G. Kristin Rosendal, Steinar Andresen, Gørild M. Heggelund, Eirik H. Steindal. Asian Perspective. Johns Hopkins University Press. Volume 44, Number 3, Summer 2020, pp. 435-460.

The Minamata Convention and Mercury Policy in China: The Role of Science[1]

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ABSTRACT

What role has science played in China's decision to support and ratify the Minamata Convention, and in its domestic policies on mercury? Since 2000 there has been a strong increase in internationally produced knowledge on mercury and China has increasingly taken part in this process, also developing a stronger domestic knowledge base for handling the mercury problem. We analyse three aspects of science which are assumed to enhance trust: credibility, legitimacy and relevance. These are explored in the study of science-policy relations in China as we examine changes in domestic mercury policies and related institutions. Also discussing the effects of other explanatory factors, we find that domestically produced scientific information may be central for understanding China's ratification of the Minamata Convention and subsequent domestic mercury policies. The study bridges the gap between capacity building in emerging economies and how domestically produced scientific information may strengthen national environmental policy making.

Key words: China, science-policy relations, mercury pollution, environmental policy, international environmental agreements, Minamata convention

1. Introduction

What role has science played in China's decision to support and ratify the Minamata Convention, and in its domestic policies on mercury? International negotiations on mercury started in 2003, agreement to start negotiating a legally binding instrument was reached in 2009 and finalized with the adoption of the Convention in 2013. In 2016, China became the 30th Party to the Minamata Convention on Mercury that entered into force in 2017.

China accounts for 30–40 percent of mercury (Hg) emissions to air globally (UNEP 2013; Fu, Zhang, Yu, Wang, Lin and Feng 2015). This calls for a better understanding of China's engagement relating to the Minamata Convention and of the factors that obstruct or promote its domestic mercury policies. China's behavior during treaty negotiations may also provide clues about what to expect in the implementation phase, although the two stages are likely to be affected by other factors as well (Underdal and Hanf 2000). During the Minamata

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negotiations, China shifted its position abruptly—from opposing to supporting a legally binding instrument on mercury. This apparently sudden change has been partly ascribed to Beijing's following suit when the Obama Administration decided to aim for a legally binding instrument on mercury in 2009 (Andresen, Rosendal and Skjærseth 2013; Eriksen and Perrez 2014). However, it might also be that Beijing's decisions to shift position in 2009, sign the adopted text, and early ratification, indicate that the Convention was compatible with China's domestic interests.

This view is supported by Stokes, Giang, and Selin (2016), who see China's domestic scientific and technological capacity as part of the explanation. However, their study is limited to the early phase of the Minamata negotiation phase (2003–2009) while our main focus is on the following phase since 2009. Moreover, they do not discuss the importance of institutional influence or the stimulus of external funding mechanisms and they do not discuss in detail the role of domestic ownership to scientific knowledge, all of which are factors that are included in our study and where we pay particular attention to domestic science.

The role of science in the China/Minamata case is interesting for empirical and analytical reasons. Empirically: although better scientific knowledge does not necessarily translate into better policy-making, the role of science in environmental policy is indisputable. Credible, relevant, and legitimate information about environmental problems is a necessary if not sufficient condition for better implementation of environmental policies (Underdal 2000; Mitchell, Clark and Cash 2006). Analytically: most studies have focused on developed countries. As China is a developing country with an authoritarian regime, it is of interest to study how that might affect the independence and influence of science.

In order to assess the impact of scientific input, we need to investigate if and how institutional research capacity has been strengthened, by domestic decisions or by external assistance. We combine science-policy study with a multilevel approach to policymaking, to capture the complexity of Chinese policies, capacities and insights in environmental problems at local and national levels, not forgetting the numerous stakeholders, such as line ministries, provinces and cities, scientists and non-state actors (Heggelund 2004).

Regarding methodology, we draw on reports, official statements and policy documents as well as journal articles (Chinese and international), supplemented by several rounds of interviews with key stakeholders in China and statements and presentations from project workshops where key official actors participated. (The list of key interviewees referred to in the text (NN1–5) is obtainable on request from the authors.) Interviews with other key actors in the international mercury negotiations supplement those from China, to ensure an alternative perspective (Arts 1999; Gulbrandsen and Andresen 2004).

2. The mercury problem

Mercury is a naturally occurring heavy metal, it is in widespread use globally and it persists in the environment. There is full scientific agreement that mercury is a hazardous toxin with global health and environmental ramifications (Selin and Selin 2006). Exposure to mercury may affect neurological development and it is also linked to lowered fertility, brain and nerve damage (UNEP 2012). Typically, mercury can be released into the air and water through weathering of rock containing mercury ore or through human activities such as industrial processes, mining, deforestation, waste incineration, and burning of fossil fuels. Mercury use in artisanal and small-scale gold mining is the largest mercury-demand sector globally, while burning of coal is the largest single source of mercury air emissions and China is the major emitter here (Pirrone, Cinnirella, Feng, Finkelman, Friedli, Leaner 2010; Zhang, Wang, Wang, Wu, Lei, Wu, Wang, Yang, Yang, Hao and Liu 2015). Most of the emissions occur in Asia and the main industrial sectors remain non-ferrous metal production, cement production and ferrous metal production (UNEP 2018[5]). Mercury can also be released from mercury-containing products including dental amalgam, electrical applications, laboratory instruments, and antibacterial creams. The consumption of fish is by far the most significant source of ingestion-related mercury exposure in humans while plants and livestock may also contain mercury due to bioaccumulation from soil, water and atmosphere. The mercury problem is difficult to deal with as it is hard to control the sources, given the importance of mercury to industrial processes in rapidly emerging economies (Pirrone et al. 2010). UNEP's latest Global Mercury Assessment report (UNEP 2018) finds global emissions to air from anthropogenic sources in 2015 to be about 20 per cent higher than, and with emission patterns similar to the last assessment.

3. Analytical approach to the role of science in Chinese policymaking on mercury

Science is part of the broader concept of knowledge and is characterized by the use of widely agreed methods. In this study we focus on natural science.

Academics disagree as to whether science and policy can be separated. Political actors may use scientific advice to further their own interests, especially when there is uncertainty as to the problem description as well as implications—typical examples being the issues of genetic engineering and nuclear power. In addition, we need to consider how this relationship plays out under an authoritarian regime that is likely to exercise tighter control over scientists and scientific findings (Wübbeke 2013). Nevertheless, in line with the positivist tradition, we hold that it is possible to separate science and policy analytically (Andresen 2014), although this may prove difficult in practice.

Central to analytical expectations are the conditions under which science may be expected to have a more important role in policymaking. The political and cognitive features of an issue may go a long way in explaining the extent to which scientific knowledge will influence decision-making (Underdal 2000).

Concerning the cognitive dimension, various factors are involved in weakening or strengthening the role of science in decision-making. Obviously, the knowledge produced

[5] https://wedocs.unep.org/bitstream/handle/20.500.11822/29830/GMAKF_EN.pdf?sequence=1&isAllowed=y Accessed 02.01.2020.

must be trusted. First, the knowledge produced must be seen to come from competent and independent sources (not from those with vested economic or political interests): this is central to *credibility*. The more conclusive and consensual the state of knowledge, the more likely is it to be used as a premise for decision-making.

Secondly, there is *legitimacy*. Policymakers must trust not only the source, but also the underlying production of the knowledge. As much of the science adduced in global environmental treaty-making is produced by Western institutions, developing countries have often been reluctant to accept such knowledge and advice. This was evident in the Intergovernmental Panel on Climate Change (IPCC), where legitimacy rose when its researchers were drawn more widely from different global regions. In the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), this feature was incorporated from the start (Andresen and Rosendal 2017).

The third element is the *relevance* of scientific information. Scientific advice must be seen as relevant to the situation of those who will use the knowledge. In order to have an impact, scientific assessments need to be responsive to national and local concerns (Mitchell et al. 2006). A proper understanding of local aspects of the state of the environment may require domestically produced science and information. China's experience with the Clean Development Mechanism (CDM) is a case in point, when the country needed to obtain a better understanding of how CDM would work before being able to subscribe to the concept (Heggelund, Andresen and Buan 2010).

The issue of relevance strengthens our expectations concerning the importance of countries performing scientific research themselves. Several international relations scholars have noted how national policymakers are likely to doubt scientific information produced by external (foreign) actors (Morgenthau 1993; Waltz 1979). A pertinent example is when President George Bush Jr. did not trust the IPCC report, and had the US National Academy of Sciences prepare its own report (Andresen and Agrawala 2002). Externally-produced science may be interpreted as undermining domestic autonomy—and low legitimacy could reduce credibility (Bierman and Gupta 2011; Scharph 1999). Here, it seems logical to expect the credibility and influence of science to increase if international knowledge substantiates domestic information, and vice versa (Rosendal, Skjærseth and Andresen 2019). Further, scientific information produced at the international level may impact domestic policies through access to funding for capacity building. As we will show, such funding may strengthen domestic institutions and contribute to what Haas (1993) has termed "epistemic communities," which adopt an increasingly common understanding of environmental problems. Against this backdrop, we propose that:

The role of scientific information, produced at various levels, is central in accounting for China's decision to support and ratify the Minamata Convention and for spurring domestic mercury policies.

Still, science is only one of many decision premises: there are many other legitimate *political and economic interests* to consider. Decision-makers must evaluate the cost of action and the possible effects on trade and employment—and scientific advice seldom wins over strong political and economic interests (Andresen 2014). Climate change and biological diversity are typical cases where scientific advice has often been neglected in real-life policy (Andresen and Rosendal 2017). In contrast, scientific advice was followed in the case of ozone-layer protection—partly because it did not go against vested economic interests (Skjærseth 2012; Andresen, Barat, Hoffman and Farfard 2018). Similarly, the scientific community convinced Chinese policymakers to engage in protecting the ozone layer and sent observers to attend the initial negotiations of the Montreal Protocol (Zhao and Ortolano 2003). In order to assess the role of scientific information, we must check for the effects of economic interests. An alternative explanation for China's support and ratification might be that the obligations were not seen as too daunting, as the economic costs incurred would be moderate:

When international obligations are not perceived as very demanding, domestic support for the international agreement is more likely.

Another aspect of domestic political interests is found at the normative level. *Public demand* for improved environmental policies may also impact on political decisions in China; public opinion is arguably becoming more important to Chinese decision-makers (Aamodt and Stensdal 2017). Mercury has not received much public attention, but it may have interacted with policies directed at air-pollution issues, known to be of great concern in China. Thus:

When international obligations concur with public demands, domestic support for the international agreement is more likely.

We expect all these factors to have influenced China's mercury policies. However, if either (or any combination) of the alternative explanatory factors cannot with any certainty be found to account fully for the boost, that will strengthen our assumptions about the impact of scientific knowledge.

In measuring the influence of scientific advice, the standard approach is to compare advice to adopted policies, but the case here involves different types of information from different sources. Instead, we note as indications of scientific influence when research results are used directly in policymaking, where policymakers need or request data, and where this has coincided with research projects providing data (Underdal 2000). We examine how scientific consensus, conflicts, or uncertainty have developed over time, and whether there is agreement between domestic and international research findings and approaches. This involves operationalizing how *credible, relevant and legitimate* information is perceived in China.

4. Mercury in China: International and domestic policies

4.1 Chinese international policies: support for Minamata

A key player since the start of preliminary negotiations in 2007, China has become increasingly active and important.[6] Although China was noted as one of the main producers, users and emitters of mercury already in the first Global Mercury Assessment (GMA) report in 2002, it was not until the GMA 2008 report that China came into the spotlight as *the* dominating consumer and emission source globally. Its emissions to air were more than twice as large as the total emissions of India and the USA together. China was also the main producer of mercury globally; it used large amounts of mercury in VCM/PVC production, and had vast unintentional emissions from coal combustion, non-ferrous metal smelting and the cement sector. With rapid industrialization and the building boom, these increasing outputs represented major sources of mercury pollution (Global Mercury Assessment Report 2008). Until its decision to support a legally binding convention in 2009, China insisted that a voluntary agreement would suffice.

Although China agreed to enter into negotiations aimed at a legally binding agreement (LBA) in 2009, the results were unclear. In the final OEWG-group meeting, the EU, Japan, Switzerland and the USA emphasized that "the outcome of the INC is not binding to any party, as ratification occurs after the completion of the instrument,"[7] illustrating the uncertainty of the outcome. Although China in principle had agreed to work towards a legally binding approach, it entered into the negotiations seeking to avoid overly strict commitments. Together with India, China continued to argue for a voluntary and flexible approach and opposing mandatory emission targets, phase-out dates and timelines (Stokes et al. 2016).

At the fifth INC in 2013, China also accepted more strict measures and timelines on existing and new air emission sources, provided there could be flexibility in how to achieve reductions (Stokes et al. 2016). Now China took a more active role, with greater influence in shaping the text. As noted by Stokes and colleagues (2016, p. 18), from this point on "it was clear that China had a broader negotiating mandate and was interested in reaching an agreement". More generally, as the major contributor to the problem, China had a dominant position in terms of basic game-power and can therefore be expected to have exerted significant influence on the making of the Convention (Underdal 1997).

4.2 State of domestic mercury policies in China

Prior to its 2009 decision to support the Minamata Convention, China had established few dedicated domestic mercury policies or regulations.

Institutionally, the Ministry of Ecology and Environment (MEE) (formerly the Ministry of Environmental Protection, MEP), has been responsible for the mercury pollution issue.

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[6] Prior to the UN Governing Council decision in 2009, to commence the INC process, three negotiation meetings (Ad-hoc Open-Ended Working Group (AHOEWG)) were organized between 2007 and 2009.

[7] ENB OEWG 2009 summary http://enb.iisd.org/chemical/wginc1/brief/brief_mercury.pdf

Mercury policies were strengthened by the establishment of the Mercury Division on Implementation in FECO (Foreign Economic Cooperation Office; now IECO) in 2010, enabling coordination among different stakeholders (ministries and departments).[8] Another important stakeholder is the Ministry of Industry and Information Technology (MIIT): it oversees mining and industrial uses of coal, and is also responsible for planning, policies and standards in the industrial sector. In 2017, following the Minamata ratification, China established an inter-ministerial coordination body for mercury efforts, involving 17 ministries and administrations, headed by the MEE (formerly MEP).

When established in 2006, the Norwegian–Chinese bilateral cooperation on mercury, the SINOMER-I project was China's first bilateral environmental cooperation project on mercury.[9] Between 2009 and 2016 China set up several large projects on capacity building and implementation support, led by MEP–FECO. From 2012 to 2016 China was granted five GEF-funded capacity-building projects,[10] including an ongoing World Bank project to develop a national mercury implementation plan. In the same period, two phases of SINOMER (II and III) were carried out, aimed at developing knowledge-based science, supporting China in negotiations and towards ratification of the Convention.[11]

The regulatory dimension for implementation has been extensive, with significant changes between 2009 and 2016.[12] The inclusion of mercury pollution control in China's 12th Five-Year Plan for Prevention and Control of Heavy metal pollution was a clear sign of mercury being accorded much higher priority by the authorities (MEP, 2011-2015). The Plan called for a prevention system, emergency response, and environmental and health risk assessment system—signaling greater attention. China outlined its commitment to reduce output of mercury by 15 percent based on 2007 levels, as well as energy-efficiency targets of 20 percent (FYP 2006–2010) and 16 percent (FYP 2011–2015). The 13th Five Year Plan for Ecological and Environmental Protection (State Council 2016) emphasized strengthening of mercury pollution control, including the following measures: i) prohibiting new factories from using mercury-containing processes of calcium carbide for PVC production;[13] ii) the target of halving mercury use per unit of product in the PVC industry by 2020 based on year 2010; iii) stronger mercury-pollution control in coal-fired power plants and other key industries; iv) banning the construction of new mercury mines, with existing ones to be phased out. The Atmospheric Pollution Prevention Action Plan (2013–2017) addressed specific air pollution issues.

[8] http://en.mepfeco.org.cn/About_FECO/201006/t20100610_563479_1.htm

[9] At first the Chinese authorities did not see the need for such a project, as mercury was not considered a major problem then. However, after a few years of consultations, the project was officially endorsed. Similar partnerships on mercury have been involved other partner countries, including Sweden.

[10] The five projects, totalling $27.2 million and with Chinese co-funding of $116 million, were headed by the World Bank, UNIDO, and UNEP, implemented by FECO and partners, and funded by GEF. See: https://www.thegef.org/projects

[11] https://www.sida.se/contentassets/cd277bcb88804bf58c5c2eec602b1855/15353.pdf

[12] NN1, presentation at Peking university, 11 October 2018. List of key interviewees (NN1-5) with authors.

[13] It was also decided to prohibit *new* mercury mining from 2018 and *all* mercury mining from 2032. Here, policies have been put in place to strengthen monitoring and supervision of use.

What, then, of the results from these policies and regulations? It is still early days to assess effects of implementation, but trends may be observed. We are particularly interested in any improvements prior to China's 2016 ratification.

First, according to government officials, mercury consumption has been reduced by 160 tons (from more than 1000 tons) in specific sectors (NN1). *China's Roadmap for Gradual Mercury Content Reduction in Fluorescent Lamps* reportedly contributed to reducing the production of mercury-containing fluorescent lamps from about 6 billion units in 2014 to some 3.2 billion in 2016. Further, atmospheric emissions standards have been strengthened since 2010, and mercury was added as a target in control measures (Lin, Wang, Hovland Steindal, Zhang, Zhong, Tong, Wang, Veiteberg Braaten, Larsen and Wu 2017, p. 2). Although published and reported in 2017, these data are likely to have been known to the authorities prior to the 2016 ratification.

However, major implementation challenges remain for reducing mercury emissions from coal-fired power plants (CFPP) and coal-fired industrial boilers (CFIB) (NN1). Current emissions limits in China are much higher than those in the USA, Canada or Germany, and resistance to lowering the threshold further may be expected. Many new coal-consuming plants have been established, and this might mean increased emissions. Effects from shutdowns are likely to be limited as it is the smaller ones that are being closed. Further, the central government does not fully control local government in this area, the local authorities are lacking in competence, and local administrations are overloaded with issues relating to economic development and poverty reductions. The latter provides a strong incentive for local government to invest in the CFPP and CFIB industries (NN1).

In sum, we find quite high levels of Chinese international activity and domestic mercury policy measures preceding the 2016 ratification. At the international level, China was a fierce negotiator in the early stage, working hard to avoid tight regulation of key industries, but then in 2013 accepting more strict measures. Domestically, this included the institutional changes to aid mercury policy measures, emission reductions and targets, executing several capacity-building projects, and introducing a range of mercury-reducing policies. However, several major challenges of implementation remain.

How can this be explained? We first turn to the assessment of the role of science in accounting for China's shift in decision-making on mercury. Next, we discuss whether economic interests may account for that shift and then check for the possible impact of normative factors through public demand.

5. Analyzing and explaining mercury policies in China

5.1 Role of Science

5.1.1 International knowledge producers

How does China view external producers of knowledge? Central elements here are how the UN-led synthesis reports on mercury meet the criteria of credibility, relevance and legitimacy of scientific knowledge in China.

There are indications that the knowledge produced by UNEP and the Arctic Monitoring and Assessment Programme (AMAP) may have had both credibility and legitimacy in China. The UNEP-led voluntary Global Mercury Partnership (GMP) is known to have generated scientific leverage for development of the Minamata Convention. Importantly, China's lead negotiator has been participating in the GMP since 2011.

Further, the list of Chinese participants in the meetings of the Intergovernmental Mercury Negotiating Committee (INC) 2010–2016 shows that China consistently included experts from leading universities and public research institutes in its official delegation. Participation and contribution to these processes increases the chance of these international outputs being perceived as both *relevant* and *legitimate* to China (see also below).

Internationally produced information by UNEP and AMAP repeatedly showed that Chinese emissions were detrimental across borders (GMA 2002, 2008, 2013, 2018). The UNEP Global Mercury Assessment report (GMA 2002) provided the basis for the negotiations; the 2008 GMA was even more widely cited. Despite some disagreement among governments and experts on the quality and relevance of specific parts of the data, these reports have generally served as key instruments in building the global consensus on scientific knowledge. The 2002 UNEP Global Mercury Assessment report was based on an independent study (Lacerda 1997), which estimated that artisanal and small-scale gold mining (ASGM) was a significant source of mercury emissions and releases in China. Although the 2002 GMA report did note that this practice was banned in China (GMA 2002, p. 133), the 2008 GMA (p. 19) identified China as the major source of mercury emissions from ASGM. These findings were strongly contested in China, where it was argued the ASGM practice had indeed been banned. Later, several Chinese-funded peer-reviewed publications provided data showing that ASGM and related emissions were insignificant in China (Zhang, Wang, Wang, Wu, Lei, Wu, Wang, Yang, Yang, Hao and Liu 2015; Hui, Wu, Wang, Liang, Zhang, Wang, Lenzen, Wang, Xu and Lin 2017). This may have severely eroded China's trust in the *credibility* of internationally produced knowledge about mercury pollution. It may also have been a reminder of the relevance of staying close to the international arenas of scientific production and synthesis. Key Chinese experts from Tsinghua University and the Institute of Geochemistry of the Chinese Academy of Sciences contributed to developing the 2013 GMA report, to a greater extent ensuring that Chinese data and science would be taken into consideration,[14] and enhancing domestic credibility.

5.1.2 Bilateral knowledge production

Influence from external scientific institutions may also come through links between these institutions and the central government, through capacity-building and epistemic communities, which might engender a common understanding about scientific information. We focus primarily on the SINOMER (Norway–China) bilateral collaboration as it is the first of its kind. Moreover, the collaboration has been running for twelve years now, making it the

[14] Personal communication and observation by Eirik Steindal, member of the Norwegian delegation during MC negotiations.

most extensive bilateral cooperation on mercury. Third we have had easy access to information through both the Chinese and the Norwegian participants (which necessitates careful use of the information provided by these informants).

In 2004–2005 there was initial reluctance to initiating a bilateral project with a strong scientific scope (SINOMER): there was little awareness of the mercury issue among government officials (NN3), and the domestic scientific community was in its infancy. The SINOMER project was finally approved in 2006, and key researchers attempted to set up the first international conference on mercury from coal firing in China.[15] Permission was first refused, but after some bureaucratic bargaining and convincing the MEE that the conference would be strictly technical (no politics involved), it was granted (NN4).

Several domestic institutions have relied on external funding for sustaining their resource base, both through funding from the GEF and UNEP[16,17] and through the SINOMER project (NN3).[18] These projects, and interlinked activities operated by key project partners, are seen as giving key inputs to China's international negotiations and domestic policies (NN2). For instance, there are linkages and networks between FECO and MEE, key domestic academic institutions and international organizations, increasing the internationalization of academic experts on mercury. Relevant examples are the representation of key Chinese academics with close links to the government who have participated in UN-led expert groups under the Convention (e.g. the development of guidance on BAT/BEP for air emissions) and as experts developing the Global Mercury Assessment report coordinated by UNEP and AMAP. Through bilateral projects, Chinese domestic capacity has been strengthened, and this has been contributing to the country's potential to develop and strengthen its own scientific research base.

5.1.3 The role of domestically produced scientific knowledge

Here we distinguish between scientific experts and scientific knowledge.

Regarding the former, key Chinese experts have played an important role in developing the domestic scientific foundation for China's involvement in negotiations and ratification. Scientists from Tsinghua University (TU), Peking University (PU) and the Chinese Research Academy of Environmental Sciences (CRAES) have attended most WEOG, INC, and COP meetings.

Expert participation has been consistent in the negotiations delegation, with representation of a few key experts from major academic institutions. At the preparatory meetings (WEOG) there were two or three academic experts; at the INC meetings and first

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[15] https://www.tsinghua.edu.cn/publish/enven/6297/index.html

[16] https://www.thegef.org/sites/default/files/project_documents/6-26-2015_ID6921_resubmission_0.pdf
[17] https://www.thegef.org/sites/default/files/project_documents/Prodoc_22062012_0.pdf
[18] GEF projects on mercury are listed http://www.thegef.org/projects; bilateral project funded by Norway SINOMER; UNEP inventory on provincial levels; UNIDO BAT/BAP for cleaner zinc production; World Bank NIP https://thegef.org/sites/default/files/publications/GEF_Mercury-brochure-OCT7-2013_1_0.pdf

COP, between three to five scientists participated.[19] The expertise was consistent in terms of the persons involved—a factor shown in other national delegations to strengthen confidence as well as clout (Rosendal 2007). The Chinese delegation to the Minamata process grew from around ten in number in the preparatory meetings (WEOG) to 18–26 during the actual negotiations. Exceptions were the interim meetings, INC6 and INC7, when fewer issues were involved.[20] The delegation came across as increasingly better prepared for discussions of the technical issues. The strong representation of experts is likely to have secured both continuity and reliance on science in the Chinese delegation and may also have boosted China's self-confidence and reputation as a constructive, facts-oriented, visible and responsible party in the Minamata negotiations.[21, 22]

The broad participation made the Chinese delegation among the largest; the role of industry is also noteworthy. The broad range of experts and interests included in the delegation could mean that, like the USA, which is usually the party with the largest delegation, China wants and can afford to have full control over all aspects of the negotiation processes. The large delegations could indicate willingness to prioritize environmental problems, as well as an interest in remaining alert to how obligations that clash with national interests could be avoided or toned down.

The period 2002–2016 saw a considerable increase in domestic scientific capacity-building, growing exponentially over time. According to the scientific search engine Web of Science, the number of scientific publications on "China and mercury" increased from less than 10 per year in early 2000s to more than 500 in 2018. Obviously, not all of these include authors from China, however, many probably do. Two of the most prominent mercury scientists in China had less than 100 citations annually from 2001–2003, whereas in 2016–2018, they averaged annually more than 2000 citations each.[23]

Let us now look at the scientific information. In the early 2000s, China had limited scientific knowledge about its domestic use and pollution status. This lack of knowledge is one probable explanation why Beijing long resisted a legally binding approach. The Global Mercury Assessments (2002, 2008) explicitly identified China as the main producer, user and emitter. However, global data are less fine-grained than national data; a fact that points up the risks of not being able or willing to produce own data. As noted, the clearest example of where domestic science was needed to adjust the international data was the 2008 GMA report (p.

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[19] http://mercuryconvention.org/Portals/11/documents/meetings/COP1/English/1_INF17_list_of_participants.pdf

http://mercuryconvention.org/Portals/11/documents/meetings/COP2/english/2_21_e_ListofParticipants.pdf

[20] The Convention text was adopted at INC5; and INC6 and 7 did not have the mandate to adopt decisions, as the draft decisions would not be adopted until COP1.

[21] Interview with Atle Fretheim, former KLD, and leader of Norwegian delegation to the MC negotiations, June 20, 2019.

[22] Personal communication and observation by Eirik Steindal, member of the Norwegian delegation during MC negotiations and project leader of SINOMER III.

[23] A search on mercury publications 2000–2018 by the two scientists was carried out using Google Scholar.

19) that (erroneously) claimed a release of 156 tons of mercury from artisanal and small-scale gold mining (ASGM) in China—later contradicted by a group of Chinese researchers who published completely different figures (Zhang et al. 2015).[24] Further, Hui et al. (2017) provided an estimation of how much of China's emissions were export- and external consumption-driven, presenting a more nuanced picture of China and opening for more shared international responsibility for reducing emissions. That China uses international scientific reports as a reference, examining the data to confirm (or refute) the results, is likely to increase the *credibility* of the resultant scientific information.

Domestically produced research has also emphasized China's more specific mercury pollution challenges, including contaminated sites and health problems linked to contaminated food. This research showed that, unlike other countries, fish was not necessarily the dominant source of mercury contamination (NN3). In China, however, rice could be a significant exposure route, mainly in heavily contaminated areas (Jiang, Shi and Feng 2006; Feng and Qiu 2008). The nuances provided here indicate the increased *relevance* of domestic scientific information.

Domestic research has proven an important supplement to the international science basis, on all three dimensions. First, it has provided more detailed and *relevant* scientific information about the Chinese mercury situation. Second, domestically produced science has countered scientific outputs from the UNEP assessments on ASGM, thus increasing *credibility*. The accumulating body of Chinese research has supplemented the international literature, in problem understanding, national data on sources, and nation-specific solutions. Third, domestically produced science is by itself likely to increase *legitimacy*. We have also noted how the SINOMER collaboration, in a critical phase of rising public awareness and political focus, may have contributed to promote the mercury issue domestically.[25] There is hence reason to recognize the additional inputs of domestically produced information, compared to internationally produced knowledge.

It may be that the early phase of this cooperation provided data showing that local concentration levels were lower than anticipated. As a result, the authorities were probably relieved that the situation was not as bad as might have been expected, which helped to lower the bar for accepting international obligations.

If, however, the authorities were thus relieved by domestic scientific findings, this gives rise to a contrafactual question: would the effect of domestic science have been equally significant if these findings had instead fully supported the international data? This question also touches upon the *credibility* of scientific information, which is more difficult to ascertain than relevance and legitimacy. It may be speculated that if such were the case China might

[24] "Updated emission inventories for speciated atmospheric mercury from anthropogenic sources in China". This work was funded by Major State Basic Research Development Program of China (973 Program) (No. 2013CB430001), National Science Foundation of China (No. 21307070), and MEP's Special Funds for Research on Public Welfares (No. 201209015).

[25] Eirik Steindal: This has been stated by officials in meetings/seminars with the Norwegian government.

have been more reluctant on the international arena, while also feeling more compelled to act domestically. On the other hand, as the Chinese science did offer some positive news to policymakers concerning the potential health impacts of mercury, this gives rise to the question, "why the remaining reluctance at the first intergovernmental negotiation meeting?" One explanation (NN4) may lie in the dual domestic scientific findings: that the mercury pollution situation was not as bad as portrayed by international reports, *but still an important issue that needed to be dealt with, and China was a major source.* It may be that this nuanced picture has contributed to a gradual change, with the boost in research and subsequent development of mercury policies in China.

More generally, in global environmental governance, developing countries have emphasized the need to consider their own socioeconomic and technological circumstances regarding the production of legitimate and relevant scientific information. Legitimacy is essential, and China has tended not to accept findings from outside—especially from Western countries (NN2). Chinese experts must take part in the investigations before the results are officially accepted. That interviewee noted how, in international negotiations, many small countries accept UN-produced science without question as they lack the capacity to perform the science themselves. This is different in China, which has the capacity to do own research.

All this appears to support our expectations about the importance of domestically produced scientific knowledge as a source of greater legitimacy and relevance, even credibility, and in explaining behavioral change. It remains to check for effects from other explanatory factors.

5.2 Economic interests: Role of industry associations

Here we examine the role of economic interests (business sector, industry associations) and their interaction with the local and the central government. Beijing attaches increasing importance to a range of stakeholders and considers incorporating their advice into policymaking (Wübbeke 2013; Li 2017, pp. vii and 11; NN2). Prior to the Minamata negotiations, the Chinese government arranged broad stakeholder consultations, including researchers and industry associations. In addition, multiple stakeholders, including domestic industry and industry associations and scientists, have taken part in the international and bilateral collaboration projects mentioned above—and these projects have provided key inputs.

Several of these key industry associations were represented in the official Chinese delegation at most of the five INC meetings, as well as in the final preparatory working group meeting (OEWG) prior to the INC process.[26] Representatives of the China Petroleum and

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[26] Representatives from the China Petroleum and Chemical Industry Federation participated at most INC meetings; the China Chlor-Alkali Industry Association, China Nonferrous Metals Industry Association and the China Electricity Council were also represented in some. Several industry associations also participated in the final preparatory meetings prior to the INC process. Lists of INC5 participants are available at http://www.mercuryconvention.org/Portals/11/documents/meetings/inc5/English/5_INF3_Rev2_List%20of%20participants.pdf, accessed October 10, 2019

Chemical Industry Federation attended the four (out of five) INC meetings on which we have records.[27] China's coal-fired power plants (CFPP) and industry boilers (CFIB) do not have an association. However, the CFPP industry has been generally positive to the government's evolving mercury policies, because the industry is (allegedly) in the international technological forefront, using advanced air pollution abatement technology and controlling almost 90 percent of mercury emissions (NN2, NN4).

The initial level of Minamata obligations was not very demanding on China—flexible and "soft" enough to be implemented (Stokes et al. 2016). The close involvement of industry during the entire process may have provided the Chinese negotiators with a good idea of how far the industry would be willing to go. Regarding the CFPPs, NN4 suggests that there was confidence that the well-developed industry sector could manage quite tough restrictions. For mercury-containing products it was also very likely that industry would succeed in finding alternative technologies: mercury-free or low-mercury-content products were already being manufactured for export, which would enable the emissions-reduction targets to be met.

Still, reports from the INC meetings show that China fought persistently against specific emissions reduction targets, until it opened for more stringent—but flexible—targets at INC5 (Eriksen and Perrez 2014; Stokes et al. 2016). Beijing made it clear that it did not intend to go too far in committing to restrictions on air emissions, including the coal-combustion sector.[28]

On the one hand, the efficiency targets could be achieved by shutting down or modernizing small, inefficient coal-combustion plants (Bergsager and Korppoo 2012) and China seem to have the necessary technology available for limiting the use of subcritical coal-combustion plants. Moreover, NN4 argues that parts of the private sector have themselves been pushing these targets, partly to demonstrate a green image, and partly recognizing that those who pollute less will still be allowed to produce, thereby reducing competition. The real pressure here seems to come from Beijing: by extensive restructuring of several industries, the government wanted to modernize industry in general. This restructuring policy indirectly involved phasing out the small, heavy polluters as the large companies are likely to profit from the general modernization process (NN3). As a result, China's opposition to a legally binding international agreement may have softened somewhat over time (Andresen et al. 2013).

However, many new coal-combustion plants are still being established, increasing emissions. Even though these new plants come with high-end abatement technology, the overall effects of the shutdowns may be limited, as it is the smaller ones that are being closed.

On the whole, during the negotiations many of the larger Chinese industry interests were not very much affected by, or opposed to, stricter control measures.[29] And the close

[27] Later, at INC6 and 7, as well as COP1 (2017), when the legally binding convention text had been adopted and mostly guidance documents and forms remained among the technical issues, none of the industry associations were represented.

[28] The coal-combustion sector was regulated, together with waste incineration, cement production and non-ferrous metals; thus, it may be that the non-ferrous metals association had more challenges than the coal-combustion sector.

[29] Concerning future implementation, NN4 explains that after 2025, the government has more ambitious goals for mercury-reduction targets. This is also reflected by the exemptions that China has requested under the

interaction with industry associations in the negotiation process, apparently paving the road towards a more flexible position at INC5, provided the delegation with leverage to influence the Convention in accordance with China's own capacity. However, there may be other variables that may contribute to explain the development of mercury policies in China.

5.3 Normative aspects: Public demands for health and environment

While mercury has been moving higher up on the agenda in China, there has been limited public pressure for *directly* mitigating mercury pollution. The main explanation is the moderate exposure levels found in Chinese fish, otherwise considered the dominant exposure route globally. Several studies have reported that, due to biological and ecological differences, mercury levels in Chinese fish are comparatively lower than elsewhere in the world (Zhang, Feng, Larssen, Qiu and Vogt 2010; Cheng and Hu 2012). Despite the elevated levels of mercury found in rice in hotspot areas, the risk of chronic negative health effects caused by mercury has been deemed limited; moreover, except for incidents of high occupational exposure, mercury rarely causes acute poisoning. Hence, public protest has usually been limited to geographically small hotspot areas. Besides mercury, China has for many years been struggling with high levels of other heavy metals in the soil, an issue receiving higher priority and attention than mercury alone (Zeng, Ma, Yang, Zhang, Liu and Chen 2019).

However, with improved welfare in China, the public is increasingly concerned about environmental problems, particularly local air pollution, which causes severe health problems also in major cities like Beijing. In recent years, several measures have been introduced for dealing with this problem (Heggelund and Nadin 2017), which shows that public opinion is becoming increasingly important to decision-makers.

The Chinese public is increasingly demanding blue skies and safe water. The firm public demand for better air quality has *indirectly* impacted government attention to mercury pollution. The dominant sources of mercury emission—coal combustion, cement production and non-ferrous-metal smelting—are also key sources of local air pollution and CO^2 emissions. Mercury has to a certain extent been a free-rider, as significant proportions are sequestered by the same abatement technology (Hui et al. 2017).[30] Soil contamination, local air pollution and climate change are environmental problems that have generated strong public opinion in China.[31,32] The corresponding actions have not been directed at mercury; however, it is

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Convention, extending phase-out dates on manufacture, import and export of certain products from 2020 to 2025.

[30] https://pdfs.semanticscholar.org/1415/36fb395dfa386d5905747e6b73052bc05036.pdf?_ga=2.103373769.837844292.1551688362-817225171.1551688362

[31] https://pdfs.semanticscholar.org/1415/36fb395dfa386d5905747e6b73052bc05036.pdf?_ga=2.103373769.837844292.1551688362-817225171.1551688362

[32] http://www.asianews.it/news-en/Hundreds-of-students-with-cancer-and-leukemia-in-school-built-on-contaminated-land-3728/7.html

probable that these domestic drivers have indirectly contributed to creating general leverage for China to enter into international commitments to combat mercury.

6. Concluding remarks

China's evolving mercury policies and the establishment of the Mercury Division (2010 in FECO, affiliated with the Ministry of Ecology and Environment) illustrate the significant governmental support to dealing with this problem. Prior to 2010, China had no coordinated mercury policy. The GMA 2002 and 2008 reports identified China as the main problem globally, and China has never really opposed that contention. On the contrary, it has generated its own data on mercury emissions, to nuance the international scientific information, to strengthen its foundation for negotiations, and to explore domestic solutions.

Despite initial concerns over a new instrument that could hit China's economic interests hard, Minamata negotiations provided confidence that the international obligations would only marginally affect Chinese economic interests. Increased public demand to reduce local air pollution also had the positive side-effect of reducing mercury emissions. These factors go some way but cannot fully explain China's mercury policies. Hence, we conclude that scientific information constitutes a significant factor for explaining China's support for the Minamata Convention and for its own emerging domestic mercury policies.

Studying different levels of science production, we found that credibility attached to scientific information from the UN system has varied. With assistance from bilateral scientific collaboration, China has strengthened its capacity to produce domestic scientific information and integrate policy needs. This has probably helped to increase the legitimacy and relevance of science in China, strengthening both domestic and international policies.

The interaction between the three factors of norms, interests and knowledge merits further consideration. Despite the positive side-effect from strong public demand for better air quality, mercury pollution is not an issue familiar to the general Chinese public, and the domestic health effects directly linked to mercury have been found to be limited. Hence, the normative factor hardly subtracts much from the possible effect of scientific information: on the contrary, as domestic scientific data showed that health effects from mercury were not a major problem.

China's central role as the major source of mercury makes the country indispensable to the international mercury negotiations. This has provided it with a very high level of basic game power and has probably contributed to its achieving exceptions and various flexibility measures sought in the Convention (Steindal et al. in progress). While China is responsible for a sizeable share of the mercury pollution elsewhere in the world, science has shown that the domestic impacts of mercury pollution through fish consumption are less critical than could have been expected. In that sense, China's push to fulfill its mercury obligations might be more reputationally motivated than stemming from domestic health issues.

Mercury remains a challenging issue and dealing with it will affect Chinese industry greatly. Despite soliciting some exemptions under the Convention, mercury will present China with challenges in implementation of its international obligations. The sizeable Chinese delegation has included representatives from scientific and industry associations. These two groups may have influenced the policy process differently: the former providing China with more confidence in accepting Minamata; the latter leading China to press for a tougher bargain.

Finally, this study has indicated a largely neglected field in empirical and theoretical science-policy research. There has been scant research bridging the gap between studies of capacity-building in developing and emerging economies, and studies of how domestically produced scientific information could strengthen the field of environmental policy-making.

Acknowledgments

The authors are grateful to Professor Thorjørn Larssen, Research Director and environmental chemist at the Norwegian Institute for Water Research, who has collaborated extensively with Chinese scientists and policymakers on various pollution issues for more than 20 years, including on mercury for the last 10, for sharing valuable knowledge. We are also much obliged to Atle Fretheim, formerly with the Norwegian Ministry of Climate and Environment and leader of the Norwegian delegation to the MC negotiations, for sharing valuable insights in China's role in the Minamata negotiations. We would also like to extend our gratitude to Erik Solheim, former Executive Director to UNEP and former minister of the Norwegian Ministry of the Environment, who has provided us with helpful insights in China's role in UN environmental policy-making. Many thanks also to two anonymous reviewers with the Asian Perspective Journal who proffered helpful comments.

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