

Towards Open Science: China's Scientific Research and Libraries

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Abstract:

The advance of networking and computing technologies offers unprecedented opportunities for the implementation of principles and practices of open science. By demonstrating attempts of openly working and researching in scientific research and libraries, this paper aims to introduce China's efforts towards Open Science. Firstly, this paper reviews Chinese Science & Technology policy and innovation policy towards Open Science by data statistics, indicating that China demands and promotes Open Science. Based on the situation of Chinese Open Science initiatives, this paper also explores current services of Chinese government, organizations and libraries of moving forward to openness by sharing some cases. Moreover, Chinese Academy of Sciences is presented in this paper as an example of one of Chinese academic library to introduce its "Open and Collaboration" service strategy planning and Open Knowledge service practice to the need of Open Science and Open Innovation.

Keywords: Open Science, China, Innovation, Library, Practice

Introduction

New Internet technologies are radically enhancing the speed and ease of scholarly communications, and are providing opportunities for conducting and sharing research in new ways. Open Science seeks to facilitate knowledge acquisition through collaborative networks and encourage the generation of solutions based on openness and sharing. In general, Open Science is a broad concept that includes these closely related areas of open access, open data, Open Science infrastructure, Open Science evaluations and Open Science tools.

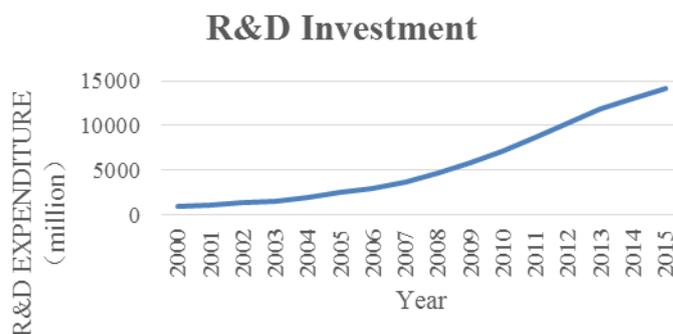
There have been several attempts at promoting “Open Science” in the world, such as Organization for Economic Co-operation and Development (OECD) countries who has made efforts to adapt legal frameworks and implement policy initiatives to encourage greater openness in science. Facilitate Open Science Training for European Research (FOSTER) tries to provide the integration of Open Science best practices into the daily routine of performing and supporting research. Digital Curation Centre (DCC) collaborates with SPARC Europe to extend their coverage to make it more comprehensive at European level and to cover open research practice more generally. Besides, EU Competitiveness Council is also committed to accelerating Open Science. All these projects and policies indicate that many international organizations are campaigning for Open Science, as it takes benefits to research from openness. With the globalization of open scientific process, China has also set out some principles and offered some open knowledge services to guide researchers with their outputs.

Developing the Open Environment in China

China has developed its research in a rapid pace in about 20 years, and a set of measures and policies from Chinese government have been defined to encourage Open Science. In 2012, 18th Chinese Communist Party (CCP) Congress proposed “Innovation-driven Development Strategy”, which means that scientific innovation serves as the key driving force for social and economic development. In 2015, 5th Plenary Session of 18th CCP emphasized the idea of “Innovation, Coordination, Green, Open, Sharing”. Also in 2016, 12th National People's Congress established “a platform which will be created for crowd innovation, crowd support, crowd sourcing, and crowd funding, and the mechanisms will be built to encourage new types of business startups and innovation making through cooperation between enterprises, institutions of higher learning, research institutes, and makers[].”Launching with these important policies, it can be inferred that Chinese government advocates the implementation of knowledge opening and sharing with a strong and firm attitude.

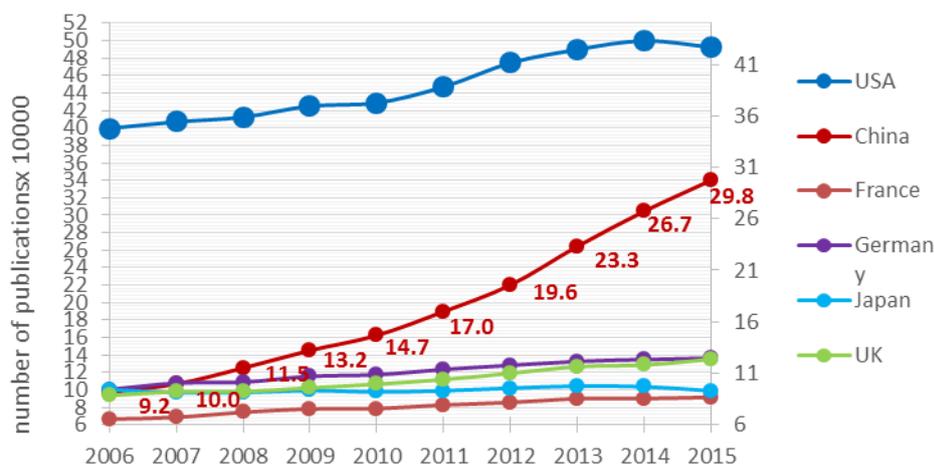
Relevant R&D statistics in China confirms the above opinion. From Figure 1, in 2000-2015, the total investment amount in China has been steadily increased, and the amount reach to 14,169.88 million in the last year, about 8.87% over 2014.

Figure 1. R&D Investment



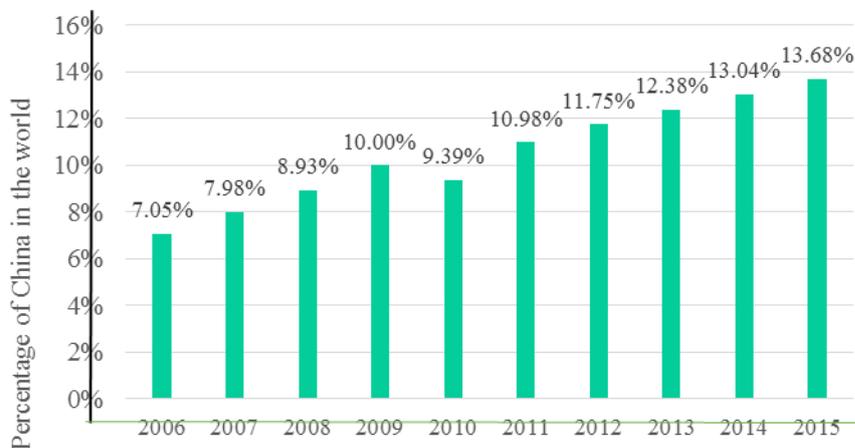
In the publications of main countries of Figure 2, we can see the growth of Chinese research outputs is prominent. Chinese research papers in 2006-2015 by SCI reach from 91,550 to 297,694, the increase tide in dramatically rapid while the others in a relatively slow. Moreover, the gap between USA and China is significantly narrowed in 2016.

Figure 2. Publications of main country in 2006-2015



According to publications of main countries, we calculate in the Figure 3 about the percentage of Chinese publication in the world, the rising tide is also apparent and in 2015 reach to the summit about 13.68%, the percentage is approximately twice more than in 2006.

Figure 1. Percentage of China in the world total in 2006-2015



China leads in numbers of publications in Chemistry, Engineering, Material Sciences, and Physics in 2006-2015 in the world from Figure 4, especially in the material science. In recent years, Chinese research outputs in Chemistry, Engineering and Physics have risen sharply and shown a good tendency.

Figure 2. Publication ranking of China in chemistry, engineering, material science and physics in 2003-2012

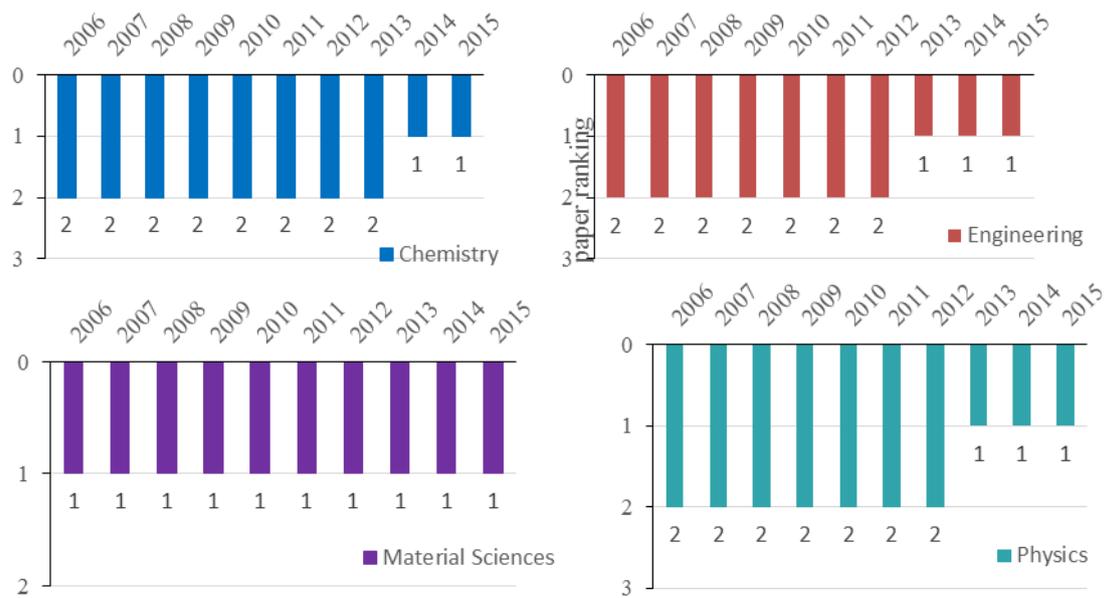
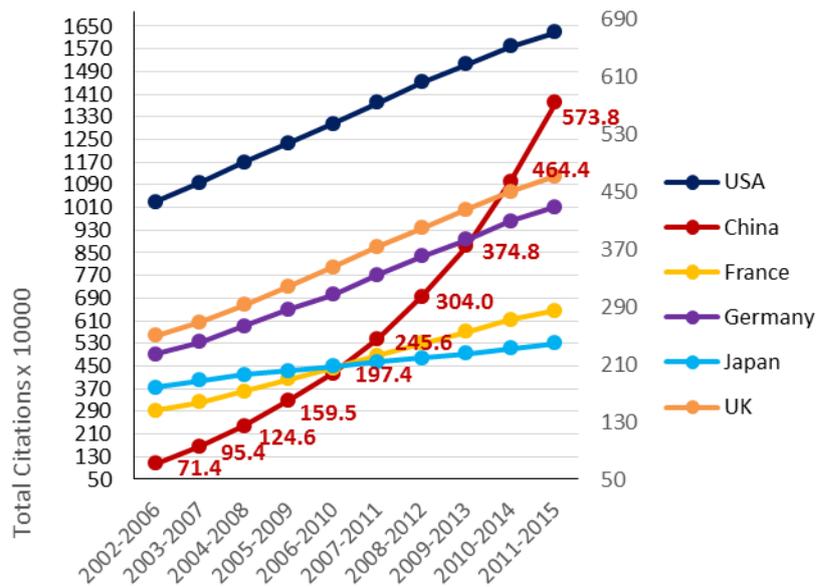
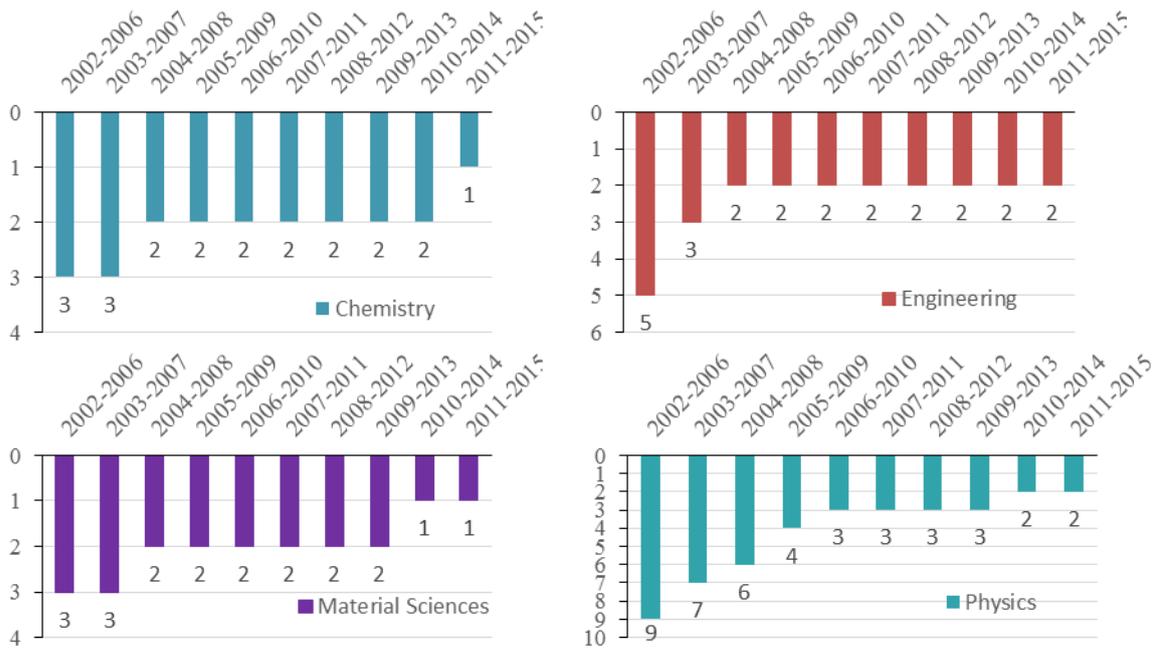


Figure 3. Total citations of main countries in 2002-2015



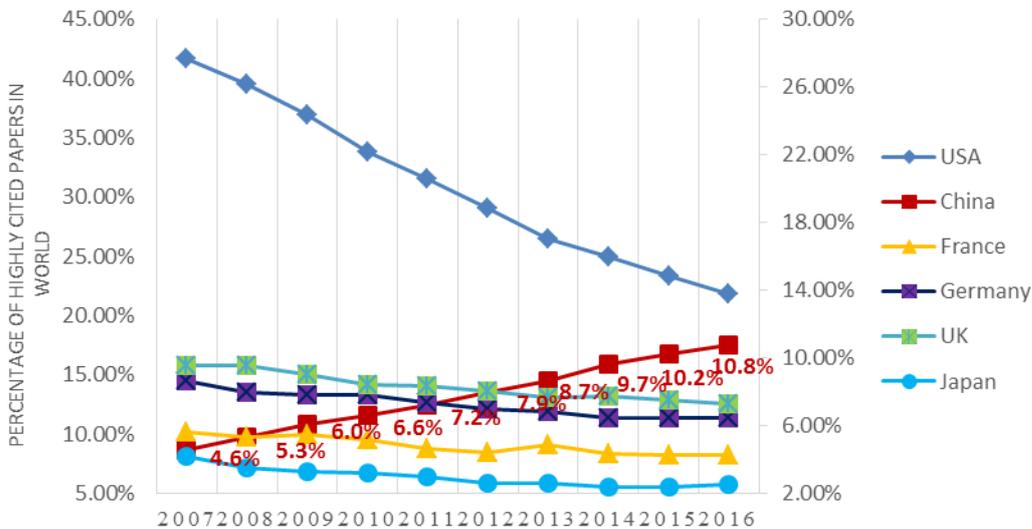
From the perspective of impact, Figure 5 shows that the total citation of Chinese research in the main countries grow from 0.71million in 2002-2006 to 5.7million in 2011-2015 with a fast speed. China fall behind in the total citation in 2002 whereas go ahead progressively from 2007.

Figure 6. Citation ranking of China in chemistry, engineering, material science and physics in 2002-2015



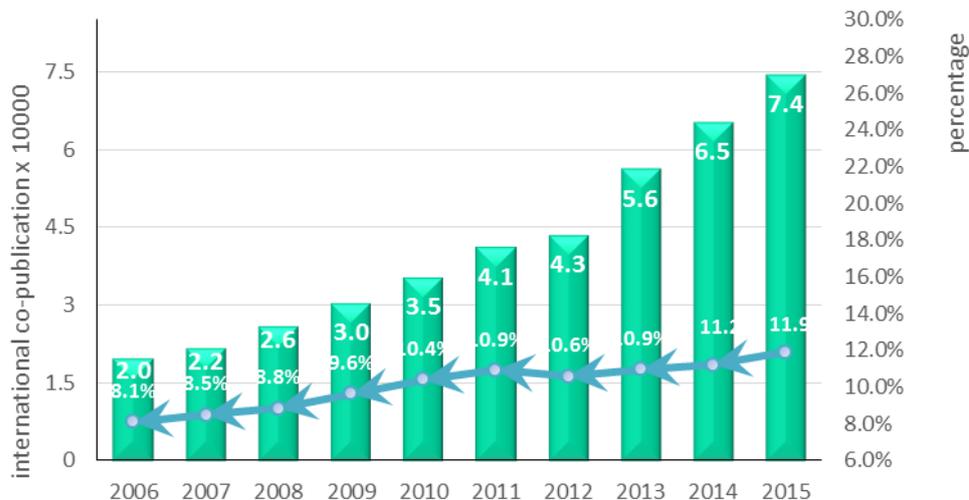
In the Figure 6, China' citation ranks increase steady in Chemistry, Engineering, Material Sciences, and Physics in 2002-2015. Apparently, each rank in the four areas is progressing and China plays the leading role in recent years.

Figure 4. Percentage of highly cited papers in 2007-2016



In the highly cited papers of Figure 7, the percentage of China rise from 4.6% in 2007 to 10.8% in 2016 whereas the other countries steady or sharp decrease. It is a powerful evidence that China has strong scientific research outputs.

Figure 5. International co-papers of China in 2006-2015



From Figure 8, we can see that China’s International co-operation papers are 2.2 in 2007 to 74,462 in 2015, and the co-operation paper in China occupy 8.1% in 2007 to 11.9% in 2016. With these figures, China has a rapid rise in scientific research and possesses huge potential for innovation. Therefore, China demands Open Science.

Enriching the Open Services

Based on the situation of a large number of population, quantities of Internet information and rising R&D activities, China has to strengthen its research capacity through open data and open infrastructure to gain the rising tide of scientific data. Several operational practices for Open Science are presented in China during a couple of years, ranging from Chinese government organizations to libraries, and other private enterprises.

Practice 1: Open Repository Policies

Bernard Rentier said: “An empty repository is useless; a partly filled repository is partly useless; there is a need for an institutional open access policy.” There are considerable repository policies in China. In 2014, the Chinese Academy of Sciences (CAS) and the National Natural Science Foundation of China (NSFC) have both issued new open access policies which will contribute to making research more available. CAS will require its researchers and graduate students to deposit the final, peer-reviewed manuscripts of their research articles resulted from any public funding, submitted and consequently published, since the issuing of the policy, into the open access repositories of their respective institutes, to be made open access within 12-months of their official publication. Putting research results in the public sphere (like repository) with an important and practical policy will make science better and strengthen our knowledge-based economy.

Practice 2: Open Reproducible Research

Technological Report Sharing System is another breakthrough of Open Science in China, like the establishment and formation of a system named National Science and Technology Report Service (NSTRS), the mode of spread and communication of scientific and technological report have been changed and innovated. NSTRS has already possessed 85,146 reports which come from different government organizations and submitted by each organization to make sure the authenticity. The public begin to explore and use newly knowledge from this report system, based on transparency and effectiveness. It is of great importance for China to strengthen national innovation and make national decisions by developing an integrated

approach to reproducible research, not just providing a free integrated system, but to help institutions with technical, implementation, and consultation assistance.

Practice 3: Open Publishing and Open Resources Integration

Golden OA becomes a key topic in academia now and increasingly turn into a new evaluation for high-level research. Institutions in China also addressed the importance of implementing open scholarly publishing.

China Scientific Data, an Open Data Journal funded by CAS, is dedicated to promoting the sharing and citation of scientific data, to making data findable, accessible, intelligible and reusable. All the open publishing process shall be efficient, high exposure, rapid dissemination and intelligent services. Strict observance shall cover both articles and datasets to guarantee the quality of the publication as well as the reuse of the datasets.

Besides, sustainable open integration platforms give researchers assist from information provision to knowledge services. For example, China Open Access Journals (COAJ) allows researchers to use research funding to publish Open Access articles and now possesses 654 journals and 1,420,383 articles. COAJ is a community-curated online directory that indexes and provides access to high quality, open access, peer-reviewed journals in China, covering science and social science. COAJ is conducive to open knowledge particularly in scholar communications and open findings.

Practice 4: Open Education Resources

Open education is a way for people to produce, share, and build on knowledge. Proponents of open education believe everyone in the world should have access to high-quality educational experiences and resources, and they work to eliminate barriers to this goal. With the influence of Massive Open Online Courses (MOOCs) in the world, MOOCs refer to any online learning or using of education technologies, government organizations and private enterprisers in China keep on promoting the dissemination of knowledge resources. China, a country with over 1.3 billion people, certainly is hard to offer everyone an opportunity to attend university. Chinese expect China MOOCs to bring “revolutionary” change to the education system by reducing inequity between urban and rural schools and by sharing the best teaching resources. The young Chinese are keen to learn cutting-edge knowledge in development, therefore the online education and open knowledge resource system are sustainable growing and promising with an unprecedented way. From 2007 to 2016, more and more Internet Media (e.g. NetEase, Inc) and universities (e.g. Qinghua University, Peking University) in China put forward their open course online. On April 28, 2016, Ministry of Education of the P.R.C announced that the government will strengthen the supervision and guidance of MOOCs’ development in universities.

Practice 5: Open Scientific Data

Open scientific data is always seen to create tremendous opportunities, and its benefits extend to all branches of society. .By collecting, integrating and syncretizing data, China has established many platforms to push forward scientific data sharing, such as National Scientific Data Sharing Platform, which includes Health and Population, Earth Systems, Agriculture, Basic Sciences, Material Sciences, Meteorological data. The goal of the project is to integrate data which is scattered at colleges, research institutes, scientists, and research project. This kind of platforms increases value of data and play a key role in Open Science to better serve for S&T researchers

NSLC “Open and Collaboration” Service Strategy and Practice

During the moving towards Open Science, National Science Library, Chinese Academy of Sciences (NSLC) attempts to re-define strategies and responsibilities. NSLC is one of the largest research and academic libraries in China, specialized in S&T information and interdisciplinary services. Since its establishment in 1950s, different models and tools have already engaged and used successfully in NSLC to push the degree of open-operability implemented. From 2011, NSLC develop the knowledge service in CAS. Later in 2015, NSLC puts forward its goal of constructing National Authority S&T Knowledge Services and comes out its “Open and Collaboration” Service Strategy, containing Open Content, Open Collaboration, Open Services and Open Function. Based on the strategy NSLC has obtained a series of practical achievements.

Initiative 1: Open Content: Transforming into Open Publishing and Communication

Through a series of OA publishing exploration and practice, NSLC is dedicated to provide more open access content to researchers, from preprints to OA publishing funds, to open data journal, to Institutional Repository. In 2009, CAS joined the BMC Institutional Membership to support researchers publish OA articles. Now NSLC owns the largest IR Grid in the world, the first Dark Archive System for Subscription S&T e-Resources as well as the first Pre-print Archive Service ChinaXiv, in accordance with the international practice and standards in China.

What’s more, each year NSLC holds more than 40 international or national symposiums, like China Open Access Week, China Fair Use Week, and Chinese IR Conference etc., NSLC serves as the forerunner and practitioner in Open Access in China. These conferences, mostly discussing the development trend of open access, the best practice of related areas of Open Science and the challenge of open publishing or open data etc. These summit meetings always lead to surprising discoveries and creative insights about Open Science and research.

Initiative 2: Open Collaboration: Constructing Big Data Scientific Research Infrastructure

NSLC in 2016 transformed the traditional library into open knowledge centre, through Big-Data Based Scientific Research Knowledge Centre project, couple of characteristic databases are created, which may last and serve for a long time to sustain for future access.

Collaborating with Institutes of Chinese Academy of Sciences, NSLC are constructing distributed knowledge resources centre, institutional repository, which effectively improves the quality of research. The CAS IR Grid portal is an integrated service platform for aggregating data(now just metadata and will be extended to full content soon) from institute’s IRs across CAS, the portal has integrated 112 institutions and 782,965 resources, targeted to be a collective knowledge repository to facilitate capture, access, preservation, dissemination of CAS-wide knowledge attainments.

Collaborating with information suppliers, such as publishers, both are exploring new ways and opportunities in the area of local metadata, Open Access Resources Integration and dark archive. For example, GoOA was launched in 2014, funded by CAS and run by NSLC, evaluates, selects and integrates high qualified OA journals and articles, recommending journals for researchers to contribute. Furthermore, another open resources platform named OAinONE allows you to search across and free access to all types of open resources in online format, like books, theses, journals, reports, policies, in order to facilitate openness and sharing of research information through Open Science in academic institutions. Also, NSLC

has established formal preservation programs for traditional materials which include regular allocation of resources for preservation, preventive measures to arrest deterioration of materials, remedial measures to restore the usability of selected materials, and the incorporation of preservation needs and requirements into overall program planning. Moreover, localizing storage metadata is a special service in NSLC by collaborating with publishers, to expand and strengthen the services in depth mining, mobile services, long-term storage etc. The extension of these principles of metadata have widely reuse available for researchers, and contribute to Open Science step by step.

Initiative 3: Open Service: Developing Open Services and Open Knowledge

Open Science strategies and policies are means to support better quality of science, especially by increasingly collaboration and engagement between research and society. In 2017 May, NSLC launches Sci-think v2.0. Based on Sci-think 1.0 with customizable knowledge service mobile platform, Sci-think 2.0 updates social & academic collaboration network, and accurate personalized knowledge service with large data analysis. With the support of Sci-think platform, NSLC achieves to co-construct and share resources and information, jointly develop new model of knowledge services, customize and promote library services, deepen cooperation on information research and practices, and co-explore in depth with each and every concerned country/nation. To analyze and research on the international cooperation potential and to spread new knowledge wider, faster and free, to be a comprehensive research and development network.

NSLC also provides solutions of knowledge organization for HUAWEI Corporate to customize open service, based on semantic intelligence, scene, and linking push service of precision knowledge with expert network service, to offer knowledge finding, analyzing and organizing services. This customer service will lay a basis on data construction of intelligent semantic knowledge network system.

Initiative 4: Open Function: Expanding the Roles of Library

NSLC not only plays a key role in the advancement of knowledge which is vital for the development of openness and scientists, but also helps opening communities to organize and carry out strategic studies on different topics.

For instance, NSLC establishes Science and Culture Communication Center, which is committed to the dissemination of scientific knowledge, spirit and culture among the general public, and appealed individuals to engage in the Open Science environment.

Another case is History Museum of CAS, which was established by NSLC. It is responsible for further strengthening its role and capacity as an independent strategic think tank on major issues of national, regional and global concerns. History Museum expects to play a more effective role in strategic advice while continuously taking advantage of CAS integrated and comprehensive strength and wisdoms and efforts of the whole Chinese scientific community.

To sum up, NSLC makes efforts to propel Open Science implementation and addresses three aspects for new and sustainable knowledge:

- a. Make accessible and usable by the public
- b. Provide free, continuous and long-term service
- c. Ensure transparency and information supporting

Summary

Based on NSLC practices, Open Science is a revolution in the way scientists work. Open Science will lead to increased transparency, better quality research, a higher level of citizen engagement, and will accelerate the pace of scientific discovery through the facilitation of data-driven innovation.

Nevertheless, Open Science is still in many ways an open goal yet to be reached. There are also various challenges that hinder Open Science, three questions in particular [**Error! Bookmark not defined.**]: How can we motivate and inspire organizations and people? How can we ensure bridging between different networks? How can we deliver infrastructures, services and support for competence building? Furthermore, concerns about lack of incentives, rewards and support, lack of time, skills and other resources may also present some problems and restrictions in Open Science. To sum up, in order to make a progress, it is still important to understand what Open Science brought us to the situation we face today.

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