

博士論文（要約）

**Yokkaichi Asthma and the Formation of  
Environmental Standards and the Certification System  
in the 1960s and the 1970s**

(1960、70年代における四日市喘息と  
環境基準と認定制度の形成)

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## Abstract

This thesis investigates the history of Yokkaichi asthma, and discusses the process of establishing environmental standards and an environmental certification system in the 1960s and 1970s. It focuses on how air pollution erupted and asthma patients emerged in the Yokkaichi area, how early measurements and investigations were conducted by scientists in Yokkaichi and other cities, and what pollution control measures were taken by local and national governments. It will closely examine the construction of standardized procedures for measuring meteorological conditions or diagnosing asthma patients in order for governments to establish certification systems. Particular attention will be paid to the environmental standard and the certification standard for designating patients affected by pollution.

Numerous works have already been written on this historic event, but as this thesis attempts to demonstrate, there is still a need for an analysis and narrative of the whole historical process of Yokkaichi asthma that focuses on the development of various standards to deal with issues emerging from air pollution. Those who were involved with this environmental problem, both researchers and administrators, set up an environmental standard and attempted to establish a certification system of patients suffering from air pollution. In creating such a system, medical experts also learned the need to standardize ways of diagnosing suffering patients. This thesis thus attempts to analyze the role and significance of various aspects of standards and standardization, while narrating the historical process of air pollution in the Yokkaichi area and its environmental, medical, and legal effects.

When the new petrochemical complexes in Yokkaichi started to operate in the early 1960s, a new type of asthma began cropping up in Shiohama district. It soon became known as Yokkaichi asthma. Local scientists and government responded rapidly to the reports of the new asthma. The lead-peroxide candle method and conductometric method were adopted as the main measuring procedures to measure levels of the pollutant sulfur dioxide. Katsumi Yoshida, a professor of medicine at Mie Prefectural

University, initiated an epidemiological investigation based on the medical bills of affected residents. To do so, he received special permission from the local government to inspect the confidential data from medical bills stored at the local government office because of the National Health Insurance System. Yoshida's research indicated the plausibility of a statistical correlation between the frequency of residents' asthma attacks and the regional concentration of sulfur dioxide. It provided valuable data for the national investigative team that was dispatched by the Ministry of Health and Welfare and the Ministry of International Trade and Industry—the Kurokawa Investigative Team. Based on Yoshida's epidemiological data, the team decided to make Yokkaichi one of the designated areas of the Smoke and Soot Regulation Law, and proposed measures to diffuse the gas discharged by petrochemical complex plants by raising the height of their smokestacks.

Yoshida's research and his data also became a valuable basis for establishing a certification system for pollution-related patients and environmental standards for sulfur oxides in Japan. As is discussed in Chapter 4, the establishment of the certification system was difficult due to the non-specific nature of asthmatic respiratory diseases. In establishing this system, government officials and experts relied on a previous system that had been developed to certify atomic-bomb survivors. Leukemia, for instance, occurred at higher rates after the detonation of the atomic bomb, but it also occurred among the general public even without the after-effects of the atomic bomb. To certify such patients, the government relied on statistical judgment and introduced epidemiological criteria to identify patients who were likely suffering from leukemia due to radiation exposure. Besides the designation of the specific diseases reasonably caused by radiation, the government designated a specific area around the bomb's hypocenter and a specific duration during which people with leukemia had to have resided in that area to be considered certified atomic-bomb patients. In the Yokkaichi certification system, specific geographical areas and the temporal duration of residence within these areas were also designated as the two key epidemiological criteria for certification, in addition to a diagnosis with a specific pathological disease. As medical

experts recognized, the diagnostic concepts of respiratory diseases that served as the basis for epidemiological investigation also needed to be standardized.

The epidemiological data and concepts that led to the establishment of the local government's certification system also affected the lawsuit instituted by patient-residents against corporations, which resulted in a victory for the residents. The Yokkaichi lawsuit set a standard for the amount of legal compensation victims could receive, and influenced the later national Relief Law and Compensation Law. The Yokkaichi lawsuit ordered accused corporations to pay measureable compensation for the victims' monetary loss due to their incapacity to work because of disease. The Compensation Law, based on this judgment, set a new model worldwide for dealing with such issues. The Yokkaichi lawsuit, for the first time, provided an official method of calculating the compensation for damages due to air pollution events in Japan.

The effort to measure air pollution in Yokkaichi formed part of the national process of setting environmental standards for air pollution. The early epidemiological investigations in Osaka also provided valuable data for this environmental standard setting. Osaka was a successful case in regulating the pollution measures in these early days. It approved the environmental management standard for sulfur dioxide to control industrial pollution in the city. The special attention the national government paid to pollution started with establishing the department of environment pollution, which was set up within both MHW and MITI. As the first head of the department at MHW, Michio Hashimoto played a central role in mediating pollution issues and establishing an environmental pollution control law. In the Basic Law for Environmental Pollution Control enacted in 1967, the concept of *kōgai* and environmental standards were interpreted in detail. The latter was defined as an administrative goal desirable to maintain. The phrase often at issue was "harmony with the economy." It was inserted in the finally approved version of the Basic Law in 1967, but was eliminated from the 1970 amendment.

Based on early epidemiological data in Yokkaichi and Osaka, standard values for sulfur oxides were established. The Environmental Pollution Council in MHW

assembled an expert panel on environmental standards for sulfur oxides in November 1966. They focused on two issues: measurement and medical influences on the human body. After a year and two months of deliberations, the expert panel submitted a report on the SO<sub>x</sub> standard in January 1968. A one-day value of 0.05ppm and a one-hour value of 0.1ppm were approved as the threshold values. This was determined based on the four epidemiological conditions including those concerning the statistical tendencies of the death and prevalence rates under these values. When it was established, it was one of the most stringent standards in the world. However, objections from industrialists and others made MHW reconsider the strict standard values. While the threshold values remained unchanged, the final standard values were twice relaxed owing to objections from the industrial sector. The values were based on early epidemiological investigations conducted in Yokkaichi and Osaka. In the social process of setting environmental standards, citizens' movements should not fail to be mentioned. Local citizens launched a series of protest movements—including mounting a signature campaign, measuring pollutants themselves, and filing the joint lawsuit—that influenced the government in deciding to reconsider the SO<sub>x</sub> standards. Soon after the judgment on the Yokkaichi lawsuit was pronounced in 1972, the newly established Environmental Agency focused on formulating environmental policies. Under the new policies, not only SO<sub>x</sub>, but also many other air pollutants were restricted to meet certain standard values.

The decade from the early 1960s to the 1970s witnessed the emergence of a social and legal mechanism to control environmental pollution and compensate the sufferings of pollution victims primarily based on epidemiological analysis and estimation of the correlation between the pollution and the suffering. As the present case study shows, this mechanism emerged through a decade-long process of social negotiations and reconciliations that involved patients, industrialists, politicians, doctors, lawyers, and scientists. This decade-long process did not lead to a complete settlement between the sufferers and those responsible for their suffering, and the process of negotiation continued further. Yet, the emergence of such a socio-legal control mechanism was a

significant event in the environmental history of Japan. The present research focused on the process of setting a variety of standards and the crucial role played by epidemiological science in this process. The non-specificity of asthma and other related diseases as well as the difficulty in establishing causal relationships between individual actors posed difficult problems that could not be solved solely by political decisions or scientific argument. They could be solved only through the collaborative efforts of patients and politicians as well as legal and scientific experts. The social history of Yokkaichi asthma is a typical case of what Sheila Jasanoff has called “regulatory science.”

## Contents

### Introduction

### Chapter 1 Air Pollution and Yokkaichi Asthma

#### 1.1 Air Pollution before 1960

##### 1.1.1 Air Pollution Episodes Abroad

##### 1.1.2 Air Pollution in Japan

#### 1.2 The Establishment of the Petrochemical Complex

##### 1.2.1 Petrochemical Industry Plan

##### 1.2.2 Yokkaichi Petrochemical Complex

#### 1.3 Occurrence of Yokkaichi Asthma

##### 1.3.1 Shiohama Asthma

##### 1.3.2 Government Response to Yokkaichi Asthma

### Chapter 2 Air Pollution and Measurement

#### 2.1 Air Pollution in Yokkaichi

##### 2.1.1 Climatic Conditions and Pollution Occurrence

##### 2.1.2 The Eruption of Air Pollution

##### 2.1.3 Early Measurement and “Shippu Osen”

#### 2.2 Choosing Measuring Methods for SO<sub>x</sub>

##### 2.2.1 Choosing the Lead Peroxide Candle Method

##### 2.2.2 The Development of the Conductometric Method

##### 2.2.3 The Adoption of the Conductometric Method

##### 2.2.4 Methods Conversion and Comparison

### Chapter 3 Early Epidemiological Investigations in Yokkaichi

#### 3.1 Kokuho Investigation

##### 3.1.1 Epidemiological investigations before Kokuho

##### 3.1.2 Yoshida and Kokuho Investigation in Yokkaichi

#### 3.2 Kurokawa Investigation

##### 3.2.1 Kurokawa Investigative Team

##### 3.2.2 Committee Achievements

#### 3.3 Investigations of MHW

##### 3.3.1 Early Surveys via Questionnaires and Mass Examinations

##### 3.3.2 Health Impact Investigation of Residents

##### 3.3.3 Investigation of School Children

### Chapter 4 Certification System of Pollution-related Patients in Yokkaichi

#### 4.1 Demands for Relief Measures in Yokkaichi

## 4.2 The Certification System for Atomic-Bomb Victims

### 4.2.1 Early Investigations

### 4.2.2 A-bomb Medical Law

## 4.3 Yokkaichi Certification System

### 4.3.1 Designated Areas and Duration

### 4.3.2 Designated Diseases

## 4.4 After Establishing the Certification System

## Chapter 5 The Basic Law for Environmental Pollution Control

### 5.1 Before the Establishment of the 1967 Basic Law

#### 5.1.1 Starting the Early Environmental Pollution Administration

#### 5.1.2 Early Experiences in Osaka

### 5.2 Establishing the Basic Law for Environmental Pollution Control

#### 5.2.1 Interim Report of the Basic Policy for Environmental Pollution

#### 5.2.2 Establishing the Basic Law for Environmental Pollution Control

### 5.3 Aftereffects of the Basic Law

#### 5.3.1 K-value Regulation

#### 5.3.2 Reviewing the Basic Law

## Chapter 6 Establishment of the National Standard of Sulfur Oxides (1966-1969)

### 6.1 Foundation of the Expert Panel

#### 6.1.1 Expert Panel Composition

#### 6.1.2 Two Working Groups: Expert Panel Report

### 6.2 Determination of the Threshold Values

#### 6.2.1 Osaka Case

#### 6.2.2 Determining the Threshold Values

#### 6.2.3 Other Countries Cases

### 6.3 Setting the Standard

#### 6.3.1 From Criteria (Threshold Values) to the Standard Values

#### 6.3.2 From Living Environment Council to Cabinet Council

## Chapter 7 The Yokkaichi Lawsuit

### 7.1 Preparation

#### 7.1.1 The Preparation of Plaintiff Counsel for Litigation

#### 7.1.2 Considering Epidemiological Methodology

#### 7.1.3 Filing the Lawsuit

### 7.2 Testification and Examination

#### 7.2.1 Epidemiology: Four Principles

#### 7.2.2 The Role of the Meteorologist and Statistician



7.2.3 The Legal Validity of Epidemiological Causation

7.2.4 The Argument regarding the Standard Values

7.3 Judgment

7.3.1 Epidemiological Causation and Legal Causation

7.3.2 The Role Epidemiology Played in the Judgment

7.3.3 Influences of the Lawsuit—Compensation Standard

Chapter 8 Revision of the SO<sub>x</sub> Standard

8.1 Citizen Protest Activities regarding the Environmental Standard

8.1.1 Citizen Protests regarding Standard Setting

8.1.2 Creating Detector Paper

8.2 Establishment of the New SO<sub>2</sub> Standard

8.2.1 Measuring Method and Network

8.2.2 Strengthening the SO<sub>x</sub> Standard

8.2.3 Determining the Criteria Values

8.3 Emission Regulation and Local Standards

8.3.1 Total Emission Regulation in Mie Prefecture

8.3.2 Diffusion Simulation: Setting the Target Value

Conclusion: Environment concerning Standards in Japan

Bibliography

Acknowledgement

## Introduction

This dissertation will describe and discuss the historical process of the eruption and the aftermath of one of the gravest environmental pollutions and the disease caused by it in postwar Japan – Yokkaichi air pollution and Yokkaichi Asthma. There already are numerous works written on this historic event, but as this dissertation attempts to demonstrate below, there still needs a work to analyze and narrate the whole historical process of this event from a viewpoint – creating various standards to deal with issues emerging by the air pollution. Those who were involved with this environmental problem, both researchers and administrators, had set up an environmental standard and then attempted to establish a certification system of patients suffering from the air pollution. In creating such a system, medical experts also learned the need to standardize ways of diagnosing suffering patients. This dissertation thus attempts to analyze the role and significance of various aspects of standards and standardization, while narrating the historical process of the air pollution in Yokkaichi area and environmental, medical, and legal effects and events emerging afterwards.

### Air Pollution as a Historical Issue

Among postwar rapid economic growth and accompanying environmental pollution, asthma-related diseases caused by air pollution received more attention. Compared with other types of pollution, atmospheric pollution seems more serious and comprehensive, for we must breathe air every moment. The smog which occurred in Yokkaichi and other places were due to chemical substances. Yokkaichi experienced rampant obstructive pulmonary diseases and bronchial asthmas whose patients were mainly native fishermen. A common point among most of the cases was that, when the patients moved away, their symptoms alleviated. However, although the pollutant was confined to sulfur dioxide, the causative agent was unclarified.<sup>1</sup>

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<sup>1</sup> About the causative agent and disease agent, see Toshihide Tsuda, *Igakusha ha Kōgai Jiken de Nani o Shitekitanoka (What did Medical Scientist do in Environmental Event)* (Tokyo: Iwanami Shoten, 2004).

Until the early post-war period, atmospheric pollution had focused on coal burning in industrial smoke discharge. The aftereffect was also seen in foreign cases. One well-known episode was that of London smog, which occurred in December 1952. It lasted for six days and during the week more than 4000 people died from the respiratory and cardiac diseases. Shortly afterwards, in the summer of 1953, the Beaver Committee was set up to examine the national problem of smoke pollution. This Committee made recommendations in their final report in 1954, suggesting the establishment of the Clean Air Council and smokeless zones and smoke-controlled areas by local authorities.<sup>2</sup> After the 1955 bill was debated, the Clean Air Act was finally passed in 1956.

Focusing on the atmospheric pollution in Great Britain and Japan, the role of public health should not be overlooked. Great Britain established its Law of Public Health in 1875, which was revised in 1936 and evaluated as typical regulation for modern environmental pollution. In the end of 19th century, Japan also established special ordinance for aqueduct, but the real advances were promoted till the period after World War II. It was policemen who were in charge of the hygienic administration before, but it was changed by the guidance of healthcare centers after the war period.<sup>3</sup>

Epidemiology, as one part of public health, also played a particular role in air pollution cases.<sup>4</sup> In November 1957, the WHO Regional Office for Europe sponsored a conference in Milan on public health aspects of air pollution in Europe. It was considered as the first meeting of its kind in this continent.<sup>5</sup> Soon after that, the WHO Expert Committee on Environmental Sanitation discussed a series of air pollution problems. It showed clearly that “there was a widespread but rather uncoordinated interest in the epidemiology of air pollution” and how epidemiological and related research might develop effectively was discussed in the arranged international meeting.

In the United Kingdom, until 1956 when the Clean Air Act was enacted, the air

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<sup>2</sup> The smokeless zones were watered-down at final act.

<sup>3</sup> Kyujuro Fujiwara, “Kōshu Eisei Hyakunen no Ayumi o Gaikan shite (Reviewing the Centurial History of Public Health),” *KōshuEisei (Public Health)*, 1(1968): 51-53.

<sup>4</sup> See Seiji Morioka(森岡聖次)and ItsuzoShigematsu (重松逸造), *Nihon no Iryo to Ekigaku no Yakuwari: RekishitekiFukan (A Historical View of Healthcare in Japan and the Role of Epidemiology)*(Tokyo: Kokuseido, 2009).

<sup>5</sup> P. J. Lawther, *Epidemiology of Air Pollution: Report on a Symposium*, WHO: Geneva, 1962.

pollution and smog situation was unimproved. Anthony Kessel emphasized the role public health played in atmospheric pollution. He mainly noted the epidemiological research progressed in demonstrating the association between atmospheric pollution and chronic lung diseases.<sup>6</sup> In Japan, more knowledge of public health came from Germany. At first, this subject mainly focused on infectious diseases such as tuberculosis and dysentery. After World War II, sanitary conditions improved, and public health—especially epidemiology—was applied to the diseases caused by industrial pollution.<sup>7</sup> Epidemiology played a complementary role when pathology could not satisfy the whole principles. Experiment and reductionism was not always necessary to medical science.<sup>8</sup>

What about the legal role epidemiology played in the lawsuits? In Japan, epidemiology received more attention when it possessed a position in the lawsuits for environmental pollution. The four major pollution episodes utilized this scientific method in their legal processes. The Itaiitai and Niigata Minamata Disease Judgments adopted epidemiological methodology as a complement, while the Yokkaichi Asthma Judgment adopted it as the main composition of the plaintiffs' arguments.<sup>9</sup> The litigations promoted the legal process of setting compensation system for pollution-related victims. Before, there was a certification system that was established by Yokkaichi government. It also promoted the setting process of later government environmental standards for atmospheric pollution.

Setting environmental standards was paid more attention when the Basic Law for Environmental Pollution Control was being established. The 1960s was an age of worrying about the increasing environmental pollution issues, and it was a fruitful period for pollution-control policies that were established in succession. Japan

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<sup>6</sup> Anthony Kessel, *Air, the Environment and Public Health* (Cambridge: Cambridge University Press, 2006), p. 94.

<sup>7</sup> See KyujuroFujiwara, op.cit. In the industrial plants, another subject was applicable: labor hygienics. See Toyohiko Miura, "RodoeiseiHyakunen Shi (History of Labor Hygienics for 100 years)," *Kōshu Eisei*, 1 (1968): 23-29. The limitations of modern epidemiology were also mentioned by Kessel.

<sup>8</sup> Toshihide Tsuda, *Igaku to Kasetsu (Medicine and Hypothesis)* (Tokyo: Iwanami Shoten, 2011), p. 37.

<sup>9</sup> Sumida emphasized an interaction between science and law in four major pollution lawsuits, and attempted to analyze the co-production in Japanese context. See Tomohisa Sumida, "When Science and Law meet: Formation of Epidemiological Causation around the Four Major Pollution Trials in Japan," *TetsugakuKagakushiRonso (Disputation of Philosophy and History of Science)*, 13 (2011): 45-73.

established its first atmospheric environmental standard—the sulfur oxide standard in 1969. Before that, the European countries and the U.S. had set their own ambient air quality standards in the early 1960s. The WHO Inter-Regional Symposium on Criteria for Air Quality and Methods of Measurement was held in 1963. The guides to air quality were presented as four categories of concentrations, exposure times, and corresponding effects.

In fact, the ideal standard should arrive at a high level, but different countries have different situations, and a lower level was considered finally. In the Soviet Union, the original values were presented in 1952, and the Lists of Norm for 55 substances were published in 1964.<sup>10</sup> The Clean Air Act of the United States was passed in 1963, which regulated the gas discharged by automotive vehicles and sulfur oxides. The U.S. published its Air Quality Criteria for Sulfur Oxides in April 1967 and built the Air Quality Act in the same year, which was based on epidemiological investigations and considered the influences on animals and plants.<sup>11</sup> The states of New York, Montana, Colorado, and Pennsylvania determined their own standards even earlier than the federal government did, and their investigative data were consulted. In 1971, the regulation of a country standard for sulfur dioxide was established.

Unlike traditional science, studies in environmental science did not concentrate on developing one theory and then substantiating it. They discussed how to solve the problems that were caused by modern technology, and the resolution was either to protect beforehand or to develop new technologies to solve the old problems. Most developed countries experienced pollution first and control afterwards. To avoid this old model, scholars advocated a precautionary principle to prevent pollution beforehand.<sup>12</sup> The leap-forward development pattern was thought to be an ideal model applying to

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<sup>10</sup> Takeo Suzuki, "Aryūsan Gasu no KankyōKijunSettei no Tame no Shiryō to Kōsatsu (Reviewing the Document for setting Environmental Standards for Sulfur Dioxide)," *TaikiOsenKenkyu (Air Pollution Research)*, 3 (1971): 315-357.

<sup>11</sup> Robert Martin and Lloyd Symington, "A Guide to the Air Quality Act of 1967," *Law and Contemporary Problems*, 2 (1968): 239-274.

<sup>12</sup> About the precautionary principle, some experts mentioned its shortage and gave suggestions. See Kiyoshi Niwa, *GijutsuKeiei (Technology Management)* (Tokyo: University of Tokyo Press, 2006), p. 280; Miwao Matsumoto, *Technoscience, Risk to Shakaigaku (The Social Risks of Technoscience)* (Tokyo: University of Tokyo Press, 2009), p. 291; Junko Nakanishi, *Kankyo Risk Gaku (Environmental Risk Theory)* (Tokyo: Nihon Hyoronsha, 2011), pp.191-192.

developing countries, but the implementation is difficult. In Beijing in 2008, the Blue Sky Project contributed a great deal to providing clean air for the Olympic Games. However, severe pollution following occurred. Learning from the pollution histories of developed countries would be of great help in constituting the appropriate environmental policies in the less advanced countries.

### Reviewing the Existing Literature

Above retrospect concerned with kōgai, atmospheric pollution, and epidemiology. So what is kōgai? Jun Ui (宇井純) gave lectures to the students in the University of Tokyo, and collected those talks into a book—*Kōgai Genron*.<sup>13</sup> Hikaru Shōji (庄司光) and Ken'ichi Miyamoto (宮本憲一) showed a pollution map of Japan on which various incidents of air pollution, water pollution, noise pollution, and other “kōgai” occurred.<sup>14</sup> Focusing on the conception of kōgai and citizen movement, Nobuko Iijima (飯島伸子) conducted a good work from a socialist viewpoint.<sup>15</sup> According to Iijima, the word kōgai can be traced back to Meiji-era Japan. The law that referred to this word did not give the exact meaning.<sup>16</sup> The word was related to public environmental pollution until the middle of the twentieth century. She defines “kōgai” as “the phenomenon when a private company or public enterprise, or even residents themselves, disturbs the natural environment and thereby reduces the health, lifespan, and quality of life of residents in that environment.”<sup>17</sup> It did not have the right corresponding word in English but was a direct translation—kōgai meant “public nuisance,” though this phrase could not express properly the meaning of the word. In a broader definition, it could also be considered environmental pollution caused by modern industrial activities.<sup>18</sup>

<sup>13</sup> Jun Ui, *Kōgai Genron (Original Discussion on Kōgai)*, composite volume (Tokyo: Akishobo, 1988).

<sup>14</sup> Hikaru Shōji and Ken'ichi Miyamoto, *Osorubeki Kōgai (Fearful Environmental Pollution)* (Tokyo: Iwanami Shoten, 1964).

<sup>15</sup> Nobuko Iijima, *Kankyō Mondai to Higaisha Undō (Environmental problems and movements by the victims)* (Tokyo: Gakubunsha, 1984).

<sup>16</sup> The law in Osaka referred to “one that damages the public interest.”

<sup>17</sup> Ibid., p. 3. See also Zenji Suzuki, “Anti-pollution Measures (25),” in Shigeru Nakayama, Kunio Gotō and Hitoshi Yoshioka ed., *A Social History of Science and Technology in Contemporary Japan (Tsūshi Nihon no Kagaku Gijutsu)* (Melbourne: Trans Pacific Press, 2001-): 441-451, on p. 441.

<sup>18</sup> In most places of this thesis, environmental pollution is used to substitute kōgai.

In studying the atmospheric pollution in London, Whitehead offered a geographic point of view.<sup>19</sup> “The London fog disaster,” as he called it, caused an extra 0.5 deaths per thousand in one week in London. Reconsidering Foucault's science of government, Whitehead conceived another possible expression: government with science. In *Atmospheric Pollution*, Jacobson described the atmospheric science and regulation and reviewed the London-type smog and its long history.<sup>20</sup> This type of smog or fog in London had existed since the nineteenth century. Other countries had such experiences too; for example, the Meuse Valley episode in Belgium in 1930 and the Donora episode in Pennsylvania in 1948. However, the London smog lasted the longest and happened repeatedly later in 1956, 1957, and 1962. Kessel reviewed the whole process—from London smog to the Clean Air Bill and the Clean Air Act—and made a comparison of them.<sup>21</sup>

On reviewing the postwar history of atmospheric pollution in Japan, Yokkaichi asthma was a good starting point. There were several studies on the Yokkaichi asthma episode. In early period, Eiji Ono (小野英二), a member of the local civil association, wrote his memory book on the ten years of pollution in Yokkaichi.<sup>22</sup> Norie Huddle and others reviewed the environmental pollution (kōgai) situation in Japan, including the Yokkaichi episode.<sup>23</sup> Hideyuki Kawana (川名英之) reviewed Japanese kōgai in his environmental book series.<sup>24</sup> Julian Gresser made an introduction of the 1973 Japanese Law for the Compensation of Pollution-related Health Damage.<sup>25</sup> Michael R. Reich gave a description of Yokkaichi case and the compensation system, also noticed their influence to the United States.<sup>26</sup>

<sup>19</sup> Mark Whitehead, *State, Science and the Skies: Governmentalities of the British Atmosphere* (Chichester, U.K.: Wiley-Blackwell, 2009).

<sup>20</sup> Mark Z. Jacobson, *Atmospheric Pollution: History, Science, and Regulation* (Cambridge: Cambridge University Press, 2002).

<sup>21</sup> Anthony Kessel, op.cit.

<sup>22</sup> Eiji Ono, *Genten: Yokkaichi Kōgai 10nen no Kiroku (Origin: The 10-year Record of Yokkaichi Kōgai)* (Tokyo: KeisoShobo, 1972).

<sup>23</sup> Norie Huddle et al. *Island of Dreams* (New York, Tokyo: Autumn Press Inc., 1975), “A Million Dollar Night View”.

<sup>24</sup> Hideyuki Kawana, *Dokumento Nihon no Kōgai (Document of Kōgai in Japan)* (Tokyo: RyokufuShupan Inc., 1988), vol. 2.

<sup>25</sup> Julian Gresser et al., “The 1973 Japanese Law for the Compensation of Pollution Related Health Damage: An Introductory Assessment,” *Law in Japan*, 8 (1975): 91-135.

<sup>26</sup> Michael R. Reich, “Environmental policy and Japanese society: part II. lessons about Japan and about

Later, Takashi Hirano (平野孝) concentrated on the regulation of environmental pollution.<sup>27</sup> Michio Hashimoto (橋本道夫), the director of Environmental Pollution Department (公害課) of the Ministry of Health and Welfare (MHW) and later director of Ministry of the Environment, reviewed the Yokkaichi episode when he was in charge of the deliberation of pollution control policies.<sup>28</sup> Katsumi Yoshida (吉田克己)'s memoir drew an outline of the Yokkaichi pollution regarding the appearance of asthma, the epidemiological surveys, and later government actions from a scientific point of view.<sup>29</sup> There were also three volumes of historical works on the atmospheric pollution in Japan, edited by the Japan Society for Atmospheric Environment, which also mentioned the eruption of Yokkaichi pollution and the policies aftermath.<sup>30</sup>

How were standards and environmental standards, in particular, developed in history and society? Takehiko Hashimoto (橋本毅彦)'s work reviewed the history of standard technology and paid attention to the compatibility of product such as screw. From compatibility technology to de facto standard, the issue of standardization was discussed as well as the definition of standard itself. Besides the standard of boundary compatibility, there are minimum standards, including the safety standard constraining by law.<sup>31</sup> Setting environmental standards is sometimes included in such minimum standards with a limiting value—with or without legal force. Standards for the protection of the environment, as Lawrence Busch pointed out, “whether highly precise or rather vague, are an attempt to define the degree to which a given person, organization, process, product, or thing contributes to the protection of nature, which is seen as the common inheritance of humanity.”<sup>32</sup> It might be quite different from industrial claims and sometimes may cause conflicts. Specific definition of

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policy,” *International Journal of Environmental Studies*, 3-4(1983):199-207.

<sup>27</sup> Takashi Hirano, *Nanohana no Umibekara (From the Seashore of Rape Blossoms)* (Kyoto: Houritsu Bunka Sha, 1997), vol. 1-2.

<sup>28</sup> Michio Hashimoto, *Shishi Kankyō Gyōsei (A Private History of Environmental Administration)* (Tokyo: Asahi Shimbun Company, 1997).

<sup>29</sup> Katsumi Yoshida, *Yokkaichi Kōgai: Sono Kyōkun to 21seiki heno Kadai (The Lesson of Yokkaichi Kōgai and Challenge to 21st Century)* (Tokyo: Kashiwa Shobo, 2002)

<sup>30</sup> Taiki Kankyō Gakkai Shiryō Seiri Kenkyū Iinkai (The Research Committee on Historical Documentation of the Japan Society for Atmospheric Environment), ed. *Nihon no Taiki Osen no Rekishi III (The History of Atmospheric Pollution in Japan)* (Tokyo: Lattice, 2000).

<sup>31</sup> Takehiko Hashimoto, *Hyojun no Tetsugaku (Philosophy of the Standards)* (Tokyo: Kodansha, 2002), p. 206.

<sup>32</sup> Lawrence Busch, *Standards: recipes for reality* (Cambridge, Mass.: MIT Press, 2011).



environmental standards was classified by Arthur C. Stern as air quality criteria, air quality goals, air quality standards, emission goals, emission standards, and design standards, which was cognition for many countries.<sup>33</sup>

Looking at the environmental standard setting for air pollutants in Japan, the first one to be mentioned is sulfur dioxide. The related parties had their opinions. Takeo Suzuki (鈴木武夫) reviewed the environmental standard-setting situation of WHO and several countries, and categorized them in four types: standards, guides or guidelines, goals, and criteria. The first three were considered administrative ideas, and criteria were deemed a scientific consideration. He interpreted the setting process of standards for sulfur oxides from a public health viewpoint.<sup>34</sup> Hikaru Shoji reviewed the setting process of standards for sulfur oxides and indicated the difference between air quality standards and the threshold limit values in the plant.<sup>35</sup> Michio Hashimoto interpreted the legal character of environmental standard and focused on the arguments regarding setting the standards for sulfur oxides in Japan and foreign cases.<sup>36</sup> Later, Jun Kagawa (香川順) reviewed the reference data for setting the SO<sub>x</sub> standard with the expert panel.<sup>37</sup> On setting environmental standards, some scholars in different fields also had different opinions. The arguments were mainly from a legal or scientific viewpoint but rare social or philosophical point of view. How could the concept of regulatory science play a role in reviewing Japanese case for environmental standard as well as other standard establishment? The process will be historically reconsidered under the context of science, technology and society.

Several standard domains were mentioned related with Yokkaichi asthma episode. As one of the four major pollution episodes in Japan, it was related closely to the following standards setting concerning with pollution-related certification,

<sup>33</sup> Arthur C. Stern ed., *Air Pollution (second edition)*, vol. III (New York: Academic Press, 1968), pp. 609-718.

<sup>34</sup> Takeo Suzuki, "KankyoKijun o megutte (Focusing on Environmental Standards)," *HōritsuJihō (Legal Times)*, 8 (1971): 37-44.

<sup>35</sup> Hikaru Shoji, "Sulphur Oxide Standards," *Nippon EiseigakuZasshi (Japanese Journal of Hygiene)*, 5-6 (1970): 463-471. He also mentioned Stern's work.

<sup>36</sup> Michio Hashimoto, "KankyoKijun o meguruRonsonitsuite (Arguments focusing on Environmental Standards)," *Doryoku (Motivity)*, 105 (1968): 172-176.

<sup>37</sup> Jun Kagawa, "Wagakuni no Nisankaiō no KankyoKijunSettei no motoninataKenkoeikyōnikansuruChikken no Shuttenadonitsuite (Knowledge Sources of the Health Impact becoming the Basis of Setting the Environmental Standard for Sulfur Dioxide in Japan)," *KukiSeijo (Contamination Control)*, 2(1987): 13-22.

environmental standards and damage compensation. The pollution introduced by a petrochemical complex in Yokkaichi caused asthma to catch the attention of local scientists and government and led to early epidemiological investigations. A few of these works did give a whole description of the setting process for above environment concerning standards including environmental standards, certification standards and their relationship with the Yokkaichi episode, though some of them provided detailed data for the establishment of a certification or compensation system for the pollution-related patients. In Yokkaichi city, a Kōgai Archive Center containing nearly the entire collection of Yokkaichi pollution documents is situated.<sup>38</sup> It recently opened as an environmental study center, and both college students and children are welcome. Other documents are preserved in the court of Yokkaichi city: the entire collection of documents regarding the Yokkaichi Lawsuit.<sup>39</sup>

#### Contents of this thesis

This research will focus on the new types of air pollution discovered after World War II in Japan; the actions of scientists, government, industry, and citizens facing such problems; and the establishment of pollution-control policies during the 1960s and 1970s. The author tries to ascertain the history, from both social and technological viewpoints, of the Yokkaichi episode, including how the first certification system and compensation system for air pollution victims were established and how the first environmental standard was enacted in Japan. Scientific committees and government investigations promoted the pollution related research, which was based on epidemiological data. Following eight chapters described an outline of this thesis.

Chapter one will review the happening of Yokkaichi asthma episode in Japan. It was neither London type nor Los Angeles type of smog because of different meteorological conditions. The pollution was caused by the newly transformed

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<sup>38</sup> It will be mentioned as the Yokkaichi Kōgai Archives.

<sup>39</sup> Regarding the environmental destruction by radiation, Miura and Nakagawa respectively gave vivid descriptions of the historic process. See Toyohiko Miura, *Taiki Osenkaramita Kankyō Hakai no Rekishi (History of Environmental Destruction Seen by Atmospheric Pollution)*, (Kawasaki: Rodo Kagaku Kenkyujo, 1975); Yasuo Nakagawa, *Hōshasen Hibaku no Rekishi (The History of Radiation Exposure)* (Tokyo: Corporation of Technology and Human, 1991). An enlarged edition was published by Akashi Shoten in 2011.

energy—petroleum. When asthma occurred in the small town of Isozu with a higher rate than usual, both doctors and scientists paid attention. The local government also conducted a series of early actions regarding this matter. Chapter two focuses on the Yokkaichi pollution episode as the meteorological conditions there were unlike other places. It was called Gale (Shippu) Pollution. The lead-peroxide candle method and conductometric method were adopted as the main measuring procedures. Subsequent measures by the local government in the Yokkaichi areas included the early epidemiological investigations and the pollution-related patient-relief system based on these scientific data.

Chapter three mentions the early epidemiological investigations. Epidemiologist Katsumi Yoshida, who was a medical professor in Mie Prefectural University, played a crucial role in early surveys. He took the lead of the local epidemiological investigation with residents who enrolled in the National Health Insurance (Kokuho) Program, which provided valuable first-hand data on Yokkaichi. Later, a Kurokawa investigative team adopted Yoshida data for the report. It was a preliminary action before the national government started its own investigations. Chapter four reviews the establishing process for a certification system in Yokkaichi for the victims of air pollution. Local government adopted the three conditions of epidemiology, which were also considered by the national government when setting the Atomic Bomb Medical Law, for both leukemia and asthma were non-specific diseases. Designated area, designated period and designated diseases were confined to be the certification standard.

Chapter five focuses on the establishment of the fundamental national law for environmental pollution. When the Basic Law for Environmental Pollution Control was enacted in 1967, both the concepts of *kōgai* and the environmental standard were approved as the main items. Osaka had its own experiences on this dispute that there was already an environment management standard for sulfur dioxide. As a coordinator of officials for this law, Michio Hashimoto published his own opinions on the enactment of the process. Chapter six focuses on the setting process of the first environmental standard in Japan. Early epidemiological investigative results from Yokkaichi and

Osaka provided crucial data to determine the threshold values. Although objective opinions were not the minority, after a deliberation of the early data and other countries' cases, the expert panel submitted its report on setting the sulfur oxide standard—which led to the first atmospheric pollutant standard—and also the first environmental standard in Japan.

The Yokkaichi Lawsuit will be focused on in Chapter seven. It was a pioneer litigation regarding air pollution in Japan. Expert testimony and citizen movement promoted the advance of the legal process. As a scientist from the field of public health, Katsumi Yoshida adopted epidemiological causation in the court to ascertain the legal causation. The validity of epidemiology and other sciences in the court will be discussed. The compensation standard, which was firstly adopted by the lawsuit judgment, influenced later Compensation Law. The last chapter will review how the sulfur oxide standard was revised in 1973 after the Yokkaichi lawsuit, which was considerably strengthened and even stricter than other countries in the world. How citizen movement in Yokkaichi area promoted government regulations will be also mentioned in this part.

## Conclusion: Environment concerning Standards in Japan

Standards, as JIS definite, are between related human beings to obtain benefit fairly, with a goal of unification and simplification, which are decided by the things (production of productive activity) and other things (organization, responsibility of authority, system, methods).<sup>1</sup> It mainly indicated the standards in industrial field. Early Standard could be traced back to the 18th century France on producing the components with compatibility of military weapons.<sup>2</sup> Standardization was based on the feature of compatibility, such as screw. There are four levels of standards according to hierarchy, international, regional, national and corporational standards.

Lawrence Busch maintained that industrial claims for quality might be quite different from developing standards for domestic, civic, merchant, and environmental claims, sometimes “divergent justifications can lead to conflicts over standards.”<sup>3</sup> In his book *Standards*, Busch wrote, “Standards for the protection of the environment, whether highly precise or rather vague, are an attempt to define the degree to which a given person, organization, process, product, to thing contribute to the protection of nature, which is seen as the common inheritance of humanity.”<sup>4</sup> The ISO 14001 standard for environmental management system was implemented in 1996.

Several standard measurements were mentioned in this study, including standardized medical questionnaires, the measurement methods for pollutants, the diagnostic concepts of respiratory diseases; but among them, two standards are worth mentioning here. One is the environmental standard, and the other is the certifying standard of the certification system for pollution victims, and the standard for legal compensation in Yokkaichi.

The three epidemiological principles once used in the Atomic Bomb Medical Law were also active in the certification of the air pollution victims. As “Yokkaichi asthma”

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<sup>1</sup> Japanese Industrial Standards Committee (JIS Z 8002:2006).

<sup>2</sup> Takehiko Hashimoto, *Hyojun no Tetsugaku (Philosophy of the Standards)*, op.cit., chapter one.

<sup>3</sup> Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, Mass.: MIT Press, 2011), pp. 258-259.

<sup>4</sup> Ibid.

is non-specific in nature, it could occur even without air pollution. In identifying the causal factors in non-specific diseases, leukemia was used as a reference, which had also occurred in the population without the after-effects of the atomic bomb. To judge whether or not a specific patient's leukemia resulted from radiation exposure, the government designated a specific area around the bomb's hypocenter, and a specific duration of time in which people resided in that area. That is to say, specific geographical areas and temporal duration were designated as two conditions for the epidemiological criteria, in addition to the designation of specific pathological diseases.

Another standard for legal compensation was adopted by the Yokkaichi lawsuit, and influenced later national Relief Law and Compensation Law. The part of medical fees afforded by the patient in the national health insurance was paid by the government since Yokkaichi certification system. The Yokkaichi lawsuit gave a measureable compensation standard for the loss fees of capacity to work of the victims and other allowances to be afforded by the corporations. The Compensation Law based on the judgment set a new model in the world to treat such kind of issues. Reich pointed out that the system composed by the law was also used "as the basis for a model act for the United States to compensate victims of toxic substance pollution."<sup>5</sup> Certification standard and compensation standard coordinated with environmental standard. This research focused on the Yokkaichi asthma episode, including the frequent occurrence of respiratory diseases. It followed epidemiological investigations and the choice of proper methods for measuring pollutants, establishing the relief system for certifying victims of air pollution in Yokkaichi, and the widely known Yokkaichi Lawsuit. This episode is closely related to a national topic: the establishment of environmental standards for sulfur oxides (SO<sub>x</sub>). It began with the Osaka environmental management standard, continued through the national legal concept of environmental standards of the Basic Law, and then achieved the first set of standards for sulfur oxides.

Epidemiology played a crucial role in all of these processes. A retrospective of the

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<sup>5</sup> Michael R. Reich, "Environmental policy and Japanese society: part II. lessons about Japan and about policy," *International Journal of Environmental Studies*, 3-4(1983):199-207, on p.204.

Yokkaichi episode showed that the *Kokuho* investigations conducted by Yoshida and his colleagues provided valuable statistical data between the prevalence rate of the residents and the concentration of the pollutants, particularly of sulfur dioxide. Setting environmental standards with the adopted Yoshida data showed that there was a high association with the resident prevalence when the sulfur dioxide concentration was above 0.2 ppm. The early data in Yokkaichi was used by the government investigative team, the Kurokawa Investigative Team, and was also applied in the final setting of the sulfur oxides standard.

The Basic Law for Environmental Pollution Control, for the first time, clearly interpreted the conceptions of *Kōgai* and the Environmental Standards under the social semantic background, using the environmental pollution law. Reviewing the establishment process, Osaka was a successful case in regulating the pollution measures at an early age. It approved the environmental management standards referencing the control of industrial pollution in the city, although it was still only a regulation, without the force of law. Special attention being paid to pollution by the national government began with creating the Department of Environmental Pollution, which was set in both the MHW and MITI. As the first leader of the department in the MHW, Michio Hashimoto played a central role in mediating pollution matters, and in establishing the environmental pollution control law. The entire history of the establishment of the basic law indicated how a fundamental environmental law was enacted in the background, while environmental pollution erupted in most of the industrial cities in Japan, and how it influenced the later environmental pollution administration in this country.

The first environmental standard to be established was the standard for sulfur oxides. Not only Yokkaichi city, but also the Osaka prefecture, were collected epidemiological and measurement data, which was typical for the industrial cities. The expert panel report regarding the SO<sub>x</sub> standard was submitted in January of 1968. The early Osaka data contributed a lot to the first step resolution of the standard setting, although Yokkaichi data was found more useful when the revision. A one day value of 0.05 ppm and a one hour value of 0.1 ppm were approved as the threshold values;

however, under the pressure of objections from industry (and other fields), MHW was forced to rethink the rigor of the standard values. They were twice weakened from the original ones, and because the first new standard was easily achieved by most of the cities, the local community called for a much stricter one. In the revision, the standard values were strengthened when compared to the original values.

The two standards mentioned above both were established by the government (local and national); one for the pollution victims, and the other to regulate the concentrations of pollutants by corporations. Certifying pollution-related patients and giving legal compensation was a relief measure to remedy the effects of air pollution; while the environmental standard was to control the pollution situation and prevent a worsening of the living environment. The latter was followed more closely because in setting an environmental standard, an interdisciplinary act plays into the “science in policy.”<sup>6</sup>

Not only SO<sub>x</sub>, but many new types of air pollutants were restricted to satisfy certain regulated standard values. Before the environmental standard for sulfur dioxide was revised, another pollutant, nitrogen dioxide, came under discussion. This standard was paid more attention by critics because the process of setting this standard was much more difficult than any other. Takeo Suzuki, the leader of the SO<sub>x</sub> expert panel when it was revised, was also the leader of the NO<sub>x</sub> expert panels for the original and revision sessions. He maintained the same strict attitudes toward setting both the SO<sub>x</sub> and the NO<sub>x</sub> standards.

#### <The NO<sub>x</sub> standard>

The early cause of air pollution was due to the falling dust created by burning coal, and was later caused by the combustion of petroleum. Not very much later, chemical toxic pollutants became the main cause of urban atmospheric pollution. Different than in the past, not one, but several kinds of substances became air pollutants, such as sulfur oxides, nitrogen oxides, and photochemical oxidants. They reacted together and created

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<sup>6</sup> Science in policy and policy for science were mentioned in *The Fifth Branch*. See Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge, Mass.: Harvard University Press, 1994). It will be mentioned hereinafter.



secondary air pollutants which coexisted with the primary pollution substances. This situation was referred to as Combined Pollution (複合汚染). It appeared and spread during the 1970s with the expanding use of automobiles. A 5 year investigation into the influences of combined air pollution on housewives in 6 cities was conducted beginning in 1971.<sup>7</sup> It showed that although the concentrations of floating dust and SO<sub>2</sub> were lowering, the concentrations of NO<sub>x</sub> were increasing in Japan. This valuable survey result was translated into English and highly praised by the WHO.

The United States set up their criteria for NO<sub>2</sub> as an annual average value of 0.05 ppm in 1971. These criteria were criticized by many fields, even bringing about a lawsuit. In a review in 1973, the criteria were finally considered to be appropriate, and the expert panel leader, Dr. Carl Shy, submitted an explanation from the viewpoint of epidemiology. He noticed the situation and referred to the investigative data in Japan, where criticism from the industrial field with regard to the NO<sub>2</sub> standard was ongoing.<sup>8</sup>

Japan contributed much to the epidemiological studies, which were scarce throughout the world. Their study data indicated that if the human body was exposed in NO<sub>2</sub> over time, the prevalence for chronic respiratory diseases would also increase. However, it was necessary to conduct a longitudinal study for the population exposed to air pollution at various concentrations. Previously, in this subject, only the Yokkaichi data from Isozu for SO<sub>2</sub> pollution concentration variations was available. The expert panel suggested a maximum exposure value of 0.10-0.17ppm for one hour, which could not occur more than once. This was converted into a daily average value of 0.037-0.067ppm, which was equal to 0.04-0.07ppm, as suggested by the WHO. When compared with the United States, the epidemiological research in Japan not only referred to the data on the prevalence of respiratory diseases in polluted areas, but also to the data on the prevalence in areas with no air pollution. The health impact indexes in the two countries were also different that the one in the U.S., indicating a situation with

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<sup>7</sup> Takeo Suzuki et al., "Taiki Osen to Katei Fujin no Kokyuki Shoyo oyobi Kokyu Kino tono Kankei nitsuite (The Relationship between Air Pollution and Respiratory Symptoms and Respiratory Functions on Housewives)," *Taiki Osen Gakkai Shi (Journal of Air Pollution Society)*, 8 (1978), pp. 310-355.

<sup>8</sup> Jasanoff mentioned Shy Panel in ozone standard case. See Sheila Jasanoff, *The Fifth Branch*, op.cit., chapter 6.

worse symptoms.<sup>9</sup>

On 20 June 1972, the expert panel for NO<sub>x</sub> approved the criteria for nitrogen dioxide, considering its acute and chronic effects, and the additive action with sulfur dioxide, in that the concentration for one year should be maintained below the one hour value of the 24 hour average value of 0.02 ppm.<sup>10</sup> This was stricter than the standards in any other country at that time. However, after attracting the attention of critics from various fields, there was a revision toward relaxation. In March of 1978, the expert panel report gave the guideline values of 0.1-0.2ppm for a one hour exposure, and 0.02-0.03ppm for the annual average level. This reached a verdict by the Central Committee for Environmental Pollution Control who announced that the one hour value of the 24 hour average value should be between 0.04-0.06ppm. These values were two to three times looser than the original values, and thought to be a move backward.

The relaxation of the NO<sub>x</sub> standard was considered to be “a branch point in the history of environmental pollution in Japan.”<sup>11</sup> The achievement ratio of the environmental standard for NO<sub>x</sub> in the fiscal year 1976 was only 9.0%, but when the new standard was approved, the ratio went up to 95.4% in the fiscal year of 1977. This also led to litigation on 11 October 1978, in a lawsuit by 15 citizens for canceling the relaxation, which was a demonstration to the environmental administration. The plaintiff included the certified pollution victims, the doctors and nurses of the victims, and others. However, the judgment in September of 1981 declared that the revision of the environmental standard did not change the rights and duty of the residents, nor their legal position. Thus, it could not be treated as an administrative disposition (行政処分), which was the object of the litigation.<sup>12</sup>

How was a daily value of 0.02ppm weakened to an annual value of 0.02-0.03ppm in

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<sup>9</sup> Kiyoo Wadachi, Nisanka Chisso no Kenkō Eikyō nikakawaru Hantei Jōken nado nitsuite (Criteria for the Health Impact of Nitrogen Dioxide), 22 March 1978, *Amagasaki Taiki Osen Kōgai Jiken Shi (History of the Air Pollution Episode in Amagasaki)* (Tokyo: Nippon Hyōron Sha, 2005), p. 529.

<sup>10</sup> Chisso Sankabutsu nado ni kakawaru Kankyo Kijun nitsuite no Senmon Inkaikai Hokoku (Expert Panel Report on the Environmental Standards for Nitrogen Oxides etc.), *Kankyō Mondai Shiryō Shūsei (Corpus of Environmental Problems)* 7, Nihon Kagakusha Kaigi, ed. (Tokyo: Junposha, 2003), pp. 240-245.

<sup>11</sup> Gyo Saito, “Why need to consider environmental standard at present?” *Sangyō Keiei Kenkyū (Research on Industrial Management)*, 16 (1995), pp. 55-67, on p. 57.

<sup>12</sup> Nisanka Chisso Kankyo Kijun Kokuji Torikeshi Seikyu Jiken (二酸化窒素環境基準告示取消請求事件), <http://hanrei.biz/h69377>.

the revision? The reason might be that it was difficult for the industrial field to fulfill the former value, so they asserted the daily value of 0.05ppm, which was officially approved by the United States. Japan has no responsibility to fulfill much stricter standard values than other countries. Meanwhile, a large cost for pollution control would lead to a lower international competency. On the other hand, the environmentalists did not agree with the industrial side, who claimed for the priority of protecting human health, and insisted on the old value. But to what extent did scientific evidence act? Is 0.02 ppm a reasonable value to follow or 0.04-0.06 ppm is a better one?

What else is of note? Michio Hashimoto, in his memoir, described in detail how the standard for NO<sub>2</sub> was enacted.<sup>13</sup> He explained the different roles that science and government should play: criteria and guidelines belong to science; policy judgments and setting environmental standards under those scientific values belong to the government. To set up an expert panel, it is very important to choose the right members. He chose experts from all fields relevant to the environment, including clinical studies, epidemiology, public health, labor health, toxicology, measurement, and analysis. He also included members regularly working for WHO and members who did not work for WHO; the elderly and the young; members agreeing with the viewpoint of the government, and in the political left or right.

Alvin Weinberg proposed a term in the 1970s, called “trans-science,” which works in the boundary between science and politics, containing the problems which could not solely be answered by science.<sup>14</sup> Sheila Jasanoff has discussed and elaborated the concept of “regulatory science” which works in such boundary social setting involving both scientific and political considerations.<sup>15</sup> Liora Salter introduces the concept of “mandated science” in similar vein, which she defines as “the science that is used for the purposes of making public policy” or for the purpose of supporting regulatory

<sup>13</sup> Michio Hashimoto, *Shishi Kankyō Gyōsei*, op. cit., pp. 270-297.

<sup>14</sup> Alvin M. Weinberg, “Science and Trans-Science,” *Minerva*, 10 (1972): 209-222.

<sup>15</sup> See Sheila Jasanoff, “Contested Boundaries in policy-relevant Science,” *Social Studies of Science*, 2(1987):195-230; idem, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge, Mass.: Harvard University Press, 1994); and idem, *Science at the Bar: Law, Science, and Technology in America* (Cambridge, Mass.: Harvard University Press, 1995).

decisions at various levels of governments in particular. And she considers the standard-setting process as a particularly good example of such “mandated science.” For decisions about standards reflect the contradictory demands of science and economic interests, and standards are the product of negotiations that occur in a variety of settings and jurisdictions.<sup>16</sup>

As for environmental standards, Jasanoff pointed out in the paper, “Science and Judgment in Environmental Standard Setting,” an analogical situation between standard setting in environmental protection and education and also the existence of several types of environmental standards such as design, performance, exposure, product safety standards as well as those of practice and behavior. In it, she also argued that the credibility of environmental standards “depends more often on the methods by which they were generated and enforced than on their validation against observable natural phenomena,”<sup>17</sup> and emphasized that “even when standards are thought to be entirely scientific or technical, they almost certainly contain embedded social judgments.”<sup>18</sup> On setting environmental standards for sulfur oxides in Japan, the process was scientific and societal. Scientists were selected from renowned universities and institutions. They were the authors or cooperators in publications and papers with high credibility. However, it was the first time for them to participate and for the government to compose such panel in Japan. As in other cases, it was criticized by industries before becoming a legal standard from the Living Environment Council to the Cabinet Council. The process of setting first standards could be divided to two parts: to be threshold values and to be legal standard values. They act respectively scientifically and socially. The latter was a compromised production of politics and economy, but the former reached agreement under scientific judgment. The revised standard was established based on more valuable scientific data, accepted measuring methods, and received a balance between science and government policy.

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<sup>16</sup> Liora Salter, *Mandated Science: Science and Scientists in the Making of Standards* (Dordrecht, The Netherlands: Kluwer Academic Publishers, 1988).

<sup>17</sup> Sheila Jasanoff, “Science and Judgment in Environmental Standard Setting,” *Applied Measurement in Education*, 1 (1998): 107-120, on p. 108.

<sup>18</sup> *Ibid.*, p. 119.

In the United States, the Science Advisory Board (SAB) was an advisory organization of the EPA, which had cooperated with them since 1974. However, there were two problems: obtaining adequate feedback from the agency and matters with scientific uncertainty. As a loosely structured advisory system, the SAB acted as expected, but when a certain standard for a pollutant was to be determined, another kind of expert panel was necessary. Such expert panels were common in the 1960s and 1970s in Japan. They were short term ones which would be dismissed after the standard (usually the threshold values and the criteria) having been established.<sup>19</sup> The panel members were assigned by the MHW (later by the Environmental Agency), and might have opinions differing from each other. Another form was early government investigation committees such as Kurokawa Investigative Team.

From the SO<sub>x</sub> case to NO<sub>x</sub> case, more expert members from the interdisciplinary fields participated. In a round-table discussion, Suzuki asserted that not only scientists from medicine, hygiene, physics, and chemistry determined the environmental standards, but also the social economists and policy makers must articulate their opinions.<sup>20</sup> From the scientific community to interdisciplinary fields, and to governmental officials, a consensus by all fields was needed to fulfill the final enactment of the standard.

Besides environmental standards, this study also focuses on several other standard domains, such as standardized medical questionnaires and the measurement methods for pollutants. As discussed above, another one concerning relief and compensation of the pollution-related patients was mentioned in this study. Yokkaichi lawsuit was a typical case to study the role of epidemiology in the court, the causation both of legal and epidemiology, and the compensation standard for burdening the medical and damage fees of the plaintiff. The compensation system established in the 1973 national law was the first of its kind in the world.

Environment concerning standards are often sponsored as the local regulation, such

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<sup>19</sup> Smith pointed out the four forms of composing scientists in policymaking. See Bruce L.R. Smith, *The Advisers: Scientists in the Policy Process*, Brookings Institution (1992).

<sup>20</sup> Takeo Suzuki et al., "Chisso Sankabutsu no Kankyō Kijun nitsuite (About the Environmental Standards for NO<sub>x</sub>)," *Kōgai Kenkyū (Environmental Pollution Study)*, 1 (1978), pp. 40-50, on p. 46.

as that of cities and prefectures, before nationally established in Japan. Yokkaichi city government initiated the certification system for pollution-related patients before the national relief law was enacted. The total emission standard was firstly adopted as the regulation of Mie prefecture. Meanwhile, the lawsuit also set typical example for the legal standard and system. Citizens and media played an extraordinary role in establishing certification and compensation system than in the SO<sub>x</sub> standard setting. In Yokkaichi lawsuit, the plaintiff held priority in most of the judicial debate; the defendant even could not invite an expert with authority in his field. The judgement finally adopted the compensation standards proposed by the expert on plaintiff side. The role of scientist in the court were sometimes more effective than in science itself. The citizens and media promoted the proceedings of the judgement.

To solve the external diseconomy of the environmental problems, only the conscious of corporations is not enough, government must make policies to encourage industry to adopt clean air devices and sewage disposal facilities. Since 1962, Japan has spent more than 10 billion yen on setting environmental standards, including the investigative and measurement expenses. They have been highly praised by international society, which has encouraged developing countries to make more efforts to ameliorate their own environmental problems.

Japan also has an International Center for Environmental Technology Transfer that is located in Yokkaichi city. By learning about the Yokkaichi asthma episode, visiting groups from various countries learn valuable lessons about conquering industrial pollution. For example, they learn that not only the collaboration between scientists and government is required, but also the participation of citizens and corporations, for protection from environmental pollution. Beijing could be a pioneer city in China to create a strict environmental standard system for air pollutants and fulfill air quality standards effectively in order to improve the severe air pollution situation over the next one or two decades.