

## COMPARATIVE STUDY ON AIR POLLUTION AND HEALTH DAMAGE — A CASE OF OSAKA CITY

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### Сравнительный анализ загрязнения воздуха и ущерба здоровью населения — пример города Осака

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In this study, a trend analysis was conducted using the interannual data of measured values of sulfur dioxide in the air and the number of officially recognized victims of pollution-related diseases, in Osaka City, in order to clarify the health impact of air pollution. As a result, it has been shown that the number of victims tends mostly to decrease as the level of sulfur dioxide in the air becomes lower.

*Keywords: Environmental pollution, air pollution, health damage, trend analysis*

В исследовании был проведен анализ тенденций с использованием межгодовых данных измеренных значений диоксида серы в воздухе и числа официально признанных жертв заболеваний, связанных с загрязнением, в городе Осака, чтобы прояснить воздействие загрязнения воздуха на здоровье человека. Показано, что число жертв в динамике периода наблюдения уменьшается, поскольку уровень диоксида серы в воздухе становится ниже.

*Ключевые слова: загрязнение окружающей среды, загрязнение воздуха, ущерб здоровью, анализ тенденций*

### Frequent Severe Environmental Pollution and Health Damage

In postwar Japan, soil and water conservation together with economic recovery became the prime tasks, aiming to reestablish people's livelihood by reconstructing the war-devastated land while subduing severe pollution. To achieve these tasks, it was first necessary to recover national strength independently by rebuilding key industries, however this meant a huge policy challenge for Japan as it lacked natural resources. In combatting such hardship, the so-called «priority production system» was implemented, which involved intensively repeating the process; to increase steel production by using the maximum amount of heavy oil which the country was allowed to import, then to produce coal using steel, and allocate the coal for the production of more steel. With this method, Japanese industries began to slowly move along the recovery track during such troubled times.

Triggered by the outbreak of the Korean War in June 1950, the Japanese struggling economy rapidly turned to recovery with the rising demand for production materials which generated a ripple effect on all industries. Taking this as a favorable opportunity, the Japanese economy took a leap forward and entered the high economic growth period during which demand created demand.

Although such high economic growth brought people an affluent lifestyle, it also came with a high price.

Resulting from the development of heavy and chemical industries that supported economic growth, but which continued to emit large amounts of hazardous pollutants in the form of waste water and exhaust gas, it caused a serious issue of pollution. Natural and living environments were destroyed in wide areas, while a large number of human lives as well as fishery and other assets were lost or suffered damage. As this pollution issue became apparent and chronic nationwide, Japan in those days was called the polluted islands. Minamata disease (Kumamoto and Kagoshima prefectures), Itai-Itai disease (Toyama prefecture), Yokkaichi asthma (Mie prefecture) and Niigata Minamata disease are known as four major Japanese pollution diseases.

Against a backdrop of such painful pollution issues, the Basic Law for Environmental Pollution Control was enacted in 1967 (integrated into the Basic Environment Law in 1993) for the purpose of protecting the health of people and preservation of living conditions. Under this law, environmental pollution was defined as seven types; air pollution, water pollution, soil contamination, noise, vibration, ground subsidence, and offensive odor. Based on this law, relevant laws including the Air Pollution Control Law and Water Pollution Prevention Law were enacted in 1968 and 1970 respectively, in order to implement effective measures against pollution.

Among the above seven types of pollution, the Law Concerning Pollution-Related Health Damage Compen-

sation and other Measures was established in 1973 focused specifically on victims with health damage due to extensive and serious air and water pollution. The objective of the law is the protection of victims and preservation of their health, through programs concerning compensation, welfare, and prevention of health damage caused by air pollution. As shown in this objective, the health damage by air pollution was so serious in those days that such compensation program was introduced and still continues today as a way of compensation payment and other pollution-related health and welfare programs.

This study, with a focus on the health damage caused by air pollution, aims to clarify the relationship over time between the level of air pollution and the number of officially recognized victims with pollution-related health damage, by selecting the city of Osaka which suffered severely due to air pollution.

### **Historical Background of Osaka City Concerning Air Pollution**

Once called «the city of smoke» or «Manchester of the East», Osaka City was the largest industrial and commercial city in Japan and smoke represented the symbol of its prosperity.

Pollution in Osaka City began along with the modernization of Japan in the Meiji Period (1868–1912), during which many spinning and metal plants were built and people complained about the smoke emitted by them, creating a social problem. To this end, the city banned the construction of plants with chimneys in the former city area in 1888, and established the Production Site Control Regulation in 1896 in which the term 'kogai (pollution or literally public hazard)' was used. When industrialization further advanced following the second expansion project of the Osaka City area in 1925, the city began measuring the level of dustfall. In 1932, Japan's first Smoke and Soot Prevention Regulation was issued which reveals how serious air pollution due to smoke was in Osaka City.

In 1945 when World War II ended and industrial activities resumed, the Osaka Prefecture Workplace Pollution Control Ordinance was enacted to control smoke and soot in 1950. However, as the pollution problem drastically increased, it was revised in full four years later in 1954. The city, while implementing preventive measures against air pollution in collaboration with Osaka Prefecture and other neighboring cities, urged plants and workplaces to found organizations to prevent smoke and soot emissions. As a result, they voluntarily began promoting pollution prevention activities through such organizations.

In 1967, the Basic Act for Environmental Pollution Control was established in order to effectively implement pollution prevention activities against the social background of the four major pollution-caused diseases which occurred during the 1950s and increasing amount of pollution damage, since which various other pollution-related laws including the Air Pollution Control Act were

introduced. In 1969, the environmental standards for sulfur dioxide were set which was essential for the protection of human health, which was successively followed by other environmental standards.

In concert with these environmental policy developments, the Osaka Prefecture Pollution Control Ordinance was revised in full in 1971, and the Osaka Area Pollution-Prevention Plan and the Osaka Prefecture Environmental Management Plan were drawn up in 1972 and 1973 respectively. In the same period, Osaka City formulated the Basic Concept for Air Pollution and the Clean Air Plan '73 in 1971 and 1973 respectively with emphasis on measures to combat sulfur dioxide, thereby systematically promoting the improvement of air pollution. Meanwhile, the city had been trying to improve its air pollution by commencing air monitoring in 1965 and preparing a system to provide guidance in 1969 regarding special measures against air pollution.

Osaka Prefecture announced the Regulatory Standards on Total Concentration Levels of Sulfur Dioxide and Fuel Standards in 1972 and revised the Osaka Area Pollution-Prevention Plan in 1978. Through these, combined with the before-mentioned Clean Air Plan '73, the city has achieved a long-term evaluation for environmental standards concerning sulfur dioxide since 1979. Under such circumstances, the Osaka City Air Environment Conservation Basic Plan (New Clean Air Plan) was drawn up in 1984 for the strengthening of preventive measures concerning air pollution caused by sulfur dioxide and suspended particulate matters which had become more serious along with the progress of motorization as well as for the creation of a pleasant urban environment. Based on this New Clean Air Plan, Osaka City formulated the Osaka City Nitrogen Oxides Countermeasure Guidelines to reduce emissions of Nitrogen Oxides from fixed sources and the Osaka City Automotive Pollution Prevention Plan in 1985 and 1989 respectively. Thus the focus of the air pollution problem of Osaka City shifted from sulfur dioxide to nitrogen oxide.

With the expanding range and type of environmental problems, the city drawn up the Osaka City Environmental Basic Ordinance in 1995, based on which the Osaka City Environmental Basic Plan was enacted, enabling it to comprehensively combat and promote environmental issues.

### **Relief of pollution victims**

As air pollution was significantly grave among all other pollution problems in Osaka City, it was necessary to strongly promote its prevention and at the same time to help its victims. The city had thus provided victims with relief under the Law Concerning Special Measures for Relief of Pollution-Related Patients enacted in 1969, subject to the Nishiyodogawa-ward. The city however provided some subsidy for victims under medical treatment by establishing the Osaka City Pollution-Related Victims Relief Rules in 1973 as ad hoc measures until the national compensation system was enforced. In 1974, the Pollution-Related Health Damage Compensation Law was enforced, under which the entire Osaka City became its desig-

**Table 1. Changes in the air pollution and number of officially recognized victims of pollution-related diseases in Osaka City's administrative districts**

Zones	Names of administrative districts	Sulfur dioxide (SO <sub>2</sub> ) (ppm)				Number of officially recognized victims of pollution-related diseases (person)			
		1986	1996	2006	2016	1986 March	1996 March	2006 March	2016 March
Coastal	Nishiyodogawa	0.011	0.007	0.006	—	2,732	1,890	1,196	782
	Konohana	0.013	0.008	0.005	0.004	1,515	1,030	634	408
	Minato	—	—	—	—	917	600	349	257
	Suminoe	0.011	0.007	0.005	0.004	788	571	400	298
Near-coastal	Yodogawa	0.012	0.006	0.005	0.005	766	631	416	301
	Fukushima	—	—	—	—	421	296	184	128
	Nishi	0.010	0.006	0.005	0.004	370	230	143	110
	Taisho	0.011	0.009	0.006	0.004	1,078	787	466	331
Inland	Higashiyodogawa	—	—	—	—	486	352	234	171
	Asahi	0.011	0.006	0.006	0.005	464	330	222	149
	Miyakojima	—	—	—	—	404	329	225	157
	Kita	0.010	0.006	0.004	—	290	209	148	117
	Tsurumi	0.009	0.006	0.005	—	642	570	428	315
	Joto	0.011	0.006	0.006	0.004	1,782	1,347	921	646
	Chuo	—	—	—	—	220	178	124	86
	Higashinari	—	—	—	—	320	243	159	118
	Tennoji	—	—	—	—	172	111	84	60
	Ikuno	0.010	0.007	0.006	0.004	1,289	835	499	335
	Naniwa	—	—	—	—	444	270	164	97
	Nishinari	0.012	0.007	0.006	—	1,514	1,119	644	422
	Abeno	—	—	—	—	339	271	177	111
	Higashisumiyoshi	—	—	—	—	657	432	288	193
	Hirano	0.010	0.007	0.005	0.006	792	589	413	294
Sumiyoshi	—	—	—	—	557	431	273	182	
<b>Osaka City</b>		<b>City average</b>				<b>Total</b>			
		0.011	0.007	0.007	0.004	19,639	13,651	8,791	6,068

**Note.** Prepared by the author based on data extracted from the Osaka City Environmental White Paper. «—» indicates that an environment monitoring station is not yet installed.

nated area. Under this law, the city awarded compensation to pollution victims at the expense of the polluter. As the Pollution-Related Health Damage Compensation Law was partially amended in 1987 and the air pollution in the city showed improvement, no new pollution victims were officially recognized after 1988 when enforcement of the above law began, provided however that compensation for those already recognized as victims was continued. Furthermore, it was decided to implement projects regarding environmental health and improvement in order to secure people's health, while preventing air pollution-caused health damage. In Osaka City also such environmental health and air pollution control measures were further enhanced.

As Nishiyodogawa-ward had a large number of officially recognized victims of pollution-related disease due to its significantly high air pollution caused by sulfur dioxide and nitrogen oxide, the residents filed a lawsuit against local corporations and road management authorities and won after 20 years. Presently in the ward, a public interest corporation takes its own measures while aiming for the revitalization of pollution affected areas, by allocating a part of the settlement money.

### Trend Analysis of Air Pollution and Number of Officially Recognized Victims

Osaka City, a waterfront city facing Osaka Bay on its west, has, as of 2018, an area of approximately 225 km<sup>2</sup>

and population of 2.73 million which, in population, represents the third largest city in Japan.

After the war, heavy and chemical industries essential for economic and industrial reconstruction built many plants in coastal areas throughout Japan, of which the waters were quiet, thus providing convenient locations for sea transportation. Likewise in the coastal area of Osaka City, a thermal power plant and many other plants of heavy industries, such as steel, petroleum, chemical, and shipbuilding were built, as in Amagasaki City adjacent to its west and Sakai City to its south. As a result, a large scale coastal industrial zone was formed centered on Osaka City at the back of Osaka Bay. In the meantime, pollution of the air became significantly bad once again with the frequent occurrence of health damage among citizens in Osaka City which has long suffered from soot and smog pollution as mentioned above. As the desulfurization technology for petroleum fuel had not been developed in those days, these giant-size plants emitted massive amounts of sulfur oxide and sulfuric acid gas. Thus residents who suffered chronically from respiratory diseases including asthma and other lung disorders due to sulfur oxide as the major cause increased drastically. The most severe case of this pollution disease is known as Yokkaichi Zensoku (pollution-caused asthma in Yokkaichi, Mie Prefecture). The aim of the study intends to help people who suffer from such pollution-related health damage.

To this end, the study carried out a trend analysis of air quality including sulfur dioxide, the main cause of chronic respiratory problems among air contaminants of the city, and a number of officially recognized pollution victims. Aimed at clarifying the analysis, data was taken during four periods every 10 years; 1986, 1996, 2006, and 2016. The city's administrative districts were divided into three zones; Coastal, Near-coastal (along the back of the Coastal Zone), Inland (surrounding the Near-coastal Zone), and the number of officially recognized pollution victims based on these districts in three zones were organized, as shown in Table 1 which revealed the following facts.

Firstly, the average level of sulfur dioxide in the city was 0.011 ppm in 1986, but was 0.004 ppm in 2016, showing a decrease of nearly one third over a period of 30 years. The number of officially recognized pollution victims was 19.639 and 6.068 in 1986 and 2016 respectively, likewise showing a decrease of nearly one third over the same period. Although the number of officially recognized pollution victims fluctuates due to varying factors such as victims being cured, deceased, and moving out of the city, it can be said that the improvement of air throughout Osaka City generally contributed to a decrease in the number of officially recognized pollution victims.

Secondly, the level of sulfur dioxide in the air in the Coastal Zone was slightly higher than that of Near-coastal and Inland Zones in 1986, while the level of concentration was more or less the same in all three zones in 2016. On the other hand, the number of officially recognized pollution victims decreased in the three zones in all subject years, however the number in the Coastal Zone remained higher compared with the other two zones even in 2016. This perhaps indicates that a respiratory disease caused by sulfur dioxide, once developed, tends to take longer to recover from.

Lastly, looking at the change in the number of officially recognized pollution victims at intervals of 10 years from 1986 to 2016, the number in all zones decreased at a high rate from 1986 to 1996 and to 2006, while from 2006 to 2016, it decreased by a lesser number. In other words, the reduction in the number of officially recognized pollution victims in Osaka City has tended to

become successively less. This is perhaps because, although air pollution related to sulfur dioxide has been improved in Osaka City, there are other air pollutants which have begun replacing it and damaging human health.

## Future Task

This study aimed at clarifying the adverse impact on humans by air pollution, selecting the city of Osaka which has suffered from severe pollution problems due to air contamination in the past. For this, a trend analysis was conducted through use of the interannual data of measured values of sulfur dioxide in the air and the number of officially recognized victims of pollution-related diseases, demonstrating that both had a certain correlation. However, at the same time a remaining problem has also emerged that will prevent further in-depth study. The key causal contaminants in the air have changed from sulfur dioxide to nitrogen oxide and fine particulate matter (PM 2.5) due to changes in motorization and combustion technology. There are now concerns regarding other respiratory disorders caused by nitrogen oxide and fine particulate matter, but the present situation does not allow us to identify victims with pollution-related health damage caused by these contaminants. This is because new pollution victims are no longer recognized officially under the revised Pollution-Related Health Damage Compensation Law. Thus it is not possible to obtain new data concerning the number of officially recognized victims, which poses a huge problem in furthering this study. It is necessary to consider other available data that can replace this.

Today there tends to be no end to the concentration of populations into urban areas worldwide. Because of this, the health and welfare of people who live and work in large cities have become important tasks as part of municipal policy, in addition to the improvement of urban comfort. In order to find solutions to such problems, the impact on human health by air pollution caused not only by sulfur dioxide but also nitrogen oxide and fine particulate matter is a paramount theme concerning health issues. Thus, it is vital to continue such study in the future.

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