



Asymmetric barriers in atmospheric politics of transboundary air pollution: a case of particulate matter (PM) cooperation between China and South Korea

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Abstract

Existing studies have argued that regional cooperation is urgent in order to tackle transboundary air pollution. However, few studies have operationalized atmospheric cooperation steps and theorized the underlying logic of asymmetry as a barrier to further cooperation. Given that air quality degradation and its impact on neighboring countries have worsened around the world, it is imperative to identify a framework with which to analyze the degree of transboundary cooperation. This study aims to provide a general explanation of barriers to transboundary air pollution cooperation and test the explanation empirically through a case study of China and South Korea. Our findings suggest that asymmetric barriers—in state capacity, economic interests, domestic pressures, and international pressure—impede the process of cooperation in atmospheric politics. This systematic analysis points to policy suggestions including the improvement of regional epistemic community, economic co-benefits, and multilateral institution that enhance the chances of reducing transboundary air pollution.

Keywords Atmospheric politics · Transboundary air pollution · Asymmetry · China and South Korea relations · Interactions between domestic politics and international politics

1 Introduction

March 7, 2019, the Korean government took emergency measures to reduce particulate matters (PM) 2.5 which rose to a bad or very bad level (81–150 $\mu\text{g}/\text{m}^3$ or 151 $\mu\text{g}/\text{m}^3$) for 7 days in a row. Most South Koreans blame China for being the primary source of PM_{2.5}, PM₁₀, and yellow dust emissions. Satellite images of PM in the media vividly show the high PM density as well as the direction of PM-laden wind moving from China to the Korean peninsula. Scientific research has also pointed to the “strong influence of

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the east-central Chinese emission on South Korea, at maximum 200% over the pathway of long-range transport of aerosol pollution compared to the mean condition” (Lee et al. 2019), particularly in “multi-days severe air pollution in cold seasons” (Oh et al. 2015). The citizen-led petition to the Blue House—the Presidential Office of South Korea—on this issue attracted 278,128 signatures in just 1 month, from March 24 to April 23, 2018 (President Office 2018), forcing the Presidential Office to engage with China diplomatically.

While severe transboundary air pollution in Northeast Asia demands urgent regional cooperation (Kim 2007; Shim 2017; Yarime and Li 2018), both bilateral and multilateral cooperation still remain rudimentary. Despite the series of meetings and initiatives including the Acid Deposition Monitoring Network in East Asia (EANET) and Long-range Transboundary Air (LTP), China and Korea have not reached a consensus even on the scientific facts and related responsibility, to say nothing of a binding agreement (Kim and Kim 2018; Shim 2017; Yoon 2007). Compared to cooperation on transboundary air pollution in other regions such as Europe (Fraenkel 1989; Tuinstra et al. 2006) and Southeast Asia (Nurhidayah et al. 2015), there has been little bilateral cooperation. Why is there so little consensus on the causes and effects of transboundary air pollution in Northeast Asia, particularly between China and South Korea? Furthermore, why is there neither a bilateral nor a multilateral agreement on transboundary air pollution in Northeast Asia?¹

Although existing studies have argued that regional cooperation is urgently needed to tackle transboundary air pollution (Kim 2007; Min 2001; Shim 2017; Yarime and Li 2018) along with other issues (Haas 1990), few studies have operationalized atmospheric cooperation steps and theorized the underlying logic of asymmetry as a barrier to further cooperation. The existing literature has not systematically analyzed the steps of transboundary air pollution cooperation. Given that air quality degradation and its detrimental impacts on neighboring countries are worsening around the world, it is imperative to identify an adequate framework with which to analyze the degree of bilateral and multilateral transboundary cooperation. This study aims to explain the barriers around transboundary air pollution cooperation in general and to test the explanation empirically through a case study of China and South Korea. Our conceptualization of the process of cooperation in atmospheric politics and our illustration of asymmetric barriers—in state capacity, economic interests, domestic pressure, and international pressure—theoretically and empirically contribute to the field of global environmental politics and China and Korea studies. We theoretically find that asymmetries are likely to impede the steps of bilateral environmental cooperation. Empirically, this study contributes to the understanding of challenges in transboundary cooperation between China and South Korea. This systematic analysis points to policy suggestions that improve the chances of reducing transboundary air pollution.

To this end, Sect. 2 analyzes the nature of transboundary atmospheric politics and operationalizes cooperation steps as the dependent variable. We also theorize asymmetric barriers in state power, economic interests, and domestic pressures as well as a lack of international pressure as the independent variable to explain the lack of cooperation between the two countries. Section 3 empirically analyzes the suggested causal relation and its consequences. Section 4 concludes the paper and provides policy suggestions to improve transboundary air pollution cooperation between the two countries, as well as between countries across the world.

¹ As explained below, our analysis focuses on the bilateral case rather than the multilateral case, which needs more theoretical sophistication.

2 Atmospheric political cooperation and its barriers

2.1 Cooperation steps for atmospheric politics

No one can stop breathing for more than a few minutes. Some may take clean air for granted, but in many parts of the world, this is not possible. Thus, ensuring high air quality has been a core task of environmental management. However, the atmosphere cannot be contained by human-made boundaries. Dust, particulate matter, and acid rain containing pollutants easily cross state borders. Transboundary air pollution demands international cooperation, yet bilateral or multilateral cooperation on air pollution is a challenge. In particular, cooperation between countries with asymmetries in power, interests, and domestic and international pressure faces many difficulties.

To explain this phenomenon, we begin by operationalizing cooperation steps and theorizing asymmetric barriers in cooperation on atmospheric politics, focusing on the transboundary air pollution issue. With the well-developed literature on hydropolitics as a guide (Daoudy 2009; Dinar 2009; Han 2017; Warner and Zawahri 2012), we identify the components of atmospheric politics, examining the degree of cooperation and contention among stakeholders in a shared atmosphere with the following questions: (1) What are the characteristics of atmospheric politics? (2) What are the frameworks by which to analyze countries' cooperation on atmospheric politics? (3) How do these characteristics and frameworks form different dynamics that revolve around the countries' (or political entities') cooperation on agreeing to decrease transboundary air pollution?

We define atmospheric politics as the authoritative allocation of value with respect to the atmosphere. The scope of atmospheric politics covers global issues (such as climate change and ozone layer depletion), regional issues (such as transboundary air pollution and acid rain), and local issues (such as air quality degradation) (Mitchell 2010). This study focuses on regional atmospheric politics, particularly transboundary air pollution. Atmospheric politics necessarily involves problems with amorphous attributes (blurred boundaries and multiple causes), issues of quality rather than quantity (fewer incentives for economic cooperation), and direct links to economic development based on energy use.

First, the amorphous aspects of atmospheric politics tend to lead to a mismatch of jurisdictions. While sovereign airspace exists, atmospheric boundaries are blurred, and transboundary air flows are multi-directional. This can create difficulties in establishing clear jurisdiction, reasonability, causes and costs of damages, and coordination between science and policy (Tuinstra et al. 2006). Second, the quality is more important than the quantity of transboundary air issues. Without proper schemes, air pollution quantity is not financially beneficial for trade. In contrast, in hydropolitics, water quantity can be a clue for cooperation (as well as conflict) through sharing water resources (irrigation, industrial use, or hydropower generation). Cooperation with a large volume of water resources for electricity generation or other water usages can facilitate mutual and direct economic benefits for participating countries. However, unlike hydropolitics, atmospheric politics does not generate immediate and monetary incentives for cooperation because states do not gain anything material or visible. Of course, cooperation in atmospheric politics could beget benefits such as public health and eco-system enhancement, but these incentives and outputs tend to be long-term and are not easily convertible to monetary value. Third, emissions of air pollutants (and bad air quality) are closely linked to economic and industrial development. When more economic development (including increases in energy consumption and motor vehicles) is pursued, greater emissions are produced (Harris and Lee 2017). To reduce air

pollution, substantial regulatory and monetary efforts should be in place with proper linkages between governance, institutions, and actors (Selin and Van Deveer 2003). In summary, atmospheric politics, including regional transboundary air pollution, global climate change, and ozone depletion, concerns problems that are challenging to solve collectively.

The process of environmental cooperation has been discussed in the literature. Hass et al. (1993), for example, proposed the three phases of policy activities; agenda setting, international policies; and national policy response. Agenda setting is to identify problems for collective response. International policies aim to coordinate policy measures for collective application. National policy response is to comply with international measures. Mitchell (2010) added some other components in international environmental negotiation. To set the agenda, it needs to build up knowledge, concern, and urgency. In the process of international policy making, mutually acceptable goals and policies should be generated. After maintaining and promoting momentum, regulatory or procedural form of institution can be initiated and strengthened (O'Neill 2009).

Based on the phase of environmental cooperation (Mitchell 2010; O'Neill 2009; Yarime and Li 2018), we operationalize the four step process of environmental cooperation on transboundary atmospheric politics in Fig. 1. We develop this process to analyze transboundary air pollution cooperation at bilateral and multilateral levels, but this can be utilized as a step in identifying general environmental cooperation.

The first stage is issue identification, in which bilateral or multilateral discussions about atmospheric politics and the causes and effects of transboundary air pollution begin (Mitchell 2010; Yarime and Li 2018). Paying attention to shared atmospheric problems and initiating discussion is the first stage in cooperation in atmospheric politics. In this stage, it is critical to identify the parties' shared issues. Identifying stakeholders is also imperative to beginning discussions.

The second stage involves collaborative research, shared recognition of air pollution responsibility, and a search for policy options. This stage aims to build scientific, political, and economic consensus on the issues identified (Kim 2007). This step can be facilitated by collaborative research to identify the causes and effects of transboundary air pollution. Collaborative research consists of (1) monitoring emissions data (sources and amount) and air and precipitation quality, and (2) modeling air pollutant flows and the causes and effects of pollutants (Kim 2014, 156) based on scientific data and research (Lee et al. 2019). It is critical to identify where, how much, and which air pollutants come from and flow to. In addition to natural scientific research, social science research to examine policy options and economic viability is also required (Mitchell 2010). All collaborative research outputs should be shared and made publicly available in order to proceed toward a binding agreement. Otherwise, uncertainty in scientific findings in natural and social science may impede progress. Related to knowledge and information, a number of studies also mention the absence of an epistemic community as a factor that explains the poor level of environmental cooperation in Asia as compared to that in other regions (Kim 2007).

After setting the agenda in the first and second steps, the third step is to make a legally binding agreement on air pollution management through negotiation process (Mitchell 2010; O'Neill 2009). This multilateral or bilateral environmental agreement should set out rights and obligations that include procedural details, implementation schemes, organizational cooperation (institutional) setting, funding, and reporting requirements (Min 2001). Policy coordination lays out the procedure for environmental cooperation by setting out which state parties have what kind of responsibilities.

The final step is to implement an agreement on atmospheric politics. With funding and institutional schemes, the concerned parties translate the agreement into international and

domestic actions. Stakeholders implement the enacted policy options with organization and resources. This stage includes conducting domestic and international measures to mitigate transboundary air pollution, monitoring the performance of international cooperation and domestic action, and making revisions to address unexpected drawbacks.

Proposed cooperation steps for atmospheric politics of transboundary air pollution can be applied to analyze past efforts including the USA–Canada Air Quality Agreement (Roe-lofs 1993) and Finland–USSR. This framework can be also useful to analyze and propose cooperation schemes to address current bilateral transboundary air pollution among Pakistan–India–Bangladesh, other countries and regions.

2.2 Asymmetric barriers to advancing cooperation in transboundary air pollution

Three asymmetries—in state capacity, economic interests, and domestic pressure—and a lack of international pressure are key factors in producing conflict and cooperation in atmospheric politics, which revolves around transboundary air pollution between “source” and “receptor” countries.

First, asymmetry in general state power stems from differences in state power between the involved countries. State power depends on multiple factors, such as economy (e.g., General Domestic Product), military, territory, population, and cultural heritage. This asymmetry allows a hegemonic state located in the “upstream” or source position to evade or prevent advancing four-step cooperation with countries in the “downstream” or affected position (Warner and Zawahri 2012). If their state powers significantly differ, the weaker state can neither force nor financially help the stronger state to agree and implement an agreement. As is witnessed in hydropolitical dynamics, following the simple logic of realism in international relations (Haas 1990; O’Neill 2009), which analyzes the conflictual process among multiple states with general power asymmetries and ensuing consequences, an upstream hegemon has more incentive to ignore the afflicted countries with lesser state capacity and less incentive to cooperate with them (Dinar 2009). In a similar vein but from a different angle, this asymmetry of state capacity produces a “politics of over-attention and inattention” (Shin et al. 2016; Womack 2015). This is a situation in which weaker countries give most of their attention to bilateral atmospheric political interaction while trying to force their larger counterparts to cooperate. Stronger countries, however, are occupied with other international security and economic issues and thus do not devote as much attention to the conflictual relationship (Shin et al. 2016; Stephen 2009; Womack 2015). We hypothesize that a higher level of asymmetry in state capacity likely hinders progress in transboundary air pollution cooperation in Northeast Asia.

The second asymmetry in economic interests is another factor that influences the phased development of cooperation in transboundary air pollution atmospheric politics (Fraenkel 1989). If countries in the region shared similar costs and benefits, as in the hydropolitical cases, cooperation is likely. Despite state capacity differences between stronger hegemon upstream and weaker neighbors downstream, environmental regimes for cooperation occasionally work through the co-benefits of joint action to create and share added value according to a neoliberal theory perspective, which emphasizes that economic co-benefits propel multiple states to cooperate on a certain bilateral and/or multilateral issue (Dinar 2009; Han 2017; Hussein and Grandi 2017; Kim 2014). However, asymmetries in economic costs and benefits based on the polluter-pays principle hinder cooperation (Perrin and Bernauer 2010). We assume that, unlike hydropolitical cooperation, which produces electricity, water irrigation, environmental diversity, and other shared economic benefits,

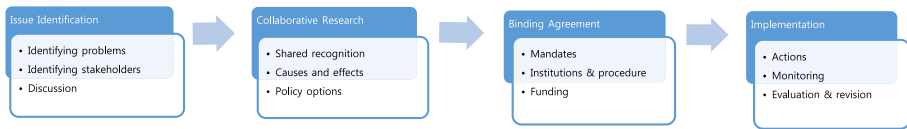


Fig. 1 Cooperation steps for atmospheric politics of transboundary air pollution

in atmospheric politics, transboundary air, whether clean or dirty, creates few if any bilateral economic opportunities or international markets. This means that each country—be it a source, a receptor, or both—is more likely to obtain economic benefits if the source country reduces domestic air pollution. However, any type of added value such as electricity in hydro politics cannot be created in atmospheric politics, aside from potential benefits from reducing environmental risks. Therefore, one of the two dimensions of economic co-interests from hydro political cooperation—not added value but reduced pollution—is the only dimension for economic interests that typically matters more in a receptor country. We argue that a higher level of asymmetry in economic interests is likely to hamper the advancement of transboundary air pollution cooperation.²

The third factor, that of asymmetry in domestic pressure, is based upon the established literature on the interaction between domestic politics and international politics. Domestic and international politics frequently, if not always, interact (Putnam 1988). Domestic changes prompt changes in the international context and vice versa; the causal directions usually run both ways. A set of domestic variations in the countries directly involved play an important role in the foreign policy decision-making process. This asymmetry is fundamental for state leaders to take transboundary air pollution seriously and try to solve the issue in an international framework. The source country's domestic audience cares about the serious air pollution within its territorial boundary because it directly harms their quality of life, and only rarely because it also harms the quality of life in neighboring countries. They do not care about and so ignore the effect of transboundary air pollution in foreign lands. By contrast, the receptor country's domestic audience puts enormous political pressure on their government to bilaterally negotiate with the source country to reduce its domestic air pollution or multilaterally attract international attention and cooperation. We argue that asymmetries in domestic pressure at the giving and receiving ends are likely to impede international cooperation on transboundary air pollution.³

In addition to these three asymmetries, the last element in atmospheric political cooperation on transboundary air pollution is international pressure. Neoliberal scholars of international relations pay great attention to the role of international organizations or regional integration in mediating between stakeholders in international conflicts (Keohane

² Note that financial support/subsidy transfer from the receiving country to the transferring country is another aspect of this economic-interest dimension. In fact, the case of China–South Korea experienced this economic interaction at a very low scale, which does not qualify as a game-changer due to the difference in size between the two countries and the sheer volume of air pollution in mainland China. If the receiving end is much larger economically and more capable of subsidizing the transferring end, this might be a critical factor in the game. This policy suggestion is applicable to the case of North Korea (source) and South Korea (receptor).

³ The degree of domestic audience pressure depends on multiple factors (variables) such as the nature of the political regime (democratic or authoritarian), the level of economic development (poor, developing, or developed), and scientific information on the various features of the air pollution (transboundary, domestic-generated, atmospheric dynamics, impact on quality of life, etc.), which are beyond the scope of this paper.

and Joseph 2012; Luterbacher and Sprinz 2001). There are many examples of global—often regional—organizations that mediate and settle serious conflicts of interest among the member countries of a region. Moreover, such a binding international regime puts substantial pressure on larger and stronger countries, often called regional hegemony, to protect smaller neighboring countries through either international legal mechanisms or the collective efforts of smaller countries in the region. If there is a binding international organization or integration structure such as the European Union (EU) or the Association of Southeast Asian Nations (ASEAN) in the region of the transboundary air pollution conflict, phased cooperation on reducing transboundary air pollution is more likely to happen.

3 Transboundary air pollution cooperation between China and South Korea

This study uses a primarily qualitative methodology because it aims to understand the causes and effects of the degree of phased transboundary air pollution cooperation among countries with an in-depth case study. This study depends on qualitative data—(1) archival data (government documents, statistical data, policy briefs, media reports, etc.) and (2) interview data collection and analysis (utilizing key interviews with sixteen experts, officials, and journalists among many others). Interviewees were selected due to their expertise in environmental cooperation and transnational air pollution issues (published journal articles, news articles for scholars and journalists, and primary tasks for public officials). We conducted semi-structured interviews with open-ended questions. The data were collected from the targeted countries—South Korea (Seoul) and China (Nanjing, Beijing, and Jilin Province)—at various (national, local, and partly individual) levels during recurring fieldwork from June 2018 to August 2019.⁴

3.1 Transboundary air pollution cooperation between South Korea and China

Based on the theoretical framework, we empirically examine the process of transboundary air pollution cooperation between South Korea and China. This study focuses on the barriers to cooperation for agreement on the causes and effects of transboundary air pollution between South Korea and China rather than real actions that have been taken to deal with such pollution, as no actions have yet been taken. In the above analytical scheme of cooperation steps for atmospheric politics, we find that South Korea and China have achieved some attributes of the intermediate stage of collaborative research. South Korea and China bilaterally have not achieved a legally binding agreement (the third step) or implementation (the fourth step). The concrete contents are as follows.

Bilateral environment cooperation between the government of the Republic of Korea and the government of the People's Republic of China began in 1993 with the signing of the Agreement on Environmental Cooperation. After the collapse of the Soviet Union and expanded diplomatic relations with former communist countries, South Korea regarded environmental cooperation with China as fundamental for extending and deepening the countries' bilateral relationship. In the agreement, both governments share broad and

⁴ Note that in addition to the interviews conducted during the fieldwork, some interviews were conducted via email and phone to obtain more diverse interviewees in China and South Korea.

somewhat symbolic issue identification, such as “coping with global environmental degradation threatening human survival (MoE 1993).”

Ten years later, in 2003, the agreement identified the primary ministries for cooperation with a Memorandum of Understanding (MOU) between the Ministry of Environment of the Republic of Korea and the State Environmental Protection Administration of the People’s Republic of China on Environmental Cooperation. The symbolic agreement required identifying the responsible party for environmental cooperation on a range of issues. The MOU between the Ministry of Environment (South Korea) and the State Environmental Protection Administration (China) aimed to solidify the 1993 agreement in order to recognize increasing threats from transboundary air pollution (yellow dust) and desertification. The MOU also stated that both ministries recognized the benefits of collaborative research on long-range transboundary air pollution (MoE 2003). However, there was no concrete plan or schedule for collaborative research.

In 2005, more focused cooperation for transboundary air pollution was discussed under an arrangement between the Ministry of the Environment of the Republic of Korea and the State Environmental Protection Administration of the People’s Republic of China on Ground Monitoring and Information Exchange for Dust and Sand Storms (MoE 2005). This arrangement proposed a monitoring and alarm system to track transboundary air pollution. However, the results of the collaborative research and information/data exchange were not made public. After the arrangement came a series of MOUs for collaborative research and potential agreements to tackle transboundary air pollution,⁵ but these efforts were in vain. Kim and Kim (2018) identified a lack of actual collaboration between China and South Korea on transboundary air pollution, despite a number of MOUs. Our interviews with South Korean experts and public officials confirmed a lack of collaborative research and sharing of research outputs between South Korea and China.⁶ Furthermore, scientific studies on transboundary air pollution from Chinese experts have mostly focused on China’s domestic air pollution rather than regional (Asian or international) pollution (for example, Gu and Yim 2016).

Instead, the Ministry of Environment of South Korea collaborated with the US space agency NASA (National Aeronautics and Space Administration). Their joint project, KORUS-AQ (South Korea-US Domestic Air Quality Collaborative Research), announced that approximately 52% of PM_{2.5} came from domestic sources; 34% from China; 9% from North Korea; and 6% from other places in 2017 (NIER 2017). This scientific research project was conducted through international cooperation, but without China’s participation.⁷

A number of proposals for collaborative research between South Korea and China have been announced. For instance, the Korean National Institution of Environmental Research and the Chinese Research Agency for Environmental Science (CRAES) signed the MOU for the establishment of a Collaborative Research Team between South Korea and China in 2015. However, in contrast with the public announcement of collaborative research outcomes between South Korea and the United States, China refused to publicly announce

⁵ July 3, 2014, Memorandum of Understanding between the Ministry of Environment of the Republic of Korea and the Ministry of Environmental Protection of the People’s Republic of China on Environmental Cooperation; 2016 MOU for Collaborative Research Team on Air Quality of Korea and China.

⁶ Interviews with South Korean experts, January 12, August 23, 2019; officials January 13, 2019.

⁷ Despite a series of research efforts inside and outside of China, we could not find any data that reported the scientific evaluation of transboundary air pollution between China and South Korea. See Kim and Kim (2018).

the outcomes of collaborative research on China, Japan, and South Korea's transboundary air pollution (LTP: Long-range Transboundary Air Pollutants in Northeast Asia).⁸ While collaborative research has been conducted following suggestions from the Tripartite Environmental Ministers' Meeting among South Korea, China, and Japan (TEMM) and other MOUs, China argued that collaborative research results are "expected" to be published rather than "agreed" in the MOU. China also insisted that the data for research were obsolete (data from China from 2008 and 2010, compared to data from South Korea from 2013) and therefore too unreliable to present publicly. Thus, South Korea and China failed to publicly share collaborative research that could identify the causes, trajectories, and effects of transboundary air pollution in East Asia.⁹ The spokesperson of China's Ministry of Ecology and Environment recently argued that PM in Seoul comes from Seoul itself rather than China. He insisted that the PM level in Chinese cities has dramatically improved while the level in Seoul has worsened. In summary, Chinese officials publicly announced that there was little evidence that Seoul's PM was caused by China (Chinese Ministry of Foreign Affairs 2017; Kim and Kim 2018). The Minister of Environment of Korea rejected the Chinese argument, saying that data have shown that high levels of PM in South Korea were coming from China and other foreign sources (Cho 2019).

In applying the analytic framework of cooperation steps/phases for atmospheric politics, South Korea and China have managed to identify transboundary air pollution as a shared environmental problem. From the beginning of the bilateral agreement, transboundary air pollution has been on the list of issues requiring cooperation. Both countries are trying to find multiple stakeholders, encompassing ministries, businesses and industries, and researchers. At most environmental meetings, transboundary yellow dust and PM issues have been discussed as key agenda items.

However, China and South Korea have not reached the second step for collaborative research. Based on the shared recognition of the importance of collaborative research, it is critical that the two countries conduct and share natural and social scientific analysis. While substantial emphasis has been placed on collaborative research, China and South Korea have not presented research results stating the cause, trajectories, and effects of transboundary air pollutants. Without common and shared beliefs regarding the causal mechanisms of air pollution, it will be challenging to propose policy options as well as a binding agreement with mandates.

3.2 Hindering asymmetries in cooperation on transboundary air pollution between China and South Korea

We empirically apply the proposed theory of asymmetry to a case of transboundary air pollution cooperation between South Korea and China. As the previous section illustrated, this study focuses on the lower stage of bilateral cooperation in the phased development of transboundary air pollution settlement: the countries in question have passed the first stage of issue identification and are stuck at the second stage of collaborative research regarding the causes and effects of transboundary air pollution. Thus, this empirical study does not deal with the third and fourth stages, as they have not yet occurred.

⁸ Hangyoreh Newspaper, June 19, 2018. China, Japan, and Korea's collaborative publication of PM from China broken down. (<http://www.hani.co.kr/arti/society/environment/849781.html>)

⁹ Interview with Chinese expert, January 11, 2019; Chinese official, January 20, 2019. Cho (2019).

The failure to establish cooperation to settle transboundary air pollution between South Korea and China stems from the following factors. The suggested three asymmetric categories—state power, economic interests, and domestic pressure—and the element of international pressure play a critical role in producing such a result. On the one hand, China's much larger state capacity, the lack of common economic interests related to the issue, the lack of domestic pressure in China, and little international pressure have hindered the two countries from settling the issue of transboundary air pollution of PM10 and 2.5 from China to South Korea throughout the 2010s. On the other hand, the mounting domestic pressure in South Korea to settle this issue has pushed the South Korean government to accelerate the phased development of settlement (Kim 2018; Oh 2019). The aforementioned scientific research shows that this air pollution was a serious problem in South Korea well before the 2010s. However, the severity of the pollution and renewed public awareness have forced the South Korean government to redouble its efforts to complain to and negotiate with China since 2016, as demonstrated by the aforementioned petition to the Presidential Office. These asymmetric factors have been combined with a lack of bilateral cooperation and deepened the two countries' environmental conflict.

First, there is obvious asymmetry in the state power of China and South Korea. China's territory is 100 times the size of South Korea; its population is twenty-eight times as large as that of South Korea. Differences in their economic and military state capacities are substantial. The GDP ratio is almost ten to one—China's was USD12.2 trillion and South Korea's was USD1.5 trillion in 2017. The military spending ratio is eight to one—China's was USD225.7 billion and South Korea's was USD37.3 billion, not counting nuclear weapons and aircraft carriers, in 2017.¹⁰ Moreover, the South Korean economy has become increasingly overdependent on China since the 2010s, creating another economic asymmetry; the mutual trade ratio is 30% for South Korea and 8% for China.¹¹ In other words, South Korea is significantly less powerful in military capacity than China, impeding it from coercing China to cooperate. Even though China's military superiority is not directly used for environmental gains in this case, it allows China not to seriously consider more cooperation with South Korea on settling the environmental conflicts. It also has significantly fewer economic resources than China, meaning that it cannot subsidize or finance China to reduce its air pollution or to cooperate in the phased development of the PM issue settlement.

As the theory of asymmetry in international relations predicts (Shin et al. 2016; Womack 2015), a larger country, often referred to as a "regional hegemon," gives little or no attention to the conflictual issues of transboundary air pollution with its smaller neighbor, which usually generates excessive attention on the issue among the elite and the public. In this context, even though the domestically pressured South Korean government demands that the Chinese government cooperates on the PM issue, thus far its demands have been in vain (Huanqiushibao 2017; Kim 2018; President Office 2018).¹² China has not been very proactive in the settlement of the PM issue with South Korea (Huanqiushibao 2017)¹³; for the Chinese government, this transboundary air pollution issue is minor in comparison

¹⁰ Data retrieved from the World Bank Dataset (<https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>) and SIPRI dataset (<https://www.sipri.org/databases/milex>).

¹¹ Data retrieved from the Korea Customs dataset (<https://unipass.customs.go.kr:38030/ets/>).

¹² Interviews with South Korean officials and experts, January 12, 2019; Chinese experts and journalist, January 8, 11, and 25, 2019.

¹³ Interviews with Chinese experts and officials, January 8, 11, 20 and 25, 2019.

with other issues it faces, such as North Korean nuclearization, the trade war against the USA, and frictions involving the Belt and Road Initiative.

Another dimension of asymmetry is the lack of economic opportunities to create added value and environmental advantages that are mutually beneficial for South Korea and China. As we discussed above, the settlement of pollution in hydropolitics can generate substantial economic added value in addition to the general ecological and hygienic benefits for both source and receptor countries. However, in the case of transboundary PM pollution between South Korea and China, there are few if any mutually beneficial economic interests.¹⁴ If the PM transfer from China to South Korea is dramatically reduced, South Korea will receive enormous economic benefits through improved public health. Last a few years, South Korean national and local government has increased its budget to improve the deteriorating quality of air, mainly due to PM 2.5 and 10. The government increased the budget to cut the PM pollution in South Korea from 2.3 trillion Korean Won (20 billion USD) in 2019 to 4 trillion Korean Won (3.7 billion USD) in 2020, 74.6% increase in just one year (Park 2019). The financial cost is significant for South Korea, but it does not directly benefit China.

Moreover, the fact that atmospheric politics lack an economic mechanism to generate cooperation (unlike hydropolitics, which impacts fishery resources, electricity, etc.) exacerbates asymmetry between the countries, thus hindering international cooperation. One economic incentive for China to reduce transboundary air pollution might be targeted financial and technological support from South Korea, as South Korea attempted to provide in 2016 and 2017.¹⁵ However, these efforts had negligible effects in the Chinese cities in which they were tested because the amount of support was insufficient. As such, South Korea cannot create the economic incentive structure for China to reduce the transboundary PM so far.

Third, there is an obvious asymmetry in the pressure of the countries' domestic audiences to settle this PM transfer issue—it is high in South Korea but almost nonexistent in China. South Korea is the receptor, with a consolidating democracy, developed economy, and scientific knowledge on transboundary air pollution among the domestic audience.¹⁶ The Chinese public, however, stands in the opposite position and criticizes its South Korean counterparts on this issue. The public, led by the national media (Dong 2018),¹⁷ deny any transboundary PM from their country to South Korea and call South Korea's claims groundless (Dong 2017; Huanqiushibao. 2017; Liu and Wang 2017), even though these Chinese citizens heavily criticize the identical air pollution in their domestic environment and have placed heavy pressure on their central and local government to reduce it. Instead, they point out that South Korea itself generates a substantial amount of PM, according to Chinese, South Korean, and other investigations. Above all, most citizens, including Chinese experts who study the Korean peninsula and who are most knowledgeable about bilateral relations, neither recognize nor care about the issue.¹⁸ Kim and Kim's (2018) content analysis from 1996 to 2016 found that news reports and scientific research

¹⁴ Interviews with Chinese experts and officials, January 8, 11, 20 and 25, 2019.

¹⁵ Interview with South Korean experts, January 13, 2019.

¹⁶ By contrast, North Korea is a closed authoritarian state with an underdeveloped economy and little scientific knowledge. North Korea is not demanding that China settle this transboundary PM issue.

¹⁷ Interviews with Chinese experts, January 8 and 25, 2019.

¹⁸ Interviews with Chinese experts, November 16, 2018; January 9, 11, 20 and 25.

from China have not linked air pollution in China to its transboundary impacts on Northeast Asia.

Another element that hinders cooperation on this issue is the lack of international regime pressure on China. Northeast Asia has no reliable or functioning regionally integrating organization such as the EU in Europe (Fraenkel 1989; Tuinstra et al. 2006) or, to a lesser extent, ASEAN in Southeast Asia (Nurhidayah et al. 2015). This type of international organization among countries with less asymmetrical state power usually possesses binding power to help member countries negotiate and settle conflictual environmental issues. Transboundary air pollution is a good example of issue-specific buffering to accept the guidelines for dispute resolution, or to submit a dispute to an international tribunal. If the PM issue were framed in a broader multinational or international regional context, the bilateral asymmetry would be reduced, and the phased development of the PM issue settlement could be accelerated. Nevertheless, South Korea's ongoing attempts to work with Japan to encourage cooperation from China to investigate this particular atmospheric political issue in the 2010s via the Tripartite Environmental Ministers Meeting have not had substantial success. Moreover, a more comprehensive multilateral regional organization, the North-East Asian Subregional Program for Environmental Cooperation (NEASPEC), does not yet have an effective regional architecture with binding institutions or treaties in Northeast Asia.

3.3 Discussion and policy suggestions

Given the barriers, in the foreseeable future, cooperation through bilateral or multilateral international negotiations to settle transboundary air pollution between these two countries hardly move beyond the second step of collaborative research to produce shared recognition of the causes and effects and then consider policy options, not to mention the third step of binding agreement and implementation in the foreseeable future.¹⁹

Instead, it appears that the solution to such a conundrum should come from both the international dimension and domestic Chinese domestic politics. Note that there is a “positive externality” factor of the source-transferor country's own efforts to reduce air pollution in its territory. In this context, a more plausible solution for transboundary air pollution might be motivated not by international negotiations and cooperation but by the pollution transferor's domestic needs to reduce it for its own sake. In addition, domestic pressure to reduce regional as well as intranational transboundary air pollution across one's own territory—for example, from province A to province B—may motivate the central and provincial governments to take actions to curb the pollution and may also be effective in the international arena. The positive externality of these domestic conflicts would be another critical factor in the process of international transboundary air pollution cooperation.

In making progress in bilateral cooperation with South Korea to reduce the transfer of polluted air, the already mounting domestic pressure in China and its government's proactive and serious responses to reduce PM would be a key under the international stalemate

¹⁹ Joint research projects (of China, Japan, and South Korea) for Long-range transboundary air pollutants in Northeast Asia recently announced the summary report of 4th stage (regarding PM) LTP project (Nov. 20, 2019). LTP (2019). While it was the first collaborative research outcome announcement, detailed contents on the influence of sources (Chinese cities) on receptors (South Korean cities) between China and South Korea estimates are not identical. In addition, transports of PM during high level seasons (from December to March) were not included in the report (Kim 2019).

(Ahlers and Shen 2017; Chinese State Council 2015; Tilt 2019). PM in mainland China has been skyrocketing, to the extent that everyday life cannot be sustained in many parts of the country—especially in Beijing, the northeast provinces, and the coastal provinces. This air pollution, along with other forms of severe environmental pollution, has even destabilized the Chinese authoritarian regime; since the early 2000s, the number of incidents of pollution-related social unrest has soared (Ahlers and Shen 2017; Nielsen and Ho 2013). Since Xi Jinping came to power in 2012, and particularly in the last few years, the Chinese central government has made great efforts to reduce PM across China, especially in the Beijing area (Chinese State Council 2015; Zhen 2018).²⁰ Even though such a strong drive is often labeled “environmental authoritarianism” (Beeson 2015) and involves penalizing polluting industries as well as disadvantaged citizens in order to reduce PM, particularly in winter (Ahlers and Shen 2017; Beeson 2015), it has vastly improved the region’s air quality and was praised by domestic and international media (Zhen 2018). In fact, this success was lauded by many South Korean media outlets, which criticized their own government’s inability to reduce domestically produced PM (Yang 2018). To be sure, despite this domestic success, PM within and outside of China remains a severe hazard.

Reducing asymmetries may facilitate the atmospheric politics of transboundary cooperation. It may be challenging to lessen state capacity asymmetry within the short term, but economic asymmetries can be reduced by creating win–win economic benefits for transboundary air pollution. Sharing best practices and technologies to mitigate PM in both countries can produce economic benefits. In addition, strengthening the international regime can lower asymmetries in transboundary air pollution. Countries in Northeast Asia have developed multilateral environmental cooperation networks, including the Acid Deposition Monitoring Network in East Asia (EANET) and Long-range Transboundary Air Pollutants (LTP) (Yarime and Li 2018). The current development (October 2018) of the Northeast Asia Clean Air Partnership (NEACAP) provides a multilateral arena as “a voluntary, science-based, and policy-oriented programme under NEASPEC (UNESCAP 2018).” In addition to bilateral efforts for cooperation, a multilateral regime can put forward potential legal agreements for transboundary air pollution by proposing technical and policy measures for Northeast Asian countries (NEASPEC 2018).²¹ Bilateral cooperation between Korea and China would be facilitated through the existing multilateral efforts. Despite the challenges in multilateral coordination, LTP, EANET, and NEASPEC could reduce the competition over the concern on “who takes initiatives” as well as offer forum for collaboration.

In the process of regime building, lessons from EU CLRTAP, ASEAN agreement on transboundary haze pollution, and the Paris agreement on climate change should be acknowledged and reflected. Forming and operating multilateral cooperation in Europe for 40 years provide promising reference to build up effective atmospheric political cooperation (Fraenkel 1989; Tuinstra et al. 2006). Recent formation of ASEAN agreement could also offer how multiple participants make agreement to curb regional transboundary air pollution. Close examination on the effectiveness of ASEAN agreement will guide East Asian countries’ regime design and implementation scheme, avoiding a symbolic institution formation (Nurhidayah et al. 2015).

Particularly, a multilateral nationally determined contribution (NDC) agreement, utilizing the Paris Agreement format for climate change, would be a scheme to reduce

²⁰ Interviews with Chinese experts, November 16, 2018; January 9, 11, and 17, 2019.

²¹ Interviews with a South Korean expert, January 21, 2019.

transboundary air pollution in the region. In such a scheme, each country nationally commits a reduction target, makes plans, implements pollution reduction policies, and ratifies the agreement, conducting measure, report, and verify (MRV) pollutant reduction and capacity building support through international treaty organizations. In the situation of asymmetries, multilateral cooperation, instead of bilateral polluter's pay principle such as US-Canada air pollution settlement case, would be a long-term, plausible and comprehensive strategic solution. Furthermore, strengthening epistemic communities that share a core belief in causes and effects as well as policy options might help reduce asymmetries in knowledge and thus facilitate collaborative research.

4 Conclusion: implications and further studies

This study develops a conceptual framework for one of the key atmospheric political issues, transboundary air pollution, with an in-depth analysis of factors that hinder the development of cooperation to resolve issues related to transboundary air pollution between China and South Korea since the early 2010s. We discussed three asymmetric factors—state capacity, economic interest, and domestic pressure—and the element of international regime pressure as key variables hindering bilateral cooperation to reduce transboundary PM moving from China to South Korea. Empirical studies on transboundary air pollution cooperation thus far have primarily examined European and Southeast Asian cases; Northeast Asia has been understudied, with few exceptions (Kim 2007, 2014; Shim 2017). Our study fills this gap in the literature.

Considering these factors' negative effects on cooperation between the source country and the receptor country, it is clear that bilateral cooperation to resolve the transboundary PM issue between China and South Korea faces severe difficulties in the short term (Shim 2017).²² Cooperation will likely be stuck at the second step of the suggested conflict-resolution model of collaborative research, even though the South Korean government continues to make efforts to negotiate with China bilaterally and multilaterally. Moreover, it might be problematic for South Korea to demand that China reduce the transboundary PM, or even to reduce its own PM production, because this pollution generation is also attributed to its economic interdependence with Chinese polluting industries. Moreover, South Korea produced a massive amount of PM during its industrialization period and, to a lesser extent, still does.²³ Unfortunately for South Korea, it happens to be on the downstream side of wind currents, while China is on the upstream.²⁴

In this context, as discussed above, South Korea has no choice but to hope that domestic pressure in China to accelerate the reduction process of Chinese intranational

²² Interviews with Chinese experts, January 11, 2019; Chinese officials, January 20, 2019; South Korean experts, January 12, May 21, 2019.

²³ It is analogous to the certified emissions reduction issue in climate-change debate, because South Korea produced a massive amount of PM in the last several decades without being recognized as a source-transferor to its neighboring countries, but now blames China for generating and transferring PM to it.

²⁴ Hypothetically, if China was downstream and South Korea was upstream, there would be a much lower level of conflict revolving around the transboundary PM. Instead, China might be in South Korea's position and be demanding a resolution to the issue. If so, South Korea would be under severe pressure to cooperate with its more powerful neighbor, and the asymmetric logic would run the opposite way, accelerating the cooperation process. From a different perspective, the primary receptors victimized by the massive PM transfer from China would be the countries of Central Asia and Southeast Asia.

transboundary PM is maintained and enforced. Reducing PM within China's own territory would automatically reduce the volume of transferred PM to South Korea, leaving China more open to cooperating with South Korea (and Japan) in the atmospheric political arena. Ironically, China's domestic pressure to protect its own citizens, who generally deny the harmful effects of transboundary PM on South Korea, will most likely serve as an impetus for China to address the PM problem that also affects South Korea. If this is the case, China, with its improving environmental credentials, is more likely to communicate and cooperate with South Korea on this issue in the coming years.

For students of global environmental politics, comparative politics, and China and Korea studies, addressing severe transboundary PM is an urgent task for both academic and policy purposes. Topics that will be addressed in further research are as follows. First, comparative studies between ASEAN's transboundary haze pollution agreement and cooperation efforts and those of Northeast Asian countries—China, South Korea, North Korea, Mongolia, and Japan—will be pursued to generalize the conceptual frameworks that were proposed in this paper. Second, we will focus on the sub-national and intranational level of analysis by examining important domestic actors such as local governments, industries, media, NGOs, and ordinary citizens in atmospheric politics.

Appendix: List of interviewees

Interviews were conducted in a face-to-face manner with semi-structured questions concerning the causes or drivers of international cooperation over transboundary air pollution. Interviewees agreed to be anonymously interviewed. All interviews lasted between 30 min and 1 h or via email.

Code	Background	Date
1	Professor at a University in Northeast China (International Relations)	January 8, 11 and 20, 2019
2	Researcher at a University in South Korea (China Studies, China-South Korea Relations)	November 16, 2018; January 25, 2019
3	Journalist from a Newspaper in Beijing	January 25, 2019
4	Local government official from Tianjin (External Affairs)	January 25, 2019
5	Chinese government official from the Ministry of Commerce	January 24, 2019
6	Scholar from a University in Beijing	January 26, 2019
7	Chinese scholar from a University in Seoul	January 9 and 17, 2019
8	Local government official from Jilin (Environmental Affairs)	January 20, 2019
9	Professor of a University in Jilin Province (China Studies, China-South Korea Relations)	January 20, 2019
10	South Korean official (Foreign affairs)	May 9, 2019
11	Researcher at Hanyang University, South Korea (Environmental Politics)	August 23, 2019
12	Professor from Korea University (Energy and Environmental Politics)	August 12, 2019
13	Professor from Kwangwoon University, South Korea (Environmental Politics)	July 4, 2019
14	Environmental activist from South Korea	July 4, 2019

Code	Background	Date
15	Professor of Atmospheric science at Yonsei University	May 21, 2019
16	Researcher from the Korea Environmental Institute	May 21, 2019

References

- Ahlers, A. L., & Shen, Y. (2017). Breathe easy? Local nuances of authoritarian environmentalism in China's battle against air pollution. *The China Quarterly*, 234, 299–319.
- Beeson, M. (2015). Authoritarian environmentalism and China. In T. Gabrielson, C. Hall, J. M. Meyer, & D. Schlosberg (Eds.), *The Oxford handbook of environmental political theory* (pp. 520–532). Oxford: Oxford University Press.
- Chinese Ministry of Foreign Affairs. (2017). 2017 nian 3 yue 21 ri wajiaobu fayanren huanchunying zhuchi lixing jizhehui. *Ministry of Foreign Affairs Spokesperson Hua Chunying Conducts a Press Conference, March 21, 2017*. Retrieved March 21, 2018, from http://www.fmprc.gov.cn/web/fyrbt_673021/jzhsl_673025/t1447426.shtml.
- Chinese State Council. (2015). Shengtai Wenming Tizhi Gaige Zongti Fangan. General Scheme for the Reform of the Ecological Civilization System. Beijing. Retrieved March 21, 2019, from http://www.gov.cn/guowuyuan/2015-09/21/content_2936327.htm.
- Cho, A. (2019). Minister of Environment, Myoungrae Cho say, "Chinese Ministry of Ecology and Environment acknowledges the PM from China" Hankook Ilbo 2019. 3. 7. Retrieved March 21, 2019, from <https://www.hankookilbo.com/News/Read/201903071577354424?did=DA&dtype=&dtypecode=&prnewsid=>.
- Daoudy, M. (2009). Asymmetric power: Negotiating water in the Euphrates and Tigris. *International Negotiation*, 14(2), 361–391.
- Dinar, S. (2009). Power asymmetry and negotiations in international river basins. *International Negotiation*, 14(2), 329–360.
- Dong, L. (2017). Wu mai zeren, huanjing wajiao yu zhongrihan hezuo. Responsibility for PM, environmental diplomacy and China–South Korea cooperation. *Dangdaihanguo. Contemporary Korea*, 2, 1–14.
- Dong, X. (2018) Hanguo de wumai laizi Zhongguo? Tamen ziji de! [South Korea's PM Comes from China? It Comes from Itself!] Beijingqingnianbao. Beijing Youth Daily. 28 December. Retrieved December 6, 2019, from http://www.sohu.com/a/285136718_255783.
- Fraenkel, A. A. (1989). The convention on long-range transboundary air pollution: meeting the challenge of international cooperation. *Harvard International Law Journal*, 30(2), 447–476.
- Gu, Y., & Yim, S. H. L. (2016). The air quality and health impacts of domestic trans-boundary pollution in various regions of China. *Environment International*, 97, 117–124.
- Haas, P. M. (1990). *Saving the mediterranean: The politics of international environmental cooperation*. New York: Columbia University Press.
- Han, H. (2017). China, an upstream Hegemon: A destabilizer for the Governance of the Mekong River? *Pacific Focus*, 32(1), 30–55.
- Harris, P., & Lee, T. (2017). Compliance with climate change agreements: The constraints of consumption. *International Environmental Agreement*, 17(6), 779–794.
- Huanqushibao. (2017). Hanguoren yin shouer wumai yao Beijing peichang jingshen sunshi, duicini zenmekan?. How Do You Think about South Korean Demanded Beijing Reparation in Cash for Their Mental Damage by PMs? Retrieved 6 April, 2018, from http://surveyx.huanqiu.com/survey/survey_hq/68.
- Hussein, H., & Grandi, M. (2017). Dynamic political contexts and power asymmetries: the cases of the Blue Nile and the Yarmouk Rivers. *International Environmental Agreements: Politics, Law and Economics*, 17(6), 795–814.
- Keohane, R. O., & Joseph, N. (2012). *Power and interdependence* (4th ed.). Boston: Longman.
- Kim, I. (2007). Environmental cooperation of Northeast Asia: Transboundary air pollution. *International Relations of the Asia-Pacific*, 7(3), 439–462.
- Kim, I. (2014). Messages from a middle power: participation by the Republic of Korea in regional environmental cooperation on transboundary air pollution issues. *International Environmental Agreements: Politics, Law and Economics*, 14(2), 147–162.

- Kim, S. (2018). "Sijjiping ege masuku batdawara. jaenangup miseonje gyukyung [Make Xi Jinping pay for dust masks. Soaring anger caused by disastrous particulate matter [PM]]" Newsis. Retrieved December 5, 2019, from http://www.newsis.com/view/?id=NISX20180326_0000262407.
- Kim, H. (2019). "32% of PM comes from China. China first admitted" Chosun Ilbo. Retrieved December 6, 2019, from https://news.chosun.com/site/data/html_dir/2019/11/21/2019112100269.html.
- Kim, S., & Kim, D. (2018). Analysis of the recognition differences and cooperation between Korea and China on the transboundary environmental pollution issues: Focusing on peaceful conflict resolution (in Korean). *The Journal of Peace Studies*, 19(1), 253–277.
- Lee, S., Kim, J., Choi, M., Eck, T. F., Hong, J., Lim, H., et al. (2019). Analysis of long-range transboundary transport (LRTT) effect on Korean aerosol pollution during the KORUS-AQ campaign. *Atmospheric Environment*, 204, 53–67.
- Liu, Q., & Wang, Q. (2017). "Zhongrihan kuajie daqiwuranzhong de zhongguo zeren shibie yanjiu [Study on China's Responsibility in the China-Japan-South Korea Transboundary Atmospheric Pollution] Dongbeiyaruntan [Northeast Asia Forum], 6, 7–91.
- LTP. (2019). Summary Report of the 4th stage (2013–2017) LPT project. National Institute of Environmental Research: Joint research project for long-range transboundary air pollutants in Northeast Asia. Retrieved November 21, 2019 from https://nier.go.kr/NIER/cop/bbs/selectNoLoginBoardArticle.do?menuNo=14001&bbsId=BBSMSTR_00000000012&ntId=25825&Command=READ.
- Luterbacher, U., & Sprinz, D. F. (Eds.). (2001). *International relations and global climate change*. Cambridge: MIT Press.
- Min, B. (2001). Regional cooperation for control of transboundary air pollution in East Asia. *Journal of Asian Economics*, 12(1), 137–153.
- Mitchell, Ronald B. (2010). *International politics and the environment*. California: Sage Publications.
- MoE. (1993). Agreement on environmental cooperation between the Government of the Republic of Korea and the Government of the People's Republic of China, ROK-China, Oct. 28, 1993. *National Archives of Korea*. <http://www.archives.go.kr/next/search/listSubjectDescription.do?id=002962>.
- MoE. (2003). Memorandum of Understanding between the Ministry of Environment of the Republic of Korea and the State Environmental Protection Administration of the People's Republic of China on Environmental Cooperation, ROK-China, July. 8, 2003 *Ministry of Environment*. <http://webbook.me.go.kr/DLI-File/091/025/003/5631039.pdf>.
- MoE. (2005). Arrangement between the Ministry of the Environment of the Republic of Korea and the State Environmental Protection Administration of the People's Republic of China on ground monitoring and information exchange for dust and sand storms, ROK-China, June. 7, 2005. *Ministry of Environment*. <http://webbook.me.go.kr/DLI-File/091/025/003/5631039.pdf>.
- Nielsen, C. P., & Ho, M. S. (2013). *Clearer skies over China: Reconciling air quality, climate, and economic goals*. Cambridge: MIT Press.
- NIER (National Institute of Environmental Research). (2017). *KORUS-AQ Rapid Science Synthesis Report*. Incheon: NIER.
- Nurhidayah, L., Shawkat, A., & Lipman, Z. (2015). The influence of international law upon ASEAN approaches in addressing transboundary haze pollution in Southeast Asia. *Contemporary Southeast Asia: A Journal of International and Strategic Affairs*, 37(2), 183–210.
- Oh, J.H. (2019) Summakhi Han Misemunji, Junge halmaleun hara [Suffocated South Korea Say Its Piece to China]. *Seoul Economic Daily* Page 1, 4, 5 (15 January).
- Oh, H., Ho, C., Kim, J., Chen, D., Lee, S., Choi, Y., et al. (2015). Long-range transport of air pollutants originating in China: A possible major cause of multi-day high-PM10 episodes during cold season in Seoul, Korea. *Atmospheric Environment*, 109, 23–30.
- O'Neill, K. (2009). *The environment and international relations*. New York: Cambridge University Press.
- Park, S.M. (2019). 2020 yesan: misaemunji haegyeeole sajo ssenda... muknunmul gwanlido ganghwa [2020 Budget: Spending 4 Trillion Korean Won to Settle the PM Pollution and Enforcing the Tap Water Management] *Yeonhapnews* (29 August). Retrieved December 3, 2019, from <https://www.yna.co.kr/view/AKR20190828157800004>.
- Perrin, S., & Bernauer, T. (2010). International regime formation revisited: Explaining ratification behaviour with respect to long-range transboundary air pollution agreements in Europe. *European Union Politics*, 11(3), 405–426.
- President Office. (2018). Citizen Petition on protest against particulate matter from China. Retrieved April 24, 2018 from <http://www1.president.go.kr/petitions/174292>.
- Putnam, R. (1988). Diplomacy and domestic politics: The logic of two-level game. *International Organization*, 42(3), 427–460.
- Roelofs, Jeffrey. (1993). United States-Canada air quality agreement: A framework for addressing transboundary air pollution problems. *Cornell International Law Journal*, 26(2), 421–454.

- Selin, H., & Van Deveer, S. (2003). Mapping institutional linkages in European air pollution politics. *Global Environmental Politics*, 3(3), 14–46.
- Shim, C. (2017). Policy measures for mitigating fine particle pollution in Korea and suggestions for expediting international dialogue in East Asia. *JICA-RI Working Paper*, pp. 1–31.
- Shin, G., Izatt, H., & Moon, R. J. (2016). Asymmetry of power and attention in alliance politics: The US–Republic of Korea case. *Australian Journal of International Affairs*, 70(3), 1–21.
- Stephen, P. (2009). Asymmetry and selectivity: What happens in international law when the world changes. *Chicago Journal of International Law*, 10(1), 91–123.
- Tilt, B. (2019). Review: China’s air pollution crisis: Science and policy perspectives. *Environmental Science & Policy*, 92, 275–280.
- Tuinstra, W., Hordijk, L., & Kroeze, C. (2006). Moving boundaries in transboundary air pollution co-production of science and policy under the convention on long range transboundary air pollution. *Global Environmental Change*, 16, 349–363.
- UNESCAP. (2018). Review of programme planning and implementation transboundary air pollution in North-East Asia: Twenty-second Senior Officials Meeting (SOM) of NEASPEC.
- Warner, J., & Zawahri, N. (2012). Hegemony and asymmetry: Multiple-chessboard games on transboundary rivers. *International Environmental Agreements: Politics, Law and Economics*, 12, 215–229.
- Womack, B. (2015). *Asymmetry and international relationships*. Cambridge: Cambridge University Press.
- Yang, G. (2018). Misemeonji wayi jeonjaeng junggukkeu sunggonghanunde [China succeeds in war against PMs] Sisain. Retrieved February 7, 2018, from <https://www.sisain.co.kr/?mod=news&act=articleView&idxno=31197>.
- Yarime, M., & Li, A. (2018). Facilitating international cooperation on air pollution in East Asia: Fragmentation of the epistemic communities. *Global Policy*, 9(3), 35–41.
- Yoon, E. (2007). Cooperation for transboundary pollution in Northeast Asia: Non-binding agreements and regional countries’ policy interests. *Pacific Focus*, 22(2), 77–112.
- Zhen, L. (2018). Beijing meets national air pollution standard for first time. South China morning post. Retrieved February 7, 2018, from <https://www.scmp.com/news/china/society/article/2132406/beijing-meets-national-air-pollutant-standard-first-time>.

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