『社会科学ジャーナル』78〔2014〕
The Journal of Social Science 78[2014]
pp.*43-63*

Foreshadowing Social Risk: The Dual Aspects of the Chemical Industry in Early Twentieth Century Japan

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I. Introduction

In recent years the discussion of "risk" in connection with science and technology policy have attracted much public attention. Indeed the progress of science and technology has helped to improve the convenience of the everyday life, but at the same time, if not managed properly, may be the cause of serious harm to human society. The radioactive contamination caused by the Fukushima Daiichi nuclear power plant following the disastrous East Japan Earthquake of March 11, 2011 is an obvious example. In addition to simple health hazards, the "accident" revealed the existence of critical (mis)communication problems between experts and non-professionals that hindered smooth and careful decision making.

Studies on risk inherent in modern society are abundant with Beck's *Risk Society: Towards a New Modrnity*, pioneer in the field. Recent research has been carried out from different perspectives, including research on the "uncertainty" of science and technology, and new approaches to the concept of "risk governance".(1) According to Lundgren and McMakin, studies that focus on communication between stakeholders over issues of risk is another essential area.(2) These points can be extended to the problems of general and social science and technology. For example, Mitcham applies the concept of risk to ethics and science and technology,(3) whereas Susanna sheds light on science, technology and communication.(4)

Nonetheless, while discussion on risk has been eagerly addressed in recent

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years, little attention has been devoted to issues of historical background. In particular, there a paucity of research on risk in science, technology and society in historical perspective.

This article maintains that social dangers do not appear suddenly, but develop over time. In other words, risk has a history that may foreshadow potential harm in the future. An understanding of the history background of any problem will necessarily help to ward off its repetition. The human and environmental damage caused by Minamata disease is a good example. Methyl mercury contained in wastewater discharged without treatment by the Chisso Corporation from the 1950s was able to ender the body via the food chain. Then, neuropathy of the whole body was affected, leading to death in severe cases. Many cases of fetal Minamata disease caused by mercury entering the bloodstream through the placenta were also common. Government and non-governmental group took action in the 1970s, but victims are still suffering and even today the problem not been fully solved.

This article is an exercise in environmental history. In particular, it will examine the interaction between the development of the ammonium sulfate industry in Japan and its environmental consequences.(5) This article will trace the history of the chemical industry of Japan from late nineteenth century, the Meiji period when Japan began a process of rapid westernization, and, paying attention of issues of risk, follow the development of the chemical industry, with special focus on the transwar period of the 1930s to the 1950s, hoping thereby to find lessons applicable to the similar sorts of risks confronting Japanese society today.

II. Origins

1. Industrialization during the Meiji Period (1868-1912)

After the Meiji Restoration of 1868, the Japanese government actively imported Western technology as a means to strengthen and enrich the country. The chemical industry, along with textiles and mining (iron, copper, and coal), was a key component in the quest to develop the country. The chemical

industry was of strategic importance, both because produced gunpowder and other explosives necessary for Japan's modern army and navy and its success in war (the Sino-Japanese War 1894-95 and the Russo-Japanese War 1904-05), but perhaps more fundamentally because of a rapidly growing population and the very real possibility of famine. During times of peace and war, the health and strength of Japanese people depended on the production of food. Indeed, securing adequate supplies of food was as urgent a matter as improvements in armaments and industry. By the end of the Meiji period, the government encouraged the development of the chemical fertilizer industry as a means to insure enough nourishment for its growing population. The production of ammonium sulfate (*ryūan*) was especially important. It maintained a share of approximately 80 percent of the production of chemical fertilizers in Japan from until the end of World War II. Without ammonium sulfate the history of modern Japan would be completely different. This one chemical played a strategic role in improving the productivity of Japanese agriculture.

2. Establishment of the Ammonium Sulfate Industry

The nineteenth century saw the birth of chemical industry all over the world. It developed through demand for chemical dyes in Germany and for chemical fibers in England. The Japanese chemical industry had its origin with the production of chemical fertilizers. In 1884, Takamine Jōkichi, an engineer attached to the Ministry of Agriculture and Commerce, brought back samples of superphosphate from the United States. He experimented and was able to produce a sort a coal-based fertilizer in cooperation with a superphosphate of lime manufacturing plant in Osaka. This was the beginning of the history of chemical fertilizer production in Japan.[6] Once its fertilizer effects were confirmed in 1888, the Tokyo Artificial Fertilizer Co., Ltd. was established, thereby focusing attention on the nascent chemical industry.[7] In 1896, Suzuka Mercantile, an agriculture supply outlet in Fukagawa, Tokyo, imported five tons of ammonium sulfate from a gas company of Australia. Other companies also embarked on the development of chemical fertilizers by using the import

ammonium sulfate. Ammonium sulfate began to be manufactured by Osaka Gas Company and Tokyo Gas Company in 1900, and the Yahata Ironworks in 1904. Other enterprises began to participate in ammonium sulfate production, and soon the product was in high demand with a high product value.[8]

In the early twentieth century, domestic production of ammonium sulfate was not able to meet demand, creating opportunities for new industrial ventures. In 1908, Noguchi Shitagau, the founder of Nihon Chisso Fertilizer Company, purchased coal nitrogen production (the so-called Frank-Caro process) patents from Germany, and quickly succeeded to modify ammonium sulfate from coal nitrogen.[9] In 1914, he opened a plant in Minamata (Kumamoto prefecture) to produce ammonia sulfate using a nitrogen-fixation process, and then in 1918 set up a new state-of-the-art factory in nearby Minamata, able to large volumes of ammonium sulfate at costs less than half of what was hitherto possible.[10] Under Nihon Chisso's leadership, the ammonium sulfate industry in Japan became immensely profitable.[11] In 1921, Noguchi purchased patents for a new method to produce ammonia that had been developed in Italy by Dr. Luigi Casale.[12] In 1923, Noguchi succeeded in applying the Casale method to factory production of ammonia at its Nobeoka plant in Miyazaki Prefecture, thereby establishing Chisso a world leader in the newly emerging but rapidly growing chemical fertilizer business.

Initially the Japanese chemical industry depended upon the introduction of technology from overseas. In Chisso's case, the acquisition of foreign patents proved decisive. Dai Nippon Artificial Fertlizer Company, founded in 1884, was another pioneer in the chemical fertilizer business, later becoming Nissan Chemical Industries.[13] The usual story of Japan's industrial revolution in the late nineteenth and early twentieth century focuses on the transition of light industry (textiles) to heavy manufacturing (iron and steel and shipbuilding). The chemical industry deserves a special place in this narrative; indeed it was vital to Japan's success in achieving wealth (*fukoku*) and power (*kyōhei*). Chemicals played an important role in increasing productivity of Japan's soil thereby allowing Japan to feed a rapidly growing population; chemicals also gave the Japanese military

the means with which to secure and maintain a rapidly growing empire.

III. Chemicals and Military Might

1. Expansion of State Control

The Japanese government recognized the advantages of the use chemical fertilizers in obtaining high crop yields and included the production of ammonium sulfate as an important goal in agricultural policy. Problems arose in the 1920s, however, when cheap imported ammonium sulfate flooded the market, threatening Japanese producers. In 1927, calling for a "rural development policy based on an equitable distribution of fertilizer," the Ministry of Agriculture and Forestry set up a Fertilizer Investigation Committee (Hiryō Chōsa I'inkai) composed of 6 members the Agriculture and Forestry Ministry, 4 from Commerce and Industry, 3 from domestic producers of chemical fertilizer, and 7 other members, seeking to find a means for the equitable marketing of fertilizers in Japan.(14) The investigation committee drew up a Fertilizer Control bill for this purpose. It was presented to the 56th Diet in February 1929.(15) Debate ensued, seeing a compromise between industrial, agricultural, and the interests of the commercial fertilizer producers and retailers. There was much disagreement over the involvement of the government in fertilizer marketing and distribution. The Ministry of Agriculture and Farming was in favor of such intervention, while the Ministry of Commerce and Industry was opposed. Agreement among the three parties was reached in November and the bill passed a special Diet meeting in 1930, resulting in the establishment of a Fertilizer Section within the Ministry of Agriculture and Forestry and the enactment of Fertilizer Distribution Improvement Regulations. Cooperatives were established that allowed domestic producers to directly to farmers, thereby circumventing distributors and causing prices to go down.(16) In this way, farmers could buy more fertilizer and increase their yield, resulting in more profit. Thus, at the outset of the Great Depression, thanks both the results of scientific research and to government intervention, ammonium sulfate increasingly entered into the daily lives of people.

During the war years that began in the middle 1930s, Japan's chemical

industry continued to produce ammonium sulfate, but less for chemical fertilizer. Instead, mobilized for war, most chemical factories were converted into the production of chemicals for munitions. The production of ammonium sulfate was transformed from peacetime to wartime uses, helping Japan to develop it military arsenal. The Japanese government enacted a Distribution Control and Ammonium Sulfate Production Law in April 1938 seeking to increase production by 40% in 1941.[17] The government set up the Nippon Ammonium Corporation in 1938 as one means to increase production. From August 1939, a distribution quota system of fertilizer was implemented, effectively placing the entire chemical industry under government (military) control.

On the one hand, the Japanese government spurred farmers to make intensive use of chemical fertilizer; indeed by the late 1930s, fully one-quarter to one-third of farm expenditures were devoted to the purchase of chemical fertilizer. On the other hand, ammonium sulfate and other chemicals were important for the production of munitions and Japan's war effort. These controls paid off. In 1941, Japan's chemical industries produced some 1,240,295 tons of ammonium sulfate, the peak of production since the birth of the industry.[18]

2. Defeat

The chemical industry collapsed after the outbreak of war with the United States on December 8, 1941. Production declined steadily. Bomb damage and disruption in transportation meant that the production of ammonia in 1944 was less than half of the 1941 output. By this time many factories were forced to stop production.[19] Compared with the prewar peak, the ability for substantial production of the chemical fertilizer at the end of the war had fallen drastically: to 10 percent of coal nitrogen, 71 percent of ammonium sulfate, and 21 percent of phosphoric acid coal.[20] Damage inflicted on ammonium sulfate industry due to bombing amounted to 91 percent for Showa Denko, (Kawasaki), 73 percent for Nihon Chisso (Minamata), 63 percent for Mitsubishi Kasei (Kurosaki), and 59 percent for Asahikasei (Nobeoka).[21] Around these main facilities, 13 our to 14 factories devoted to the production of ammonium sulfate received substantial

damage.[22] The damage rate inflicted on the entire chemical industry amounted to 54 percent. Naturally the production of artificial fertilizer decreased sharply. In August1945, the production of ammonium sulfate stood at 4 percent, coal nitrogen at 15 percent, and phosphoric acid coal at 1 percent, compared with the mean monthly production between 1935 and 1937.[23] The *History of the Ammonium Sulfate Industry in Japan* (Nihon ryūan kōgyō-shi), described the situation of the ammonium sulfate industry just after the war as follows:

> Everyone knew that the restoration of the artificial chemical industry was an urgent matter. Without exception, the people engaged in fertilizer industry began work to restore the industry from the day they heard the imperial edict that ended the war. In fact, however, there was little they could do. … Everything was connected with ammonium sulfate production was in short supply. Even one-tenth of the required amount of the steel and cement could not be obtained. Raw materials such as coke, coal, and pyrites were also unavailable. Gradually wartime mechanics and mobilized students returned home, but the work force remained insufficient as well. The life of the employees and their family members who stayed at the factory was miserable.[24]

Furthermore, the loss of territories and colonies that made up the prewar empire, including Manchurian, Korea, Taiwan and Karafuto, was the cause of further difficulties in restarted the domestic chemical industry, as many Japanese firms had established ammonium sulfate factories overseas to help boost production. These factories were all destroyed or lost. For example, the prewar Korea Konan nitrogen fertilizer plant was one of the ten largest synthetic ammonia factories in the world. Its 500,000 ton per year production capacity was more than 26 percent of the 1,889,900 ton per year production capacity of all domestic production in 1943.[25] However, Japan lost all these factories at once in 1945. Table 1 summarizes the extent of damage suffered by major chemical companies specializing in the production of ammonium sulfate.

Table 1. Damage to Japan's Ammonium Sulfate Plant by Air Raids[26]

Company (location)	Production 1944*	Production 1945*	Damage Rate (%)
Shōwa Denkō (Kawasaki)	330	300	91
Shin Nihon Chisso (Minamata)	75	55	73
Mitsubishi Kasei (Kurosaki)	80	50	63
Asahikasei (Nobeoka)	54	32	59
Tōagōsei (Nagoya)	110	60	55
Tōyō Kōatsu (ōwada)	200	100	50
Ubekōsan (Ube)	200	100	50
Beppu Kagau (Beppu)	50	25	50
Nittō Kagaku (Hachinohe)	50	25	50
Nittō Kagaku (Yokohama)	50	20	40
Nisshin Kagaku (Niihama)	240	60	25

*1000 tons

IV. Postwar Recovery

1. Hunger and the Reform of Japanese Society

Japan's surrender on August 15, 1945 did not immediately lead to an end to hunger. Food shortages were already serious before aerial bombardments began in the summer of 1944. As the war continued, food production lagged, causing both physical hunger and mental fatigue. American bombing raids did not necessarily aim at disrupting the food supply; however, the destruction of Japan's chemical factories that were linked to munitions, in effect reduced food production capacity by limiting the production of chemical fertilizers. Such multilayer damage combined with the aggravation of agrarian conditions accumulated from the war years necessarily contributed to severe food shortages following defeat. General McArthur and other occupation authorities known as SCAP (Supreme Command for Allied Powers) required the Japanese government to ameliorate the critical food shortage, but relief was slow to come.[27] People living in the city had to resort to black market buying and selling due to lack of basic foodstuffs.[28] Government actions proved ineffective, causing widespread feelings of exhaustion and depression among the Japanese people.

By late 1946, the Japanese government under the leadership of Prime Minister Yoshida Shigeru, committed itself to maximizing economic growth. It adopted a priority production system that focused on the coal and steel industries. However, well before Yoshida's plan was announced, in a radio broadcast on August 21, 1945, the Minister of Agriculture and Forestry, Sengoku Kōtarō, announced: "Japan must restart as an agrarian country."[29] The first step to rebuild Japan, according to Sengoku, was to improve the food situation and thereby stabilize society. Thereafter, the Ministry of Agriculture and Forestry focused on the revival of the ammonium sulfate industry was directly connected to an increase in food production. In this way, the revival of the ammonium sulfate industry was of key importance to national reconstruction.

Due to the occupation, the Japanese government required permission from SCAP for all official actions related to reconstruction. The Japanese side drew up a basic policy regarding plans to restore the ammonium sulfate industry by the end of 1945. Japanese planners from the Ministry of Agriculture and Forestry insisted on the re-conversion of munitions factories to ammonium sulfate plants of munitions factories. SCAP officials agreed, especially as the Japanese request was in line with occupation plans to thoroughly demilitarize Japan. On September 28, 1945, Ministry of Agriculture and Forestry requested SCAP's section on proceed with the conversion.[30] According to the Ministry's priority production system (*keisha seisan hōshiki*), some two million tons of contents were required to stabilize the production of nitrogenous fertilizer.[31] Another 1,330,000 tons were to produced in a restored ammonium sulfate factory, 200,000 tons were to be produced in a plant converted from a synthetic oil factory into an ammonium sulfate factory, 90,000 tons from a converted methanol factory, and 380,000 tons were to be produced by coal nitrogen.[32]

SCAP accepted the conversion of several military installations on October 1 and gave orders to start rebuilding existing factories on October 10. Moreover, SCAP allowed for the conversion of three large-scale navy fuel depots in Yokkaichi, Nagoya, and Tokuyama into production facilities for ammonium sulfate. Furthermore, on the next day, October 11, Japanese government issued

"Emergency Measures to Ensure the Production of Fertilizer."[33] In order to restore production of ammonium sulfate, the government announced plans to secure necessary funds, apparatus, materials, and raw materials. Later, on March 2, 1946, another set of plans was announced by the Ministry of Commerce and Industry: "Outline of Emergency Measures Regarding Chemical Fertilizer."[34]

2. Ammonium Sulfate Industry Conference on Reconstruction

A council of chemical fertilizer companies was formed in 1947 to discuss ways in the ammonium sulfate industry could contribute to Japan's reconstruction. Known as the Ryūfuku (Amonium Sulfate for Reconstruction), the council, along with a similar coal industry council, was an important starting point for Japan's economic recovery. The occupation initially sought to democratize and decentralize the whole of Japanese society, including industry. On October 26, 1946 the Japanese Trade Union Confederation proposed the establishment of a broad group of industrialists for recovery purposes.[35] Within the ammonium sulfate industry, the "National Industrial Ammonium Sulfate Federation of Trade Unions" (under the leadership of President Shoji Kan'ichi) began to discuss the idea of ammonium sulfate council to focus reconstruction initiatives. Later, on December 19 the Ammonium Sulfate Confederation officially set up a Ammonium Sulfate Fertilizer Manufacturers' Association, which resulted, after another six months of discussion, in the establishment of the Ammonium Sulfate Reconstruction Council (Ryūfuku) on May 23, 1947. Its initial meeting was held on June 10 at the Ueno Seiyōken in Tokyo.[36]

Ryūfuku decided on a series of measures to increase production of ammonium sulfate. For example, in response to the national five-year reconstruction plan that was to begin in April 1948, Ryūfuku issued it own "New Policy to Increase Production" that aimed at an output of 2,700,000 tons of ammonia-based fertilizer ammonium.[37] As a result, significant increase in production were observed. By the end of 1949, a production capacity of 1,860,000 tons of ammonium sulfate conversion had been reached.[38] By producing 1,707,000 tons of fertilizer and 190,000 tons of other ammonia-

based produce, ammonium sulfate group of industries were nearly able to meet the production goal of 1,897,000 tons, the final goal of the five-year plan.(39) In addition, they set further goals to find ways to distribute this ammonium sulfate to consumers cheaply, and made efforts to bring down the cost of chemical fertilizers.(40)

Three years had passed since the council was formed. During this period, manufacturing volume rose by 10 times, and controls on raw materials were also gradually relaxed. Moreover, various ammonium sulfate companies began to place priority on management strategy rather than simply increase in production. As a result of these developments, many agreed that the mission of Ryūfuku had been fulfilled. On April 21, 1950, the group of ammonium sulfate companies decided to disband the council and establishment a new organization.(41) The suggestion was approved and in June 1950 the Japan Ammonium Sulfate Industry Association took over a leadership role over the industry. The role played by Ryūfuku, however, was important. It had succeeded consolidating and rationalizing Japan's domestic chemical industry, and in creating a diversified and democratic management style in company. It prepared the way for free competition between in fertilizer companies. And, of course, Ryūfuku helped to increased production of chemical fertilizers so important to helping to improve Japanese food output.

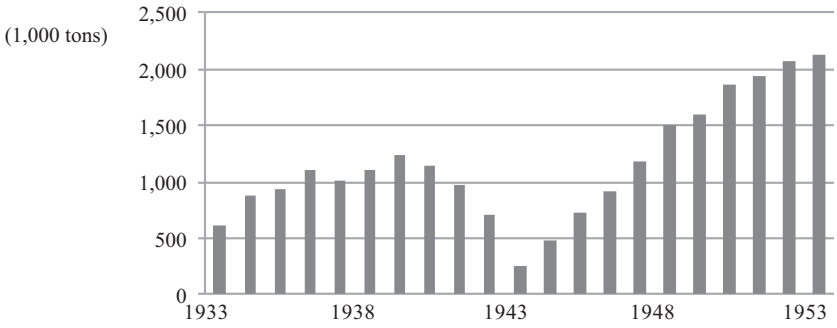
3. Success of Chemical Industry after the Second World War

After the war, the reconstruction of agriculture aimed at the rationalization of farm work. Alongside the introduction of new machines and new seeds, the chemical industry played an important role in helping to make Japanese soil more fertile. Although rice production stood only at 5,872 tons in 1945, it was doubled to 9,208 tons in 1946.(42) The production capacity of the land was restored and gradually continued to improve. The return of peace and farm workers helped of course, but at the same time there was a rapid increase of demand for chemical fertilizers that, as we have seen, the ammonium sulfate industry strove to meet. In 1945, the production volume of ammonium sulfate

stood at 243,021 tons. It nearly doubled every year thereafter. And, in 1950, it reached 1,501,293 tons, far beyond the 1,240,295 tons which was the peak reached in the prewar period (in 1941).[43] Furthermore, around 1950 the ammonium sulfate industry began to stabilize and the production volume finally exceeded domestic demand. Gradually ammonium sulfate came to be counted as one of Japan's "exports products." The chemical industry, including the production of ammonium sulfate, was destined to play a part in the spectacular recovery of the Japanese economy after the Second World War.

"The year 1950 is considered to be a turning point of ammonium sulfate industry because of exports."[44] The year also represented the takeoff in the "postwar chemical industry." It was a major growth industry; chemicals were used in many other areas beyond agriculture, namely in plastics, household appliances, automobiles, medicine, preservatives; indeed chemicals entered in nearly every aspect of daily life. Moreover, the postwar chemical industry began to have direct ramifications on lifestyles and the security of people as well as a beneficial effect on local economies.

Table 2. Production of Ammonium Sulfate, 1933 - 1953



V. Unexpected Social Changes: The Four Major Pollution Diseases

The development of chemical industry in Japan was an essential element in Japan's rapid economic growth years, the late 1950s and throughout the

1960s. Japanese life became richer in substance, but chemical industry also had a negative effect on Japan's environment and society. While the chemical industries succeeded in reducing production costs, and thereby lowering the price of chemical fertilizers, a number of serious environmental pollution problems arose. Chemical pollution was widespread, such as air pollution, water pollution and soil contamination. The waste from chemical plants polluted the river and the sea and destroyed whole ecosystems. The health of workers and people living near industrial chemical factories were severely affected; especially by the discharge of methyl mercury into the food chain.. The adverse effects of the Japanese chemical industry were revealed in the form of several now-infamous pollution diseases that emerged in the 1960s and 1970s.

Ironic and tragic are the world to describe Japan's postwar rapid economic growth. Japan's chemical industry was responsible for four major pollution-related illnesses as well as the pollution of the natural environment. In 1956, Minamata disease was discovered in Kumamoto Prefecture, a form of mercury poisoning caused by untreated industrial wastewater emitted from Nihon Chisso Company's Minamata nitrogen fertilizer plants.(45) The scale of death and injury to health marks the Minimata disease has surely darkened the pages of human history. In 1965, a second outbreak of Minamata disease occurred in the Agano river basin in Niigata Prefecture. The pollution source was mercury contained in the wastewater from the acetaldehyde synthesis process of Showa Denko's Kanose factory, tragically following along the same lines as the first Minamata disease ten years earlier.(46) Victims and their supporters sued Showa Denko in 1967, the first industrial pollution trial in Japan, but not the last. Itai-Itai disease also resulted from industrial pollution. It first appeared in the Jintsu river basin in Toyama Prefecture before the prewar period. It was caused by heavy metal poisoning, in particular by cadmium flowing out from Mitsui Mining & Smelting mining sites in Kamioka. Survivors and patients filed suit for damages against Mitsui Mining & Smelting in 1968.(47) A fourth disease related to soot pollution emitted from chemical plants. In September 1967, residents of Yokkaichi, Mie Prefecture brought action against six companies as victims of severe asthma

attacks caused by pollutants from the chimneys of the neighborhood industrial complex.[48]

Pollution damage spread widely because the government and the industries themselves did not act quickly enough to stop the pollution. In the case of the first Minamata disease, Chisso was quick to deny any responsibility, even after they knew the truth.[49] In 1959, research revealed that the causative agent of Minamata disease derived from methyl mercury discharges. Nevertheless, it took a long time for the government to come to the aid of the victims, so influential was the interests of big business on government leadership at this time. Finally, in 1967, bowing to pressure from citizen protest movements, the government identified Chisso as the source of the pollution and issued the Environmental Pollution Prevention Act, the first of series of laws designed to limit industrial pollution and clean up Japan's natural environment. The 1967 law was later strengthened by the Environmental Basic Law passed in 1993. The laws encouraged legal action against company that were responsible for pollution and opened paths for victims to gain compensation for their health issues. Some companies took their responsible seriously and carried out anti-pollution measures and the soil and water clean-up measures, but there were also companies that sought to destroy evidence of their polluting activities, leaving areas of doubt even today.

These examples of environmental pollution caused by the Japanese chemical industry deserve an in-depth study.[50] Against this backdrop, there is one point that needs to be emphasized: The same company executives that were responsible for serious environmental pollution contributed to the development of science and technology in prewar Japan, and tried to find a means to solve the problem of hunger after the war. Nevertheless, tragically and ironically, their actions produced results that cost lives rather that saved them. The rush to increase the production of ammonium sulfate perhaps encouraged irresponsible cost-cutting; nonetheless, it is possible to see here the complexity of contemporary environmental issues in which the good and the bad, the ugly and the beautiful seemingly are destined to co-exist. The reality of science and

technology and environmental issues today is that they cannot be understood without placing them in social and historical context.

VI. Conclusion

This article has touched on the environmental damage caused by the Japanese chemical industry. These toxic results were the result of weak or even non-existent environmental protection laws and policies. Strict pollution laws and regulations are necessarily the first step to protect the environment. At the same time, we have seen that the Japanese chemical industry produced chemical fertilizers so necessary to enrich the fertility of the soil. Chemicals thus helped the Japanese overcome food shortage at the end of the Second World War.

Japan, in the 1950s, was highly focused on the goal of economic recovery. We can also see that priorities were placed on economic interest accepting risks to the health of the environment and the human body. The chemical Industry was highly commercialized and sought to expand indefinitely if possible. No or little thought was given to the need to prevent any adverse effects of such expansion.

One conclusion to be drawn from this tragic but ironic story is the absolute necessity to publicly discuss issues of risk when new technology is introduced into society. Lacking then and even today, as can be seen after the meltdown of the Fukushima nuclear energy plants in 2011, is an inquisitive, investigative and pro-active media; a transparent and flexible decision-making system; adherence to and maintenance of law and regulation; and the clear communication of ethical values between experts and general populace. Environment problems have been part and parcel of the industrialization and modernization of Japan, as with societies everywhere. However, the sorts of environmental problems encountered in Japan and elsewhere today are qualitatively and quantitatively different from those of the early and mid-twentieth century; they are increasingly global in impact. It is necessary not only to think about profit and risk, but also think seriously about global risk management. The Minamata disease and the Great East Japan Earthquake are unresolved tragedies highlighted in this paper. These calamities provide historical lessons that need to be learned and

fully understood. They should not be seen as event of a certain era of the past. Rather, they should remind us to fully consider the risks and implications that advances in science and technology will continue to deliver to society. Only by facing these issues honestly and deal carefully with the interaction of risk and convenience, can we dream of creating an ideal society in which the good will be greater than the bad, the beautiful more powerful than the ugly.

Acknowledgement

I would like to express my deepest gratitude to Professor William Steele whose comments and suggestions were innumerably valuable throughout the course of my study. I am also indebted to Mrs. Miyuki Mizuno and Professor Ed Franco who provided technical help and sincere encouragement.

Notes

(1) See Bammer, Gabriele and Smithson, Michael. eds. *Uncertainty and Risk: Multidisciplinary Perspectives*, London: Routledge. 2009, and Renn, Ortwin. *Risk Governance: Coping with Uncertainty in a Complex World*, London: Earthscan. 2008.

(2) Lundgren, Regina E. and McMakin, Andrea H. *Risk Communication: A Handbook for Communicating Environmental, Safety, and Health Risks* (4th edition). Hoboken: Wiley-IEEE. 2003.

(3) Mitcham, Carl. ed. *Encyclopedia of Science, Technology and Ethics*. Detroit: Thomson/Gale. 2005.

(4) Priest, Susanna H. ed. *Encyclopedia of Science and Technology Communication*, Thousand Oaks: Sage. 2010.

(5) Studies of industrial history have been carried out from the beginning of the ammonium sulfate industry until Japan became a leader in the fertilizer industry. See Shibamura Yōgo, *Kagakuhiryo* (Chemical fertilizer), Yūhikaku, 1959, 1-9.

(6) See Nōmushō. *Hiryō Yōran* (Annual reports of chemical fertilizers). Tokyo: Nōmushō, 1949, 1-3.

(7) Ibid.

(8) Ibid.

(9) See Kagaku Keizai Kenkyūjo. *Nihon no Kagaku Kōgyo 50nen no Ayumi* (50 years' History of Chemical Industries in Japan). Tokyo: Nihon Kagaku Kōgyo Kai, 1998, 7.

(10) See Nihon Kagaku Kai. *Nihon no Kagaku Hyakunenshi* (A hundred years' history of Chemistry in Japan). Tokyo: Tokyo Kagaku Dozin, 1978, 641.

(11) On Chisso and the prewar Japanese chemical industry in general, see Barbara Molony, *Technology and Investment: The Prewar Japanese Chemical Industry*, Harvard East Asian Monographs, 1990.

(12) Ibid.

(13) See Nihon Kagaku Kai. *Nihon no Kagaku Hyakunenshi* (A hundred years' history of Chemistry in Japan). Tokyo: Tokyo Kagaku Dōzin, 1978, 641-642.

(14) See Nōmushō. *Hiryō Yōran* (Annual reports of chemical fertilizers). Tokyo: Nōmushō, 1949, 6-8.

(15) Ibid.

(16) Ibid.

(17) See Nōmushō. *Hiryō Yōran* (Annual reports of chemical fertilizers). Tokyo: Nōmushō, 1949, 6-8.

(18) Ibid.

(19) See Bruce Johnson, *Japanese Food Management in World War II*, Stanford University Press, 1953, 105-07.

(20) See Nihon Ryūan Kōgyokai. *Nihon Ryūan Kōgyō Shi* (A history of Ryūan industries). Tokyo: Nihon Ryūan Kōgyō Kai, 1968, 194-195.

(21) See The Ministry of International Trade and Industry. *Shōkō Seisakushi* (A history of Trades and Industries). Tokyo: Shōkō Seisakushi Kankōkai, 1968 8-14, and Nakamura Takahide and Miyazaki Masayasu. eds. *Shiryo Taiheiyō Sensō Higai Chōsa Houkoku* (A report of damages by WWII). Tokyo: University of Tokyo Press, 1995, 330-331.

(22) Ibid.

(23) See Nihon Ryūan Kōgyōkai. *Nihon Ryūan Kōgyō Shi* (A history of Ryan industries). Tokyo: Nihon Ryūan Kōgyō Kai, 1968, 204.

(24) Ibid. (Authors translated Japanese original into English)

(25) See The Ministry of International Trade and Industry. *Shōkō Seisakushi* (A history of Trades and Industries). Tokyo: Shōkō Seisakushi Kankōkai, 1968, 43-67.

(26) See Nakamura Takahide and Miyazaki Masayasu. eds. *Shiryō Taiheiyō Sensō Higai Chōsa Houkoku (A report of damages by WWII)*. Tokyo: University of Tokyo Press, 1995, 324-331.

(27) For information on attempts to deal with the immediate postwar food crisis, see John Dower, *Embracing Defeat: Japan in the Wake of World War II*, Norton, 2000, 139-147.

(28) See Takemae Eiji and Nakamura Takahide. eds. GHQ *Nihon Senryōshi* (A history of SCAP's occupation in Japan) Vol. 35. Tokyo: Nihon Tosho Center, 2000, 177.

(29) See Nōmushō. *Hiryō Yōran* (Annual reports of chemical fertilizers). Tokyo: Nōmushō, 1949,6.

(30) Nihon Ryūan Kōgyōkai. *Nihon Ryūan Kōgyō Shi* (A history of Ryūan industries). Tokyo: Nihon Ryūan Kōgyō Kai, 1968, 210-212.

(31) Ibid.

(32) Ibid.

(33) Ibid.

(34) See Nihon Ryūan Kōgyōkai. *Nihon Ryūan Kōgyō Shi* (A history of Ryūan industries). Tokyo: Nihon Ryūan Kōgyō Kai, 1968, 210-212.

(35) See Ryūan Kōgyō Fukkō Kaigi. *Ryūan Fukkō Sōkangō* (Recovery of Ryūan Industries Vol. 1). Tokyo: Ryūan Kōgyō Fukkō Kaigi, 1947, 7-8.

(36) Ibid.

(37) Ibid.

(38) See Ryūan Kōgyō Fukkō Kaigi. *Ryūan Fukkō Saishugō* (Recovery of Ryūan Industries Vol. 35). Tokyo: Ryūan Kōgyō Fukko Kaigi, 1950, 8.

(39) See Ryūan Kōgyō Fukkō Kaigi. *Ryūan Fukkō Saishugō* (Recovery of Ryūan Industries Vol. 35). Tokyo: Ryūan Kōgyō Fukkō Kaigi, 1950, 1-8.

(40) Ibid.

(41) Ibid.

(42) See Nōrinshō. *Sakumotsu Tōkei* (Statistics of food condition). Tokyo: Nōrinshō, 1960, 232.

(43) See Nōmushō. *Hiryō Yōran* (Annual reports of chemical fertilizers). Tokyo: Nōmushō, 1949, 2.

(44) See Kōgyō Gijutsuin. *Gijutsu Hakusho* (Annual Report of Technology in Japan). Tokyo:

Kōgyō Gijutsuin, 1956, 242.

(45) See Nihon Kagaku Kai. *Nihon no Kagaku Hyakunenshi* (A hundred years' history of Chemistry in Japan). Tokyo: Tokyo Kagaku Dōzin, 1978, 238-239.

(46) Ibid.

(47) Ibid.

(48) Six companies are Mitsubishikasei Kōgyō, Mitsubishi Yuka, Mitsubishi Monsanto, Showa Yokkaichi Sekiyu, Chūbu Denryoku, and Ishihara Sangyō. See Nihon Kagaku Kai. *Nihon no Kagaku Hyakunenshi* (A hundred years' history of Chemistry in Japan). Tokyo: Tokyo Kagaku Dōzin, 1978, 239.

(49) On the Minimata pollution incident, see Timothy George, *Minamata and the Struggle for Democracy in Postwar Japan*, Harvard East Asian Monographs, 2002.

(50) For several examples, including the Kamioka copper smelting operations in Toyama Prefecture, see Bret Walker, *Toxic Archipelago: A History of Industrial Disease in Japan*, University of Washington Press, 2009.

References

Bammer, Gabriele and Smithson, Michael. eds. *Uncertainty and Risk: Multidisciplinary Perspectives*, London: Routledge. 2009.

Barbara Molony, *Technology and Investment: The Prewar Japanese Chemical Industry*, Harvard East Asian Monographs, 1990.

Barnhart, Michael. 'From Hershey Bars to Motor Cars: America's Economic Policy toward Japan, 1945-76'. Irie, Akira. and Wampler, Robert. eds. *Partnership — The United States and Japan 1951-2001*, New York: Kodansha International. 2001.

Beck, Ulrich. *Risk Society: Towards a New Modernity*, London: Sage. 1992.

Bret Walker, *Toxic Archipelago: A History of Industrial Disease in Japan*, University of Washington Press, 2009.

Bruce Johnson, *Japanese Food Management in World War II*, Stanford University Press, 1953, 105-07.

Cohen, Jerome. *Japan's Economy in War and Reconstruction*, New York: University of Minnesota Press. 1949.

George, Timothy S. *Minamata: Pollution and the Struggle for Democracy in Postwar Japan*, Cambridge: Harvard University Asia Center. 2002.

Gordon, Andrew. ed. *Postwar Japan as History*, Berkeley: University of California Press. 1993.

John Dower, *Embracing Defeat: Japan in the Wake of World War II*, Norton, 2000, 139-147.

Kagaku Keizai Kenkyūjo. *Nihon no Kagaku Kōgyō 50nen no Ayumi* (50 years' History of Chemical Industries in Japan). Tokyo: Nihon Kagaku Kōgyō Kai, 1998, 7.

Kōgyō Gijutsuin. *Gijutsu Hakusho* (Annual Report of Technology in Japan). Tokyo: Kōgyō Gijutsuin, 1956, 242, 262.

Lundgren, Regina E. and McMakin, Andrea H. *Risk Communication: A Handbook for Communicating Environmental, Safety, and Health Risks* (4th edition). Hoboken: Wiley-IEEE. 2003.

Mitcham, Carl. ed. *Encyclopedia of Science, Technology and Ethics*. Detroit: Thomson/Gale. 2005.

Nakamura Takahide and Miyazaki Masayasu. eds. *Shiryō Taiheiyō Sensō Higai Chōsa Houkoku* (A report of damages by WWII). Tokyo: University of Tokyo Press, 1995, 330-331.

Nihon Kagaku Kai. *Nihon no Kagaku Hyakunenshi* (A hundred years' history of Chemistry in Japan). Tokyo: Tokyo Kagaku Dōzin, 1978, 238-239, 641-642.

Nihon Ryūan Kōgyōkai. *Nihon Ryūan Kōgyō Shi* (A history of Ryūan industries). Tokyo: Nihon Ryūan Kōgyō Kai, 1968, 194-195, 204, 210-212.

Nōmushō. *Hiryō Yōran* (Annual reports of chemical fertilizers). Tokyo: Nōmushō, 1949, 1-8.

Nōrinshō. *Sakumotsu Tōkei* (Statistics of food condition). Tokyo: Nōrinshō, 1960, 232.

Priest, Susanna H. ed. *Encyclopedia of Science and Technology Communication*, Thousand Oaks: Sage. 2010.

Renn, Ortwin. *Risk Governance: Coping with Uncertainty in a Complex World*, London: Earthscan. 2008.

Ryūan Kōgyō Fukkō Kaigi. *Ryūan Fukkō Sōkangō* (Recovery of Ryūan Industries Vol. 1). Tokyo: Ryūan Kōgyō Fukkō Kaigi, 1947,7-8.

Ryūan Kōgyō Fukkō Kaigi. *Ryūan Fukkō Saishūgō* (Recovery of Ryūan Industries Vol. 35). Tokyo: Ryūan Kōgyō Fukkō Kaigi, 1950, 1-8.

Shibamura Yōgo *Kagakuhiryo* (Chemical fertilizer), Yūhikaku, 1959, 1-9.

Takemae Eiji and Nakamura Takahide. eds. GHQ *Nihon Senryōshi* (A history of SCAP's occupation in Japan) Vol. 35. Tokyo: Nihon Tosho Center, 2000, 177.

The Ministry of International Trade and Industry. *Shōkō Seisakushi* (A history of Trades and Industries). Tokyo: Shōkō Seisakushi Kankōkai, 1968, 8-14, 43-67.

Timothy George, *Minamata and the Struggle for Democracy in Postwar Japan*, Harvard East Asian Monographs, 2002.

Worster, Donald. ed. *The Ends of the Earth: Perspectives on Modern Environmental History*. New York: Cambridge University Press. 1988.

Foreshadowing Social Risk: The Dual Aspects of the Chemical Industry in Early Twentieth Century Japan

<Summary>

Akinori YAMABE

While the development of science and technology, has influenced the convenience and wellbeing of our society, there is a need to consider the social consequences and the effects of pollution into the environment. This article will focus on the damages and impacts of the environmental pollution caused by the Japanese chemical industry. This disaster was instigated by the lack of environmental protection laws and poor policies in Japan which could have enforced strict environmental pollution regulations. The disaster first started during the Japanese industrialization period back in the Meiji era. Later, it continued after the severe food shortages, caused by the effects of WWII. During this period the Japanese chemical industry provided a strong production of chemical fertilizers in order to restart the production crops and food for the whole country. Many serious environmental problems occurred between 1950s and the 1970s, in particular in postwar Japan and during the period of the revival of the Japanese chemical industry. This period serves as a historical example and clearly highlights the need for risk management and the need for further understanding of the repercussions that science and technology present the environment and the need for further study.