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Master's Thesis of Public Administration

# Setting priorities in solving the transboundary air pollution problem in Northeast Asia – Focusing on fine dust problem –

분석적 계층화 기법(AHP)을 이용한 동북아시아  
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## **Abstract**

# **Setting priorities in solving the transboundary air pollution problem in Northeast Asia**

**– Focusing on fine dust problem –**

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The fine dust is one of the biggest concerns for Korean peoples. According to a survey conducted by Gallup Korea in 2017, 82% of respondents felt uncomfortable with fine dust. The problem is that much of the fine dust concentrations comes from China. It was found that 39% of PM<sub>10</sub> and 48.8% of PM<sub>2.5</sub> were originated from outside of Korea, including China as studied by the Seoul Institute and Anyang University in 2014. When exposed to fine dust for a long time, the immune system is rapidly weakened, and it can be exposed to various diseases such as cardiovascular and skin diseases as well as respiratory diseases. In particular, PM<sub>2.5</sub> may penetrate deep into the bronchi and lung in the human body and cause various diseases.

In this regard, this study aims to analyze, identify, and rank policy criteria and alternatives to solve the transboundary fine dust problem in the Northeast Asia region. In the first section, a comprehensive literature review was used to identify four key criteria and thirteen policy alternatives that considered important indicators. In the second section, AHP (Analytic Hierarchy Process) analysis was implemented to rank the importance of each criterion and alternative to developing an integrated assessment framework. The AHP survey was conducted by a total of 26 participants from four expert groups including government officials, researchers, professors, and NGOs between August 1, 2018, and September 30, 2018. The consistency ratio of 26 respondents in total was 0.05 (5%), and the consistency ratio of all 26 was below 0.1.

From the weight estimation results, the experts chose the diplomatic approach (.291) as a top priority and followed with the policy-based approach (.267), the technological approach (.264), and the international legal approach (.179). Consistent with previous studies, this study confirmed that the international legal approach should be pursued in the long term. Among the thirteen policy alternatives, the experts preferred the efficiency or unification of existing environmental cooperation organizations (.1045) first and followed with the cooperation in scientific research of the fine dust between China and Korea (.1040), the establishment of various stakeholder governance (.0983), and setting a binding reduction target (.0946). Among the 13 policy alternatives, the lowest four variables are the polluter pays principle (.0526), the cross-border environmental impact assessment (.0490), the state responsibility system (.0419), and the international litigation (.0356).

This study will be helpful to suggest policies that should be prioritized in reducing the transboundary fine dust concentrations from China. The 26 experts ranked the efficiency or unification of existing cooperation organizations first. Of the existing cooperation examples, the Tripartite Environment Ministers Meeting

(TEMM) has played an important role as a substantial policy-making body on environmental issues among China, Japan, and Korea to some extent. Therefore, the TEMM should be actively utilized to find practical alternatives. On top of that, the second-ranking was the cooperation in scientific research of the fine dust between China and Korea since it is necessary to provide scientific analysis and evidence data on the movement path of fine dust. The key is how to bring China to the table of cooperation. In order to bring China into cooperation, it is necessary to create an environment in which the expert groups of both countries can conduct pure joint research without taking into account the political pressure. Lastly, experts ranked the establishment of various stakeholder governance third. Given the complexity of the international environmental problems, the issue of the transboundary air pollution requires the involvement of various social sectors such as central governments, local governments, industries, and NGOs.

**Keyword :** transboundary air pollution, fine dust, international environmental law, diplomatic, technological, policy-based, AHP method

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# **Chapter 1. Introduction**

## **1.1. Research Background**

In the cold war era, environmental issues were classified as a lesser priority within international relations. As a result, there has been relatively little interest in the subject of the environment in the international community and academia (Kim et al., 1998). Low politics issues such as the environment did not play a major role in international politics as compared to high politics ones like political and military security (Lee, 2002). The only argument concerning the environmental sector suggested that it should be included in the security issues of international organizations such as the United Nations.

However, there were concerns about the negative impact of global environmental issues such as climate change, depletion of natural resources, land/soil degradation, loss of biodiversity, water pollution, and air pollution beyond borders. And, as the importance of an ecologically sustainable future is emphasized, the international community has begun to recognize environmental problems as important security situations.

In the meantime, the Conference on the Environment and Development (UNCED or “Earth Summit”) held in Rio de Janeiro, Brazil in June 1992 recognized the need to integrate economic development and environmental protection into the goal of sustainable development. Since then, there has been national interest in the environment worldwide. Many countries have been discussing in earnest how environmental problems such as resource depletion and pollution deteriorate social conditions like hunger, poverty, racial conflict, and political instability in the field of international relations, political science, and economics. This is because the damage caused by environmental pollution is not limited to any particular region or country, pollution damages neighboring countries as well as distant countries due to

the long distance movement of pollutants. This has inevitably resulted in conflict between countries. In addition, these problems are increasing as the international community strengthens environmental regulations to preserve its natural resources. Specifically, in many megacities of the world, Particulate Matter (PM) has become one of the major air pollution sources and is getting worse as population, traffic, industrialization, and energy use increase. Trans-boundary transport was one of the most important formation mechanisms of regional high-pollution episodes. In fact, hemispheric-scale transport of particulate matter across Europe, Africa, the Atlantic Ocean, and North America has been reported (Kallos et al., 2007).

In a more specific example, the transboundary air pollution problem in Northeast Asia is recently receiving increasing scientific interest and political concern due to a significant increase in emissions in East Asia region. In Korea, the atmospheric conditions are serious, and this problem cannot be solved by domestic efforts alone. According to the Environmental Performance Index (EPI) 2016 rankings developed jointly by the Yale University Environmental Law and Policy Center (YCELP) and Columbia University's International Earth Science and Information Network Center (CIESIN) in cooperation with the World Economic Forum (WEF), South Korea ranked 173rd out of 180 countries in terms of air quality, scoring 45.51 out of a possible 100. The country was one of the poorest performances among Asian countries (YCELP, 2017).

One of the possible causes for the poor air quality is that air pollutants coming from China along with the westerly winds have a negative influence on the air quality of Korea. According to "A study on the fine dust characteristics through detailed monitoring of air pollution in Seoul" conducted by the Seoul Institute, it was found that 39% of PM<sub>10</sub>, particulate matter with a diameter of 10 micrometers or less, in Korea were originated from China (Seoul Metropolitan Government, 2014). Moreover, 48.8% of Korea's PM<sub>2.5</sub>, particulate matter with a diameter of 2.5 micrometers or less, were originated from outside of Korea, including China

according to "PM<sub>2.5</sub> Reduction Measures Research" jointly conducted by Anyang University and Suwon University. Fine dust consists of ionic compounds such as NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, and SO<sub>4</sub><sup>2-</sup>, carbon compounds, metal compounds, etc., and also include black carbon designated as a primary carcinogen by the World Health Organization (WHO) (Lee, 2018). As a result, when exposed to fine dust for a long time, the immune system is rapidly weakened, and it can be exposed to various diseases such as cardiovascular, skin, and eye diseases as well as respiratory diseases such as colds, asthma, and bronchitis (Lee, 2018). In particular, PM<sub>2.5</sub> may penetrate deep into the bronchi and lungs in the human body and cause various diseases (Lee, 2018).

## **1.2. Purpose and Necessity of Research**

In the winter and spring of 2017, the fine dust concentrations in Korea were serious. From January to May of 2017, there were 289 PM<sub>10</sub> and PM<sub>2.5</sub> warnings (More than 150  $\mu\text{g}/\text{m}^3$  per hour for 2 hours) and alerts (More than 300  $\mu\text{g}/\text{m}^3$  per hour for 2 hours). This was the greatest number of public health notices since 2015. As such, fine dust is one of the biggest concerns for Korean peoples. According to a survey conducted by Gallup Korea survey in 2017, 82% of respondents felt uncomfortable with fine dust (very uncomfortable 57%, slightly uncomfortable 25%). In the case of women in their 30s, 98% of the respondents said that they were uncomfortable due to fine dust, which was the highest among sex and age groups.

As explained in the research background, one of the causes is the fact that a significant proportion of the fine dust concentrations is coming from China. In particular, it became clear that the air in the Shandong Peninsula circulated by the stationary high pressure and flowed into Seoul (Kim et al., 2016). The pollutants in China flowed into Korea through westerly winds, and the air stagnated, causing high concentrations of fine dust. Furthermore, as a sandstorm headed to the Korean

Peninsula via the industrial areas of Eastern China where they pick up anthropogenic air pollutants, the visibility range decreased to 14.7km in 2015, having heavily affected Korean citizens' daily lives (Korea Environmental Policy Bulletin, 2017).

There are various policy measures to reduce the fine dust concentration level from China. The most basic of these is to understand the precise movement path of fine dust. Accurate modeling is needed to know precisely what proportion of fine dust is originating from foreign countries, including China. Moreover, Korea needs China's help to get accurate data on the fine dust movement route. Meanwhile, since the mid-1990s, the Korean government has made continuous efforts to manage transboundary air pollution with other countries, including China, Japan, Mongolia, and etc. Furthermore, the Korean government announced its plan to launch top diplomatic activities in addressing the fine dust problem caused by China in 2015. However, China, Japan, and Korea have different positions regarding the issue. The Ministry of Foreign Affairs of China stated, in March 2017, that "Scientific research is necessary to clarify whether air pollution in China affects neighboring countries". Moreover, the Chinese public media network went one step further, saying, "The grounds for seeing the fine dust pollution in Korea as China are not clear". The media claimed that Korea's coal consumption grew by 56 percent in 2005 and that 64 percent of its electricity is produced from fossil fuel. Japan, which is one of the representative nations in Northeast Asia, has a position similar to Korea in that it requires cooperation between China, Japan, and Korea in order to mitigate the fine dust concentrations coming from China. In Japan, however, it is not a direct victim, so there is no pressing demand for intervention.

In this situation, it is necessary to precisely monitor transboundary air pollution, and the concerned countries should cooperate with each other to work out the transboundary fine dust problem. So far, several policies have been proposed to address this issue. However, it is important to consider the current dynamics around Korea and seek appropriate alternatives under various constraints: temporal, physical,

and monetary. In addition, although there were a lot of environment cooperation meetings and organizations in Northeast Asia, competition and overlap among them has not developed into an effective system for air pollution management in Northeast Asia (Kim, 2014a).

In light of the problems presented and the circumstances under which the policies are being implemented, this study aims to elucidate the policy alternatives that should be pursued in the short, mid- and long-term through strategic and technologic practices, by analyzing the various countermeasures that have been discussed in a lot of studies and classifying them under the structure of a general environmental cooperation approach.

### **1.3. Subject and scope of research**

The thesis is organized by the following structure. It is started with Chapter 1 as the introduction of the research. It consists of the background of the study, research purpose and necessity.

Chapter 2 reviews the background theories of international environmental issues and analyzes countermeasures related to transboundary air pollution in Northeast Asia through previous literature reviews. It covers the fundamental theory of international environmental cooperation and relevant studies in the field.

Chapter 3 investigates Korea's efforts to solve transboundary air pollution and air quality management in China. In addition, it examines overseas cases such as Trail Smelter Arbitration Case, European CLRTAR, and the Haze Pollution problem in Southeast Asia.

Chapter 4 represents the methodology applied to this study. The methods of this research include a literature review and questionnaire survey. The literature review investigates existing literature such as various academic research papers and periodicals at the theoretical background and the status analysis stage. The

questionnaire survey was conducted by approximately 26 experts related to environmental cooperation in Northeast Asia. The survey design and AHP method were used to prioritize strategies to mitigate regional air pollution in neighboring countries in Northeast Asia. The analytic Hierarchy process, developed by Prof. T.L. Satty in the 1970s, is known as a representative technique among multi-criteria decision-making processes that can flexibly accommodate quantitative evaluation criteria as well as qualitative evaluation criteria. Also, unlike traditional methods that pursue optimal solutions under existing strict assumptions, it has a feature to systematically classify the opinions of experts who have a lot of experience in actual management. This is useful for economic, administrative, political, and industrial purposes, providing practical assistance to many policymakers who are struggling with the gap between theory and reality (Cho et al., 2003).

Chapter 5 illustrates analysis results based on AHP method. In-depth analysis of the findings is provided in this chapter.

Finally, the thesis is summarized in chapter 6 along with policy implications and suggestions. This chapter also presents research limitations.

< Table 1-1 > Flow chart of the research

Research item	Research content	Research method
Introduction	Background, Purpose and Scope of research	
Theoretical framework	Approaches to International Environmental Issues Previous Literature Review	Literature review
Domestic and overseas case study	Korea's Effort for the transboundary air pollution problem in Northeast Asia Trail Smelter Arbitration Case, The CLRTAR agreement, Singapore-Indonesia Case	Literature review & Policy analysis
Survey research and analysis	Questionnaire Design Analyzing the priorities of experts' opinions	Survey method (AHP)
Conclusion	Summary of Research results, Policy suggestions and Implications	

## **Chapter 2. Analytical framework**

### **2.1. Theoretical Background: Approaches to International Environmental Problems**

#### **2.1.1. Normative Approach: International Environmental Law**

As a means to resolve international environmental issues and to continue environmental cooperation, a new academic system of international environmental law (IEL) has been established since the 1970s. IEL is concerned with the attempt to control pollution and the depletion of natural resources within a framework of sustainable development (Guruswamy, 2012). It is a branch of public international law. IEL covers topics such as population; biodiversity; climate change; toxic and hazardous substances; air, land, sea and transboundary water pollution; conservation of marine resources; desertification; and nuclear damage.

IEL has been developed based on two major declarations. The first one is the Declaration of the United Nations Conference on the Human Environment (UNCHE, the 1972 Stockholm Declaration). This declaration represented a first major attempt at considering the global human impact on the environment, and an international effort to address the challenge of preserving and enhancing the human environment. The Stockholm Declaration espouses mostly broad environmental policy goals and objectives rather than detailed normative positions. The second one is the Rio Declaration on Environment and Development in 1992. The Rio Declaration consists of 27 principles intended to guide future sustainable development around the world.

In general, public international law comes from one of four sources: international conventions, customary law, general principles of law recognized by civilized nations, and judicial decisions (Hunter et al., 2009). Each of these categories is very important in the

development of international environmental laws. As a relatively new and growing field, IEL is also developing from other less traditional and less binding sources. Resolutions and declarations issued by international organizations like the United Nations Environment Program (UNEP), the World Health Organization (WHO) have played a very important role in the development of international environmental principles, even though they are often non-binding (Hunter et al., 2009). There are some principles and standards related to transboundary air pollution problem, and the debate over the effectiveness of these principles is still continuing (Hunter et al., 2009).

### **The need for cooperation**

Much of international environmental law relates to a general obligation of states to cooperate in investigating, identifying, and avoiding environmental harms (Hunter et al., 2009). Every international environmental treaty has general provisions requiring cooperation in generating and exchanging relevant information (Hunter et al., 2009). It is one of the most important tools for monitoring the domestic implementation of international environmental obligations. In addition, due to the critical importance of scientific knowledge in driving international law and policy, many environmental treaties include the research, analysis and dissemination of scientific findings (Hunter et al., 2009). Notification in the case of an emergency is also an important aspect of international cooperation. Emergency notification is intended to allow affected parties the greatest possible opportunity to prepare for and mitigate potential damage (Hunter et al., 2009).

### **The duty to avoid environmental harm**

The no-harm principle is widely accepted as one of the international environmental laws' that states are required to follow to ensure that activities within their jurisdiction or control do not damage the environment of other states or the commons (Principle 21 of the Stockholm Declaration) (Park, 2017). This principle is often associated with the Trail Smelter Arbitration between Canada and the United States. The case will be explained in more detail in Chapter 3, overseas case study.

Moreover, as set forth in the Rio Declaration, the precautionary principle is one of the most important general environmental principles for avoiding environmental damage and achieving sustainable development (Hunter et al., 2009). Once the environment is destroyed, it is difficult or impossible to restore it. Therefore, it is necessary to prevent environmental damage or to pay attention to the environment before it is destroyed (Noh et al., 1999). Finally, many international institutions and countries require some forms of environmental impact assessment (EIA). EIA is a process for assessing proposed activities in order to maximize the environmentally sound and sustainable development (Hunter et al., 2009).

### **Principle of cost burden**

The biggest concern in environmental cooperation in Northeast Asia is the question of who carries the cost. The principles for determining the cost of environmental protection are the polluter pays principle (PPP) and the victim pays principle (VPP) (Noh et al., 1999). The PPP was recommended by the OECD council in May 1972, and since then PPP has been increasingly accepted as an international environmental principle. It has been explicitly adopted in several bilateral and multilateral resolutions and declarations, including Principle 16 of the Rio Declaration (Hunter et al., 2009). However, there are many problems in applying PPP to transboundary environmental problem. For PPP to be effective, there must be effective means of forcing the polluter to bear this burden. However, it is not easy for pollution victims to ignore the sovereignty of the polluting country and to collect the surcharge from the polluter (Noh et al., 1999).

In general, as a subject of international law, the state should be held responsible for causing transboundary environmental pollution. The State Responsibility System is one of the important institutions of international law, and it is a crucial means for the state to bear international legal responsibility when problems arise from pollution. However, it cannot be regarded as a realistic plan to take against China, which has

an asymmetric superiority of national power in relation to fine dust. The international legal approach also has difficulties in judging the cause of the pollution, proving the causal relationship and calculating the amount of damage (Won, 2014).

## **Dispute Resolution Procedures**

In the event of a dispute between countries, including environmental issues, the dispute should be settled peacefully under Article 33 of the UN Charter and recognized as an obligation under customary international law (Noh et al., 1999). As a means of resolving disputes, it is possible to use political solutions such as negotiations, arrangements, and mediation, or to use judicial remedies such as arbitration or trial (Noh et al., 1999). However, international environmental disputes are difficult for identifying cause and causal relationship because they are caused by various factors. Therefore, when environmental conflicts arise, countries tend to avoid legal dispute resolution and resolve politically whenever possible.

The issue of transboundary air pollution in Northeast Asia has been discussed in the field of international law so far. These discussions are based on the normative approach, such as seeking the possibility of responsibility for China, which is a major polluter, based on state responsibility theory. The question is whether we can solve environmental problems in Northeast Asia by taking responsibility for China based on state responsibility system for environmental pollution in its territory.

### **2.1.2. Diplomatic Approach**

As explained above, it is not easy to solve the damages caused by transboundary air pollution through international legal approach. There are numerous obstacles and uncertainties in such state responsibility claim. In the pursuit of state responsibility, it is necessary to overcome state attribution of individual offences, the determination of violations of international obligations, joint liability or solidarity responsibility,

the content or standard of due diligence obligations, and proof of causation (Park, 2017). Furthermore, if the issue of transboundary air pollution is raised in international jurisdictions, it is still not easy to identify the facts and causal relationships between transboundary air pollution and the behavior that generate particulate matters. In addition, there is a lack of scientifically proven data on the effects of fine dust from China on air pollution in Korea. Therefore, the Charter of the United Nations and customary international law require that priorities be settled through diplomatic negotiations before arbitration or the International Court of Justice (So, 2017). From this point of view, a political (diplomatic) approach can be considered. It is imperative to raise the institutional level for cooperation between countries in order to rise beyond the borders and solve environmental problems. In other words, it means a way to find solutions through environmental conventions or an establishment of environmental cooperation organization in case of environmental problems between neighboring countries.

## **International Environmental Agreements**

Environmental issues such as climate change, ozone depletion, marine pollution, biodiversity loss and hazardous waste are global problems, not national ones. In order to address them, international cooperation is inevitably necessary. Over the past few decades, the international community has sought to establish international environmental agreements and conventions to address international environmental issues (Park, 2017).

The history of environmental agreements has been discussed since the early nineteenth century. As the industrialization of mass production and mass consumption progressed, various environmental problems began to occur. In June 1972, the world's first international environmental conference (UNCHE), was held in Stockholm, Sweden. Since the UNCHE, awareness of the importance of discussions and cooperation between countries has been widespread for solving

environmental problems. Many countries have begun to create agreements to overcome various environmental problems. The United Nations Framework Convention on Climate Change (UNFCCC) at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil in 1992 is a representative example.

Therefore, in order to form an international environmental cooperation system for resolving the transboundary air pollution, all concerned countries can assume a certain level of responsibility and carry out corresponding actions (Won, 2014). The most representative approach is to establish bilateral or multilateral agreements that comply with the norms of international law as diplomatic cooperation between countries (Won, 2014). Moreover, if legally binding agreements are concluded between the Parties in relation to the fine dust issue, they will be of great help in working out the problem quickly and clearly. For example, in Europe, the CLRTAR was concluded to jointly exchange information, study and monitor information on air pollutants in 1971, and establish policies and strategies for pollutant reduction. The CLRTAR also made claims against the country that caused the damage.

### **International environmental regime**

International environmental regimes are a type of institution, where an institution is understood as “a cluster of rights, rules, and decision making procedures that gives rise to a social practice, and guides interactions among occupants of these roles” (Young, 2008). According to scholars (Krasner 1983; Keohane 1984; Mear-Sheimer 1994; Bull 1995; Ruggie 1998) who have established regime theories, regimes can be classified into two types. First, the regime means a set of principles, laws, regulations, customs, and financial obligations in international relations. According to this definition, the regime includes the balance of power, international law, and multilateralism. (Lee, 2002). Second, regime is a formal institution with a clear rule recognized by the government. In other words, a regime is an institutionalized

intergovernmental agreement dealing with issues in particular international relations (Lee, 2002). These include multilateral institutions such as the United Nations and the WTO. If these formal institutions do not exist, even if the agreed laws or norms have been created among the governments, there will be no mechanism to effectively implement them. Conversely, if multilateral institutions do not have the rules and norms that nations agree on, it will be difficult to find reasons for the existence of such institutions. Therefore, regimes are a collection of laws and regulations, and also refer to cooperative and institutionalized entities.

So far, the diplomatic approaches have been discussed. Since environmental problems are not only limited to one or two countries but also are a wide range of local issues in Northeast Asia, bilateral cooperation efforts alone cannot solve the local environmental problems effectively. In other words, continuous efforts for bilateral environmental cooperation are necessary, but it is very important to strengthen multilateral regional cooperation through the so-called Northeast Asia environmental regime (Lee, 2002).

### **2.1.3. Technological Approach**

Environmental cooperation requires various efforts and step-by-step development. Han (2007) attempted to analyze the stepwise typology of regional environmental cooperation by comparing Europe and Northeast Asia. This study is based on the following assumptions. After confirming the facts of environmental damage, it is essential to achieve scientific results on the causal relationship. Moreover, depending on the extent to which the performance is recognized, the level of awareness of the parties involved in the environmental pollution is determined and the institutionalization phase is set accordingly (Ye, 2010). In other words, the identification of damage facts is not a sufficient condition for the institutionalization

of environmental cooperation. It must be a social issue and scientific discovery is essential. Thus, as shown the <figure 2-1>, the identification of scientific evidence is vital for the institutionalization of environmental cooperation. As the scientific and economic factors become stronger, the proportion of political considerations decreases, and cooperation can be achieved based on rational judgment (Ye, 2010).

**< Figure 2-1 > Progress of local environmental cooperation**

Confirmation of facts ⇒ accumulation of scientific knowledge ⇒ expansion of awareness of environmental problems ⇒ coping with environmental problems through institutionalization

(Source: Ye Jong Young, 2010)

The Convention on Long-range Transboundary Air Pollutants (CLRTAP) can be an example of the technological approach. In Europe, the forces opposing the CLRTAP (such as the coal mining industry) have been weakened in front of the scientific basis for the damage of air pollutants (Ye, 2010). Germany was in the opposite group of the CLRTAP concluded, but it was found that Germany was also a victim country, and from then on it supported CLRTAP (Ye, 2010). The accumulation of objective and verifiable scientific knowledge was a fundamental and necessary condition for the institutionalization of environmental cooperation.

The Trail Smelter Arbitration Trial is another example highlighted by the importance of the scientific approach. Indeed, much of the trial data was attributable to causality, although the trial between the United States and Canada was in fact the process of adjusting the compensation and mitigation measures after Canada agreed to compensate for the damage (So, 2017). Given this, it is absolutely necessary to obtain scientific evidence on the transboundary air pollution source movement in Northeast Asia.

Scientific knowledge is a time-consuming task, but technical efforts such as

identifying damage caused by pollutants, identifying sources of pollutants and rational reduction of pollutants are very important (So, 2017). Once the scientific data are collected, it will be possible to establish a plan to reduce air pollutant emissions and strengthen regional cooperation. In addition, it is essential to clarify the facts and causal relationships of the fine dusts, even if related countries already attempt to solve the problem from the viewpoint of state responsibility theory or international litigation in accordance with an international legal approach (So, 2017).

Regarding the issue of transboundary fine dust, Japan and Korea claim that most of fine dust originated from China, but China claims that there is no scientific basis. In order to reduce the recognition gap between the Parties and to promote efficient environmental cooperation in Northeast Asia, scientific co-investigations and research is necessary to clarify the relationship between problems and causes. Furthermore, the results of the investigation shall be promptly provided to the Parties, and most importantly, the attitude of all Parties shall be accepted by the results of the investigation. This will ensure that all parties are actively involved in the formulation of preventive measures.

#### **2.1.4. Policy-based Approach**

Relying on the normative approach in international environmental law has a limit to effectively address the environmental pollution in Northeast Asia. In addition, from a long-term point of view, the resolution of environmental problem can be considered to conclude binding agreements and introduce solutions at the international legal level. However, in order to achieve the goal of establishing an environmental cooperation organization in the short term, it is necessary to make the basis of the environmental cooperation declaration at the soft law level and to promote policy cooperation through a step-by-step and concrete implementation strategy. Thus, the policy-based approaches can be an alternative to the normative

and diplomatic approach.

Jeong (2006) proposed several factors as policy-based approach. First is the importance of interdisciplinary research under international law. In order to address the environmental problems, it is necessary to induce environment friendly economic activities. In this case, specific resolution methods often require economic judgment before the normative approach of international law. Moreover, the resolution of international environmental problems should ultimately be guaranteed through environmental policies in domestic society. Therefore, it is very important to understand the creation, application, and implementation mechanism of legal policies in each country's domestic society. Second is the necessity of paying attention to the importance of soft law. Contrary to the traditional recognition that international law should be binding, soft law only provides guidelines for the actions of countries. In addition, soft law plays an important role as an act norm of states in the international community society, even though it is a non-binding agreement. In the case of the Stockholm Human Declaration of Human Beings, which announced the beginning of international environmental law, many provisions have been used in countless international environmental documents and realities. Third, a market-based approach should be actively considered as an approach to solve the environmental pollution. The development of environmental protection policy instruments based on the market principle is based on the logic that it is effective to devise laws and systems to access environmental problems by unseen hands in the markets where economic activities take place. The international environmental treaty that introduces this approach is the United Nations Framework Convention on Climate Change (UNFCCC) system. In the framework of the Kyoto Protocol to address the global warming phenomenon, the Kyoto mechanism was established in 1997, and a system of joint implementation and emissions trading system was devised. Mechanisms have also been devised to enable countries to achieve sustainable development and greenhouse gas emissions reduction at the same time,

with greater flexibility in choosing a method of action related to environment pollution.

On top of that, it is possible to consider the formation of “epistemic communities” that can form popular consensus and redefine the interests of individual countries (Won, 2014). Scientific knowledge plays a significant role in the transboundary air pollution due to uncertainty about the cause of fine dust generation and the route of movement. In order to establish a regional cooperation system that can effectively cope with environmental problems, it is crucial to maintain scientific purity. In this respect, joint research through ‘epistemic communities’ as well as systematic and scientific opinion gathering should be carried out. A successful example of “epistemic communities” can be found in the Intergovernmental Panel on Climate Change (IPCC), centered on scientists.

Lastly, it is also necessary to diversify and collaborate with partners. In Northeast Asia, the history of cooperation itself is very short, and there are considerable differences in the stages of economic developments, environmental awareness, environmental policies and regulatory standards. Therefore, the formation of an environmental cooperation system should be pursued through the establishment of a complex network among various nongovernmental actors as well as the governments. The role of non-government actors is especially important in relation to environmental issues. Therefore, the collaboration for the formation of a Northeast Asian environmental cooperation system should be carried out for various stakeholders such as central and local governments, industries, and NGOs.

## **2.2. Literature Review**

Research on environmental cooperation in Northeast Asia has been continuously discussed since the late 1990s. First of all, many scholars pointed out that the normative approach to international environmental law has limitations in effectively addressing environmental problems in Northeast Asia. NOH (2001) presented the

principles and trends of international environmental law as an approach to environmental cooperation in Northeast Asia. He introduced the principles of prevention of international environmental law, post-relief and private surveillance, dispute settlement procedures, notification and consultation obligation, and the principle of cost burden. In order to revitalize environmental cooperation in Northeast Asia, collecting and analyzing data on environmental problems is vital. He also emphasized that the cost-sharing method should be derived according to each country's ability.

Jeong (2006) and Lee (2017) demonstrated the importance of the policy-based approach to address serious regional environmental problems in Northeast Asia in a more effective way. Jeong (2006) commented that the normative approach has revealed its limitations to provide practical and effective solutions to the region despite its popularity in dealing with regional pollution problems. Without considerable variables such as the external problems, vagueness of the concept of the sustainable development, difficulty in cooperation among sovereign status, and unique geopolitical situation in Northeast Asia, normative approach of the international law may face serious limitations in applying international law instruments such as state responsibility system and draw actual results in decreasing the regional pollution. Lee (2017) mentioned that the air pollution problem caused by fine dust is not the one that can be by simply enforcing legal system and policy in one country. He emphasized that the aim was to elicit implications through the comparison method in a case of EU as the regional community, which had solved a social issue through utilizing the consolidated legislation with seeking in public good.

So (2017) explained the state's obligation for compensation in transboundary environmental harm is not firm unlike the Trail Smelter Case (USA vs CANADA) of 1951. He mentioned that the UN international commission suggested that private entities who are the source of transboundary air pollution would be responsible for the damage compensation. This means that states have only secondary obligation to

establish appropriate compensation systems like environment insurance and industrial funds. Park (2017) mentioned the rules of state responsibility in international law whether it is possible to claim legal responsibility for particulate matter damage from China. He said that state responsibility claim for the transboundary damages in international law is still rare today. In pursuing state responsibility invocation, it is necessary to overcome the problem of state attribution of individual offenses, the issue of determination of the violation of international obligations, the content or standard of due diligence obligations, multiple responsible states, joint liability or solidarity responsibility. However, jurisprudence and rules of state responsibility could bring some deterrent effect to promote efforts to prevent or minimize the risk of transboundary damages.

Other scholars emphasized the technological approach and the stakeholder network as feasible measures to reduce the transboundary air pollution concentrations. Kim (2007) explained that the lack of domestic and regional consensus on ecological vulnerability to transboundary acid deposition and the high economic costs of reducing emission have contributed to slow development of the cooperation of Northeast Asia. In addition, the lack of solid expert communities in Japan, as a leading country, could hinder Northeast Asian countries from speeding up the transition toward regulatory regime formation from the current information sharing cooperation. Choi (2008) emphasized that by operating an authoritative 'local environmental body', the vision and strategy of environmental preservation in Northeast Asia should be established and the implementation of each country should be encouraged in "problem and countermeasure of Environmental Cooperation Structure in Northeast Asia". Soon (2009) stressed that it is necessary to connect each nation's information system onto an international network-Clearinghouse. Furthermore, he discussed that concerning that the project will require participation and collaboration from various professionals and institutes within each participating countries. Therefore, countries must find ways to induce their collaboration by way

of enticing them with expert meetings and international seminars. Park (2014) and Won (2014) emphasized building a network of stakeholders. Specifically, Park (2014) presented a solution to the haze problem in Southeast Asia region. He noted that there is a need for the private sector and non-governmental organizations (NGOs) to participate and cooperate, given the complexity and scale of transboundary air pollution (especially fog). Thus, the ultimate solution to the Hayes problem is to build environmental governance in the ASEAN region. Won (2014) discussed the necessity of constructing a complex cooperative network between various regional actors and “epistemic communities” which is a matter of building an environmental regime in Northeast Asia to address fine dust problem.

Lastly, Lee & Park (2016) proposed the need for supportive organization of Air Pollution between South and North Korea, China and Japan through discussion that focuses on forms of environmental cooperation system and business system structure as well as leading country in order to unify the environmental cooperation in Northeast Asia.

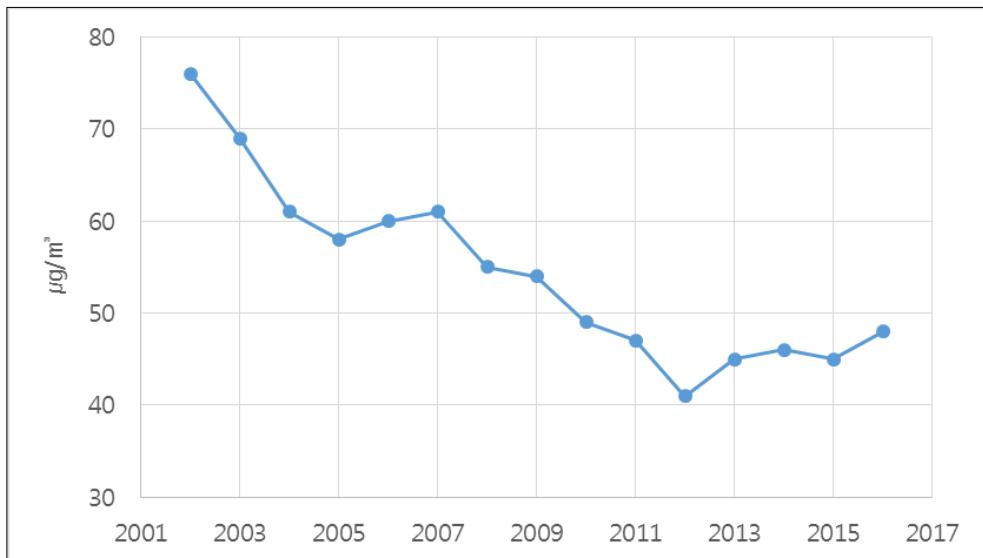
# Chapter 3. Case Study

## 3.1. Investigation and Analysis of Domestic Efforts

### 3.1.1. Fine Dust Concentration in Korea

Korea has been striving to improve air quality with a focus on emissions management in the transportation and business sectors. The government implemented the "First Metropolitan Air Quality Improvement Plan" from 2005 to 2014. This plan had led a significant decrease in the country's air pollution level from that of 10 years ago. The average level of PM<sub>10</sub> declined from 76 $\mu\text{g}/\text{m}^3$  in 2002 to 41 $\mu\text{g}/\text{m}^3$  in 2012. PM<sub>10</sub> concentration in the Seoul Metropolitan area, however, has increased since 2013 after showing steady decline until 2012 (45 $\mu\text{g}/\text{m}^3$  in 2013, 46 $\mu\text{g}/\text{m}^3$  in 2014, 45 $\mu\text{g}/\text{m}^3$  in 2015, 48 $\mu\text{g}/\text{m}^3$  in 2016). These numbers are much higher than 20 $\mu\text{g}/\text{m}^3$  recommended by the WHO.

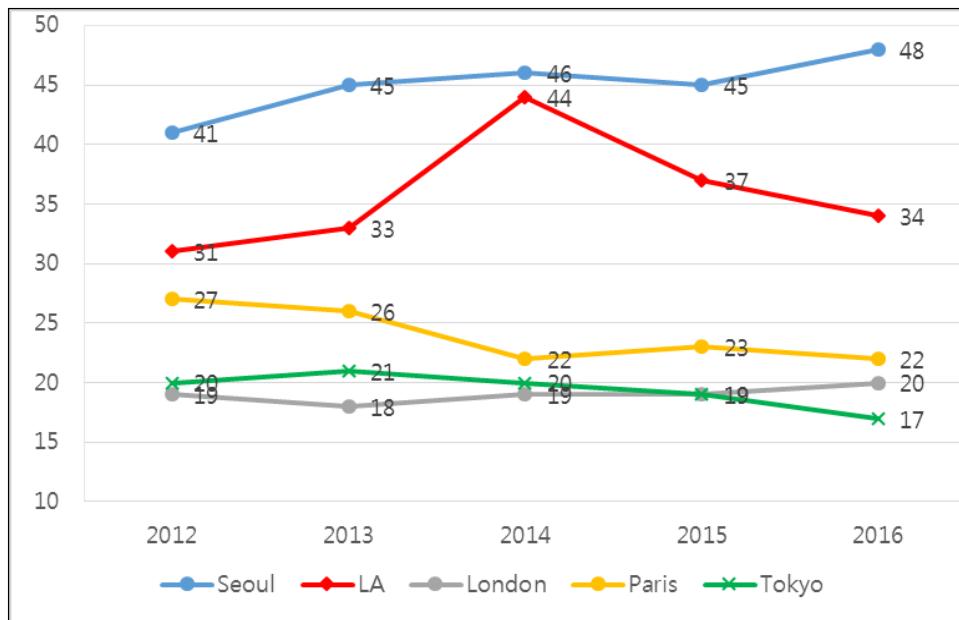
< Figure 3-1 > PM<sub>10</sub> concentration in Seoul metropolitan area



(Source: Annual Report of Air Quality, Ministry of Environment, 2016)

Moreover, the fine dust concentration level is higher in Seoul metropolitan area in many other major cities around the world: PM<sub>10</sub> concentrations is 1.4 times, 2.2 times, 2.4 times, and 2.8 times higher than in Los Angeles, Paris, London, and Tokyo respectively.

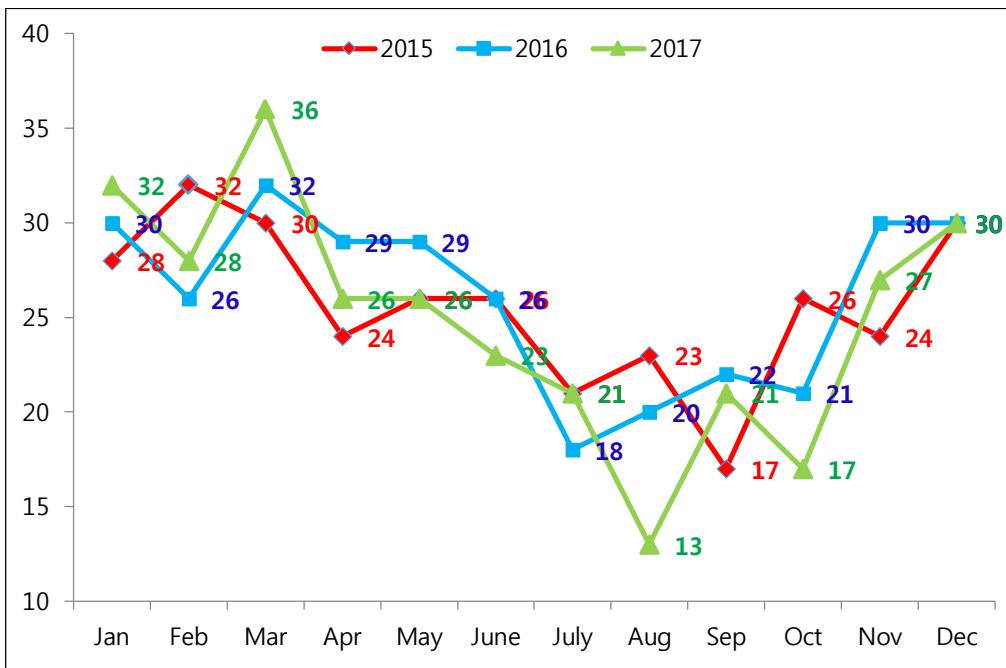
< Figure 3-2 > PM<sub>10</sub> concentration level in major cities around the world



(Source: Annual Report of Air Quality, Ministry of Environment p.367, 2016)

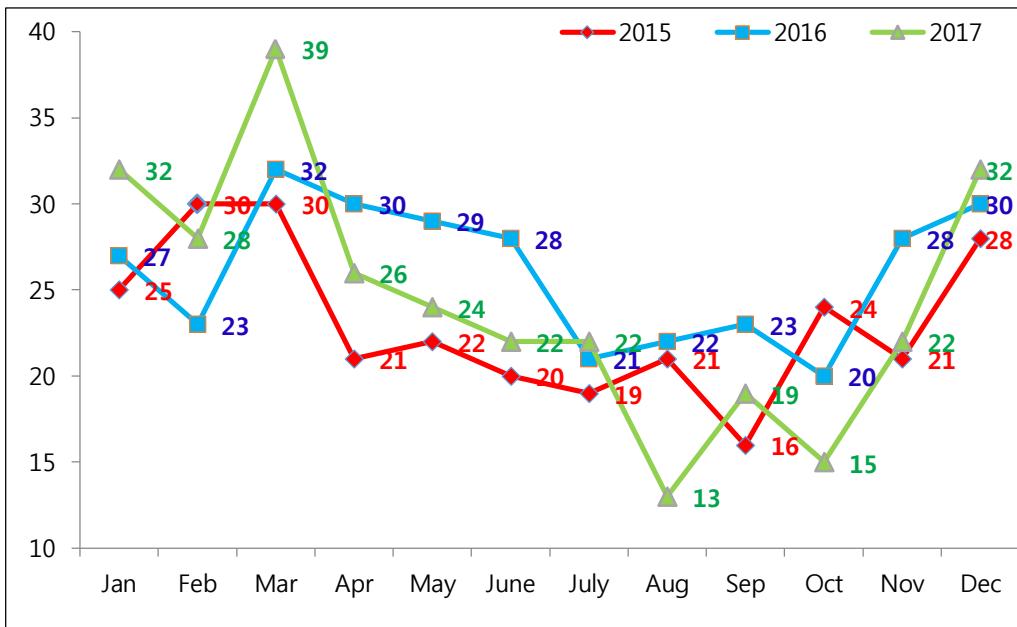
When it comes to PM<sub>2.5</sub>, the concentration level is about twice as high as the WHO's guideline ( $10\mu\text{g}/\text{m}^3$ ) or the level of other major cities in developed countries. Since 2015, the government has managed PM<sub>2.5</sub> as one of the substances that must meet Air Quality Standards in accordance with the Framework Act on Environmental Policy. However, Korean citizens experience increases in the fine dust concentrations, especially during winter and spring, from January to May. The annual average concentration of PM<sub>2.5</sub> during the season increased from  $28\mu\text{g}/\text{m}^3$  in 2015 to  $30\mu\text{g}/\text{m}^3$  in 2017, so the number of PM<sub>2.5</sub> warnings and alerts increased from 72 in 2015 to 66 in 2016 to 92 in 2017 (Korea Environmental Policy Bulletin, 2018).

< Figure 3-3 > National PM<sub>2.5</sub> concentration (194 branches,  $\mu\text{g}/\text{m}^3$ )



(Source: Monthly Report of Air Quality, Ministry of Environment, 2015-2017)

< Figure 3-4 > PM<sub>2.5</sub> concentration in Seoul (25 branches,  $\mu\text{g}/\text{m}^3$ )



(Source: Monthly Report of Air Quality, Ministry of Environment, 2015-2017)

The contributing factors of fine dust concentrations in Korea are classified into two groups: local and foreign factors. The contribution rate of foreign factors to Korea's fine dust levels varies with seasonal and weather conditions including wind directions, wind speed, and precipitation. According to the Korean government, foreign factors are responsible for 30-50% of the country's fine dust on normal days and 60-80% during high concentration episodes (18-29 days per year according to data from 2015 to 2016). The KQRUS-AQ, a joint study project by the Korea's National Institute of Environmental Research (NIER) and National Advisory Committee for Aeronautics (NASA), suggested that 48 percent of the ultrafine particulate matter measured from May to June 2016 in the air of the project area in Korea are caused by foreign factors, while the remaining 52% coming from local sources (Korea Environmental Policy Bulletin, 2018).

### **3.1.2. Domestic Efforts to deal with the transboundary air pollution problem in Northeast Asia**

#### **1. Central Government Cooperation**

##### **(1) Tripartite Environment Ministers Meeting (TEMM)**

The Tripartite Environment Ministers Meeting (TEMM) is the only ministerial level environmental cooperation forum in Northeast Asia. TEMM was established in 1999 to seek common solutions to environmental problems facing Northeast Asia, including environmental pollution and deteriorating ecosystems, accompanied by rapid economic growth. In the meantime, TEMM agreed on various measures related to the transboundary air pollutants. For example, the 16th TEMM in 2015 agreed to share real-time atmospheric observations of major cities in Korea and China from March 2015 through private lines. And the Korea-China Joint Research Group for

Identification of Air Pollution Source' was launched in June 2015. Moreover, a project to demonstrate the reduction of fine dust in China for three to five Chinese steel mills is being promoted. Korea and Japan also agreed to jointly carry out basic research on the fine dust model and the emission inventory field, and the '1st Korea-Japan Atmosphere Research Team Meeting' was held in Incheon in June 2015 (Ministry of Environment Press, June 5, 2015).

At the 20th TEMM in 2018, Korea and China agreed to promote joint cooperation projects to cope with air pollution such as blue sky projects and the fine dust information sharing through the Korea-China Environmental Cooperation Center (launched on June 25, 2018, Beijing). In addition, the two countries agreed on the efforts to create and implement new cooperative environmental projects between central governments, local governments, and the industrial sectors of both countries (Ministry of Environment Press, June 24, 2018).

As such, TEMM, the three highest-level partners in the field of environment, has repeatedly achieved the desired outcomes of cooperation on air pollution problems. However, it has not been able to draw the appropriate investment of participating countries, which was mentioned as the limit of the TEMM (Chung et al., 2005).

## **(2) North East Asian Sub-regional Program of Environmental Cooperation (NEASPEC)**

Based on the achievements of the United Nations Conference on Environment and Development (UNCED) held in 1992, NEASPEC was established in 1993 with six countries: South Korea, North Korea, China, Japan, Mongolia, and the Russian Federation. NEASPEC formed a Northeast Asian regional environmental cooperation plan to carry out the cooperative project and function as a cooperation body to deal with overall environmental conservation. And NEASPEC aims to dissolve the dichotomy between economic growth and environmental protection and

improve environmental sustainability for local economic development (Sim et al., 2013).

### **(3) Long-range Transboundary air Pollutants in Northeast Asia (LTP)**

Large amounts of air pollutants emitted from Northeast Asia causes considerable damage by traveling long distances to neighboring countries along westerly winds. Under these problems, the three countries (China, Japan, and Korea) in the region, which are under the same environmental impact zone, agreed to objectively identify the long-distance movement of air pollutants and promote joint research projects to improve the air quality. In 1995, the Korea National Institute of Environmental Research (NIER) led the Long-range Transboundary air Pollutants in Northeast Asia (LTP) (Sun, 2012).

The LTP project aims to provide policy makers with objective information obtained through scientific research so that they can make policy decisions easier. However, as individual studies are being conducted for each country, it is difficult to obtain a common opinion on the results of the research and standardized research methods have not been developed. Furthermore, it is based on the voluntary consensus of experts from research institutes in each country. Therefore, it is not easy to achieve institutionalization with specific agreement or legally binding power, and the link between scientific research results and policy decisions is weak. (Sim et al., 2013).

#### **(4) Policy Dialogue on air pollution among Korea, China, and Japan (TPDAP)**

The Tripartite Policy Dialogue on Air Pollution among China, Japan, and Korea is a director-level meeting, which was launched upon Korea's proposal at TEMM 15 in March, 2013. It has been held annually in turn since 2014. At the 1<sup>st</sup> policy dialogue, held in China in 2014, the three countries agreed to reinforce cooperation in tackling fine dust, volatile organic compounds and car exhaust. At the 2<sup>nd</sup> policy dialogue, held in Korea in 2015, the three countries launched a joint research working group upon Korea's proposal. At the 3<sup>rd</sup> policy dialogue, held in Japan in 2016, participants finalized the five-year action plan for the working group. And, at 4<sup>th</sup> policy dialogue in China, participants checked the joint research progress and shared air quality management policies of the three countries. The 5<sup>th</sup> policy dialogue, joined by 20 government officials and researchers from Korea's Ministry of Environment, China's Ministry of Environmental Protection and Japan's Ministry of Environment, was aimed at discussing ways to further cooperation to address air pollution issues of the three countries.

Working-level officials in charge of air quality shared policies to control air pollutants such as particulate matters, and decided to reflect the results of discussion into air quality improvement measures of the three countries. In addition, director-level officials from Korea, China and Japan discussed a plan to foster trilateral cooperation to combat fine dust. (Ministry of Environment Press, February 2, 2018)

<Table 3-1> Northeast Asia Regional Air Pollution Cooperation Organizations

	Functions	Target pollutants	Partner countries	Limits
NEASPEC (Northeast Asian Sub-regional Program of Environmental Cooperation)	Environmental monitoring and data collection analysis, nature conservation project	acid rain	Korea, North Korea, China, Japan, Mongolia, etc.	Difficult to expand the range of activities and monitoring
TEMM (Tripartite Environment Ministers Meeting)	Establishment of environmental conservation project in the western part of China, environmental round table, environmental education, capacity building, air pollution policy dialogue	climate change, fine dust, ozone	Korea, China, Japan	Focus on a limited range of air pollution except for the yellow dust problem
EANET (Acid Deposition Monitoring Network in East Asia)	Establish guidelines and manuals for monitoring acidic fortification, and cultivate research capacity	acid rain	Korea, China, Japan, Thailand, Indonesia, Mongolia etc.	Difficulty in expanding the scope of activities and monitoring
LTP (Long-range Transboundary air Pollution in Northeast Asia)	Monitoring and modeling long-range moving air pollutants in Northeast Asia	sulfur dioxide, nitrogen oxide, fine dust, ozone, etc.	Korea, China, Japan	Simple project, no legal forcing, non-permanent organization
NEAC (Northeast Asian Conference on Environmental Cooperation)	Information and opinions on regional environmental issues among Northeast Asian countries, environmental cooperation	yellow dust storm	Korea, China, Japan, Mongolia, Russia	Difficulties in consensus and institutionalization with legal force due to the nature of simple meetings, Difficulty in securing funds

. (Source: Lee, Sang-man, The legal and political plans for a solution of air pollution in Northeast area, 2018. <Table1-1> reconstruction)

## **2. Local Government-level Cooperation**

Local governments are working with local cities in China. The Seoul Metropolitan Government announced a joint agreement on improving the air quality with Beijing in 2014, which was the first time that Beijing made a commitment to improve air quality. The agreement included bilateral air quality improvement policies, technology, information, human interaction and cooperation to prevent air pollution, the establishment of an environmental team within the Seoul-Beijing Consolidation Committee, and joint hosting of the Seoul-Beijing-led Northeast Asia Air Quality Improvement Forum. In November 2015, the Seoul-Beijing Air Quality Improvement Forum was held. In addition, an environmental team was established to discuss practical environmental issues within the Seoul-Beijing Consensus Committee, and a joint research topics also were selected to reduce air pollution. .

### **3.2. Air Quality Management in China**

#### **1. Air Pollution Status in China**

Due to rapid urbanization, industrialization, and motorization, a large number of Chinese cities were affected by heavy air pollution. Air pollution concentrations in big cities in China were severe as they changed their daily records every winter. In November 2015, the average level of PM<sub>2.5</sub> concentration in central Beijing was 900 $\mu\text{g}/\text{m}^3$ . In the case of Shenyang in Liaoning Province in northeast China, soared up to 1,400 $\mu\text{g}/\text{m}^3$ . These figures were 36 times and 56 times, respectively, when compared with 24 hours averages of 25 $\mu\text{g}/\text{m}^3$  of World Health Organization standard.

Physicists at the University of California, Berkeley, calculated about 1.6 million people in China die each year from heart, lung and stroke problems because of incredibly polluted air, especially small particles. Furthermore, according a study co-authored in 2017 by professors from Massachusetts Institute of Technology in the

US, Tsinghua University, Peking University in Beijing, and the Hebrew University of Jerusalem, the average life expectancy of people in North China is expected to be shortened by about 5.5 years due to air pollution and cause higher rates of lung cancer, heart attacks, and strokes. Serious air pollution had a definite negative impact not only on Chinese health but also on industries.

On the other hands, the air quality of major Chinese cities has improved due to the efforts of the Chinese government. According to the China Environmental Situation Bulletin, the average annual concentration of PM<sub>2.5</sub> in 74 cities monitored in 2016 was 50 $\mu\text{g}/\text{m}^3$ , which was 30.6% lower than 72 $\mu\text{g}/\text{m}^3$  in 2013. Moreover, the ratio of days exceeding the environmental standard of daily average decreased from 33.2% in 2013 to 25.8% in 2015. The national average annual concentration of PM<sub>10</sub> in 2016 was 82 $\mu\text{g}/\text{m}^3$ , down 15.5% from 97 $\mu\text{g}/\text{m}^3$  in 2013 (Moon et al., 2018).

## **2. Chinese Environmental Law and Policies**

### **(1) Environmental Protection Law**

China, which began enacting the new Environmental Protection Law in 2015, showed a willingness to strictly enforce environmental protection standards. The revised law imposed stricter obligations on companies regarding pollution prevention and control, and provided for more severe penalties. With regard to public policy, the Revised Law specified that the Government should support the development of the environment industry and encourage industries to take environmental protection measures (Mallesons, 2014). In December 2015, the Ministry of Environment Protection (MEP) announced the full implementation of the extreme low emission standards for coal-fired electronical power plants and the energy conservation reform project and all coal-fired electronical power plants in China should install extreme low emission facilities by 2020. In January 2016, the

MEP provided a basis for local governments to enforce enhanced air quality and emission standards (MEP, 2015&2016).

## **(2) Environmental Protection Act and Air Pollution Prevention Action Plan (2013 – 2017)**

In keeping with the amendment of the Environmental Protection Act, China announced a new series of intensified laws and plans to reduce air pollution in June 2013. Specifically, China announced the Air Pollution Prevention and Control Action Plan (hereafter the Action plan), which contained ten measures to improve air pollution. The action plan, the most stringent air pollution plan to date in China, is regarded as a promising strategy to control deterioration and improve air quality (Moon et al., 2018). The plan embedded targets on air quality improvement and emission control into government performance and promotion assessment system, which greatly enhanced local official's incentives to pay attention to the implementation of the air pollution control measures (Moon et al., 2018). The new Air Pollution Prevention Act strengthens the purpose and means of preventing air pollution, the means of preventing air pollution in each industry, and establishes local air pollution prevention responsibility and pollution emission standards.

In addition, the Ministry of Finance of China had prepared funds for air pollution prevention from 2013, and by the year 2016, a total of 30.4 billion yuan had been allocated to enact and enforce local regulations on air pollution in each region (Moon et al., 2018).

< Table 3-2 > Actions in China's Air Pollution Prevention and Control Action Plan

Items	Contents
1	Strengthening comprehensive control and decreasing pollutant emissions
2	Optimizing industrial structure and promoting industrial restructuring and upgrading
3	Accelerating technological transformation in enterprises, and improving innovation capacity
4	Accelerating energy structure adjustment, and increasing supply of clean energy
5	Conducting entrance control energy saving and environmental protection concerns, and optimizing industrial layout
6	Harnessing market mechanism, improving environmental economic policies
7	Improving legislation system and regulations, and implementing strict supervision and management according to laws
8	Establishing regional cooperating mechanism to conduct comprehensive regional environment mechanism
9	Establishing monitoring and emergency response system, to deal with heavy pollution weather properly
10	Clarifying responsibilities of government, enterprises and society and mobilizing public participation in environmental protection

(Source: <http://www.sustainabletransport.org/wp-content/uploads/2017/08/National-Action-Plan-of-Air-Pollution-Control.pdf>)

### **3.3. Overseas Case study**

#### **3.3.1. Trail Smelter Arbitration Case**

##### **1. Overview**

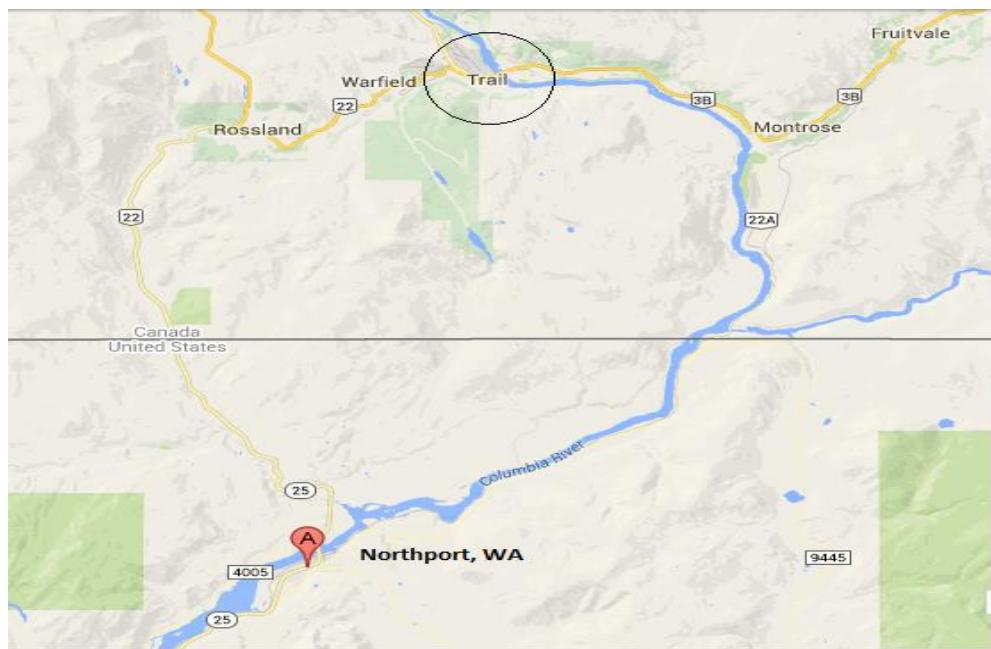
The Trail Smelter Arbitration of 1938 and 1941 was a landmark decision on the dispute over environmental destruction between the United States and Canada. This was the first decision to recognize international liability for damages incurred by another country, even if the existing treaty had no obligation to prevent such damage.<sup>1</sup>

The case started with a local problem regarding two small towns and one smelting plant. Northport is a town in Stevens County, Washington, USA. Trail is a town in British Columbia, Canada about 20 miles north of Northport beyond the border. The two towns are located along the Columbia River that flows from British Columbia to Oregon. In the late 1800s and early 1900s in Trail, British Columbia, smoke did not correlate with environmental pollution and harm to human health. Smelter smoke indicated jobs and prosperity for the local region. A smelting plant in Trail was crucial to the Trail citizens' economies and lifestyles. It has gained strength through its capital and political influence. However, because of the geographical and meteorological characteristics of the smelter located near the Columbia River, a considerable portion of the sulfur dioxide released from the smelter was blown into Washington, USA. This has caused serious damage to forests, orchards, and home premises in Northern Stevens County in the United States in the 1920s. As a result, the international dispute over air pollution took place most famously in the middle of the 20th century.

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<sup>1</sup> This case was written by referring to Trail Smelter Arbitration (Environmental Encyclopedia) and the Trail Smelter Arbitration case study (Prunella, 2014).

< Figure 3-5 > Trail Smelter



(Source: <https://www.google.com/maps>)

## 2. A tribunal decision

Canada and the United States have set up trials to resolve disputes over timber and crop damages caused by a smelter on the Canadian side of the border. The two countries agreed in 1927 to investigate the facts of the case at the International Joint Commission, the governing body of the 1909 Boundary Water Treaty, in accordance with the US proposal. However, as the damage continued, the two countries signed a special agreement to refer the case to the arbitral tribunal, and the tribunal gave its decision twice in 1938 and 1941, respectively (So, 2017).

In 1938 the Tribunal established its first decision that harm had occurred between 1932 and 1937 and ordered the payment of an indemnity of \$78,000 as the “complete and final indemnity and compensation for all damage which occurred between such dates” (So, 2017). The Tribunal’s second decision (1941) was about the last three

questions submitted by the 1935 Convention: responsibility for, and the appropriate mitigation and indemnification of, future harm. The Tribunal concluded, with respect to future harm, that 'no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence'(So, 2017). The case was landmark because it was the first to challenge historic principles of international law, which subordinated international environmental duty to nationalistic claims of sovereignty and free-market methods of unfettered industrial development.

### **3. Implications**

The Trail Smelter decision has shaped the core principle underlying international environmental law. According to this principle, a country which creates transboundary pollution or some other environmentally hazardous effect is liable for the harm this causes, either directly or indirectly, to another country. This has been the basis of Stockholm Principle 21, the main principle of international environmental law.

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or to areas beyond the limits of national jurisdiction (From Report of the United Nations Conference on the Human Environment, *Stockholm, June 1972*).

The Trail Smelter Case played a major role in the formation of the principle of transboundary air pollution of the International Environmental Law. However, it is difficult for this case to serve as a precedent for all transboundary air pollution incidents. The United States and Canada have laid the foundation for environmental cooperation through shared river management prior to this case (So, 2017). Although

the case was recognized as Canada's liability, it is unlikely that the polluting state will be liable for compensation in a similar case today. The International Law Commission (ILC), which deals with the liability for damages to the transboundary air pollution, mentioned in 2006 that the subject of compensation is only the workplace that caused the actual environmental damage (Draft Principles on the Allocation of Loss from Transboundary Harm arising out of Hazardous Activities Article 4 Clause 1). The commission gave the state responsibility for establishing systems that allow the workplace to make quick and appropriate compensation (So, 2017).

### **3.3.2. The Convention on Long-range Transboundary air Pollutants**

#### **1. Overview**

The Convention on Long-range Transboundary Air Pollutants (CLRTAP) established a broad framework for co-operative action on air pollution. The Parties undertook, by means of exchanges of information, consultation, research and monitoring to develop policies and strategies to combat the discharge of air pollutants.<sup>2</sup> The CLRTAP is one of the agreements hosted by the United Nations Economic Commission for Europe (UNECE). UNECE was organized to achieve economic prosperity through sustainable development as a multilateral system for economic integration and cooperation of the 55 member countries. The CLRTAP agreement began an international debate on acid rain at the United Nations Conference on Human Environment in Stockholm in 1972, following the discovery of acidification problems in northern European lakes in 1960. A number of studies were carried out from 1972 to 1977 that indicated that air pollutants can travel long

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2 This case was written by referring to "Legislative instrument details: CLRTAP" of European Environment Agency website (<https://rod.eionet.europa.eu/instruments/578>).

distances and cause damage.

Based on these findings, the first protocol was signed in July 1985 in Helsinki, after CLRTAP was signed in Geneva with the participation of 34 countries and the European Union in 1979 (The convention now has 51 member countries). Since then, it became clear that the development of scientific knowledge and the reduction of new pollutants were also necessary. As a result, 8 protocols, including Gothenburg Protocol in 1999, have been signed to reduce nitrogen oxides (Nitrogen Oxides: NOx), Volatile Organic Compounds (VOC), Heavy Metals Persistent Organic Pollutants (POPs), and other harmful substances. Under the convention, the member countries should review the work in progress and the action plan for the next year through the session of the executive body.

**< Table 3-3 > CLRTAP Protocols**

Eight protocols have been signed that contain specific obligations for the Contracting Parties.

Year	Protocol	Ratification	Contents
1984	The Geneva Protocol	1988.1	Long-term funding for cooperative programs for evaluation and monitoring
1985	Helsinki Protocol	1987.9	30% reductions in sulfur oxides
1988	The Sofia Protocol	1991.2	Nitrogen oxide inhibition
1991	The Geneva Protocol	1997.9	Reduction of volatile organic compounds
1994	The Oslo Protocol	1998.8	Additional reduction of sulfur oxides
1998	The Ahus Protocol	2003.12	Heavy metal reduction (2012 revision)
1998	The Ahus Protocol	2003.10	Reduction of persistent organic pollutants (2009 revision)
1999	The Gothenburg protocol	2005.5	Acidification, eutrophication, surface ozone (2012 revision)

(Source: UNECE homepage: [www.unece.org/env/1rtap/status/1rtap\\_s.html](http://www.unece.org/env/1rtap/status/1rtap_s.html))

## **2. Implications**

The Convention not only served as a political bridge to resolve common problems among countries under different political systems, but also served as a stabilizing force in Europe. In fact, the Convention did not impose binding obligations to reduce air pollution emissions between countries of different political and economic levels, but rather introduced so-called soft law principles and established a cooperative system. Thus, such a broader effort by related groups could be realized only through a compromise of intrinsic interest on both sides, although it was weaker than the state expected to be the net inflow of pollutants (Kim et al., 2015)

The CLRTAP suggests the following implications for the establishment of a system to prevent transboundary air pollution in Northeast Asia (Kim et al., 2015). First of all, The CLRTAP agreement played a key role as a political bridge to solve the common problem of air pollution. It can be referred to as a successful example in establishing a similar system among the three countries of China, Japan, and Korea. Secondly, one of the motivations for many European countries to join the CLRTAP was that they could not deny since many of the provisions of the Convention were in the soft law. Transboundary air pollution not only affects neighboring countries, but also causes the greatest damage to their own country. The accession of the Convention was favorable for its own country, and the flexible position of the Convention provided the conditions for all the member countries to participate. Third, The CLRTAP agreement had soft law provisions, but the subsequent protocol provided fairly specific air pollution prevention obligations, and is thus considered to have played a very positive role in terms of reducing air pollutants (Kim et al., 2015).

### **3.3.3. Haze Pollution in Southeast Asia**

#### **1. Overview**

Transboundary haze pollution was one of the common concerns of ASEAN in the 1990s. Haze pollution had brought disaster on health, transportation, construction, tourism, forestry, and agriculture, not to mention having an economic impact (Park, 2014). Over the past several decades, fires had been occurring almost every year due to deforestation and enclaves on the lands of Sumatra and Kalimantan jungles in Indonesia. As a result, the problem of pollution and foggy atmosphere that adversely affected national health and economic activities repeatedly occurred in Singapore and neighboring countries, resulting in regional problems. In September 1994, the Pollutant Standard Index (PSI) indices in the worst-affected areas was set at a peak of 153, resulting in the establishment of a Task Force on Haze pollution (TF) (Park, 2014). In June 1995, the ASEAN Conference on the Management of Pollution was held under the leadership of the member countries affected by fog. The ASEAN Cooperation Plan on Transboundary Pollution (ACPTP) was adopted at this meeting (Park, 2014).<sup>3</sup> Later, TF on haze pollution was in charge of implementing the measures. Then, in 1997, a serious haze recurred, and the regional action plan was signed by the ASEAN Ministerial Conference in December (Park, 2014).

However, since the 1980s, especially after 1990, regional cooperation has been attempted for joint response to haze pollution, but it is estimated that meaningful practices do not follow. Singapore has attempted to solve the haze pollution problem through regional efforts and cooperation through the 2002 ASEAN Agreement on Transboundary Haze Pollution adopted by ASEAN. But in the past 12 years, Indonesia, the main country, has refused to ratify the treaty, and in 2013, the haze pollution standard has been renewed. Therefore, Singapore moved away from its

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<sup>3</sup> This case is written by referring to “Haze Pollution in Southeast Asia and International law (Park, 2014) Environment Law Research Vol.36(2), p.145”.

traditional emotional attitude and vigorously protested the Indonesian government, demanding immediate problem solving and resolution.

Nevertheless, as the solution to the haze pollution through the international agreements has not been solved, it can be seen that Singapore has attempted to find a solution by raising the law that is applicable to the offshore subjects. On September 25, 2014, Singapore introduced “The Transboundary Haze Pollution Act”. This is a law that punishes companies or individuals that cause haze pollution, and the extra-territoriality of Act.

< Figure 3-6 > Simulation of fog pollution problem



(Source: <http://cai-asia.blogspot.kr/2010/10/asian-haze-makes-its-return.html>, 2015.9)

“The Transboundary Haze Pollution Act (2014)” required local and foreign companies and individuals who have caused forest fires in Singapore to submit relevant information and to be imposed a fine of up to \$ 2 million (US \$ 1.6 billion) or civil liability for damages. The law defined haze pollution as causing smog from landfill or firefighting outside Singapore to cause serious air pollution in Singapore.

## **2. Implications**

“The Transboundary Haze Pollution Act” attracted a great deal of attention in Korea since there was a large amount of air pollutants comes from China. First of all, unilateral domestic legal action may lead to diplomatic conflicts between countries. Considering the fact that there are practical constraints on the legal effect of the extra-territoriality of act, caution should be taken to develop a solution to resolve the transboundary air pollution facing Korea. This is because, if a diplomatic conflict with China occurs, there might be a greater disadvantage than environmental, national security and economic benefits. Second, it is not easy to gather and use objective data for legal action because it is difficult to prove that air pollutants come from China. Third, in the case of haze pollution problem, many countries such as Malaysia, Thailand, and Brunei were damaged as well as Singapore, so it was treated as a regional problem and the support of neighboring countries could be secured. On the other hand, considering Korea's regional characteristics, it is not easy for neighboring countries to participate and support the management of air pollutants from China (Lee, 2014).

Taking this situation into consideration, it is not appropriate to consider the adoption of strong measures such as domestic legislation as the top priority for Korea. It is necessary to urgently seek cooperation for joint responses through the adoption of regional or bilateral agreements such as “the 2002 ASEAN Agreement on Transboundary Haze Pollution (ATHP, 2002)”. At this time, in order to develop a kind of regional consensus involving other countries besides Korea and China, it is more effective to plan the composition as a comprehensive discussion on environmental issues, including biodiversity and climate change (Lee, 2014).

# **Chapter 4. Survey Research**

## **4.1. Overview of AHP Evaluation Model**

### **4.1.1. Basic Concepts and Characteristics**

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then (Saaty, 2008).

It has particular application in group decision making and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, shipbuilding, and education (Saaty, 2008). Rather than prescribing a "correct" decision, the AHP helps decision makers find one that best suits their goal and understanding of the problem (Saaty, 2008). It provides a comprehensive and rational framework for structuring a decision problem, representing and quantifying its elements, relating those elements to overall goals, and evaluating alternative solutions (Saaty, 2008).

Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to each other two at a time, with respect to their impact on an element above them in the hierarchy (Saaty, 2008). In making the comparisons, the decision makers can use concrete data about the elements, but they typically use their judgments about the elements' relative meaning and importance (Saaty, 2008). It is the essence of the AHP that human judgments, and not just the underlying information, can be used in performing the evaluations (Saaty, 2008).

The AHP converts these evaluations into numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing diverse and often incommensurable elements to be compared to one another in a rational and

consistent way (Saaty, 2008). This capability distinguishes the AHP from other decision-making techniques. In the final step of the process, numerical priorities are calculated for each of the decision alternatives (Saaty, 2008). These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action (Saaty, 2008).

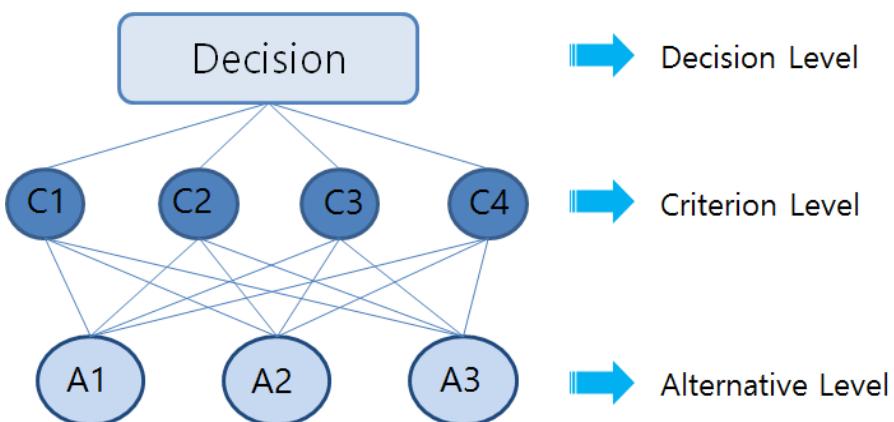
#### **4.1.2. AHP Evaluation Methods and Procedures**

When solving a problem using actual AHP, it performs four steps of setting decision structure, collecting judgment data through pair comparison, estimating relative weight, integrating and prioritizing.

##### **(1) Decision-making structure setting**

Decision-making hierarchy-setting is the task of classifying decision-making problems into a hierarchy of interrelated decision-making. At the top of the hierarchy, the ultimate goal is placed, followed by the next hierarchy. Since hierarchy is an important step of AHP, it is necessary to faithfully carry out three steps: selection of hierarchy and elements, the definitions of concepts, and the establishment of questions (Vargas, 1990).

< Figure 4-1 > Analytic Hierarchy Process



(Source:<https://people.revoledu.com/kardi/tutorial/AHP/AHP-example.html>)

## **(2) Gather judgment data through pair comparisons between decision-making factors**

In general, the degree of contribution to the upper class is given a 9-point scale when writing the questionnaire. The scaling is not necessary 1 to 9 but for qualitative data such as preference, ranking, and subjective opinions, it is suggested to use a scale of 1 to 9 (Saaty, 2008).

< Table 4-1 > AHP: Scale of relative importance

Intensity of importance	Definition	Explanation
1	Equally importance	Two elements are equally important.
3	Moderate importance	One element is slightly more important than the other.
5	Strong importance	One element is more important than the other.
7	Very strong or demonstrated importance	One element is much more important than the other.
9	Extreme importance	One element is absolutely more important than the other.
2,4,6,8	Intermediate significance between nearby numbers in close proximity	Use when needed.
Reciprocal	If one element is more important than the other, the latter has a reciprocal value compared to the importance of the former.	

(Source: Saaty & Vargas, 1991: 24)

### **(3) Estimate relative weights among decision factors**

When the judgment data are collected through the comparison between the decision factors, the relative weights should be estimated. The methods for estimating the weights include the eigenvalue method, the arithmetic mean, and the geometric mean. If the consistency of judgment data is not perfect, the eigenvalue method is the optimal alternative (Saaty, 2008).

AHP is based on subjective comparisons based on subjective judgments, so consistency of preference of A> B and B> C for A> C is necessary for comparison of importance or preference between elements (Kardi, 2006). A Consistency Index (CI) is needed to determine the Consistency Ratio (CR), and CR is an estimate of the consistency of respondents. A random exponent (RI) is a value obtained by creating a reciprocal matrix by randomly setting numerical values from 1 to 9, and calculating an average consistency index of the matrix (Kardi, 2006).

If the value of Consistency Ratio is smaller or equal to 10%, those degree of inconsistency is acceptable. If the Consistency Ratio is greater than 10%, the researcher need to revise the subjective judgment. Researchers conduct a consistency assessment to determine consistency (Kardi, 2006). Meanwhile, Go (2008) mentioned that if the value of CR is 0.1 or less, the response is considered to have a reasonable consistency, and if the value of CR is less than 0.2, the response is also acceptable. Therefore, in this paper, I used 0.1 as a consistency criterion for maximizing the availability of data.

### **(4) Synthesis and prioritization**

In order to achieve the top goal, hierarchical step-by-step priorities should be obtained through pair comparison of the elements of each layer, and when the consistency is reviewed, composite weights for overall priority determination and overall priority for alternatives should be set.

## **4.2. AHP Analysis Framework**

### **4.2.1. AHP Hierarchy**

In order to establish an AHP framework, an extensive literature review was conducted to formulate a draft which contains policy criteria and alternatives. Afterward, the draft was reviewed by experts for formulating the final framework that is used in this study. The AHP hierarchy is set as follows. As presented in <table 4-2 >, four criteria and thirteen policy alternatives were selected. Specifically, Level 1 and level 2 of the hierarchical structure were drawn up based on previous studies. In addition, the AHP model was composed of questionnaire items to enable pair comparison (Refer to appendix 2).

Descriptive explanations for the hierarchy, and also for each criterion and alternatives, will be discussed on the next page.

< Table 4-2 > AHP Hierarchy Structure

Setting priorities in solving the transboundary air pollution problem in Northeast Asia		
Criteria	Policy alternatives	References
International Legal approach	<p>(Prevention)</p> <ul style="list-style-type: none"> <li>- Cross-border environmental impact assessment</li> </ul> <p>(Post relief)</p> <ul style="list-style-type: none"> <li>- State responsibility system</li> <li>- Polluter pays principle</li> <li>- International litigation (Judicial proceedings)</li> </ul>	Hunter et al (2009), Park (2017), Noh et al. (1999), Won (2014), Ham (2014), Kim (2015)
Diplomatic approach	<ul style="list-style-type: none"> <li>- Set binding reduction targets and conclude binding environmental agreements</li> <li>- Flexible legal approach: non-binding protocol-oriented convention (Formation of an environmental regime with related countries)</li> <li>- The efficiency or unification of existing environmental cooperation organizations</li> </ul>	Park (2014), So (2017), Won (2014), Young (2008), Biermann (2007), Kates et al. (2001), Lee (2002)
Technological approach	<ul style="list-style-type: none"> <li>- Cooperation in scientific research of the path of fine dust between China and Korea</li> <li>- Air pollution modeling technology transfer to China</li> <li>- Establishment of air pollution abatement facilities in Chinese industries</li> </ul>	Han (2007), Ye (2010), So (2017), Lee et al. (2015)
Policy-Based approach	<ul style="list-style-type: none"> <li>- Establishment of various stakeholder governance (Environmental Information Cooperation Organization)</li> <li>- Eliminate scientific uncertainty by building a network of experts</li> <li>- Finding solutions based on market mechanism (Link with emission trading system)</li> </ul>	Jeong (2006), Won (2014), Lee (2018), An et al. (2016)

#### **4.2.2. The Conceptual Definition of Hierarchy**

Four major criteria have been selected as the upper layers. The four criteria are the international legal, diplomatic, technological and policy-based approach. In addition, a total of 13 policy alternatives were derived under the four criteria. The description of each factor is as follows.

First, four policy alternatives such as the cross-border environmental impact assessment, the state responsibility system, the polluter pays principle and the international litigation have been suggested in terms of the international legal approach.

- ‘Cross-border environmental impact assessment’ is a pre-assessment of the environmental impact of economic activities to ensure sound and sustainable development. The first international treaty to provide specific and systematic rules and procedures for the cross-border environmental impact assessment system is “The convention on Environmental Impact Assessment in a Transboundary context” ratified in 1997 by the United Nations Economic Commission for Europe (Kim, 2015). The Convention stipulates that negotiations should take place at an early stage with countries with significant potential to be affected or affected by transboundary air pollution. In particular, Article 8 stipulates that the development plan and the policy change information of the central government and local governments which may cause the damage of the transboundary environmental pollution should be exchanged (So, 2017).
- ‘The state responsibility system’ can be summarized as follows: states are responsible for injuries caused to the environment of another state or the global commons resulting from violations of a generally accepted international rules or standards (Hunter et al., 2009).

- ‘The polluter pays principle (PPP)’ means that the polluter should bear the expenses of carrying out pollution prevention measures or paying for damage caused by pollution (Noh et al., 1999).
- Lastly, ‘international litigation’, sometimes called transnational litigation, means litigation for or against foreign governments or entities in arbitrations or courts. The Trail Smelter Case between the United States and Canada is an example of arbitration.

Secondly, three policy alternatives such as setting binding reduction targets, the formation of an environmental regime (non-binding protocol-oriented convention), and the efficiency or unification of existing environmental cooperation organizations have been derived in terms of the diplomatic approach. In fact, the most representative form of diplomatic cooperation is to establish bilateral or multilateral agreements that comply with regulatory legal norms among countries (Won, 2014).

- ‘Setting binding reduction targets’ is to establish an agreement to set pollution reduction goals and mandate them to be implemented within a specified time frame. The Convention on Long-range Transboundary Air Pollutants (CLRTAP) is a representative example. Although the CLRTAP originally started as a non-binding convention, it successfully reduced pollutants through the eight protocols with the obligations to reduce pollutants.
- ‘Formation of an environmental regime’ means creating a type of institution, where an institution is understood as “a cluster of rights, rules, and decision-making procedures that gives rise to a social practice, and guides interactions among occupants of these roles” (Young, 2008). It is also understood as a non-binding protocol-oriented convention among countries in a broad sense.
- ‘The efficiency or unification of existing environmental cooperation organizations’ means the efficient reorganization of existing environmental cooperation organizations in Northeast Asia and the creation of unified

cooperation windows. Environmental cooperation in Northeast Asia has been achieved through international organizations such as ESCAP and multilateral meetings, and there are more than 10 examples of such cooperation. These organizations and meetings, which are held sporadically and redundantly, have a positive effect of attempting environmental cooperation in various dimensions, but they can deteriorate productivity and efficiency in that they do not have a central point (An, 2008).

Third, three alternatives were derived from the technological approach. They are the cooperation in scientific research of the path of fine dust between China and Korea, the air pollution modeling technology transfer to China, and the establishment of air pollution abatement facilities in Chinese industries.

- ‘The Cooperation in scientific research of the path of fine dust’ is to investigate the exact route and contribution rate of pollutants from China by both Korea and China. The accumulation of scientific knowledge is indispensable for the transboundary air pollution cooperation organization to function properly. This is because air pollution characteristics and route data confirmed through more objective and unified modeling are the basis for policy formation.
- ‘The air pollution modeling technology transfer to China’ means that Korea provides environmental technology to China to induce efforts to improve China's air quality.
- The final alternative is that ‘Korea and China jointly pay for the cost of installing air pollution abatement facilities in Chinese industries’. This solution will allow Korea to improve air quality in China by providing environmental technology to China and expand the opportunities for Korean environmental companies to enter China.

Fourth, three alternatives such as the establishment of various stakeholder governance (the establishment of Environmental Information Cooperation Organization), eliminating scientific uncertainty by building a network of experts, and accessing through market mechanisms (Linked with greenhouse gas reduction targets) have been derived in terms of the policy-based approach.

- ‘The Environmental Information Cooperation Organization’ is an organization that engages stakeholders in environmental issues at various levels such as central governments, local governments, industries, and NGOs in the decision-making process.
- ‘The establishment of a network of experts’ is a form of public consensus and epistemic communities (a network of knowledge-based experts) that can redefine the interests of individual countries. One of the obstacles to international environmental cooperation related to the issue of transboundary environmental pollution in Northeast Asia is scientific uncertainty. In this situation, it is important to establish a network of experts to form a common consensus rather than to identify the responsibility of fine dust in order to bring China, which is a provider of pollution, into cooperation. (Won, 2014).
- ‘The market mechanism’ is to devise solutions based on market mechanism such as an Emission Trading System (ETS) and Seoul Metropolitan Air Pollutant Emission-cap Management System. Environmental pollution is a by-product of economic activity. If it is not possible to impose and enforce effective legally binding obligations on the basis of complete information on environmental pollution, it may be more effective to devise a system that can solve environmental problems by invisible hands in markets where economic activity occurs (So, 2006).

## **4.3. Survey Research**

### **4.3.1. Questionnaire Design**

The survey questions were divided into the general questionnaire and AHP questionnaire as shown in < table 4-3 >. Generally, the questions in the first half should be as easy to respond to as possible and be interesting when determining the order of the questions. In addition, the position of the questions to be answered should be selected considering the relationship between the question items (Yun, 2002). Therefore, prior to the AHP questionnaire, I tried to improve the validity of the survey results by adding the recognition level and policy characteristics of fine dust issues.

The survey questions about the awareness level of fine dust problems consisted of basic concepts and core items. Moreover, these questions were made with reference to a recent survey questionnaire (SDU, 2017), thus raising the cogency of the survey. The AHP questionnaire consisted of policy criteria and alternatives based on preferences for addressing transboundary air pollution in Northeast Asia. This allowed pair comparisons to proceed. Furthermore, in order to examine the validity of the questionnaire, 2 experts were selected from the sample and they conducted a preliminary survey. Finally, AHP analysis and consistency testing were applied to the analysis using a consistent EC2000 program.

< Table 4-3 > Composition of Survey Items

		Contents	Question Number	Remarks
General Survey	Recognition level	Recognizing the seriousness of fine dust	1-1	Precedent research (SDU, 2017)
		Causes of fine dust	1-2	Precedent research (SDU, 2017)
	Policy	Solutions of the transboundary fine dust problem	1-3	Precedent research (SDU, 2017)
		Current government policy evaluation	1-4	Precedent research (SDU, 2017)
AHP Survey	Criteria	Priority Policy Considerations	2-1	
	Alternatives	Choosing policy alternatives through pair comparisons	2-2	

### 4.3.2. Survey Subjects and Data Collection

The AHP survey was conducted by engaging a total of 26 experts in the field of international environmental law or Northeast Asia environmental cooperation in order to evaluate the relative importance of policy criteria and priorities of multiple alternatives according to the AHP method. Experts were divided into four groups: government officials, researchers at national research institutes, professors, and

related NGOs dealing with environmental issues.

The specific subjects were selected evenly within each group. According to the AHP study and questionnaire, the sample size of 10-15 for the questionnaire is sufficient if the characteristics of the group are homogeneous (Lee, 2000). Therefore, the sample size of this paper was determined to be 26. Moreover, the subjects covered public officials, researchers, and professors with around or over 10 years of experience working in government agencies, government-funded research institutes, universities, and NGOs responsible for international environmental cooperation and air pollution policies. They are more familiar with the subject than anyone else, either because they have experience in environmental cooperation projects in Northeast Asia with experts in neighboring countries or because they are studying this issue from the current point of view. Therefore, they can make clear decisions when choosing policy criteria and alternatives for Northeast Asia's air pollution.

< Table 4-4> Survey Subjects

Groups	Government officials	Researchers	Professors	NGOs
	6	6	9	5
Total	26			

Specifically, government officials included experts from the Ministry of Environment and the National Institute of Environmental Research (NIER), and the researchers were chosen among those working at the Korea Environment Institute (KEI), Korea Environmental Industry and Technology Institute (KEITI) and the Seoul Institute (SI). University professors and NGOs included people who have written papers on the issue of transboundary air pollution.

The questionnaire was emailed to the subjects and replied to by all 26 people between August 1, 2018 and September 30, 2018 (Questionnaire, appendix 2).

### **4.3.3. Reliability of the Survey Results**

In this paper, questionnaires with a consistency ratio (CR) of 0.1 (10%) or less were analyzed. Prior to conducting the analysis by collecting the questionnaire, I calculated the consistency ratio of the responses to the questionnaire by respondents. This process was to remove questionnaire responses with a consistency ratio of more than 0.1. Thus, the reliability of the overall results can be secured by analyzing only the responses with internal consistency in the responses.

The consistency ratio of 26 respondents in total was 0.05 (5%), and this meant that the consistency ratio of all 26 was below 0.1. Thus, all 26 samples were used for AHP analysis.

< Table 4-5 > Consistency Ratio (CR) Per Sample

	Sample number	CR	Ratio to the total sample
All samples	26	0.05	100%

# **Chapter 5. Results**

## **5.1. Priority Analysis by Level 1 (Policy Criteria)**

### **5.1.1. Characteristics of Survey Respondents**

When collecting data for AHP analysis, it is said that the number of the subjects to be surveyed can be up to 10-15 persons if they have practical knowledge, professional experience, and homogeneous characteristics (Lee, 2002). In this study, the questionnaires were distributed to 26 experts in order to secure the expertise of the survey. All of the distributed questionnaires were collected and used for analysis. The survey respondents are as follows.

First, the personal details of the survey respondents are shown in <Table 5-1>. To illustrate, the survey respondents were 18 males (69.2%) and 8 females (30.8%). In the government area, there were 2 males (33.3%) and 4 females (66.7%). When it comes to researchers, there were 5 males (83.3%) and 1 female (16.7%). In the case of Professors, 7 males (77.8%) and 2 females (22.2%). There were 4 males (80.0%) and 1 female (20.0%) in the NGO sector. Looking at the career experience of the survey subjects, 6 people (23.1%) had less than 10 years of experience in their field, 8 people (30.8%) had more than 10 years and less than 12 years of experience, 8 people (30.8%) had more than 12 years and less than 16 years of experience, and 2 people (7.7%) had more than 16 years and less than 18 years of experience. Lastly, 2 people (7.7%) had more than 20 years of experience.

< Table 5-1 > Characteristics of Respondents

		Group				
		Government officials	Researchers	Professors	NGO	Total
Gender	Male	2	5	7	4	18
		(33.3)	(83.3)	(77.8)	(80.0)	(69.2)
	Female	4	1	2	1	8
		(66.7)	(16.7)	(22.2)	(20.0)	(30.8)
Work experience	Less than 10 years	0	2	4	0	6
		(.0)	(33.3)	(44.4)	(.0)	(23.1)
	More than 10 years, less than 12 years	3	2	1	2	8
		(50.0)	(33.3)	(11.1)	(40.0)	(30.8)
	More than 12 years, less than 14 years	1	1	1	1	4
		(16.7)	(16.7)	(11.1)	(20.0)	(15.4)
	More than 14 years, less than 16 years	2	0	1	1	4
		(33.3)	(.0)	(11.1)	(20.0)	(15.4)
	More than 16 years, less than 18 years	0	0	1	1	2
		(.0)	(.0)	(11.1)	(20.0)	(7.7)
	More than 20 years	0	1	1	0	2
		(.0)	(16.7)	(11.1)	(.0)	(7.7)
	Total	6	6	9	5	26
		(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

## **5.1.2. Priority Analysis of Criteria**

### **1. Overall Comparative Analysis**

The AHP method was used to prioritize the relative weight of the four approaches. And then the preferences for policy alternatives for each approach were derived in the same way. The weighted value was calculated by averaging the weights in the importance of priority among the elements. The comparison matrix of level 1 with respect to the policy criteria is shown in < table 5-2>. According to the overall ranking, the diplomatic approach was the first policy criteria that should be considered to solve the transboundary air pollution in Northeast Asia (.291). Then this was followed by the policy-based approach (.267), the technological approach (.264), and the international legal approach (.179).

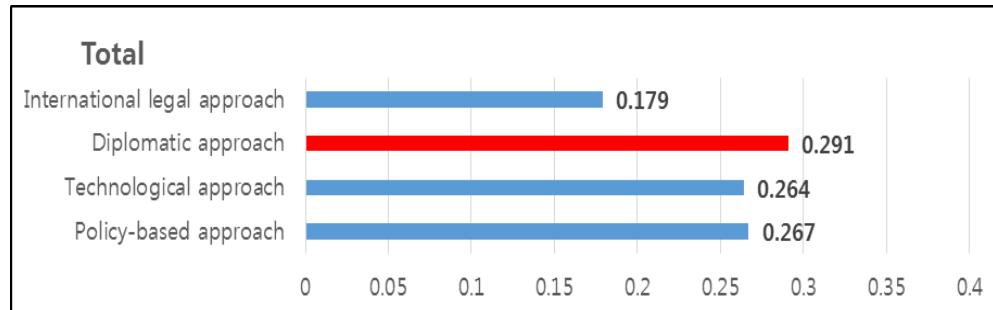
< Table 5-2 > Comparison Matrix of level 1 with respect to the policy criteria

	Priority weight	Rank
International legal approach	0.179	4
Diplomatic approach	0.291	1
Technological approach	0.264	3
Policy-based approach	0.267	2
Sum	1	

Taking the analysis result into consideration, the experts may think that the diplomatic approach is the most realistic, feasible and prioritized among the four approaches. As mentioned earlier, the international legal approach is not easy to

pursue in the short term because it is necessary to confirm that the movement route of domestic fine dust originates from foreign countries, especially China. On top of that, the technological and the policy-based approach are less formal and practical than the diplomatic approach. Perhaps, that's why survey subjects prefer the diplomatic approach. <Figure 5-1> shows the degree of importance of each relative weight.

<Figure 5-1> Comparison Graph of the four criteria



## 2. Comparative Analysis by an expert group

In terms of expert groups, government officials ranked the policy-based approach first (.327), the technological approach second (.262), the diplomatic approach third (.242), and the international legal approach fourth (.169). In the case of researchers, the first choice was the technological approach (.331), the second was the diplomatic approach (.268), the third was the policy-based approach (.238), and the fourth was the international legal approach (.164). Professors ranked the diplomatic approach first (.339), the technological approach second (.277), policy-based approach third (.244), and the international legal approach fourth (.140). Lastly, when it comes to NGOs, the first choice was the diplomatic approach (.315), the second choice was the policy-based approach (.258), third was the international legal approach (.243), fourth was the technological approach (.179). <Table 5-3> and <figure 5-2> show the degree of importance of each relative weight.

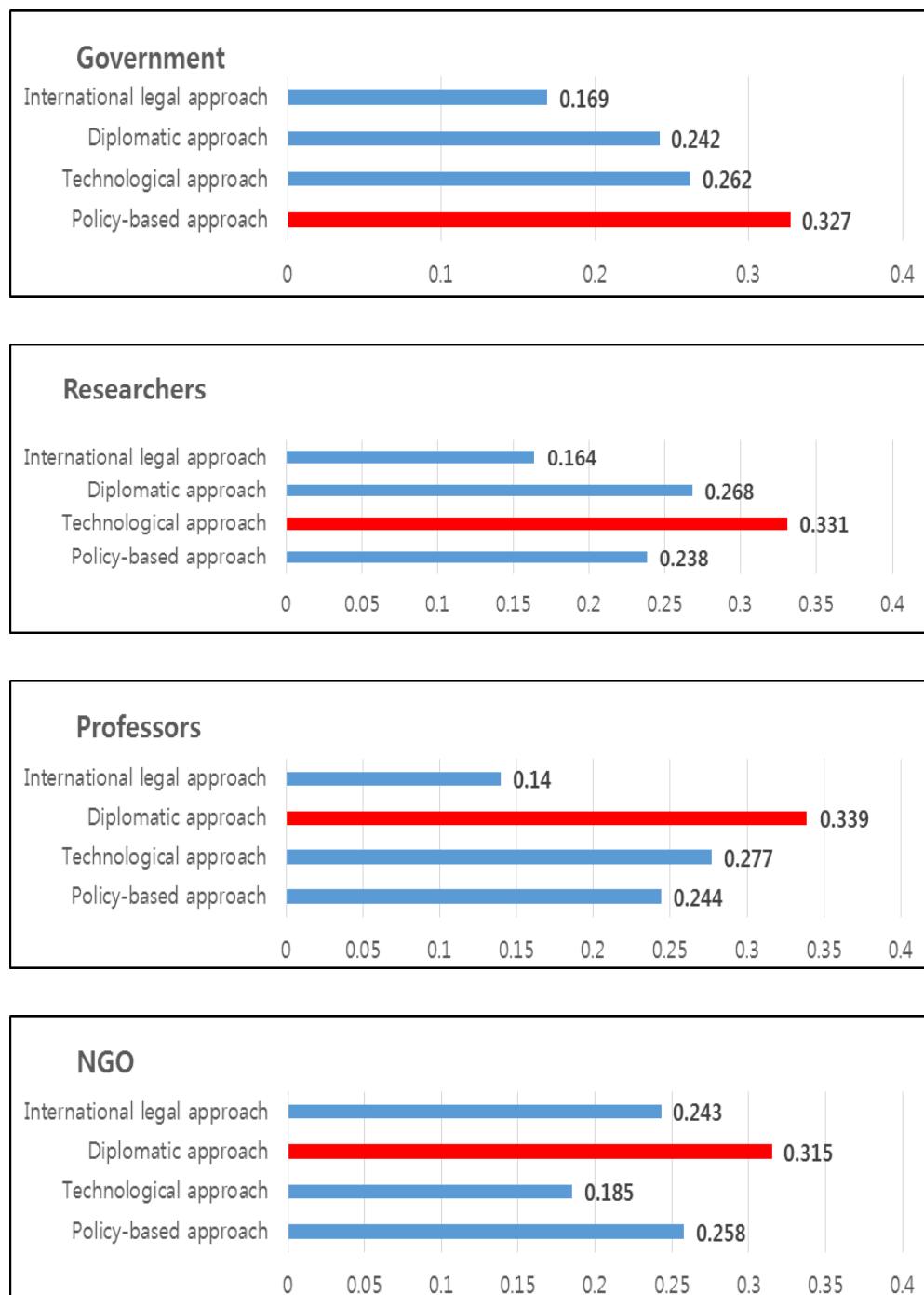
The results of policy preference by an expert group may be interpreted as follows.

First of all, it shows the characteristics of each group. Since government officials are directly responsible for environmental cooperation in Northeast Asia, they are aware of the limitations of their work and will probably prefer more realistic and practical alternatives. It is possible to interpret that researchers prefer the technological approach because they are analyzing data or pursuing in-depth research projects. In addition, professors and NGOs might prefer the diplomatic approach since they tend to suggest comparatively more aggressive and fundamental policy alternatives to the government side. They already know, however, that the international legal approach is less feasible.

< Table 5-3 > Comparison Matrix of the four criteria by an expert group

category	Government officials		Researchers		Professors		NGO	
	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank
International legal approach	.169	4	.164	4	.140	4	.243	3
Diplomatic approach	.242	3	.268	2	.339	1	.315	1
Technological approach	.262	2	.331	1	.277	2	.185	4
Policy-based approach	.327	1	.238	3	.244	3	.258	2

< Figure 5-2 > Comparison Graph of the four criteria by an expert group



## **5.2. Priority Analysis by Level 2 (Policy Alternatives)**

### **5.2.1. International Legal Approach**

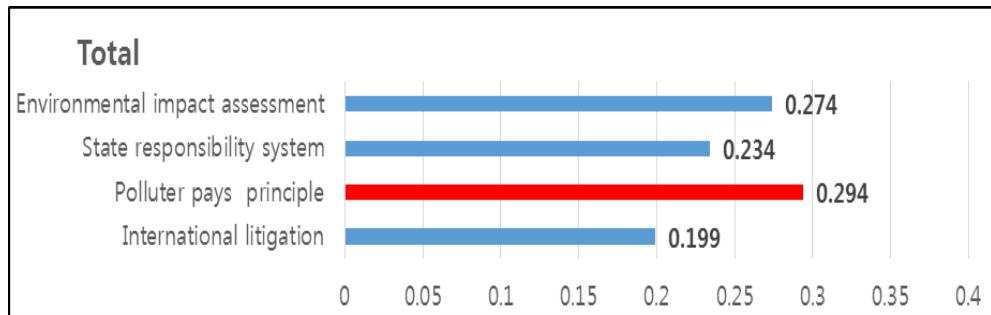
#### **1. Overall Comparative Analysis**

The relative importance of the policy alternatives of the international legal approach is as follows, see <table 5-4>. To summarize, experts preferred the polluter pays principle among the four alternatives. Specifically, in the overall ranking, survey respondents chose to apply the polluter pays principle as the most important alternative (.294). The introduction of cross-border environment impact assessment ranked second (.274). The third was the state responsibility system (.234), and the fourth was the international litigation (.199).

< Table 5-4 > Comparison Matrix of the four alternatives in the international legal approach

	Priority weight	Rank
Cross-border environmental impact assessment	0.274	2
State responsibility system	0.234	3
Polluter pays principle	0.294	1
International litigation	0.199	4
Sum	1	

< Figure 5-3 > Comparison Graph of the four alternatives in the international legal approach



## 2. Comparative Analysis by an expert group

Experts have given relative importance to respectively different policy among alternatives to the international legal approach. As a preferred policy, government officials have chosen the international litigation, researchers and professors preferred the cross-border environmental impact assessment, and NGOs selected the polluter pays principle. Taken these results into consideration, it was thought that the solution based on the polluter pays principle was rated as the most important alternative for respondents in international legal approach.

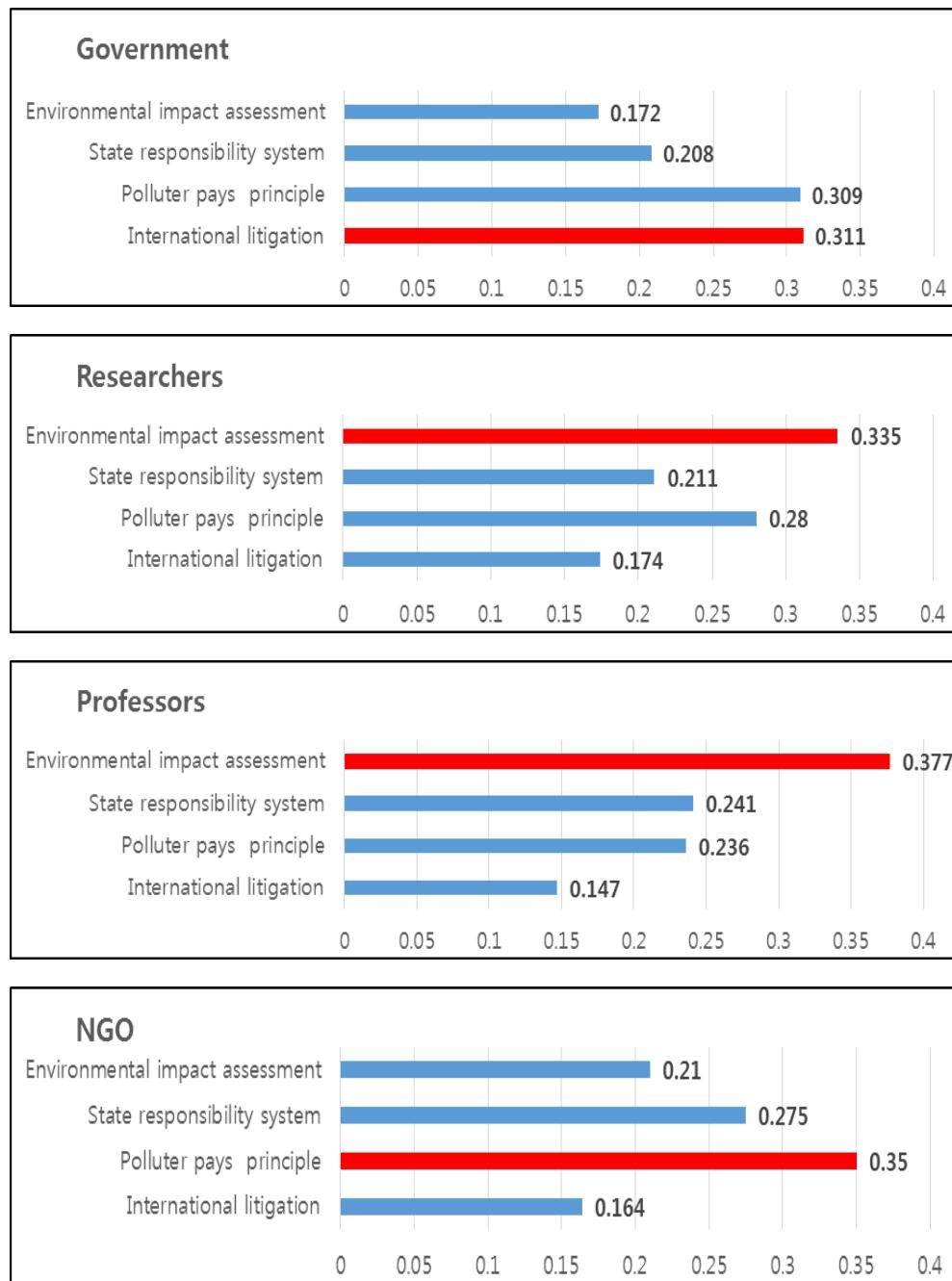
Looking at specific figures, in the case of government officials, the first was the international litigation (.311), the second was the polluter pays principle (.309), the third was the state responsibility system (.208), and the fourth was the cross-border environmental impact assessment (.172). In terms of the researchers, the first was the adoption of cross-border environmental impact assessment (.335), the second was the polluter pays principle (.280), the third was the state responsibility system (.211) and the fourth is the international litigation (.174). Professors chose the Cross-border environmental impact assessment in the first place (.377). The second was the state responsibility system (.241) and the third was the polluter pays principle (.236). Professors responded the international litigation to with the lowest ranking of

the international legal approach policy alternatives (.147). When it comes to NGOs, the polluter pays principle was chosen as the top priority (.350). The state responsibility system was the second (275), and the third was the introduction of cross-border environmental impact assessment (.210). The policy alternative that was least favored by NGOs was the international litigation (.164). <Figure 5-4> shows the relative importance of each policy alternative.

**< Table 5-5 > Comparison Matrix of the four alternatives by an expert group**

Criteria	Government officials		Researchers		Professors		NGO	
	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank
Cross-border environmental impact assessment	.172	4	.335	1	.377	1	.210	3
State responsibility system	.208	3	.211	3	.241	2	.275	2
Polluter pays principle	.309	2	.280	2	.236	3	.350	1
International litigation	.311	1	.174	4	.147	4	.164	4

< Figure 5-4 > Comparison Graph of the four alternatives by an expert group



## **5.2.2. Diplomatic Approach**

### **1. Overall Comparative Analysis**

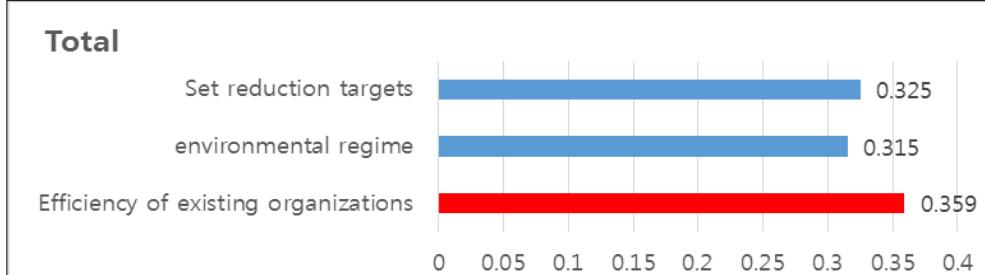
The relative weight of the policy alternatives of the diplomatic approach is as follows <table 5-5>. In the overall ranking, survey respondents chose to apply the efficiency or unification of existing environmental cooperation organizations as the most important alternative (.359), and setting binding reduction targets and concluding binding environmental agreements ranked second (.325). The third was the formation of an environmental regime with related countries (.315). In the priority analysis of criteria, survey respondents preferred the diplomatic approach, so that "the efficiency or unification of existing environmental cooperation organizations" among policy alternatives in the diplomatic approach is the one that experts consider to be the top priority in AHP analysis.

The result of the analysis may be interpreted as follows. The experts seem to have judged that it is effective to utilize the existing institutions properly. There are already many consultative bodies and organizations for environmental cooperation in Northeast Asia, but they carried out redundant functions and suggested simple projects such as sharing environmental policies success stories. Therefore, it has been pointed out that the cooperation examples should be reformed or reorganized efficiently. Moreover, the environmental agreement between Korea and China have already been established in 1993 and a memorandum of understanding on environmental cooperation (particularly on strengthening air pollution cooperation) was signed under this agreement in 2014. Therefore, signing a new agreement (including a specific reduction target) in the near future may be less realistic and it will be difficult for China to accept the new agreement.

< Table 5-6 > Comparison Matrix of the three alternatives in the diplomatic approach

	Priority weight	Rank
Set binding reduction targets	0.325	2
Formation of an environmental regime	0.315	3
The efficiency or unification of existing organizations	0.359	1
Sum	1	

< Figure 5-5 > Comparison Graph of the three alternatives in the diplomatic approach



## 2. Comparative Analysis by an expert group

In terms of expert groups, government officials ranked the efficiency or unification of an existing organization first (.408), the second was the formation of an environmental regime (.328), the third was setting binding reduction targets (.264). In the case of researchers, the first choice was setting binding reduction targets (.373), the second was the efficiency or unification of existing cooperation organizations (.361), third was the formation of an environmental regime (.265). Professors ranked the efficiency of an existing cooperation organizations diplomatic approach first

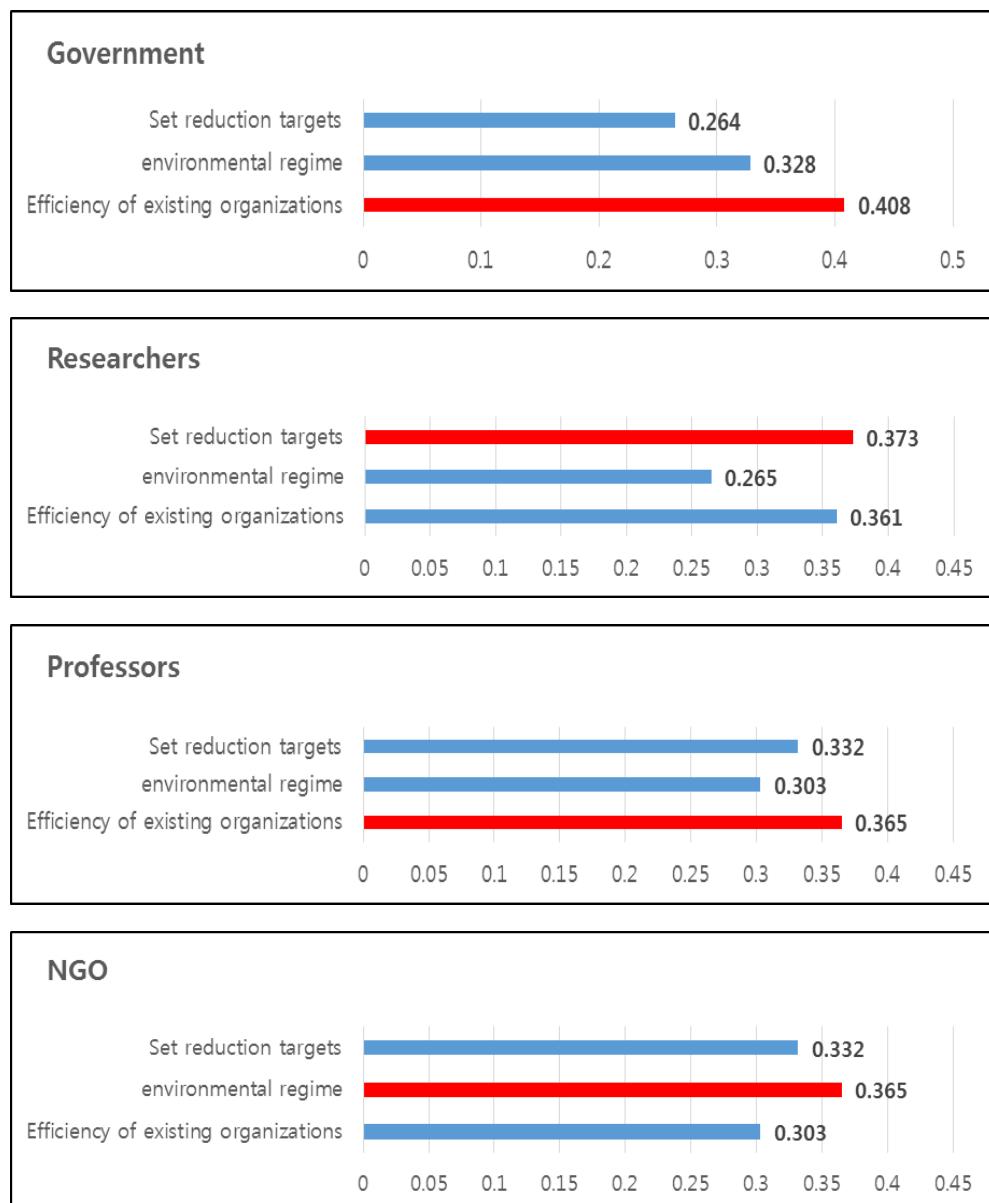
(.365), setting binding reduction targets second (.332), the formation of an environmental regime third (.303). Lastly, in terms of NGOs, the first choice was the formation of an environmental regime (.365), the second choice was setting binding reduction target (.332), third was the efficiency or unification of existing organizations (.303). The < figure 5-6 > shows the degree of importance of each relative weight.

The results may be interpreted as follows. Government officials prefer to implement feasible policy alternatives because they are the ones that create and enforce the policies on their own. Therefore, they would have ranked the third alternative as a top priority. Researchers dealing with scientific data preferred the first alternative to achieving clear and visible results. Professors preferred the third alternative. As suggested in previous studies, scholars emphasized practically feasible alternatives rather than future-oriented policies such as setting reduction targets. NGOs tend to refer to big picture in macro perspective. They favored the formation of environmental regimes as a top priority.

< Table 5-7 > Comparison Matrix of the three alternatives by an expert group

Criteria	Government officials		Researchers		Professors		NGO	
	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank
Set binding reduction targets	.264	3	.373	1	.332	2	.332	2
Formation of an environmental regime	.328	2	.265	3	.303	3	.365	1
The efficiency or unification of existing organizations	.408	1	.361	2	.365	1	.303	3

< Figure 5-6 > Comparison Graph of the three alternatives by an expert group



### **5.2.3. Technological Approach**

#### **1. Overall Comparative Analysis**

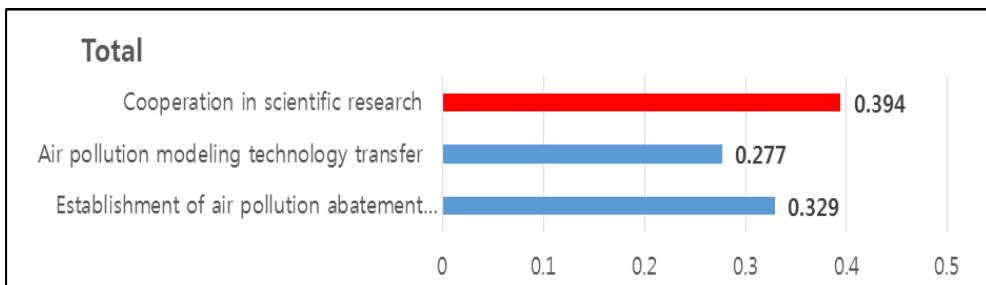
The relative importance of the policy alternatives of the technological approach is as follows < table 5-8 >. In the overall ranking, survey respondents chose to pursue cooperation in scientific research of the path of fine dust between China and Korea as the most important alternative (.394), and an establishment of air pollution abatement facilities in China ranked second (.329). The third was the air pollution modeling technology transfer (.277).

Many scholars have pointed out that the transboundary fine dust in Northeast Asia requires scientific data on the cause and route of movement. Moreover, it is necessary to grasp precise cause-and-effect relationships in order to approach from the viewpoint of international law or environmental agreement including binding reduction targets. Given these points, experts seem to regard scientific research as the most important priority factor.

**< Table 5-8 > Comparison Matrix of the three alternatives in the technological approach**

	Priority weight	Rank
Cooperation in scientific research of the path of fine dust between China and Korea	0.394	1
Air pollution modeling technology transfer	0.277	3
Establishment of air pollution abatement facilities in China	0.329	2
Sum	1	

<Figure 5-7 > Comparison Graph of the three alternatives in the technological approach



## 2. Comparative Analysis by an expert group

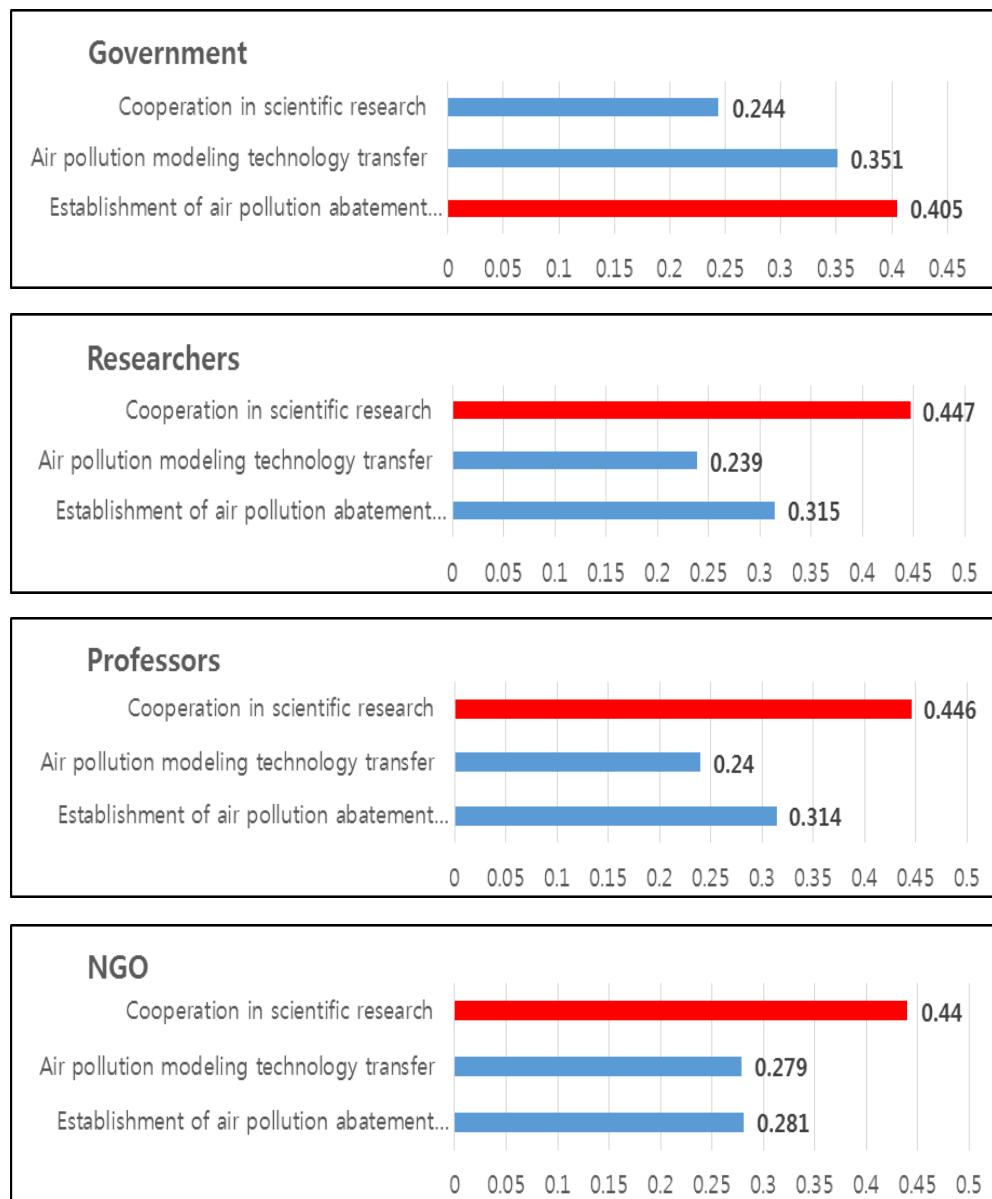
In the case of government officials, the first was the establishment of air pollution abatement facilities in China (.405), the second was the air pollution modeling technology transfer (.351), third was the cooperation in scientific research of the path of fine dust between China and Korea (.244). In terms of the researchers, the cooperation in scientific research of the path of fine dust between China and Korea ranked first (.447), the second was establishment of air pollution abatement facilities in China (.315), the air pollution modeling technology transfer ranked third (.239). Professors chose the cooperation in scientific research of the path of fine dust between China and Korea in the first place (.446). The second was the establishment of air pollution abatement facilities in China (.314). Professors responded to the air pollution modeling technology transfer with the lowest ranking of the technological approach policy alternatives (.240). When it comes to NGOs, the cooperation in scientific research of the path of fine dust between China and Korea was chosen as the top priority (.440). The establishment of air pollution abatement facilities in China was second (281), and the third was the air pollution modeling technology transfer (.279). <Figure 5-8> illustrates the degree of importance of each policy alternative.

In the technological approach, all experts, except government officials, chose the cooperation in scientific research of the path of fine dust between China and Korea as the firsthand alternative. This means that it is important for the countries concerned to cooperate and reveal scientific facts related to transboundary air pollution substances. However, government officials preferred the establishment of air pollution abatement facilities in China as the first place, unlike other expert groups. They have been negotiating with China on an ongoing basis to obtain fine dust data measured in China, and both countries have pledged to share some fine dust data step by step since 2015. However, on the other hand, the negotiation have not gone smoothly, and one of the causes is that technology level of China is still less than that of Korea. Based on these facts, government officials seem to have decided that the third alternative should be promoted at the present time, and that fine dust information sharing between the two countries should be implemented when the atmosphere of negotiations is established.

**< Table 5-9 > Comparison Matrix of the three alternatives by an expert group**

Criteria	Government officials		Researchers		Professors		NGO	
	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank
Cooperation in scientific research of the path of fine dust between China and Korea	.244	3	.447	1	.446	1	.440	1
Air pollution modeling technology transfer	.351	2	.239	3	.240	3	.279	3
Establishment of air pollution abatement facilities in China	.405	1	.315	2	.314	2	.281	2

< Figure 5-8 > Comparison Graph of the three alternatives by an expert group



## **5.2.4. Policy-based Approach**

### **1. Overall Comparative Analysis**

The relative weight of the policy alternatives of policy-based approach is as follows < table 5-10 >. In the overall ranking, survey respondents chose to pursue the establishment of various stakeholder governance as the most important alternative (.368), and the introduction of market mechanism ranked second (.331). The building a network of experts ranked third (.301).

The respondents chose the establishment of various stakeholder governance as the first alternative, which is interpreted as the importance of stakeholder involvement not only from the government side but also from various sectors such as local governments, industries, and NGOs in the decision-making process.

**< Table 5-10 > Comparison Matrix of the three alternatives in the policy-based approach**

	Priority weight	Rank
Establishment of various stakeholder governance	0.368	1
Building a network of experts	0.301	3
Finding solutions based on market mechanism	0.331	2
Sum	1	

**<Figure 5-9 > Comparison Graph of the three alternatives in the policy-based approach**



## **2. Comparative Analysis by an expert group**

In terms of expert groups, government officials ranked first in building a network of experts (.369), finding solutions based on market mechanism ranked second (.360). The establishment of various stakeholder governance ranked third (.270). In the case of researchers, the first choice was the establishment of various stakeholder governance (.442), the second was finding solutions based on market mechanism (.291), third was the building a network of experts (.267). Professors ranked the establishment of various stakeholder governance as the most important alternative (.371), the building a network of experts ranked second (.365), finding solutions based on market mechanism ranked third (.264). Lastly, in terms of NGOs, the first choice was finding solutions based on market mechanism (.407), the second choice was the establishment of various stakeholder governance as the most important alternative (.389), third was the building a network of experts (.204). The < figure 5-10 > shows the degree of importance of each relative weight.

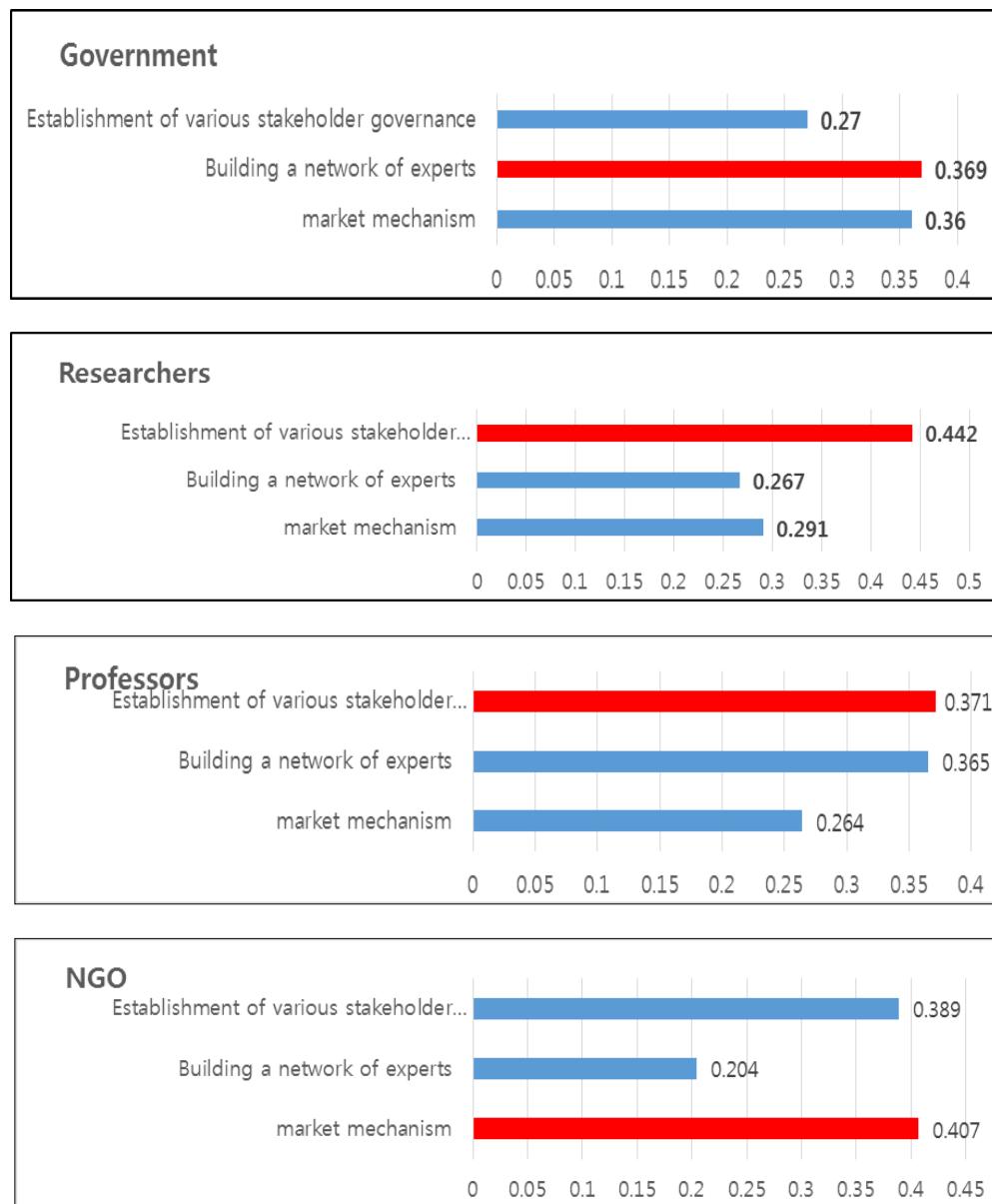
Government officials ranked building a network of experts as a top priority, while researchers and NGOs chose the establishment of various stakeholder governance as a priority. Perhaps it may be explained that government officials are showing a passive attitude toward the participation of various stakeholder governance in the policy making process. Rather, they want to reduce the fine dust concentrations with the help of a network of experts with expertise and scientific knowledge on the issues. On the other hand, researchers and professors preferred various stakeholder governance. External experts may be judging that it is important for various social actors to participate in decision making through stakeholder governance. NGOs chose the market mechanism. An emissions-trading system, a typical example of market mechanism, is a system whereby the total amount of emissions is capped and allowance can be bought and sold to meet emission reduction objectives. Such a

system could serve as a cost-effective measure to limit or reduce fine dust concentrations in the long term, provided that it is open to all economic sectors. Since NGOs generally want an ambitious alternative, they seem to consider the introduction of market mechanism as an effective means of responding to the fine dust problem.

**< Table 5-11> Comparison Matrix of the three alternatives by an expert group**

	Government officials		Researchers		Professors		NGO	
	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank	Priority weight	Rank
Establishment of various stakeholder governance	.270	3	.442	1	.371	1	.389	2
Building a network of experts	.369	1	.267	3	.365	2	.204	3
Finding solutions based on market mechanism	.360	2	.291	2	.264	3	.407	1

<Figure 5-10> Comparison Graph of the three alternatives by an expert group



## **5.3. Integrated Priority Analysis**

### **5.3.1. Overall Analysis**

Heo et al. (2010) conveyed that the results of global priorities are determined by multiplying the priority vectors of criteria (Level 1) to the priority vector of each alternative (Level 2). The calculation results that determine the overall weights of all alternatives and the global priorities are shown in < table 5-12 >.

As a result of the AHP analysis, the top four of the 13 policy alternatives are the efficiency or unification of existing organizations (0.1045), the cooperation in scientific research of the path of fine dust between China and Korea (0.1040), the establishment of various stakeholder governance (0.0983) setting an air pollution reduction targets (0.0946) in order. The most preferred policy alternative for 26 experts is ‘the efficiency or unification of existing organizations’, a sub-factor of the diplomatic approach. This result suggests that experts prefer to reorganize many cooperating organizations and meetings or to integrate organizations. The second is ‘the cooperation in scientific research between China and Korea’, which has been consistently emphasized previous studies by experts. Although the technological approach ranked third in the first-level preference, this alternative ranked second in the overall ranking. This result implies that experts regarded the cooperation in scientific research between China and Korea as relatively more important. This is probably due to the fact that reducing transboundary fine dust concentrations begins with the resolution of scientific uncertainties and the identification of causal relationships. The third preferred alternative is ‘the establishment of various stakeholder governance’. This is the result of emphasizing that the transboundary air pollution should be addressed not only by the central governments but also by all the social actors such as local governments, industries, and NGO groups. Finally, the fourth place in the top group is ‘the

setting binding reduction targets'. This option will maximize the effectiveness of the policies if it is pursued after successfully achieving the first, second, and third alternatives.

The next five middle alternatives are the formation of an environmental regime (0.0917), the finding solutions based on market mechanism (0.0884), the establishment of air pollution abatement facilities in China (0.329), the building a network of experts (0.0804), the air pollution modeling technology transfer (.0731) in order. The results of the middle group were generally based on the preference of the first level.

Among the 13 policy alternatives, the four least preferred are the polluter pays principle (0.0526), the cross-border environmental impact assessment (0.0490), the state responsibility system (0.0419) and the international litigation (0.0356). These are all sub-policy alternatives under the international legal approach. This result may be interpreted to be due to the fact that international legal approach ranked fourth in the level 1 preference analysis. In the previous research, scholars argued that in order to approach the transboundary air pollution problem based on an international legal point of view, it is necessary to scientifically prove the facts related to fine dust and to obtain exact evidence data on the movement route of fine dust from China. Failure to achieve their arguing would make it difficult to bring legal responsibility for the Chinese government (So 2006; So 2017; Park 2017; Noh 1999). <Table 5-13> shows the overall ranking of policy alternatives in order.

< Table 5-12 > Results of Integrated Priority Analysis

AHP Hierarchy		Relative importance (Level1*Leel2)	Rank
Level 1	Level 2		
International legal approach (0.179)	Cross-border environmental impact assessment (0.274)	0.0490	11
	State responsibility system (0.234)	0.0419	12
	Polluter pays principle (0.294)	0.0526	10
	International litigation (0.199)	0.0356	13
Diplomatic approach (0.291)	Set binding reduction targets (0.325)	0.0946	4
	Formation of an environmental regime (0.315)	0.0917	5
	The efficiency or unification of existing organizations (0.359)	0.1045	1
Technological approach (0.264)	Cooperation in scientific research of the path of fine dust between China and Korea (0.394)	0.1040	2
	Air pollution modeling technology transfer (0.277)	0.0731	9
	Establishment of air pollution abatement facilities in China (0.329)	0.0869	7
Policy-based approach (0.267)	Establishment of various stakeholder governance (0.368)	0.0983	3
	Building a network of experts (0.301)	0.0804	8
	Finding solutions based on market mechanism (0.331)	0.0884	6

< Table 5-13 > Overall Ranking

Rank	Total
1	The efficiency or unification of existing organizations
2	Cooperation in scientific research of the path of fine dust between China and Korea
3	Establishment of various stakeholder governance
4	Set binding reduction targets
5	Formation of an environmental regime
6	Finding solutions based on market mechanisms
7	Establishment of air pollution abatement facilities in China
8	Building a network of experts
9	Air pollution modeling technology transfer
10	Polluter pays principle
11	Cross-border environmental impact assessment
12	State responsibility system
13	International litigation

### **5.3.2. Analysis of Policy Priority by an expert group**

The following < table 5-14 > shows a comparative analysis of the integrated importance by government officials, researchers, professors, and NGOs. Government officials showed the order of building a network of experts (0.1207), the finding solutions based on market mechanism (0.1177), the establishment of air pollution abatement facilities in China (0.1061), and the efficiency or unification of existing organizations (0.0987) in the preference of policies. As in the overall rankings, the international legal approach alternatives were at the bottom of their list.

The preferences of the four criteria had the greatest impact on the overall ranking of the 13 policy alternatives. Because government officials prefer the policy-based approach, its sub-policy alternatives, building a network of experts and market mechanism, were ranked first and second respectively. Especially, unlike other experts, government officials favored the market mechanism. This seems to be due to the fact that the government is successfully operating the ‘Emission Trading System (ETS, 2015-)’ and the ‘Seoul Metropolitan Air Pollutant Emission-cap Management System (2007-)’ to cope with climate change and reduce domestic air pollution. In both schemes, the total amount of emissions is capped, and companies can buy and sell emissions credits in the market. The government has also added fine dust to the Air Pollutant Emission-Cap Management System since 2018. Based on these facts, it can be explained government officials have chosen a way to reduce transboundary air pollution by building a market mechanism that transcends national boundaries.

< Table 5-14 > Integrated Priority Analysis Results from government officials

AHP Hierarchy		Relative importance (Level1*Leel2)	Rank
Level 1	Level 2		
International legal approach (0.169)	Cross-border environmental impact assessment (0.172)	0.0291	13
	State responsibility system (0.208)	0.0352	12
	Polluter pays principle (0.309)	0.0522	11
	International litigation (0.311)	0.0526	10
Diplomatic approach (0.242)	Set binding reduction targets (0.264)	0.0639	9
	Formation of an environmental regime (0.328)	0.0794	7
	The efficiency or unification of existing organizations (0.408)	0.0987	4
Technological approach (0.262)	Cooperation in scientific research of the path of fine dust between China and Korea (0.244)	0.0639	8
	Air pollution modeling technology transfer (0.351)	0.0920	5
	Establishment of air pollution abatement facilities in China (0.405)	0.1061	3
Policy-based approach (0.327)	Establishment of various stakeholder governance (0.270)	0.0883	6
	Building a network of experts (0.369)	0.1207	1
	Finding solutions based on market mechanism (0.360)	0.1177	2

Researchers preferred the policies in order of the cooperation in scientific research of the path of fine dust between China and Korea (0.14796), the establishment of various stakeholder governance (0.10520), the establishment of air pollution abatement facilities in China (0.10427), and setting binding reduction targets (0.09996). The researchers rated the policy alternatives of the technological approach relatively higher than those of the other alternatives. As mentioned above, researchers have been involved in in-depth research projects on fine dust such as LTP, so it is possible that securing of objective and scientific data related to the movement of fine dust would be the most important challenge for them. Stakeholder governance ranked second in overall ranking despite the policy-based approach being ranked third. This group also ranked the policies of the international legal approach as the lowest.

Professors showed the order of the efficiency of existing organizations (0.1237), the cooperation in scientific research of the path of fine dust between China and Korea (0.1235), setting binding reduction targets (0.1125), and the formation of an environmental regime (0.1027) in the preference of policies. Professors favored policy alternatives in the diplomatic approach over others. The policies of international legal approach are also rated the lowest.

Lastly, NGO group preferred policies in order of the environmental regime (0.1150), finding solutions based on market mechanism (0.1050), setting binding reduction targets (0.1046), and the establishment of various stakeholder governance (0.1004). The NGO group rated the policy alternatives of the diplomatic and policy-based approach relatively higher than the other alternatives and preferred the policy alternatives of the international legal approach the lowest.

< Table 5-15 > Integrated Priority Analysis results from researchers

AHP Hierarchy		Relative importance (Level1*Leel2)	Rank
Level 1	Level 2		
International legal approach (0.164)	Cross-border environmental impact assessment (0.335)	0.05494	10
	State responsibility system (0.211)	0.03460	12
	Polluter pays principle (0.280)	0.04592	11
	International litigation (0.174)	0.02854	13
Diplomatic approach (0.268)	Set binding reduction targets (0.373)	0.09996	4
	Formation of an environmental regime (0.265)	0.07102	7
	The efficiency or unification of existing organizations (0.361)	0.09675	5
Technological approach (0.331)	Cooperation in scientific research of the path of fine dust between China and Korea (0.447)	0.14796	1
	Air pollution modeling technology transfer (0.239)	0.07911	6
	Establishment of air pollution abatement facilities in China (0.315)	0.10427	3
Policy-based approach (0.238)	Establishment of various stakeholder governance (0.442)	0.10520	2
	Building a network of experts (0.267)	0.06355	9
	Finding solutions based on market mechanism (0.291)	0.06926	8

< Table 5-16 > Integrated Priority Analysis results from professors

AHP Hierarchy		Relative importance (Level1*Leel2)	Rank
Level 1	Level 2		
International legal approach (0.140)	Cross-border environmental impact assessment (0.377)	0.0528	10
	State responsibility system (0.241)	0.0337	11
	Polluter pays principle (0.236)	0.0330	12
	International litigation (0.147)	0.0206	13
Diplomatic approach (0.339)	Set binding reduction targets (0.332)	0.1125	3
	Formation of an environmental regime (0.303)	0.1027	4
	The efficiency or unification of existing organizations (0.365)	0.1237	1
Technological approach (0.277)	Cooperation in scientific research of the path of fine dust between China and Korea (0.446)	0.1235	2
	Air pollution modeling technology transfer (0.240)	0.0665	8
	Establishment of air pollution abatement facilities in China (0.314)	0.0870	7
Policy-based approach (0.244)	Establishment of various stakeholder governance (0.371)	0.0905	5
	Building a network of experts (0.365)	0.0891	6
	Finding solutions based on market mechanism (0.264)	0.0644	9

< Table 5-17 > Integrated Priority Analysis results from NGOs

AHP Hierarchy		Relative importance (Level1*Leel2)	Rank
Level 1	Level 2		
International legal approach (0.243)	Cross-border environmental impact assessment (0.210)	0.0510	12
	State responsibility system (0.275)	0.0668	8
	Polluter pays principle (0.350)	0.0851	6
	International litigation (0.164)	0.0399	13
Diplomatic approach (0.315)	Set binding reduction targets (0.332)	0.1046	3
	Formation of an environmental regime (0.365)	0.1150	1
	The efficiency or unification of existing organizations (0.303)	0.0954	5
Technological approach (0.185)	Cooperation in scientific research of the path of fine dust between China and Korea (0.440)	0.0814	7
	Air pollution modeling technology transfer (0.279)	0.0516	11
	Establishment of air pollution abatement facilities in China (0.281)	0.0520	10
Policy-based approach (0.258)	Establishment of various stakeholder governance (0.389)	0.1004	4
	Building a network of experts (0.204)	0.0526	9
	Finding solutions based on market mechanism (0.407)	0.1050	2

By combining the above discussions, the policy preference of each group was sorted by rank.

**< Table 5-18 > Overall Ranking by an expert group**

Rank	Government officials	Researchers	Professors	NGOs
1	Building a network of experts	Cooperation in scientific research of the path of fine dust	The efficiency or unification of existing organizations	Formation of an environmental regime
2	Market mechanism	Establishment of various stakeholder governance	Cooperation in scientific research of the path of fine dust	Market mechanism
3	Establishment of air pollution abatement facilities in China	Establishment of air pollution abatement facilities in China	Set binding reduction targets	Set binding reduction targets
4	The efficiency or unification of existing organizations	Set binding reduction Targets	Formation of an environmental regime	Establishment of various stakeholder governance
5	Air pollution modeling technology transfer	The efficiency or unification of existing organizations	Establishment of various stakeholder governance	The efficiency or unification of existing organizations
6	Establishment of various stakeholder governance	Air pollution modeling technology transfer	Building a network of experts	Polluter pay principle
7	Formation of an environmental regime	Environmental regime	Establishment of air pollution abatement facilities in China	Cooperation in scientific research of the path of fine dust
8	Cooperation in scientific research of the path of fine dust	Market mechanism	Air pollution modeling technology transfer	State responsibility system
9	Set reduction targets	Building a network of experts	Market mechanism	Building a network of experts
10	International litigation	Cross-border environmental impact assessment	Cross-border environmental impact assessment	Establishment of air pollution abatement facilities in China
11	Polluter pays principle	Polluter pay Principle	State responsibility system	Air pollution modeling technology transfer
12	State responsibility system	State responsibility system	Polluter pay principle	Cross-border environmental impact assessment
13	Cross-border environmental impact assessment	International litigation	International litigation	International litigation

Looking at the policy preference ranking by an expert group, they preferred policy alternatives that were feasible and could be implemented in the short term. They commonly preferred ‘the efficiency or unification of existing environmental cooperation organizations’ and ‘the establishment of various stakeholder governance’ within the top five. On top of that, ‘the cooperation in scientific research of the path of fine dust between China and Korea’ and ‘setting binding reduction targets’ ranked within the top 9 of all expert groups. As for the differences in preference between groups, government officials preferred building a network of experts and market mechanisms as the first and second rank respectively. As mentioned previously, both policy alternatives are in the policy-based approach. Government officials seem to prefer the central government to lead negotiation with China with the help of experts with expertise and knowledge. And they believe that the ambitious introduction of a market mechanism approach will be of practical assistance in mitigating transboundary air pollutants concentrations. Researchers who could also be called scientists preferred the technological approach and preferred the cooperation alternative scientific research, which is the sub-policy alternative of technological approach. Professors cited the efficiency of existing collaborative organizations as a priority, as was repeatedly emphasized in previous studies. Researchers and professors evaluated ‘the accumulation of scientific data’ related to transboundary fine dust as the most important. NGOs stressed the importance of establishing specific reduction targets through the formation of an environmental regime and market mechanism, which may be interpreted as reflecting the characteristics of NGOs that present future-oriented policies. Finally, as already mentioned, all groups showed the lowest preference for policy alternatives to the international legal approach. It may be explained that experts think that it is difficult to implement them promptly when considering the development of international environmental law, the current international political situation in Northeast Asia, and progress of scientific research related to fine dust.

# **Chapter 6. Conclusion**

## **6.1. Summary**

In this study, four criteria and 13 policy alternatives were derived based on previous studies that addressed the environmental air pollution problems in the North East Asia region. After that, questionnaires were conducted for 26 experts in four field: government, researchers, professors, NGOs. Ultimately, the purpose of this study was to analyze the results of the AHP survey and suggest preferred solutions to the transboundary air pollution problem. The Analytic Hierarchy Process (AHP) method was used to survey 26 experts to determine what priority should be given to solve the transboundary air pollution problem.

In the first step, theoretical discussions on international environmental law and various methods for solving the problem in Northeast Asia were investigated. Second, the AHP questionnaire was completed in phase 2 (policy criteria and alternatives). Third, a comparative questionnaire survey was conducted among 26 experts in four fields, including government officials, researchers, professors, and NGOs. Finally, consistency analysis was conducted through the EC2000 program on the questionnaire collected and the questionnaire with a consistency ratio (CR) of less than 0.1 or less was analyzed.

To briefly describe the AHP questionnaire, the first level consisted of four criteria (international legal, diplomatic, technological, policy-based approach), and the second level consisted of thirteen policy alternatives based on policy criteria. First, under the international legal approach, four sub-factors such as the cross-border environmental impact assessment, the state responsibility system, the polluter pays principle, and the international litigation were derived. Second, under the diplomatic approach, three sub-factors such as setting binding reduction targets, the formation of an environmental regime, and the efficiency or unification of existing environmental cooperation organizations were derived. Third, under the

technological approach, three sub-factors such as the cooperation in scientific research of the path of fine dust between China and Korea, the air pollution modeling technology transfer, the establishment of air pollution abatement facilities in China were introduced. Lastly, under the policy-based approach, three policy alternatives have been created: the establishment of various stakeholder governance, building a network of experts, and finding solutions based on market mechanism.

The results of the AHP questionnaire survey of 26 experts on how to prioritize measures are as follows. In the policy criterion analysis, experts preferred the diplomatic approach (.291), the policy-based approach (.267), the technological approach (.264) and the international legal approach (.179) in order of high score. The top four among the 13 policy alternatives are the efficiency or unification of existing organizations (.1045), the cooperation in scientific research of the fine dust between China and Korea (.1040), the establishment of various stakeholder governance (0.0983), Setting binding reduction targets (.0946).

On the other hand, the five alternatives in the middle of the 13 alternatives are the formation of environmental regime (.0917), finding solutions based on market mechanism (.0884), the establishment of air pollution abatement facilities in China (.0869), building a network of experts (.0804), and the air pollution modeling technology transfer (.0731).

Among the 13 policy alternatives, the lowest four variables are all policy alternatives from the perspective of the international legal approach: the polluter pays principle (.0526), the cross-border environmental impact assessment (.0490), the state responsibility system (.0419), the international litigation (.0356).

## **6.2. Policy Implications and Suggestions**

First of all, as a result of AHP analysis for 26 experts, ‘the efficiency or unification of existing environmental cooperation organizations’ ranked first.

Currently, there are TEMM, NEASPEC, NEAC, EANET, and LTP for air pollution cooperation in Northeast Asia. The reason for the stagnation of these environmental cooperation examples in Northeast Asia is mostly focused on sharing opinions and success stories. The environmental cooperation structure in the form of meetings is one of the causes. In addition, since the inefficient structure was maintained as a redundant and sporadic cooperation system, the scientific knowledge, which is the basis for establishing policies for problem-solving, has not been substantially accumulated. However, as noted in previous studies, it is not efficient to create a new type of environmental cooperation organization. Instead, it is necessary to examine how to efficiently utilize the existing cooperation examples. The TEMM is a meeting organized by the Environment Minister of China, Japan, and Korea and has played a key role as a substantial policy-making body on environmental issues among three countries to some extent. It has achieved considerable achievements in establishing a cooperative base for environmental issues such as the response to the yellow dust. On top of that, since 2015, Policy Dialogue on air pollution among Korea, China, and Japan (TPDAP) has been established and operated under TEMM. Therefore, I think that the TEMM should be actively utilized to find practical alternatives for solving the transboundary fine dust problem.

Secondly, ‘the cooperation in scientific research of the fine dust between China and Korea’ ranked second. The international legal approach to addressing the fine dust problem that is coming from China is not feasible at present. One of the reasons is that it is difficult to identify scientific facts and causal relationships related to transboundary fine dust. Therefore, it is necessary to provide scientific analysis and evidence data on the movement path of fine dust, and joint research with China. The United States and Canada also conducted Particulate Matter Science Assessment in 2004 and adopted a Joint Declaration on Fine Dust in 2007. The key is how to bring China to the table of cooperation. Because countries such as China, which have technical and financial limitations for pollution abatement, often tend to reject

cooperation. Therefore, in order to bring China into cooperation, it is important to create an environment in which the expert groups of both countries can conduct pure joint research without taking into account the political position. Rather than giving them responsibility for the fine dust concentrations or putting political pressure on them, the two countries should prioritize the establishment of a scientific research field. In addition, by giving technical and financial support for China, it is necessary to make it possible for China to feel that the creation of partnership benefits its own country.

Third, 'the establishment of various stakeholder governance' ranked third in the AHP questionnaire. This may be the result of a survey reflecting the characteristics of Northeast Asian countries and the environmental pollution problems. In Northeast Asia, the history of cooperation itself is very short, and there are considerable differences in the level of economic development, recognition of environmental protection, and environmental regulatory standards. Northeast Asian countries tend to pursue only their own interests, unlike in Europe. And it is true that the "government" actors have limited scope in solving the problem of environmental pollution. Formation of the environmental cooperation system in Northeast Asia requires the establishment of a complex network between various nongovernmental actors as well as states. Regarding environmental issues, non-government actors are still active in many ways. Considering the complexity and power of the fine dust problem, the issue of the transboundary air pollution is inevitably involved in various sectors and areas in intergovernmental cooperation. Therefore, various stakeholders such as central governments, local governments, industries, and NGOs should work together to form an effective environmental cooperation system in Northeast Asia.

The fourth option the experts have chosen is 'to set a binding target for the reduction of fine dust concentrations blowing from China'. This is the most desirable alternative if it can be realized. First, the three policy alternatives mentioned above

should be implemented smoothly to solidify the cooperative basis between Korea and China. After that, it is possible to consider signing an agreement that includes substantive content as in the case of the Convention on Long-range Transboundary Air Pollutants (It is also possible to revise the MOU signed between Korea and China in 2014). In the long run, both countries should endeavor to work towards effective agreements. To this end, the environmental conventions should include practical content dealing with the obligations of the parties, as well as low-level partnerships such as setting of common goals, active cooperation for resolving environmental problems, and exchanges of environmental industry and technology.

Finally, solutions to international legal approach should be considered in the long term. Of course, as pointed out in many previous studies, there are many obstacles to international legal approach. The key logic that can demand China's responsible and active measures in diplomatic negotiations is Principle 21 of the Stockholm Declaration, no harm rule. Specifically, the polluting country should evaluate the economic activities in its country against the occurrence of transboundary air pollution due to its economic activities. In the case of suspected air pollution, the polluting country should notify the other countries where the pollution is expected, and finally, consult with the victim country to reduce the damage (So, 2017). The problem is that under international law, the subject of compensation for air pollution is not the country but the concerned industries that caused the pollution, and the state is obliged to establish the legal system such as environmental insurance and funds so that the workplace can compensate the victims appropriately and promptly. In the long run, efforts should be made to introduce a system that allows pre-assessment and notification of economic activity, even if it is difficult for the polluting country to compensate for the damage.

### **6.3. Limitations**

This study has two limitations. First, the AHP analysis results only show the priorities of policy alternatives by an expert group. I had no choice but to guess based on various sources of why the 26 experts made such a choice. In-depth interviews with experts based on the results of AHP analysis are required for further study.

Second, this paper does not include specific action plans for each alternative, which is one of the essential parts of the policy implementation. Therefore, the framework from this study should be developed into more specific implementation plans and practical roadmaps in the future.

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# Appendices

## 1. Consistency index

	Government	Researcher	Professor	NGO	total
p001	0.017	0.042	0.005	0.019	0.042
p002	0.085	0.008	0.03	0.023	0.032
p003	0.007	0.028	0.058	0.076	0.057
p004	0.015	0.015	0.006	0.02	0.07
p005	0.098	0.046	0.09	0.035	0.068
p006	0.035	0.062	0.019	0.053	0.055
p007	0.02	0.067	0.08	0.062	0.091
p008	0.087	0.021	0.082	0.031	0.064
p009	0.077	0.055	0.015	0.075	0.079
p010	0	0.002	0	0.021	0.056
p011	0.041	0.014	0.027	0.021	0.018
p012	0.026	0.086	0.067	0.015	0.082
p013	0.019	0.016	0.079	0.013	0.011
p014	0.073	0.04	0.055	0.049	0.084
p015	0.006	0.067	0.063	0.021	0.036
p016	0.01	0.046	0.051	0.047	0.02
p017	0.099	0.039	0.013	0.035	0.071
p018	0.056	0.07	0.065	0.091	0.066
p019	0.06	0.021	0.011	0.014	0.01
p020	0.02	0.022	0.064	0.012	0.015
p021	0.036	0.071	0.003	0.051	0.068
p022	0.016	0.067	0.036	0.029	0.041
p023	0.011	0.035	0.009	0.027	0.087
p024	0.045	0.048	0.021	0.029	0.04
p025	0.014	0.055	0.089	0.049	0.017
p026	0.057	0.009	0.013	0.027	0.034

## 2. Questionnaire

### 동북아시아 월경성 대기오염문제(미세먼지) 관련 설문조사

안녕하십니까? 본 설문지는 동북아시아 월경성 대기오염문제(미세먼지) 해결대책에 대한 전문가들의 인식과 선호도 및 우선순위에 대해 조사하는 것으로, 석사학위 논문의 자료로 활용하기 위해 작성된 것입니다.

본 설문은 동북아시아 월경성 대기오염문제에 대한 기본적인 인식수준, 동 문제 해결방안 마련 시 우선적으로 고려해야 할 요소에 대해 다루고 있으며, 전문가들의 의견을 수렴하여 월경성 대기오염문제 해결을 위한 정책 수립의 기초 자료로 활용하고자 합니다. 조금 귀찮으시더라도 설문조사에 적극 협조해 주실 것을 부탁드리며 본 연구에 대해 의문사항이 있으시면 아래의 연락처로 문의하여 주시면 감사하겠습니다.

아울러 본 설문조사는 무기명으로 실시되며 응답해주신 내용은 학술적 목적을 위한 분석에만 활용될 것임을 약속드립니다. 설문에 참여해 주심에 감사드립니다.

2018년 8월 이정미 ([grapple5418@gmail.com](mailto:grapple5418@gmail.com))

연구자 : 이정미(서울대학교 행정대학원 글로벌행정전공 석사과정)

지도교수 : 홍준형(서울대학교 행정대학원)

## I. 동북아시아 월경성 대기오염문제에 대한 일반적인 설문입니다.

설문 응답은 빈칸( )에 선택하신 번호를 기재하여 주시기 바랍니다.

### <미세먼지 현황의 심각성>

(1-1) 귀하께서는 국내 미세먼지 발생 현황이 얼마나 심각하다고 생각하십니까? ( )

- ①매우 심각하다.
- ②다소 심각한 편이다.
- ③별로 심각하지 않다.
- ④전혀 심각하지 않다.
- ⑤모르겠음

### <미세먼지 발생의 원인>

(1-2) 귀하께서는 미세먼지 발생원인 중 가장 심각하다고 생각하는 것은 무엇인가? ( )

- ①중국 등 외부유입
- ②자동차 배기가스
- ③발전소나 공장
- ④건설현장
- ⑤음식 조리
- ⑥모르겠음

### <미세먼지 문제 해결방안>

(1-3) 귀하께서는 미세먼지 문제의 해결을 위해 가장 중요하게 다루어야 하는 것이 무엇이라고 생각하십니까? ( )

- ①중국 등 주변국가 환경외교 강화
- ②친환경자동차 보급 확대
- ③석탄 화력발전소 미세먼지 감축
- ④학교 및 공공시설 공기청정기 설치
- ⑤미세먼지 예·경보 시스템 개선
- ⑥기타

### <정부정책의 평가>

(1-4) 귀하께서는 미세먼지 문제의 해결을 위해 정부에서 추진하는 대책 중 다음 중 어떠한 것이 가장 중요하다고 생각하십니까? ( )

- ①중국 등 주변국과 환경외교 강화
- ②친환경자동차 보급 확대
- ③석탄 화력발전소 미세먼지 감축
- ④경유차 미세먼지 감축
- ⑤미세먼지 예·경보제 개선
- ⑥기타

## II. 동북아시아 월경성 대기오염문제 해결방안의 중요도 평가를 위한 설문입니다.

□ 아래 내용은 동북아시아 월경성 대기오염문제 해결을 위한 방안으로 고려되는 항목들입니다. 항목별 정보를 읽어 보신 후 설문에 응답해주시면 감사하겠습니다.

대항목	세부항목	항목 설명
국제법적 접근	초국경 환경영향 평가제도 도입	건전하고 지속 가능한 개발을 보장하기 위해 경제활동이 환경에 미치는 영향을 사전에 평가
	국가책임제도	국가책임 성립요건: 한 국가의 국제법 위반행위 발생, 국제법상 의무위반, 인과관계
	오염자부담원칙 적용	오염방지 조치를 이행하거나 오염으로 야기된 피해를 보상하는데 드는 비용을 오염자가 부담해야 함
	사법적 해결방안	국제사법재판소(ICJ) 제소, 중재재판 신청
외교적 접근	구속력 있는 감축목표 설정	정해진 기한 내 감축목표를 설정하고 이행토록 의무화
	환경레짐의 형성	법적, 정치적 영향을 가지는 구속력 있는 협약을 매개로 기존의 국제행위자들이 수립한 국제규제와 조직의 체계. 환경레짐은 일단 구축된 후에는 국가들에 환경보전을 위한 제약 부과 및 압력 행사 가능
	기존 환경협력기구 단일화(효율화)	환경협력의 단일화: 한중일 대기협력기구 필요
과학기술적 접근	중국발 미세먼지 기여율 공동조사 (원인규명)	양국 공동으로 중국에서 불어오는 오염물질의 정확한 이동경로, 기여율 조사
	대기오염 모델링 기술 이전	한국이 중국에게 환경기술을 제공하여 중국 대기질 개선 노력
	중국 산업시설 내 대기오염 저감시설 설치	우리나라가 중국에게 환경기술을 제공하여 중국 대기질 개선과 국내 산업체 중국 진출에 기여
정책적 접근	환경정보협력기구	다양한 수준에서 환경문제의 이해관계자들을 정책 결정과정에 참여시킴
	전문가들간 네트워크 체계 확립	대중적 공감대를 형성하고, 개별국가의 이익을 재정의 할 수 있는 초국가적 인지공동체(전문가 네트워크) 형성
	시장메커니즘 도입 (예: 배출권거래제)	배출권거래제 같은 시장메커니즘에 따라 해결하는 방안 고안

## □ 설문 작성방법

(평가 척도 의미)

5 -> 항목의 중요도가 매우 높다

4 -> 항목의 중요도가 많이 높다

3 -> 항목의 중요도가 높다

2 -> 항목의 중요도가 조금 높다

1 -> 항목의 중요도가 서로 같다

(예시 1) : A 항목의 중요도가 B 항목에 비해 높다

측정 항목	평가 척도	측정 항목
A	5 4 ③ 2 1 2 3 4 5	B

(예시 2) : B 항목의 중요도가 A 항목에 비해 매우 높다

측정 항목	평가 척도	측정 항목
A	5 4 3 2 1 2 3 4 ⑤	B

(예시 3) : A 항목과 B 항목의 중요도가 서로 같다

측정 항목	평가 척도	측정 항목
A	5 4 3 2 ① 2 3 4 5	B

(응답 시 참고사항)

설문에서 비교하는 두 개의 항목은 서로 상호관계가 있으므로 논리적 일관성을 유지하는 것이 중요합니다. 따라서 다음 예시와 같은 일관성이 유지될 수 있도록 협조 바랍니다.

예시) A > B 이고 B > C 이면 ----> A > C 가 논리에 맞습니다.

## □ 설문 작성

2-1. (대항목) 동북아시아 월경성 대기오염문제 해결방안 중요도 평가 설문

측정 항목	평가 척도	측정 항목
국제법적 접근	5 4 3 2 1 2 3 4 5	외교적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
과학기술적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
측정 항목	평가 척도	측정 항목
국제법적 접근	5 4 3 2 1 2 3 4 5	외교적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
과학기술적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
측정 항목	평가 척도	측정 항목
국제법적 접근	5 4 3 2 1 2 3 4 5	외교적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	정책적 접근

외교적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
과학기술적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
측정 항목	평가 척도	측정 항목
국제법적 접근	5 4 3 2 1 2 3 4 5	외교적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
국제법적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	과학기술적 접근
외교적 접근	5 4 3 2 1 2 3 4 5	정책적 접근
과학기술적 접근	5 4 3 2 1 2 3 4 5	정책적 접근

## 2-2. (세부 항목) 동북아시아 월경성 대기오염문제 해결방안 중요도 평가 설문

### 1) 국제법적 접근

측정 항목	평가 척도	측정 항목
환경영향평가제도	5 4 3 2 1 2 3 4 5	국가책임제도
환경영향평가제도	5 4 3 2 1 2 3 4 5	오염자부담원칙 적용
환경영향평가제도	5 4 3 2 1 2 3 4 5	사법적 해결방안
국가책임제도	5 4 3 2 1 2 3 4 5	오염자부담원칙 적용
국가책임제도	5 4 3 2 1 2 3 4 5	사법적 해결방안
측정 항목	평가 척도	측정 항목

환경영향평가제도	5 4 3 2 1 2 3 4 5	국가책임제도
환경영향평가제도	5 4 3 2 1 2 3 4 5	오염자부담원칙 적용
환경영향평가제도	5 4 3 2 1 2 3 4 5	사법적 해결방안
국가책임제도	5 4 3 2 1 2 3 4 5	오염자부담원칙 적용
국가책임제도	5 4 3 2 1 2 3 4 5	사법적 해결방안
측정 항목	평가 척도	측정 항목
환경영향평가제도	5 4 3 2 1 2 3 4 5	국가책임제도
환경영향평가제도	5 4 3 2 1 2 3 4 5	오염자부담원칙 적용
환경영향평가제도	5 4 3 2 1 2 3 4 5	사법적 해결방안
국가책임제도	5 4 3 2 1 2 3 4 5	오염자부담원칙 적용
국가책임제도	5 4 3 2 1 2 3 4 5	사법적 해결방안

## 2) 정치외교적 접근

측정 항목	평가 척도	측정 항목
구속력 있는 감축목표	5 4 3 2 1 2 3 4 5	환경레짐 형성
구속력 있는 감축목표	5 4 3 2 1 2 3 4 5	기존 협력기구 단일화
환경레짐 형성	5 4 3 2 1 2 3 4 5	기존 협력기구 단일화

측정 항목	평가 척도	측정 항목
구속력 있는 감축목표	5 4 3 2 <b>1</b> 2 3 4 5	환경레짐 형성
구속력 있는 감축목표	5 4 3 2 <b>1</b> 2 3 4 5	기존 협력기구 단일화
환경레짐 형성	5 4 3 2 <b>1</b> 2 3 4 5	기존 협력기구 단일화
측정 항목	평가 척도	측정 항목
구속력 있는 감축목표	5 4 3 2 <b>1</b> 2 3 4 5	환경레짐 형성
구속력 있는 감축목표	5 4 3 2 <b>1</b> 2 3 4 5	기존 협력기구 단일화
환경레짐 형성	5 4 3 2 <b>1</b> 2 3 4 5	기존 협력기구 단일화

### 3) 과학기술적 접근

측정 항목	평가 척도	측정 항목
공동조사, 연구	5 4 3 2 <b>1</b> 2 3 4 5	대기오염 모델링 기술 이전
공동조사, 연구	5 4 3 2 <b>1</b> 2 3 4 5	중국 산업시설내 대기오염 저감시설 설치

대기오염 모델링 기술 이전	543212345	중국 산업시설내 대기오염 저감시설 설치
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측정 항목	평가 척도	측정 항목
공동조사, 연구	543212345	대기오염 모델링 기술 이전
공동조사, 연구	543212345	중국 산업시설내 대기오염 저감시설 설치
대기오염 모델링 기술 이전	543212345	중국 산업시설내 대기오염 저감시설 설치

측정 항목	평가 척도	측정 항목
공동조사, 연구	543212345	대기오염 모델링 기술 이전
공동조사, 연구	543212345	중국 산업시설내 대기오염 저감시설 설치
대기오염 모델링 기술 이전	543212345	중국 산업시설내 대기오염 저감시설 설치

4) 정책적 접근

측정 항목	평가 척도	측정 항목
환경정보협력기구	5 4 3 2 1 2 3 4 5	전문가들간 네트워크 체계 확립
환경정보협력기구	5 4 3 2 1 2 3 4 5	시장메커니즘 도입
전문가들간 네트워크 체계 확립	5 4 3 2 1 2 3 4 5	시장 메커니즘 도입
측정 항목	평가 척도	측정 항목
환경정보협력기구	5 4 3 2 1 2 3 4 5	전문가들간 네트워크 체계 확립
환경정보협력기구	5 4 3 2 1 2 3 4 5	시장메커니즘 도입
전문가들간 네트워크 체계 확립	5 4 3 2 1 2 3 4 5	시장 메커니즘 도입
측정 항목	평가 척도	측정 항목
환경정보협력기구	5 4 3 2 1 2 3 4 5	전문가들간 네트워크 체계 확립
환경정보협력기구	5 4 3 2 1 2 3 4 5	시장메커니즘 도입
전문가들간 네트워크 체계 확립	5 4 3 2 1 2 3 4 5	시장 메커니즘 도입

(설문 항목 끝)

지금까지 설문조사에 정성을 다해 주셔서 다시 한 번 깊은 감사를 드립니다.  
이미 제시된 해결방안 이외 중요한 항목이 더 있다고 생각하시면 자유  
형식으로 아래에 기록해 주시면 감사하겠습니다.

- 아 래 -

다음으로 통계처리를 위해 개인적인 사항 몇 가지만 더 여쭙겠습니다.

1. 귀하의 성별은 어떻게 되십니까? 남성 여성
2. 귀하의 소속기관은 어디입니까? ( )
3. 귀하게서 관련업무를 수행하신 기간은 얼마나 되십니까?

10년 미만 10년 이상 12년 미만 12년 이상 14년 미만 14년 이상 16년

미만 16년 이상 18년 미만 20년 이상

4. 귀하의 소속기관에서 수행하는 업무는 무엇입니까?

감사합니다.

## 국문초록

분석적 계층화 기법(AHP)을 이용한

동북아시아 지역 월경성

대기오염문제

해결방안 분석

-미세먼지 문제를 중심으로-

미세먼지는 한국인들의 큰 근심거리중의 하나이다. 2017년  
갤럽코리아에서 실시한 여론조사에 따르면, 응답자들의 82%가 미세먼지  
때문에 불편하다고 답한바 있다. 문제는 미세먼지의 상당부분이  
중국에서 기인한다는데 있다. 서울연구원과 안양대학교가 공동 추진한  
연구결과에 따르면 미세먼지( $PM_{10}$ )의 39%, 초미세먼지( $PM_{2.5}$ )의 48.8%는  
중국에서 기인하는 것이라고 한다. 미세먼지에 장기간 노출되면,  
면역체계가 악화되고, 심혈관계, 피부, 안과 질환에 걸릴 확률이  
높아진다. 특히 초미세먼지( $PM_{2.5}$ )의 경우 사람의 폐나 기관지 깊숙히  
침투하여 심각한 질병을 야기할 수 있다.

이러한 관점에서, 이 연구는 동북아시아 지역의 월경성 대기오염문제  
해결을 위해 필요한 정책기준과 구체적 정책대안을 확인하고,  
우선순위를 정하는데 목적이 있다. 이를 위해 우선, 광범위한 문헌조사가

이루어졌으며, 그 결과 4개의 정책결정 기준과 13개의 정책대안이 도출되었다. 이후, 정부, 연구소, 학계, 시민단체 등 4개 분야의 전문가 26명을 대상으로 2018년 8월 1일부터 9월 30일까지 AHP 설문조사가 실시되었다. 전체 26명의 설문조사 결과에 대한 일관성 지수 평균은 0.05였고, 26개 설문지 모두의 일관성지수는 0.1보다 낮은 것으로 나타났다.

설문조사 결과에 대해 상대적 중요도를 분석한 결과, 정책결정 기준의 선호도는 외교적 접근이 1위, 과학기술적 접근이 2위, 정책적 접근이 3위, 마지막으로 국제법적 접근이 4위였다. 세부 정책수단의 우선순위 분석 결과, 기존환경협력기구 단일화(효율화)가 1위, 중국발 미세먼지 기여율 공동조사가 2위, 다양한 이해관계자의 정책 참여 확대가 3위, 구속력 있는 감축목표 설정이 4위로 나타났다. 국제법적 접근방식의 정책수단 4개는 모두 최하위권이었는데, 오염자부담원칙 적용이 10위, 초국경 환경영향평가제도 도입이 11위, 국가책임제도 12위, 국제소송이 13위였다.

전문가 그룹별로 살펴보면, 정부공무원들은 전문가들간 네트워크 체계 확립과 시장메커니즘 도입을 각각 1, 2위로 선택했는데, 이는 공무원들은 과학적 지식을 보유한 전문가 그룹의 도움을 받아 월경성 미세먼지 문제를 주도적으로 해결하려고 하며, 아울러 그간 배출권 거래제와 수도권 대기오염총량제를 설계·운영하였고 2018년부터는 총량규제 대상물질에 면지를 추가·운영 중인바 이러한 경험을 기반으로 시장메커니즘 제도 도입을 선호하는 것으로 해석된다. 연구원들은 그 그룹의 특성에 부합하게 중국발 미세먼지 기여율 공동조사를 최우선 과제로 꼽았다. 학계에서는 대부분의 선행연구들이 실현가능하고 현실적인 대안을 강조한 것처럼, 기존 환경영향기구 단일화(효율화)를 1순위로 선택했다. 마지막으로 주로 거시적 담론을 논의하는 경향이

있는 시민단체들은 환경레짐의 형성과 시장 메커니즘 도입을 각각 1, 2위 과제로 선택하였다.

이 연구는 전문가들이 월경성 대기오염문제 해결을 위해 상대적으로 중요하다고 판단하는 정책들을 도출하는데 기여할 것이다. 우선, 전문가들은 기존 환경협력기구 단일화(효율화)를 최우선 과제로 꼽았다. 기존에 존재하는 협력기구들 가운데, TEMM은 1999년 창설 이래 한중일 사이에서 환경이슈에 대한 실질적인 정책대안을 논의하고 협력을 추진함으로써, 동북아시아 지역 환경문제 해결에 상당한 공헌을 해 왔다. 따라서, 향후 TEMM을 확대 발전시키는 방안을 적극 고민해야 한다. 둘째, 전문가들은 과학적 데이터 확보의 중요성을 강조했다. 선행연구에서 계속 강조되었다시피, 중국발 미세먼지가 한국 대기오염에 기여하는 비율, 미세먼지 이동경로, 한국에 미치는 피해에 관한 인과관계 분석 등은 미세먼지 문제 해결에 아주 중요한 과제이다. 아울러, 중국을 협상테이블로 끌어들이기 위해서는 중국에 대한 책임문제 등을 거론하는 정치적 압박보다는, 양국의 과학자들간 순수한 연구가 이뤄질 수 있는 환경이 조성되어야 한다. 마지막으로, 전문가들은 다양한 이해관계자들의 참여를 3순위로 평가했다. 월경성 대기오염문제 해결을 위해서는 중앙정부뿐 아니라, 지방정부, 산업계, 시민단체들간 협력도 활발히 이뤄져야 할 것이다.

주요어 : 월경성 대기오염, 미세먼지, 국제환경법, 외교적 접근,  
과학기술적 접근, 정책적 접근, AHP 방법

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