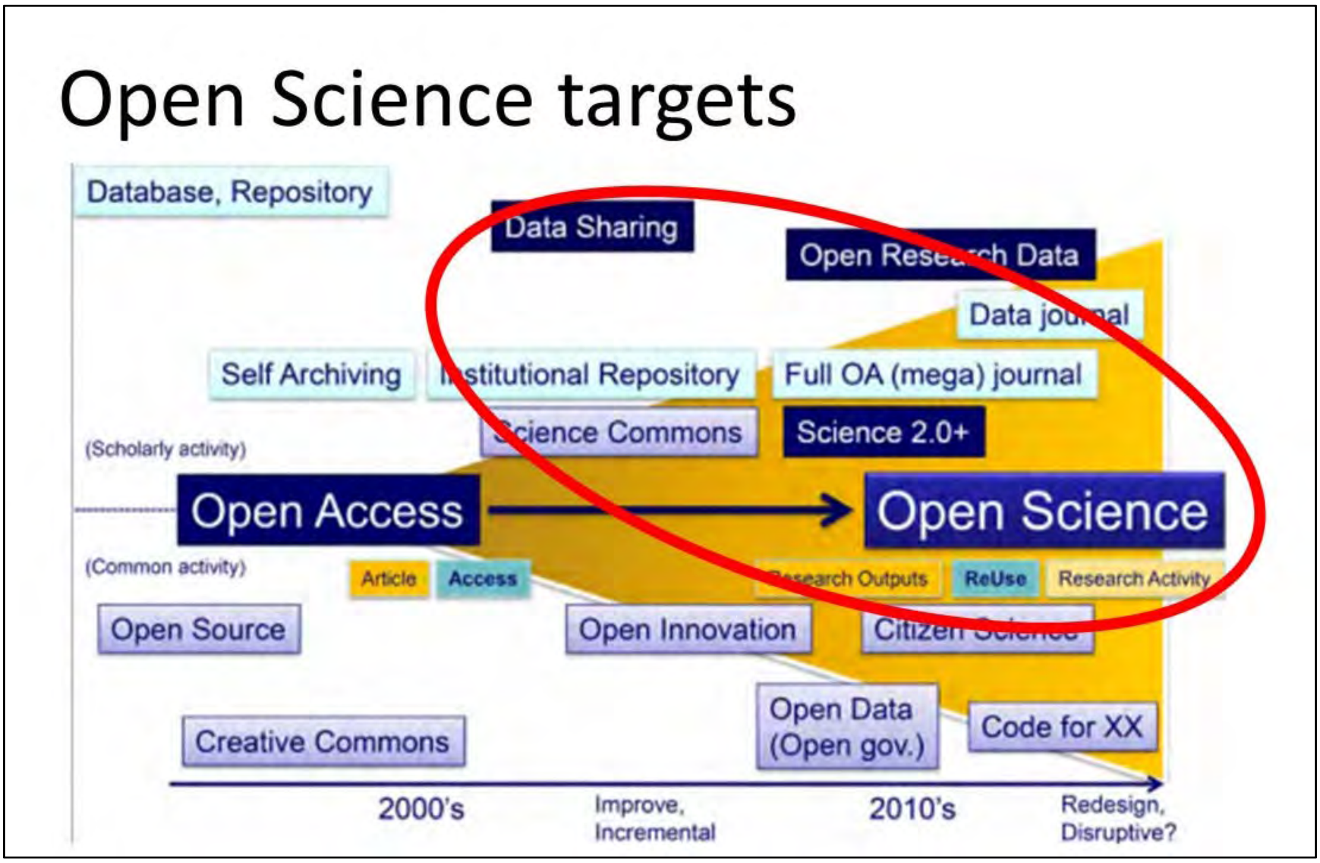

Figure 1. Open science covered
Source: Report from the Cabinet Office's Expert Panel on Open Science based on Global Perspectives

(3)Incentives for openness

To promote openness, incentives that contribute to research activities will be required, and these incentives could include convenience in the preparation of academic papers. To be specific, in the USA, for example, statistical data indicates that the database of genotypes and phenotypes database (dbGaP) at the National Institutes of Health (NIH) contains 685 registered studies and each year more than 10,000 requests to access it are received. The statistical data also shows that at least 920 academic papers have made use of its data, the volume of which is 2PB (Figure 2). Moreover, in the field of astronomy, it has been reported that the number of peer-review papers produced using the Virtual Observatory (VO)[2] database is increasing.

Besides convenience in the preparation of academic papers, the following incentives also exist:

- Acceleration of research activities through the reuse of research results
- Virtual experiments using databases and analytical tools (e.g. materials informatics)
- Acquisition of research resources (e.g. The Hyakugo Archives WEB, Ten thousand calendar edition Tripitaka (Jiaxing collection) image database)

[2] "Virtual observatory" is the term used in astronomy. In other fields, the term "virtual experiments" is used.

- Interdisciplinary integration (e.g. antique documents + civil engineering data → earthquake prediction, Hit compound library + drug-discovery screening → drug discovery)
- Social implementation (e.g. official statistics + web data → urban planning)

By making research data open, it becomes possible to utilize research data from other fields, which enables advances to be made in interdisciplinary integration and social implementation. Interdisciplinary integration and social implementation involving the use of research data are important for open innovation, which emerges from interdisciplinary collaboration as well as cooperation between academia and society. Furthermore, in the field of materials, for example, it has been reported that a nanonet linking data from different organizations has increased the number of industry-academia-government nanotechnology projects.

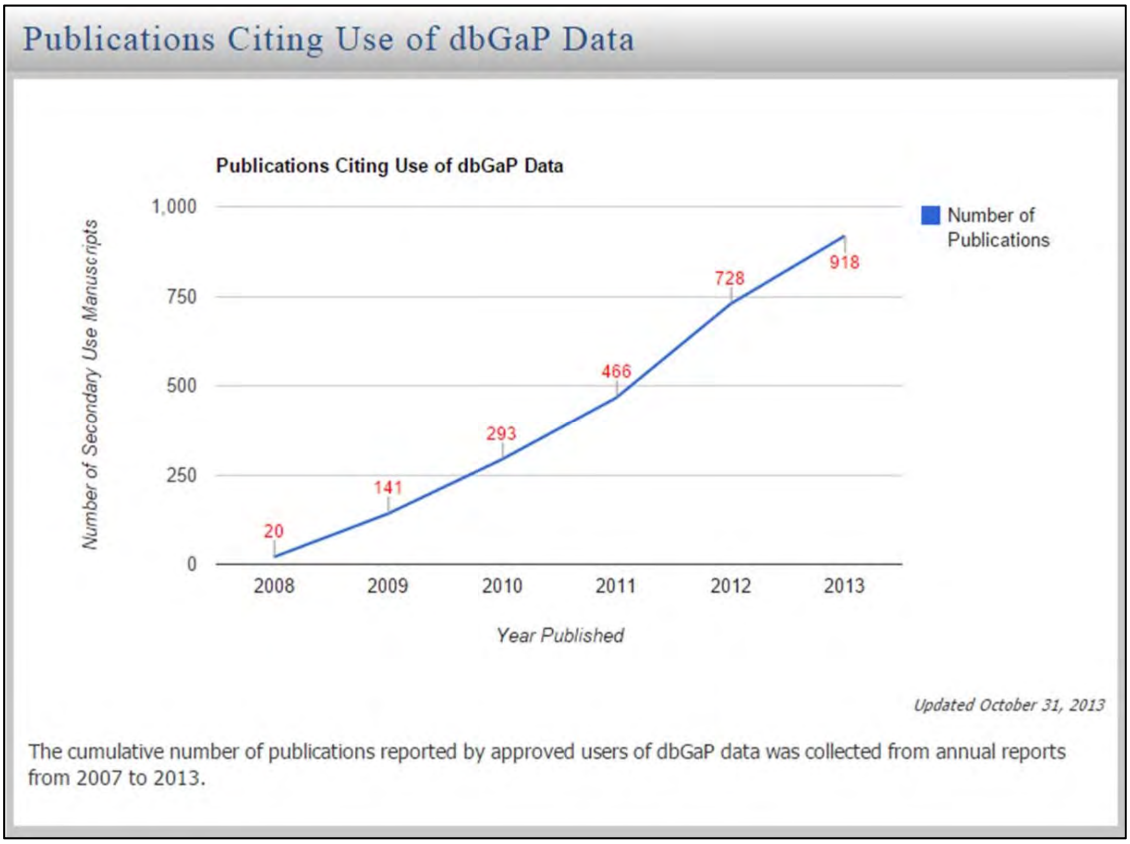

Figure 2. Publications citing use of data from dbGaP (a USA genotypes and phenotypes database)
Source: https://gds.nih.gov/19publicationsciting_dbGaP.html

It is important to verify whether this acceleration in research activities through open science is actually beneficial. The European Bioinformatics Institute (EBI) hired consultants to assess the value to the community and the impact on society of its European Molecular Biology Laboratory Nucleotide Sequence Database, and they produced their report in January

2016 [7]. As Figure 3 shows, the report found that while annual investment costs are GBP 47 million, users spend GBP 2.57 billion to access the database. This, the report states, constitutes an annual saving of between GBP 1 and 5 billion. The above findings can be said to indicate that the acceleration in research due to open science research is sufficiently in line with investment and access costs.

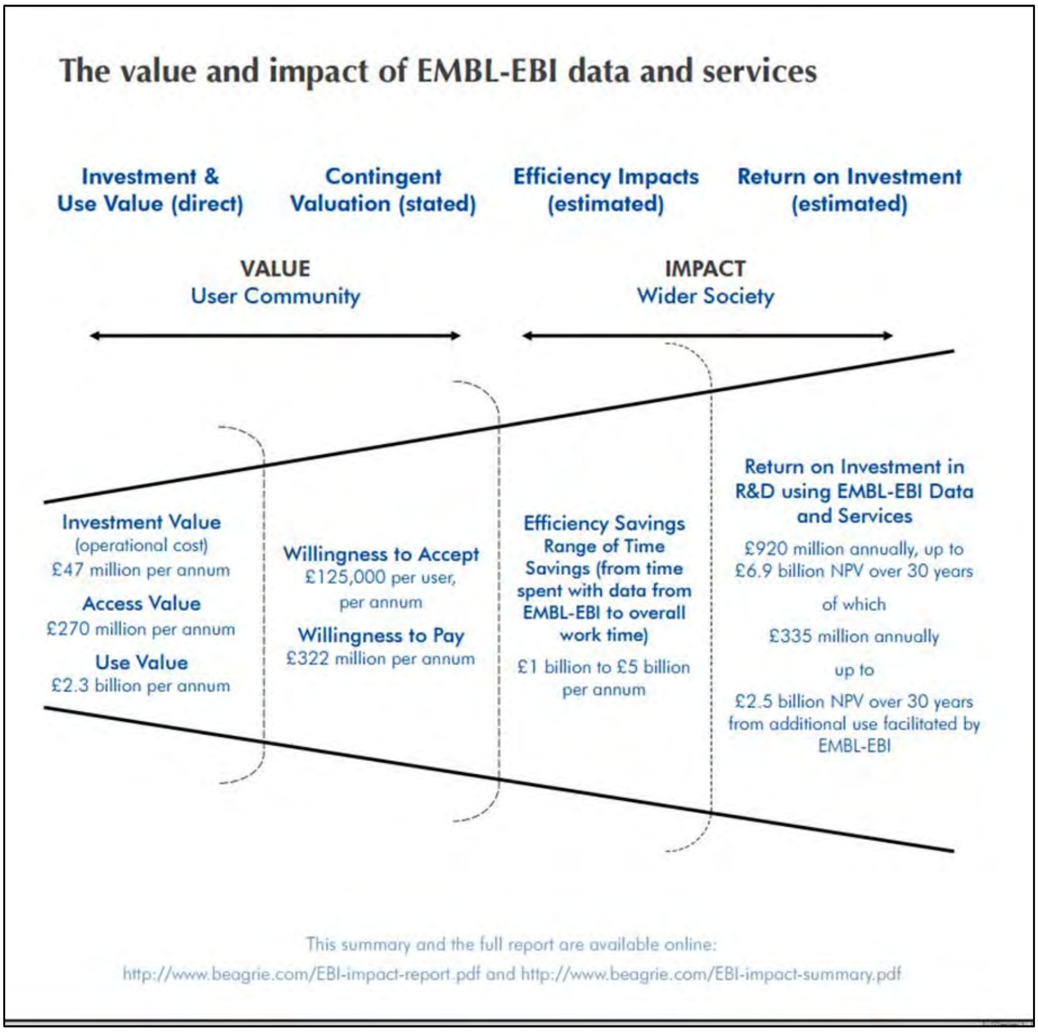

Figure 3. The value and impact of the EMBL Nucleotide Sequence Database
Source: Prepared based on http://www.beagrie.com/static/resource/EBI-impact-summary.pdf/

(4)The cost of open science

The establishment of incentives can promote openness. On the other hand, the cost of openness will need to be taken into account in order to maintain openness.

The cost of open science includes data production costs, data distribution costs, standardization-related costs incurred by researchers and engineers for distribution, and data storage costs. Therefore, it will be necessary to strike a balance between these costs and the utilization of data through openness in order to maintain openness.

Data production costs are high using large research facilities in fields such as astronomy. Openness is advancing with the aim of delivering outcomes that contribute to human knowledge or the environment. In addition, data is being collected with techniques for organizing data, formats, and so on having been prepared.

On the other hand, It is different in fields such as drug discovery and materials, where data analysis results have high commercial and non-commercial applicability. The data providers take it on oneself to handle data required for social implementation, such as metadata, and analysis programs. The gap between the academic world and corporations is being bridged through the public disclosure of data once the rights of providers have been safeguarded through, for example, the award of patents.

These developments can be summed up visually as in Figure 4, which provides an overview of the situation in each field of open science. The "sharing whole data" model makes the degree of openness high in fields such as astronomy push the openness. The "sharing bridging data model," makes the degree of openness is low in fields such as drug discovery and materials.

Figure 4. Overhead view of open science in each field

The cost of promoting open science in the future within a country's total research system is a big question that should be explored in a comprehensive fashion through international cooperation. It encompasses various issues including not only those from the perspective of openness, but also those relating to research data as a whole. Such studies need to be commenced swiftly and in lockstep with such trends as the implementation of data management plans by organizations such as those that allocate research funding.

There are also moves to develop research databases that take into account the entire process from the research phase to product development. An example of this is the DB Center for Brain Information, which is described in Figure 5. National projects such as Cabinet Office's ImPACT and Japan Science and Technology Agency (JST)'s CREST, research organizations such as the RIKEN, National Institute of Information and Communications Technology (NICT), and Advanced Telecommunications Research Institute International, as well as companies that develop products share stimulus data sets, measurement data, and analysis tools via a brain information database, and promote the utilization of data for research and product development.

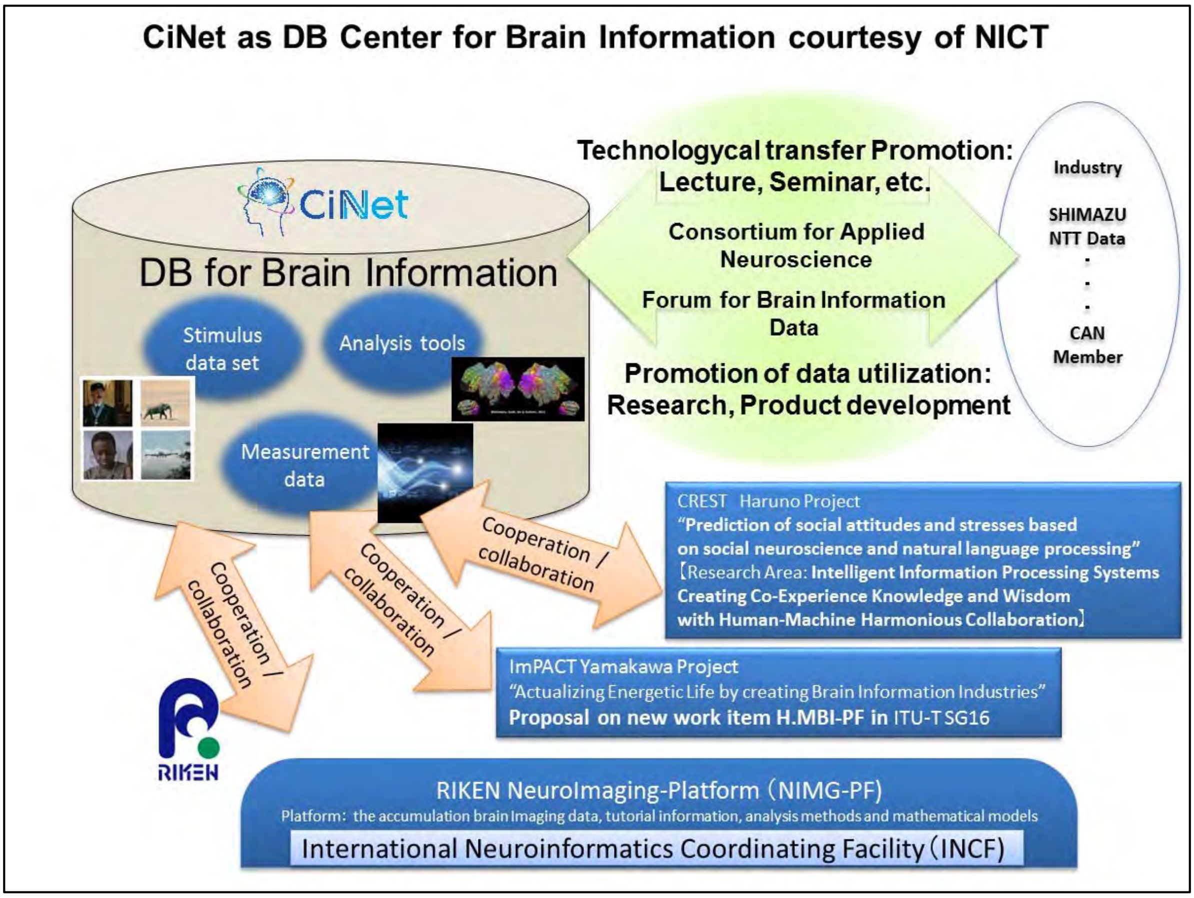

Figure 5. CiNet as data center for brain information
Source: Provided by National Institute of Information and Communications Technology (NICT)

(5)Division of labor in research and the careers of researchers

In the traditional system of research, a single researcher performs all processes, i.e. produces, distributes, and utilizes data. As a result of division of labor in research, the data producers conduct experiments and measurements to produce data, the data distributors (data curators) organize, standardize, etc. data formats, and the data users analyze open data each have their own separate roles. However, under this delineated structure, while data users can leave behind research achievements in the form of academic papers and patents, data producers and data curators cannot leave behind research achievements under their own personal names, even when high-caliber, specialist personnel are required. As a result, it is difficult for them to establish careers as researchers.

To solve problems like this, efforts are being made to make achievements clear. For example, when data is used during the presentation of a paper, the data provider is mentioned (data citation), or the scientific association awards a badge of contribution to the copyright holder. Nevertheless, such efforts cannot be said to be sufficient.

International initiatives are also being implemented to promote data citation, yet data citation needs to become much more widespread. For example, efforts are being made to promote the adoption of rules concerning the assignment of DOIs (Digital Object Identifiers) to data as is the case with academic papers, DOI citation with respect to data used in papers, and so on [8]. Among other initiatives, a system of performance evaluation indicators is also being explored.

3. Recommendations

(1)Establishment of a research data infrastructure that allows the management of and ensures the openness of interdisciplinary research data

As the results of the questionnaire survey of relevant scientific associations shows, efforts are being made to achieve open access to scientific journals. A look at the global situation, however, reveals that scientific-journal data is being hoarded by Western academic associations and publishers, with Japan being left far behind. On the other hand, progress in the adoption of ICT in research environments has resulted in an explosive increase in research data. Not only that, but the data has become more complex, and issues are who should bear the costs and how to ensure cybersecurity. There is also the issue of taking steps to safeguard privacy when research data concerning people is shared. This is a particularly important issue in fields such as life science, the humanities, and social science.

To achieve open innovation by accelerating research activity through greater openness in research data and by promoting interdisciplinary integration and social implementation, Cabinet Office and MEXT should swiftly and strategically establish a research data infrastructure for resolving these issues. It is crucial that this research data infrastructure allows high-speed, safe, and flexible data access through the deployment of high-performance network technology and authentication cooperation technology, and enables data to be stored efficiently and reliably through the use of cloud services (Figure 6).

Also required is a mechanism for establishing and administering research data repositories based on data strategies for open/closed data in each research community. Furthermore, because it is burdensome for small research organizations to store research data as a means of preventing research misconduct, in their case it would be preferable to establish a nonpublic, registration-based joint repository service. This joint repository service would need to offer a mechanism for allowing low-cost data storage. For example, cold storage could be employed for data that is accessed infrequently.

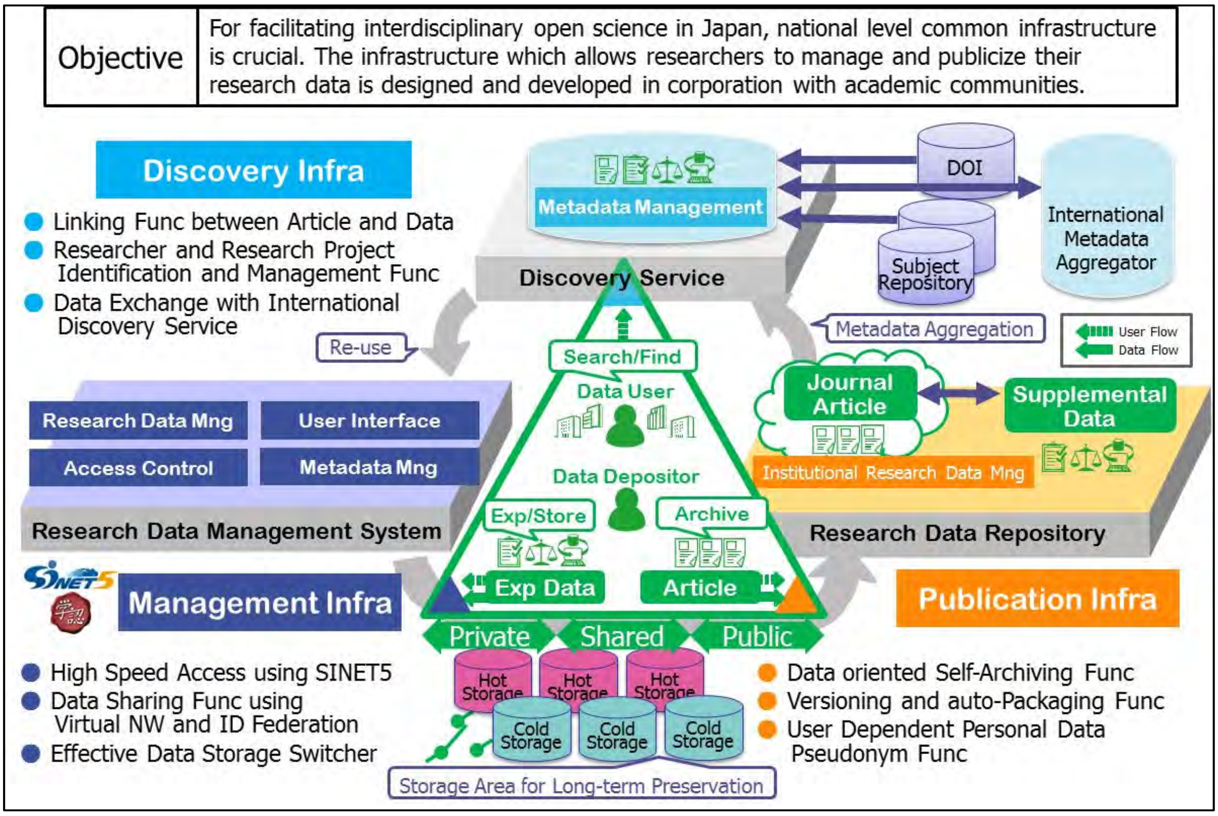

Figure 6. Research data infrastructure for open science

Specifically, the uses of research data by each type of research data infrastructure shown in Figure 6 are as follows:

- Management infrastructure: Allows low-cost, safe, and flexible data access and highly efficient and reliable data storage through the utilization of network, authentication-cooperation, and cloud technologies. Researchers assign metadata to data, such as empirical data, contained in their research using an easy-to-use API (application programming interface) to register it in the management infrastructure. The registered research data is either kept nonpublic or is shared with research communities that have been permitted to access it, and in accordance with guidelines for the prevention of research misconduct, each paper has to be stored, for example, for 10 years following its publication.
- Publication infrastructure: This term refers to next-generation repository systems that promote the openness and reuse of research data, and is the so-called open science component. When an academic paper is posted, the paper itself, which describes the results of the research, along with the research data that formed the basis for it are published from the publication infrastructure in accordance with the open/closed guidelines for the field concerned. After that, they are used for such purposes as peer

review and the verification of empirical findings.

- Discovery infrastructure: A general-purpose research data reuse system that integrates information on academic papers, researchers, and research projects. Features such as connections with overseas discovery services and functions for associating papers and research data enable researchers to access the information they need wherever they are in the world.

The above-described research data infrastructure should not be developed independently by Japan in accordance with Japanese systems. Instead, it would be appropriate to establish a joint development structure involving Western projects that are already being implemented, with the infrastructure being realized under an international cooperative framework that combines strong technologies from both Japan and the West. The construction of the database of old books at the National Institute of Japanese Literature included the establishment of a publication system as a result of cooperation from the National Institute of Informatics (NII). Consideration also needs to be given to the issue of taking steps to safeguard privacy when research data concerning people is shared, which is a particularly important issue in fields such as the humanities and social science. In the future, by employing individual achievements like these to develop the research data infrastructure, we hope that it will become possible to promote a form of open science that also reflects issues relating to data sharing and research ethics.

(2)Establishment of data strategies by research communities

Each research community should work on devising an open/closed strategy that includes predictions of the data that will be covered, the establishment of embargos, the determination of the scope of data openness, the inclusion of tools for analyzing data, and so on. What will be especially important during this process will be to ascertain and select the data to be covered. Therefore, from the perspective of storage and utilization costs, the key point will be to establish criteria for the selection of data that are as clear as possible.

With regard to data strategy, in the West, openness in data from the government and the public sector (Open Government Data) and the sharing of highly-specialized scientific data and research data (Research Data Sharing, Open Research Data) are often discussed in different policy and methodology terms. Attention needs to be paid to the fact that an expert report published in Europe [9], while conceding that the promotion of open science is important, includes the recommendation that because the research data problem is particularly complex, rules should not be established prematurely while the problem is still not understood. While taking such matters into account, it will be necessary for research communities to play the leading role in engaging in a debate, while paying attention to advantages and disadvantages in terms of promoting research, in order to organize their views as communities. A mechanism for establishing and administering data repositories based on the open/closed data strategies determined by research communities will be included in the research data infrastructure described in Recommendation (1).

(3)Career design for data producers and data curators

Data producers and data creators cannot leave behind research achievements in the form of academic papers or patents, which are the conventional way of assessing a researcher’s performance. Overseas, several incentive and evaluation mechanisms are being explored as means of solving this problem. They include the introduction of badges for contribution to copyright holders and naming the data producers and data curators who have provided data for academic papers. Data citation initiatives (current international initiatives such as exploring the possibility of assigning DOIs (Digital Object Identifiers) to data, as is the case with academic papers, promoting the adoption of rules for the citation of DOIs used in academic papers, and a system of performance evaluation indicators) are also being implemented in some areas. Japan should also be aggressive in adopting these kinds of incentives and evaluation methods so that data producers and data curators are able to forge careers as researchers. Furthermore, MEXT should act systematically and organizationally to enable such personnel to be developed in an organized fashion.

References

[1] The Expert Panel on Open Science, based on Global Perspectives, Cabinet Office, March 30, 2015.
http://www8.cao.go.jp/cstp/sonota/openscience/

[2] Follow up Expert Panel on Open Science, Cabinet Office, Nov. 12, 2015.
http://www8.cao.go.jp/cstp/tyousakai/opnscflwup/

[3] Council for Science and Technology's Subdivision on Technology's Science Information Committee, Ministry of Education, Culture, Sports, Science and Technology's (MEXT), Aug. 26, 2014.
http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu4/036/houkoku/1368803.htm

[4] Academic journal issue consider Subcommittee, Scientists committee, Science Council of Japan, Proposal Towards the resolution of the academic journal issue – The creation of a "comprehensive academic journal consortium"-, Aug. 2, 2010.
http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-21-t101-1.pdf

[5] Committee on Science and Technology Basic Plan, Science Council of Japan, Recommendations for the 5th Science and Technology Basic Plan, Feb. 27, 2015.
http://www.scj.go.jp/ja/info/kohyo/pdf/kohyo-23-t209-1.pdf

[6] ICSU-IAP-ISSC-TWAS working group, Open Data in Big Data World, Dec., 2015,
http://www.icsu.org/science-international/accord/open-data-in-a-big-data-world-short

[7] Neil Beagrie and John Houghton, The Value and Impact of the European Bioinformatics Institute, Jan. 2016,
http://www.beagrie.com/static/resource/EBI-impact-summary.pdf

[8] Data Citation Synthesis Group: Joint Declaration of Data Citation Principles. Martone M. (ed.) San Diego CA: FORCE11, 2014.
https://www.force11.org/group/joint-declaration-data-citation-principles-final

[9] RDA Europe, The Data Harvest: How Sharing Research Data Can Yield Knowledge, Jobs And Growth, Dec., 2014.
https://rd-alliance.org/data-harvest-report-sharing-data-knowledge-jobs-and-growth.html