· Article · Advances in Polar Science
doi: 10.13679/j.advps.2022.0013 December 2022 Vol. 33 No. 4: 356-367

Chinese science diplomacy in Arctic climate governance based on a survey and interviews with Chinese scientists

XU Qingchao[1,2] & XU Qingying[3*]

[1] University of Chinese Academy of Sciences, Beijing 100049, China;
[2] Center for Arctic Sustainability Studies, China Institute for Innovation and Development Strategy, Beijing 100044, China;
[3] Beijing College of Finance and Commerce, Beijing 101101, China

Received 1 August 2022; accepted 29 November; published online 30 December 2022

Abstract Science diplomacy is attracting increasing attention in the international relations literature. This study investigates how Chinese scientists understand this term and explores China's dynamic praxis in Arctic climate governance. It conducts a theoretical and practical examination of science diplomacy in terms of three dimensions—science in diplomacy, diplomacy for science, and science for diplomacy—thus achieving a high degree of consistency. A multi-method approach, combining qualitative and quantitative research methodologies and involving the adoption of a literature review, participant interviews, and questionnaires, is adopted. Data were collected from interviews with 16 Chinese scientists involved in Arctic climate governance and from 130 valid questionnaires collected from Chinese natural scientists working in the climate change field. Drawing on qualitative and quantitative findings, the study reveals that the three-dimensional framework of science diplomacy can provide insight into Chinese scientists' understandings of the topic. In contrast to the participants' vague theoretical responses, the outlines of China's Arctic climate governance can be clearly identified within this framework. The study concludes by underlining the tension between theory and practice in terms of science diplomacy and highlighting the emerging challenges for China in developing its Arctic science diplomacy against the background of the COVID-19 pandemic and Russia-Ukraine conflict. Moreover, it is suggested that, to further develop China's Arctic science diplomacy, it is vital to take account of the deficiencies in China's science diplomacy. The study's empirical results contribute to an understanding of the dynamic nature of science diplomacy in the Chinese context.

Keywords **science diplomacy, science and technology diplomacy, China's engagement in the Arctic, Arctic science diplomacy, Arctic climate governance**

Citation: Xu Q C, Xu Q Y. Chinese science diplomacy in Arctic climate governance based on a survey and interviews with Chinese scientists. Adv Polar Sci, 2022, 33(4): 356-367, doi: 10.13679/j.advps.2022.0013

1 Introduction

Science diplomacy has been a topic of great concern in Western academia for decades, and a variety of definitions of the term have been proposed. Consequently, science diplomacy has become an umbrella term to describe various formal or informal technical, research-based, academic, or engineering exchanges. Moreover, the data-driven era of "science diplomacy 2.0" (Turchetti and Lalli, 2020) is coming. As the Royal Society (UK) notes (Royal Society Science Policy Center, 2010), the concept of science diplomacy is gaining increasing currency in the United States, United Kingdom, Japan, and elsewhere. Although it is still a fluid concept, it can usefully be applied to the role of science, technology, and innovation in three related areas: informing foreign policy objectives with scientific advice (science in diplomacy, SiD); facilitating international

* Corresponding author, E-mail: xuqy@bjczy.edu.cn

science cooperation (diplomacy for science, D4S); and using science cooperation to improve international relations between countries (science for diplomacy, S4D).

In China, the term "science and technology diplomacy" appears more frequently in official usage than "science diplomacy". The Ministry of Science and Technology of the People's Republic of China (MOST) dispatches science and technology counselors to China's embassies and consulates around the world, taking on a science diplomacy mission on behalf of the People's Republic of China. As an official from MOST commented to the media in 2011, "Science and technology diplomacy has been at the forefront of China's overall diplomacy. So far, China has established scientific and technological cooperation relations with 152 countries and regions, sent 141 scientific and technological diplomats to 69 overseas offices in 46 countries, and joined more than 200 intergovernmental organizations for international cooperation, thus forming a relatively complete and diversified cooperation pattern, with the intergovernmental framework for scientific and technological cooperation as the main body" (Yu and Zan, 2011). Furthermore, as a minister from MOST observed at the 2018 National Science and Technology Work Conference, "science and technology diplomacy has become an important part of China's overall diplomatic strategy" (Hu, 2018). China's Arctic Policy, a white paper issued in January 2018, noted that "when participating in Arctic affairs, China prioritizes scientific research" (The State Council Information Office of the People's Republic of China, 2018). Outline of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development and Vision 2035 of the People's Republic of China, issued in March 2021, clearly stipulates how the next phase of Chinese National Antarctic/Arctic Research Expedition (CHINARE) will be carried out. Heavy icebreakers and other cutting-edge areas of science and technology are included in the plan. In the context of global warming, given China's increasing engagement in Arctic climate governance, how China can use science diplomacy as a tool to fulfill its Arctic policy goals is a question deserving attention.

Thus far, no fixed term—such as "China's Arctic science diplomacy" or "China's Arctic science and technology diplomacy"—has been articulated in China's official documents. However, there have been two competing voices on China's Arctic science diplomacy. On the one hand, some objective comments regarding China's overall Arctic policy have come from the external world. Marc Lanteigne (2022), for example, pointed to the "frequent attempts by US critics of Beijing's Arctic policies to arbitrarily transplant the security threats facing the South China Sea to the far north, essentially arguing that as China is challenging legal norms in the former, it must inevitably be doing so in the latter" and suggested that this is unlikely to be the case, because of the geographical and political differences between the two regions, "as Beijing has no territory there and is in no position to alter that reality, Polar Silk Road (PSR) or not." Nalan Koc argued that "China is an important contributor to the Arctic research knowledge base" (Zhu, 2020), although Eric Niiler (2019) acknowledged that "China's scientists are the new kids on the Arctic Block". On the other hand, there are still suspicions and misinterpretations of China's Arctic science diplomacy. Millard and Lackenbauer (2021) commented that R/V *Xuelong* was and is employed on purpose under the cover of science and scientific collaboration in addition to its overt scientific goals. Similarly, Doshi et al. (2021) suggested that "by asserting itself as a 'near-Arctic state' directly affected by the changing climate in the Arctic, China has pursued Arctic research opportunities to legitimize its growing involvement in the region and to obtain greater access that has, at times, dual-use implications".

Meanwhile, in the field of social sciences, science diplomacy in the Arctic appears to be an emerging topic, although the current output of related academic articles is quite small, particularly in Chinese. The main works related to science diplomacy, both in Chinese and in English, by Chinese researchers include: a book entitled "Science community and global governance: a case analysis on Arctic affairs" by Yang (2018) and articles including "The development of Arctic science and technology based on the Arctic policies of Arctic nations" by He and Zhang (2012), "The community of Chinese scientists and the agenda setting of Arctic governance" by Yang and Yu (2014), "A precautionary approach to fisheries in the Central Arctic Ocean: policy, science, and China" by Pan and Huntington (2016), "Science diplomacy and trust building: 'science China' in the Arctic" by Su and Mayer (2018), "Reforming China's polar science and technology system" by Zhang et al. (2019). Among all of this discursive literature, only one article is precisely titled "Analysis of China's Arctic science and technology diplomacy" which was published in 2020 (Zhang and Wang, 2020). However, this study did not make a distinction between China's engagement in the Arctic and China's Arctic science diplomacy, arguing that "Arctic science and technology diplomacy means science and technology diplomacy plus Arctic diplomacy" (Zhang and Wang, 2020). Taken together, these research works have not given a definition or a clear picture of China's Arctic science diplomacy and are lacking in case studies from historical perspectives.

The scarcity of related literature, both in English and in Chinese, suggests that there is great potential for further academic exploration of this topic from a Chinese perspective. In this context, science diplomacy conducted by scientists who have been empowered by the government to act as diplomats may be supposed to reshape international relations by aiming to influence policy makers and the public of the targeted nation(s) through bilateral and multilateral scientific collaborations within global academic networks. Science diplomacy usually takes scientific

activities as its vehicle, and scientific activities are the manifestation of science diplomacy. In terms of the professionals involved, scientists are actors in both science diplomacy and scientific cooperation. According to a study by Bertelsen et al. (2017), "the difference between scientific cooperation and science diplomacy lies in the potential political motivations for the use of scientific engagement: the former entails an apolitical purpose, the latter, however, denotes potential governmental interference through the word 'diplomacy', that is, the pursuit of national agendas through science and thus a politicization of science". Thus, scientists should not be regarded as science diplomats until they have been empowered to conduct science diplomacy by permission from official departments. As Figure 1 illustrates, generally speaking, science diplomacy can be considered to be the nexus of science and diplomacy. By its nature, science serves as a means of knowledge production, applications of methods, and innovative thinking, thus promoting peace, cooperation, and win-win results among countries in a diplomatic way.

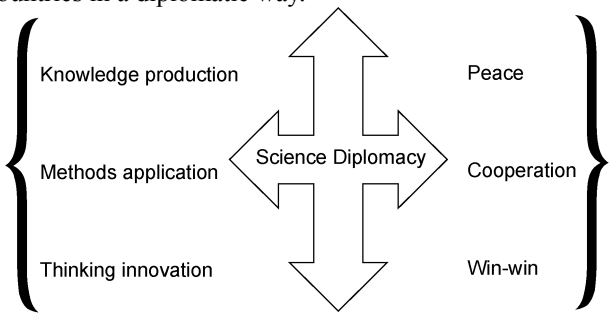

Figure 1 Science & diplomacy: science diplomacy.

Adopting the framework of science in diplomacy, diplomacy for science, and science for diplomacy proposed by the Royal Society (UK), this paper aims to explore Chinese scientists' understandings of science diplomacy and to investigate the dynamics of China's engagement in Arctic climate governance. The research questions that emerged are as follows: How do Chinese scientists understand science diplomacy? How should we perceive China's engagement in Arctic climate governance in the past, and what can we expect in the future?

2 Dimensions of China's science diplomacy in Arctic climate governance

In 1999, China made its first official large-scale expedition to the Arctic and has been increasing its presence in the Arctic ever since. Moreover, "China has gradually established a multi-discipline observation system covering the sea, ice and snow, atmosphere, biological, and geological systems of the Arctic" (The State Council Information Office of the People's Republic of China, 2018). During this period, the capacity of China's science diplomacy in the Arctic has continued to improve. In accordance with the conceptual framework of science diplomacy described above, China's science diplomacy in Arctic climate governance can be interpreted in terms of three dimensions, each of which can be elaborated on separately. Detailed cases are given below.

2.1 Informing foreign policy objectives with scientific activities under the framework of the Arctic Council: science in diplomacy

As mentioned previously, scientific research has been a priority for China's participation in Arctic affairs. Looking back on China's efforts to obtain observer status on the Arctic Council from 2006 to 2013, one can safely say that on the Chinese side, the role of science in diplomacy was emphasized. For instance, China was a charter member of the fourth International Polar Year (IPY). Under the guidance of the China Action Committee for IPY, a specific China Action Plan was formulated in accordance with the six science themes. This plan was launched in February 2007 and completed in March 2011. During this period, China implemented the third and the fourth Chinese National Arctic Research Expeditions, annual scientific investigations at the Chinese Arctic Yellow River Station in Svalbard from 2007 to 2010, and the popularization of Arctic science and data sharing. Zhang Dengyi, Chairman of the China Action Committee for IPY, once commented, "The effective implementation of the Chinese Action Plan for the International Polar Year expanded research areas in polar expeditions and made the disciplinary integration more systematic, accumulating experience in organizing and implementing large-scale international projects, promoting the formation of a China-centered international cooperation pattern on polar science, and vigorously taking China's polar career to a new level" (Chen, 2011).

According to the first and second Observer Review Reports submitted by China in June 2018 and November 2020, respectively, China participated in all intergovernmental meetings that were open to observers under the framework of the Arctic Council, and Chinese experts were involved in the work of the Arctic Council, including the Working Groups and Task Forces. Although the role China plays in different groups varies to some extent, China has gained respect, reputation, and reinforcement as an observer of the Arctic Council thanks to Chinese scientists' enduring professional efforts. For example, over the past 15 years, Chinese scientists have continued to contribute to the Intergovernmental Panel on Climate Change (IPCC) assessment reports. Some are leading authors, while many others are contributing authors. It is evident that these productive scientific activities have also played a role in achieving China's diplomatic objectives, even if the Chinese scientists involved may not have been aware of this. In this regard, the role of science in

diplomacy is remarkable.

2.2 Facilitating international science cooperation with significant diplomatic efforts: diplomacy for science

In the post-Cold War era, the substantial Chinese presence in the Arctic has increased notably, with diplomatic initiatives recognized as milestones in China's Arctic participation. First and foremost was the establishment of China's first Arctic observation station in 2004: the Yellow River Station, located in Svalbard, which provides a vital platform for Chinese scientists to conduct regular scientific research activities together with their international counterparts, thus contributing to the scientific and technological development of the Arctic region. Furthermore, the China-Iceland Arctic Science Observatory was formally opened in October 2018. This represented another significant diplomatic step after the China-Iceland Free Trade Agreement took effect in July 2014 to promote bilateral scientific cooperation between the two countries. Undoubtedly, these two research stations are the result of China's diplomatic efforts in the Arctic and have succeeded in greatly elevating the strategic importance of scientific research on the Arctic in China. Thanks to this favorable scientific research environment, Chinese scientists in the field of permafrost are taking the lead worldwide after decades of hard work.

What has impressed the world most in recent years is China's PSR Initiative, which was proposed together with Russia in 2017. The PSR combines China's Belt and Road Initiative (BRI) with Russia's Arctic strategy, with particular reference to the development of the Northern Sea Route. This was officially confirmed by the China's Arctic Policy (The State Council Information Office of the People's Republic of China, 2018). In 2017, the Vision for Maritime Cooperation under the Belt and Road Initiative announced that the path to Europe via the Arctic Ocean is envisioned as one of three planned jointly built blue economic passages (The National Development and Reform Commission and the State Oceanic Administration, 2017). The PSR Initiative has been a common research interest among scientists, both at home and abroad. Some have tried to determine the philosophy rooted in the PSR and define it in terms of sustainability. Many others have devoted themselves to the implementation of the BRI, as well as the PSR, through scientific and technological solutions. The Digital Belt and Road Program in Support of Regional Sustainability was launched by Guo Huadong (Guo et al., 2018), an academician of Chinese Academy of Sciences (CAS). A more recent development as one of our interviewees stressed is that scientists from China and Norway are collaborating on digital Arctic shipping using new data products and visualization services, even against the background of the COVID-19 pandemic.

2.3 Using the increased capacity of Chinese science to improve international relations in the Arctic: science for diplomacy

There is an undeniable capacity gap between China and the major Arctic states, such as the United States and Russia, with respect to the development of icebreakers, research stations, submarines, military bases, and allies in the Arctic region. Realistically, China has not yet become a "new polar power" in terms of strength. However, what is equally undeniable is that China's capacity building for its Arctic engagement has progressed, with increased investment in Arctic-related scientific research leading to science for diplomacy with varied scientific activities. For instance, the 320th symposium of the Xiangshan Science Conferences was held in Shanghai in April 2008 and highlighted the theme of "International Polar Year 2007–2008 and the Scientific Frontiers of Future Polar Research". Qin Dahe, another academician of CAS, made a presentation sharing his vision for how to develop China's own polar strategy, considering the severe international competition in scientific and technological development against the backdrop of rapid climate change in the Arctic region. In line with Qin's strategic thinking, in recent years China has been striving to play a positive role in several big international science projects, such as the Environment and Climate Change at the Three Poles Project initiated by CAS. The Three Poles is a collective name for the South Pole, the North Pole, and the Qinghai-Tibet Plateau. Against the background of global warming, the glaciers, frozen soil, and sea ice in the tripolar regions are changing rapidly, bringing a series of climate, ecological, environmental, and resource problems. The overall goal of the project is to build an integrated sky, earth, ice, and sea observation system for the Three Poles and to uncover the mechanism of environmental and climate change in the Three Poles. To date, more than 20 academicians of CAS or Chinese Academy of Engineering and more than 60 institutions have participated in the project (Liang, 2022).

To speed up its capacity building for Arctic engagement, Chinese scientists have been struggling to build interdisciplinary academic networks to collaborate with their international counterparts, such as the China-Nordic Arctic Research Center, China-U.S. Arctic Social Science Forum, China-Russia Arctic Workshop, and North Pacific Arctic Research Community. In addition, as of November 2022, 15 Chinese institutions of higher learning and research have joined the UArctic network.

3 Research methodology

This study focuses on Chinese scientists who are supposed to be empowered to conduct science diplomacy as "science diplomats" or "science and technology diplomats"

representing China and combines qualitative and quantitative research methodologies. The two dominant research methods are highlighted below.

One was to conduct in-person interviews with Chinese scientists who are knowledgeable about the Arctic climate governance. This is the primary research method used in this study. These face-to-face interviews, based in Beijing, involved 16 interviewees from November 2018 to November 2021, with each interview lasting an average of 90 minutes. The questions for the scientists included: (1) What is your detailed research specialty? (2) Could you please summarize the latest progress in your research and its contribution to Arctic climate governance? (3) What do you think of the concepts known as "science diplomacy" and "science and technology diplomacy"? (4) Do you think Chinese scientists have an obligation to participate in China's science diplomacy, and in what way should they do so? (5) Do you have any advice regarding China's science diplomacy in the Arctic?

The other method was to administer a survey via a web-based questionnaire to conduct a larger-scale investigation of science diplomacy in particular. This questionnaire was uploaded and distributed to targeted but anonymous Chinese natural scientists working in the field of climate change through Wenjuanxing (https://www.wjx.cn), a WeChat applet. The survey was opened on 27 January, 2022, and closed on 1 February, 2022, and 130 valid questionnaires were collected. The respondents included those from 23 provincial-level places in China, and those from the United States and Finland as well. As Table 1 presents, the web-based questionnaire entitled "survey on Chinese scientists' understandings of science diplomacy" consisted of 15 questions, including 11 single-choice questions, three multiple-choice questions, and one open-ended question.

4 Findings from the interviews and results of the questionnaire

The survey focused solely on science diplomacy, whereas

Table 1 Survey on Chinese scientists' understanding of science diplomacy

No.	Type of questions	Content of questions	Options
1	Single-choice	Do you get to know or understand the concept of "science diplomacy"?	A. I know a lot about it and quite understand. B. I know a little about it. C. I already heard about it but did not quite understand what it means. D. Never heard about it.
2	Single-choice	Where did you get to know or understand the concept of "science diplomacy" if you chose A, B or C for the previous question?	A. I happened to know about it on media by reading, watching or browsing. B. I happened to hear about it from others. C. I received specific learning/training about science diplomacy at my workplace. D. I learned by myself out of interest.
3	Single-choice	Do you get to know or understand the concept of "science and technology diplomacy"?	A. I know a lot about it and quite understand. B. I know a little about it. C. I already heard about it but not quite understand what does it mean. D. Never heard about it.
4	Single-choice	Where did you get to know or understand the concept of "science and technology diplomacy" if you chose A, B or C for the previous question?	A. I happened to know about it on media by reading, watching or browsing. B. I happened to hear about it from others. C. I received specific learning/training about science diplomacy at my workplace. D. I learned by myself because of interest.
5	Single-choice	Do you think the term "science diplomacy" and the term "science and technology diplomacy" refers to the same meaning?	A. Absolutely. B. Probably. C. I have no idea. D. Absolutely not.
6	Multiple-choice	Which one is in line with science diplomacy in your mind?	A. Informing foreign policy objectives with scientific advice (science in diplomacy). B. Facilitating international science cooperation (diplomacy for science). C. Using science cooperation to improve international relations between countries (science for diplomacy). D. None. (Please give an example of yours if you choose "none")
7	Multiple-choice	Which one should be responsible for science diplomacy/science and technology diplomacy?	A. Ministry of Foreign Affairs. B. Ministry of Science and Technology. C. Chinese Academy of Sciences. D. Others. (Please point it out if you choose "others")
8	Single-choice	Do you think it is one of Chinese scientists' duties to conduct science diplomacy/science and technology diplomacy?	A. Yes, I think so. B. No, I don't think so. C. Whatever. D. I have no idea.

Continued

No.	Type of questions	Content of questions	Options
9	Single-choice	Which kind of Chinese scientists as follows should play a leading role in China's science diplomacy?	A. Scientists with strategic visions/academicians. B. Backbone scientists. C. Young scientists. D. Those scientists who hold administrative positions at their workplace or have international reputations in his own research field.
10	Multiple-choice	Which activity belongs to the practice of science diplomacy/science and technology diplomacy from your perspective?	A. Attend important international academic conference and make presentations on behalf of China. B. Be a member of some international organization on science and plays an important role in it/them. C. Provide written materials including speech draft and related data for Chinese leaders who attend important international scientific events. D. None.
11	Single-choice	Would you like regularly to be a part of science diplomacy/science and technology diplomacy?	A. Yes, I'd like to be a science diplomat very much. B. Given conditions including my health, my time permit and my boss agrees, I would like to do that in a scale. C. Probably not. It might cost much of my time and energy, impeding greater achievements for my own research. D. Absolutely no.
12	Single-choice	Do you want to receive any learning/training on science diplomacy/science and technology diplomacy no matter you know about these concepts or not?	A. Yes, very much. I am always ready for participation. B. Given conditions including my health, my time permit and my boss agrees, I would like to do that in a scale. C. Probably not. It might cost much of my time and energy, impeding greater achievements for my own research. D. Absolutely no.
13	Single-choice	Which age group do you belong to?	A. Over 60 years old. B. 40–60 years old. C. 30–40 years old. D. Under 30 years old.
14	Single-choice	Do you occupy any administrative post within your workplace?	A. Senior officials including head of a department and bureau and beyond. B. Section-level cadre. C. Office-level cadre. D. None.
15	Open-ended question	Please give an example that in accordance with your criteria in conducting science diplomacy/science and technology diplomacy if you have any experiences.	

the interviews with Chinese scientists covered a comparatively wider range of issues including science diplomacy. Thus, the findings from the interviews and the results of the survey are correlated but not repetitive, demonstrating their respective and valuable importance for this study.

4.1 Findings from the interviews

The topics selected for the interviews with the Chinese scientists included science diplomacy, the progress of Arctic international scientific cooperation and research, and Arctic climate governance. The Chinese scientists' thoughts on these broad topics are presented below.

First and foremost, the scientists interviewed tend to think it is not easy to promote "science in diplomacy" because of the high threshold for engaging in science diplomacy for Chinese scientists. There are three types of scientists within the Chinese system, with a pyramid-shaped distribution. On the top are scientists with strategic vision who have profound scientific literacy, forward-looking judgment, excellent interdisciplinary comprehension abilities, a capacity for skillful organization, and the ability to convince the leadership of large corporations. In the middle layer are the backbone scientists, most of whom have a certain degree of influence at home and abroad in their own research fields. However, they are not likely to regard themselves as diplomats who can use their professional knowledge to speak for or act on behalf of China on the international stage. At the bottom are thousands of early-career scientists who, on a day-to-day basis, are buried in conducting enormous experiments, gathering data, and writing papers to better their career development. Restricted by their limited resources, opportunities, demands, and physical energy, they are hardly able to do anything else, such as applying science diplomacy to their routine research work. It seems that not all scientists are qualified to or should be authorized to serve in China's science diplomacy.

With the latest development of the Arctic strategic and geopolitical environment in the context of the COVID-19 pandemic, as well as the Russia-Ukraine conflict, it is challenging for China to attract favorable public opinion in the Arctic region in the face of severe United States rivalry and competition. To avoid stoking the "defining the

Chinese threat in the Arctic" narrative, it is wise for Chinese scientists to keep a low profile. It seems advisable for Chinese scientists to expand international Arctic scientific cooperation through concrete actions rather than conceptual declarations.

Second, the scientists interviewed reported that they experienced inner obstacles to institutionalizing "diplomacy for science". Interactions between the science community and the policy community in China are quite different from those elsewhere. On the one hand, with regard to the governance systems of Chinese science, there is a disconnection between China and Western countries. Most importantly, in the area of international communication and exchange, the logics and philosophies of China and the West are not good matches for each other. These cultural differences mean that although Western-led international scientific mechanisms may not intend to be exclusive, their actual effect is to tend to exclude non-Western countries. Comparatively, in terms of the similarities of scientific governance systems and mechanisms with the west, it is much easier for Japanese or Korean scientists to cooperate with Western colleagues than it is for Chinese scientists. In this regard, those departments related to China's foreign affairs should pave the way for diplomatic resources for Chinese scientists to promote international scientific cooperation.

On the other hand, the role of Chinese scientific associations in bridging science and diplomacy and energizing "diplomacy for science" is not as remarkable as that of international ones on the whole. In most cases, the level of scientific cooperation between Chinese institutions and their international partners is determined by the capacity of individual Chinese institutions for international communication. Chinese scientific associations consisting of specific institutions are not taking the lead in the same manner as their Western counterparts in promoting international scientific cooperation. Chinese scientists are not given short-term training until they have been appointed to work as science (and technology) diplomats for Chinese overseas consulates or international scientific organizations. In this case, because of the backward development of China's science-diplomacy interface, Chinese scientists are constrained in terms of their ability to act as science diplomats on Arctic-related platforms.

Third, the scientists interviewed noted that they realized the limitations of "science for diplomacy" in terms of the cause-and-effect relationship between science and diplomacy. Chinese scientists believe that, as a single variable, scientific cooperation may not be strong enough to change political relations among countries. For Chinese scientists, science diplomacy is a term with which they are not particularly familiar, although they are interested in learning more about it from political scientists. In their opinion, science itself exists for the common good and should be focused on the correct production, sharing, and application of knowledge. International scientific cooperation is required to serve all mankind and may be the "icing on the cake" of a country's diplomacy. Good diplomatic relations between countries increase the chances of scientific results emerging at just the right time.

However, because of the loose interactions between science and diplomacy within China, international scientific cooperation cannot directly produce any significant diplomatic results. As a single variable, scientific cooperation alone does not determine a country's diplomatic situation. From the perspective of Chinese scientists, diplomacy plays a bigger role in science than science does in diplomacy. In this regard, the 1987 speech in Murmansk by Mikhail Gorbachev, the then leader of the Soviet Union, was a classic and powerful use of political leverage to restart international scientific and technological cooperation in the Arctic during the Cold War. A country's diplomatic mode is determined by its comprehensive strength, and in global terms, China's overall capacity in science and technology still falls behind that of the West, or at most is parallel in some areas rather than in the lead. With that in mind, it is not appropriate for China to take "science diplomacy" as a public slogan.

Last but not least, from the perspective of Chinese scientists, the great progress China has made over the decades in the fields of science, technology, and innovation is a double-edged sword for China's increasing engagement in the Arctic. It is extremely important for Chinese scientists to learn from the past and to be alert about what is going on in world politics. They notice that although the scientific presence of China in the Arctic is generally accepted, serious concern has been expressed in the West regarding China's civil-military integration where China's influence in the Arctic is concerned. Regarding this point, Chinese scientists feel helpless because they believe their behaviors are completely in compliance with international scientific regulations and rules.

A typical case occurred in May 2017. A ceremony was held in Kangerlussuaq, Greenland's airport hub, to launch a process leading to the establishment of a satellite ground station for climate change research and the dual-use BeiDou Navigational Satellite System (Miguel, 2018). As the U.S. Pentagon mentioned in 2019, "China could use its civilian research presence in the Arctic to strengthen its military presence, including our deployment of submarines—including deployment of submarines to the region as a deterrent against nuclear attack" (Pompeo, 2019). Obviously, such an expression is merely subjective and implies disagreement with facts established in the past. However, the "suspicions about China's Arctic presence result, to begin with, from the dynamics of a global power shift" (Su and Mayer, 2018). In May 2022, U.S. Secretary of State Blinken's speech on U.S. policy toward China seems to reaffirm this, arguing that "the Biden Administration's strategy can be summed up in three words—invest, align, compete … and to the People's Republic of China: we'll compete with confidence; we'll cooperate wherever we can;

we'll contest where we must. We do not see conflict" (Blinken, 2022).

4.2 Results of the survey

The results of the survey were produced automatically using the Wenjuanxing applet. It should be noted that there were several unavoidable errors in the results: in Questions 1, 4, and 11, although the total number of respondents for each choice is correct, the sum total of percentages choosing A, B, C, and D separately is 100.01%, which is an obvious error due to the rounding-off method adopted by the Wenjuanxing. Also, because of the same calculation method, in Question 13, the sum total of the percentages choosing A, B, C, and D separately is 99.99%. On the whole, this error range is acceptable, and the data are sufficiently convincing to support this study.

It does not seem necessary to list the 130 respondents' answers to each question individually here, so the issues of underlying importance are brought into focus through selection below.

First, regarding the popularity of both "science diplomacy" and "science and technology diplomacy", 75.39% of the respondents knew only a little about the term "science diplomacy" or did not quite understand it; 20.77% had never heard of it; and only 3.85% believed that they knew a lot about it and understood the concept quite well. However, for those who claimed to know about science diplomacy, 80% of them had just learned about it through the media or from others. The situation was similar regarding what the respondents knew about the concept of "science and technology diplomacy", with 73.07% of respondents knowing only a little about it or not quite understanding its meaning. Moreover, 78.47% of those with some knowledge of science and technology diplomacy had also learned about it from the media or from others. Moreover, it seems that it is difficult for the 130 respondents to differentiate between the two terms: "science diplomacy" and "science and technology diplomacy". According to the questionnaire, 41.54% of the respondents had no idea of the difference, while 36.92% admitted that the differences existed but they couldn't explain, and another 21.54% supposed that the two have similar connotations.

Second, regarding the conceptual framework of science diplomacy mentioned earlier in this paper, although most respondents were not able to explain the connotations of the concept exactly, 70.77% confirmed that using science cooperation to improve international relations between countries (science for diplomacy) is in line with science diplomacy in their minds, 66.92% noted the importance of facilitating international science cooperation (diplomacy for science), and 56.15% agreed that informing foreign policy objectives with scientific advice (science in diplomacy) is how they understand science diplomacy. As to the governing body of China's science diplomacy/science and technology diplomacy, 82.31% believed that MOST should be responsible for it, 65.38% believed that Ministry of Foreign Affairs (MFA) should take the lead, 39.23% believed that CAS should play the leading role, and 7.69% believed that others such as the Chinese Academy of Social Sciences, individual scientists, or all foreign affairs-related departments should take responsibility for science diplomacy/science and technology diplomacy.

Third, concerning the role of Chinese scientists in China's science diplomacy in the Arctic, 69.23% of respondents believed that, in general, it is one of Chinese scientists' duties to conduct science diplomacy/science and technology diplomacy. In the meantime, they stressed that different Chinese scientists may play different roles in China's science diplomacy/science and technology diplomacy, with 38.46% believing that scientists with a strategic vision or scholars should take a leading role, 33.08% believing that those scientists who hold administrative positions at their workplace or have international academic reputations should take this job, and 28.46% of respondents expressing the belief that backbone scientists and young scientists should engage in this type of work. This result is in accordance with our findings from the interviews with the Chinese scientists mentioned above. As for approaches to science diplomacy/science and technology diplomacy by Chinese scientists, 88.46% confirmed that being a formal member of a science-related international organization is a way to practice science diplomacy/science and technology diplomacy, 76.92% attached more importance to attending important international academic conferences and making presentations on behalf of China, and 66.15% thought highly of preparing papers for the Chinese leaders.

Fourth, regarding Chinese scientists' willingness to be "science diplomats" or "science and technology diplomats", 72.31% of the participants reported that they would like to serve in science diplomacy/science and technology diplomacy if conditions permitted, 23.08% were enthusiastic about becoming "science diplomats", and only 4.62% did not show much willingness to engage in this type of work. In view of their limited understanding of science diplomacy/science and technology diplomacy, 66.15% were quite happy to accept professional training before participating in China's science diplomacy/science and technology diplomacy in the Arctic, 24.62% said that they were ready to participate at any time, and 9.23% responded that they did not find the prospect of becoming involved in this type of work more interesting than their research tasks. In addition, there may be a paradox confronting 45.38% of the respondents who belong to the 30–40 age group. On the one hand, these young scientists remain curious and enthusiastic about China's Arctic science diplomacy; on the other hand, because of their heavy teaching and scientific research tasks, they cannot be certain of having enough time or administrative resources to engage in this type of work.

The last topic concerns Chinese scientists' own practices in science diplomacy/science and technology

diplomacy. Question 15 was the only open-ended question in this survey, and a total of 33 respondents filled out the space. Our calculations show that, in their feedback, 33.33% referred to international cooperation projects, 24.24% pointed to international major academic conferences, 18.18% mentioned academic exchanges, 15.15% highlighted the important roles they play in international organizations, 6.06% addressed their participation in international negotiations or the IPCC review process, and 3.03% highlighted the professional support they provided to MOST for COP26. Compared with what we had already established regarding approaches to science diplomacy/science and technology diplomacy, we find that, in Chinese scientists' eyes, the content of science diplomacy/science and technology diplomacy in practice likely refers to the same thing—mainly including international scientific collaboration, participation in international scientific organizations, and providing scientific advice provision—but the proportion of each item is slightly different.

5 Discussion

Combining the findings from the interviews and the results of the survey, we would like to offer some thoughts regarding the framework for science diplomacy as constituted by science in diplomacy, diplomacy for science, and science for diplomacy.

First, looking ahead, the key to strengthening "science in diplomacy" lies in balanced and sustainable internal interactions between science and diplomacy, as well as politics.

Chinese scientists tend to hold prudent attitudes toward and express conditional support for science diplomacy, both in theory and in practice. A deeper reason behind this is that they are uncertain about the relationship between science and diplomacy, as well as that between science and politics. Chinese scientists believe that the great ideas for creative diplomacy, such as the "Ping Pong Diplomacy" that fueled the normalization of Sino-U.S. diplomatic relations in 1972, are absolutely the responsibility of the nation's great politicians rather than of professional scientists. They neither see themselves as connected to those historical events nor acknowledge themselves as acting as diplomats on any occasion. Most Chinese scientists appear to regard it as safe to keep their distance from politics and, therefore, from diplomacy, given that diplomacy is a branch of politics. They see politics as a matter absolutely beyond their understanding. These thoughts can surely be borne out by many diplomatic cases throughout history, but more importantly, they may serve as a reminder to China's Arctic policy makers of the importance of balancing science and diplomacy as well as politics.

Second, consistency between international and domestic systems in science governance, technology, and innovation is critical to arriving at a better "diplomacy for science".

On China's side, it would be wise to engage in reforms to remove systemic obstacles to the better performance of Chinese scientists in Arctic global governance. As countermeasures, when initiating, planning, or participating in international scientific cooperation projects, placing the scientific associations with which Chinese scientists are affiliated in a more prominent position in accordance with international practice is a pressing matter. This may be a "safer" and more effective way to depoliticalize scientific issues, especially when it comes to "sensitive" questions of international relations. In the meantime, it is recommended that Chinese scientists join international training programs such as "the United Nations Diplomacy 4.0 Training Program", which contains a special module on science diplomacy. According to its official website (https://unitar.org), the concept of "Diplomacy 4.0" explores the nexus between diplomacy and areas of artificial intelligence, cybersecurity, scientific advancements, and other significant issues, paving the way for the next generation of international affairs professionals. Fortunately, Chinese scientists with overseas study and work experience have begun to engage with specific programs in this area, resulting in a better understanding of science diplomacy.

Third, concerning "science for diplomacy", Chinese scientists have their own culture and traditions.

Chinese scientists acknowledge that science diplomacy/science and technology diplomacy are a sort of administrative command system, and they tend to obey orders in most cases. As the survey reveals, with official guidance, science diplomacy/science and technology diplomacy can be a part-time job for Chinese scientists. As mentioned previously, nearly 70% of the respondents believed that it is one of Chinese scientists' duties to conduct science diplomacy/science and technology diplomacy. Furthermore, there is potential for China to mobilize Chinese scientists to develop its science diplomacy in Arctic climate governance. More than 90% of respondents are interested in science diplomacy/science and technology diplomacy in practice and aspire to contribute to the country as "science diplomats". There is a longstanding tradition for Chinese scientists to devote themselves to the rejuvenation of the Chinese nation, which is known as "The Spirit of Scientists" in China and which features patriotism, dedication, hard work, and the courage to scale new heights in science and technology. This idea is accepted and admired across China and has inspired Chinese scientists to serve the country, the nation, and the people wholeheartedly since the "Two Bombs and One Satellite" era. In this sense, China's science diplomacy is promising given that Chinese scientists are conscious of the importance of making full use of "science for diplomacy".

Finally, any deficiencies in China's science diplomacy must be addressed to arrive at a comprehensive understanding of this area. Drawing on the analysis and

discussion above, the deficiencies in China's current science diplomacy can be summarized as the "4i" aspects, as follows. First, regarding the "idea" construction aspect: in Chinese academia, there have been no significant theoretical developments concerning "science diplomacy" or "science and technology diplomacy" over the decades. Second, regarding the "institutionalization" aspect: ways of accessing China's science diplomacy for Chinese scientists have not been institutionalized. Third, regarding the "innovation" aspect: the effectiveness of China's science diplomacy depends largely on the quality of Chinese science. However, "there have been questions on the quality and credibility of Chinese science … as the Chinese research community has faced challenges with academic misconduct involving plagiarism and corruption cases" (Bertelsen et al., 2017). Fourth, regarding the "impact" of Chinese scientists on policy makers aspect: "Some may worry that this policy-relevant role of science will have the effect of distracting scientists from their main role as producers of knowledge. But … the idea that science has a role to play in addressing matters of public policy is hardly a new one" (Berkman et al., 2011). In this sense, few Chinese scientists have the strategic vision necessary to contribute to China's science diplomacy.

6 Conclusions

Based on the analysis and discussion above, we can draw the following comprehensive conclusions.

First, Chinese scientists are not familiar with the concept of science diplomacy nor with that of science and technology diplomacy. Specifically, 63.85% of the 130 respondents had heard little about science diplomacy/ science and technology diplomacy, and 70% of the respondents did not understand the meaning of the two terms. Moreover, 63.08% of respondents were unable to clearly distinguish between "science diplomacy" and "science and technology diplomacy". In this context, there are few crucial differences between science diplomacy and science and technology diplomacy in terms of acting subjects, governing bodies, main job descriptions, and actual effects. Both refer to the same thing in nature and in practice under different terms. The point is that, for Chinese scientists as well as engineers to engage in this type of work, they have to go through an identity shift from scientists to science (and technology) diplomats, as required by the MOST and MFA.

Second, the concept of science diplomacy as being divided into three dimensions—science in diplomacy, diplomacy for science, and science for diplomacy—was generally accepted by the respondents and interviewees, even if they did not have their own definitions. However, there are still differences between the Western and Chinese understandings of science diplomacy from the perspective of scientists. A strong sense of boundary consciousness is deeply rooted in Chinese scientists' minds. They believe that engaging in science diplomacy is not part of their job, although they can do it from time to time, as required. They are not willing to cross the border between science and politics without being properly empowered to do so. Western scientists tend to consider science diplomacy as part of their scientific activities, and are not necessarily empowered to engage in this type of work by any authority. This difference is largely due to the differences in ideas about the relationship between science and politics in Chinese and Western cultures, with the former tending to be conservative and the latter tending to be liberal.

Third, China's Arctic science diplomacy has moved further in practice than in theory, implying tension between practice and theory in science diplomacy. Undoubtedly, there is a knowledge gap among Chinese scientists regarding the concept of "science diplomacy", which is not as popular among scientists and policy makers as it is in Western countries. For individual Chinese scientists, their consciousness of playing a role as a science diplomat is still vague, and there is little to encourage them to label their actions as science diplomacy. However, as elaborated on previously, what China has done in the Arctic in promoting international scientific cooperation actually reflects how the term "science diplomacy" is defined in terms of "science in diplomacy", "science for diplomacy", and "diplomacy for science". When the potential of Chinese scientists in science diplomacy is fully realized, China's Arctic science diplomacy, which is characterized by transparency, will be elevated to a new level.

Fourth, recent developments in the strategic environment in the Arctic bring emerging challenges for China in developing its Arctic science diplomacy. As mentioned previously, the COVID-19 pandemic has heavily hindered academic communication and scientific cooperation between China and the Arctic states. Most significantly, the existing Arctic global governance structure led by Arctic states is divided against the background of the Russia-Ukraine conflict. Russia was temporarily dropped out from leading Arctic governance platforms, including the Arctic Council, the International Arctic Science Committee, and the Council of Baltic Sea States. Specifically, scientific cooperation with Russia was suspended or canceled by the other Arctic states. More alarmingly, on 27 September, 2022 the two Russia-to-Germany pipelines under the Baltic Sea were damaged and four leaks were detected. It is reported that "the cause behind the leaks was not immediately clear, but the damage appeared to be considerable" (Liboreiro, 2022). This "unexpected damage" has led to a deterioration in the Arctic geopolitical environment and to the energy crisis in Europe. As the most recent literature shows, "international scientific interaction is shaped by the twofold logic of competition and collaboration" (Rüffin and Rüland, 2022). In this context, it is becoming difficult for China to elevate its Arctic science diplomacy.

Finally, and most importantly, further development of China's Arctic science diplomacy should be based on

China's own strengths while recognizing its deficiencies. Among these, there is an urgent need to improve China's strengths in science, technology, and innovation. As discussed previously, in terms of the capacity of Arctic engagement, there is a large gap between China and most Arctic states, including the Nordic states, which fundamentally determines the deficiency of China's science diplomacy in the Arctic. As Jakobson and Peng (2012) predicted and recommended in their 2012 report "China's Arctic Aspirations", "China must rely on diplomatic cooperation and the positive impact of scientific engagement and investments to promote its interest in the Arctic". China has done so before in Arctic climate governance with remarkable success and will continue to do so for the further achievement of China's policy goals in the Arctic, as the "China's Arctic Policy" states. In this process, a holistic perspective on China's science diplomacy in Arctic climate governance, with rich case studies, will be cultivated.

Acknowledgments This work was supported by the National Office for Philosophy and Social Sciences as part of the project titled "Strategic Competition and Cooperation in the Arctic among China, Russia, and the United States from the Perspective of Sustainable Development" (Grant no. 20BGJ045). We thank the anonymous reviewers and Associate Editor Prof. Li Chen for their constructive comments.

References

Berkman P A, Lang M A, Walton D W H, et al. 2011. Science diplomacy: Antarctica, science, and the governance of international spaces. Washington D.C.: Smithsonian Institution Scholarly Press, 306.

Bertelsen G R, Li X, Gregersen H M. 2017. Chinese Arctic science diplomacy: an instrument for achieving the Chinese dream?//Conde E, Sanchez S I. Global challenges in the Arctic region: sovereignty, environment and geopolitical balance. Oxon: Routledge, 442-460.

Blinken J A. 2022. The Administration's approach to the People's Republic of China. https://www.state.gov/the-administrations-approach-to-the-peoples-republic-of-china/.

Chen Y. 2011. The China Action Plan for International Polar Year successfully completed. (2011-04-09). Science and Technology Daily.

Doshi R, Dale-Huang A, Zhang G Q. 2021. Northern expedition: China's Arctic ambition and activism. Wahington D. C.: Brookings.

Guo H D, Liu J, Qiu Y B, et al. 2018. The Digital Belt and Road program in support of regional sustainability. Int J Digit Earth, 11(7): 657-669, doi:10.1080/17538947.2018.1471790 (in Chinese with English abstract).

He J F, Zhang F. 2012. The development of Arctic science and technology based on the Arctic policies of Arctic nations. Chin J Polar Res, 24(4): 408-414 (in Chinese with English abstract).

Hu Y S. 2018. Minister of Science and Technology: science and technology diplomacy has become an important component of China's overall diplomatic strategy. (2018-01-10). https://www.most.gov.cn/ztzl/qgkjgzhy/2018/2018mtbd/201801/t20180110_137630.html (in Chinese).

Jakobson L, Peng J C. 2012. China's Arctic Aspirations. Stockholm: SIPRI. https://www.sipri.org/sites/default/files/files/PP/SIPRIPP34.pdf.

Lanteigne M. 2022. The Rise (and Fall?) of the Polar Silk Road. The Diplomat. https://thediplomat.com/2022/08/the-rise-and-fall-of-the-polar-silk-road/.

Liang S Q. 2022. Summary of participation and initiation of the international science programs of China. Mod Sci, 2022(1): 22-32 (in Chinese with English abstract).

Liboreiro J. 2022. Nord Stream: explosions recorded prior to discovery of major gas leaks. Euronews. https://www.euronews.com/my-europe/2022/09/27/denmark-and-sweden-issue-navigation-warnings-over-nord-stream-gas-leaks.

Miguel M. 2018. China in Greenland: mines, science, and nods to independence. China Brief. 18(4). https://jamestown.org/program/china-greenland-mines-science-nods-independence/.

Millard B J R, Lackenbauer P W. 2021. Trojan dragons? Normalizing China's presence in the Arctic. Ottawa: CGAI. https://www.cgai.ca/trojan_dragons_normalizing_chinas_presence_in_the_arctic.

Niiler E. 2019. Chinese scientists are the new kids on the Arctic block. WIERD. https://www.wired.com/story/chinas-scientists-are-the-new-kids-on-the-arctic-block/.

Pan M, Huntington H P. 2016. A precautionary approach to fisheries in the Central Arctic Ocean: policy, science, and China. Mar Policy, 63: 153-157, doi:10.1016/j.marpol.2015.10.015.

Pompeo M R. 2019. Looking north: sharpening America's Arctic focus. https://china.usembassy-china.org.cn/looking-north-sharpening-americas-arctic-focus/.

Royal Society Science Policy Center. 2010. New frontiers in science diplomacy: navigating the changing balance of power. London: The Royal Society. https://royalsociety.org/topics-policy/publications/2010/new-frontiers-science-diplomacy/.

Rüffin N, Rüland A L. 2022. Between global collaboration and national competition: unraveling the many faces of Arctic science diplomacy. Polar Rec, 58: e20, doi:10.1017/s0032247422000158.

Su P, Mayer M. 2018. Science diplomacy and trust building: 'science China' in the Arctic, Glob Policy. doi:10.1111/1758-5899.12576.

The National Development and Reform Commission, the State Oceanic Administration. 2017. Vision for maritime cooperation under the Belt and Road Initiative. https://english.www.gov.cn/archive/publications/2017/06/20/content_281475691873460.htm.

The State Council Information Office of the People's Republic of China. 2018. China's Arctic Policy. https://english.www.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm.

Turchetti S, Lalli R. 2020. Envisioning a "science diplomacy 2.0": on data, global challenges, and multi-layered networks. Humanit Soc Sci Commun, 7: 144, doi:10.1057/s41599-020-00636-2.

Yang J. 2018. Science community and global governance: a case analysis on the Arctic affairs. Beijing: Current Affairs Press (in Chinese).

Yang J, Yu H Y. 2014. The community of Chinese scientists and the agenda setting of Arctic governance—based on an analysis of the questionnaires. J Int Relat, 6: 37-49, 148 (in Chinese with English abstract).

Yu X J, Zan X. 2011. Interview with Jin Xiaoming: Science and technology diplomacy has been at the forefront of China's overall diplomacy. (2011-08-28). http://www.gov.cn/jrzg/2011-08/28/content_1934792.htm (in Chinese).

Zhang L L, Yang J, Zang J J, et al. 2019. Reforming China's polar science

and technology system. Interdiscipl Sci Rev, 44(27): 1-15, doi:10.1080/03080188.2019.1627639.

Zhang J J, Wang C G. 2020. Analysis of China's Arctic science and technology diplomacy. World Regional Studies, 29(1): 63-70, doi:0.3969/j.issn.1004-9479.2020.01.2018387 (in Chinese with English abstract).

Zhu S. 2020. Norwegian expert: China is an important contributor to the Arctic knowledge base. http://chinare.mnr.gov.cn/catalog/detail?id=1ecb8a5eab4749eba0fbf47f53cf9047&from=zxdtmtdt&currentIndex=2 (in Chinese).