Mining pollution and infant health in modern Japan: from village/ town statistics of infant mortality

Keisuke Moriya, Kenichi Tomobe (Hitotsubashi University)

Abstract

The purpose of the paper is to explain the relationship between infant mortality rate (IMR) and mining pollution. In Japan, the pollution became a problem in various places in the 1960's, but it had occurred since then. For example, around Ashio Copper Mine in Tochigi Prefecture, the mining pollution had been occurring since 1880's, and it had become a social problem in Japan. In our previous analysis, the IMR in Japan have declined irreversibly since 1920's because people got over the beriberi and syphilis, but in the specific area, such as mining area, the IMR remained still high rate in 1930's. So we will consider the relationship between the IMR and mining pollution.

Environmental pollution and infant mortality

In the historical studies, the focus of the relationship between environmental pollution and infant mortality has been air pollution. Many researches have focused on analyzing the effects of air pollution, including research by Bailey, Timothy J, Kris Inwood (2018). Their research on the effects of coal use in Britain has identified negative effects on the infant mortality, and the health of children in the late 19th century. There are also many studies on air pollution and the health of children in developing countries. Air pollution has been regarded as a problem since the Industrial Revolution. In Japan, air pollution of sulfur oxides and nitrogen oxides caused by industrialization, including the smoke damage of Besshi Copper Mine and Yokkaichi Asthma, has become a social problem. Moreover, the WHO report (2017) also states that air pollution is the biggest cause of infant mortality from environmental pollution.

Many researches on water pollution have focused on epidemiology, or the inadequacies of water supply and sewage systems in densely populated towns. Cain and Rotella found that sanitary reforms were important in reducing infant mortality in the United States. In the WHO report (2017), infant deaths due to water pollution accounted for a large weight, and the cause was diarrheal disease due to inaccessibility of clean drinking water due to insufficient public health. It is also related to the ongoing threat of waterborne infectious diseases, especially in developing countries, and countermeasures are urgently needed. For this reason, there have been few researches on history of water pollution and soil pollution due to mining pollution.

However, in Japan, very unique statistics on infant mortality have existed. The group called Aiikukai has compiled statistics on births, stillbirths, and infant deaths in 1933 for each town and village all over the Japan and the Ministry of Health and Welfare has compiled the same ones in 1938. Bailey (2018) uses a household date and is characterized by the ability to investigate individual person. There are no such statistics in Japan, but it is possible to analyze the geographic aspect of the infant mortality rate. In Japan, heavy metal poisoning due to mining pollution has been pointed out for a long time, but there are few historical studies. Therefore, in this study, we would like to analyze the spread of mine pollution using the unique statistics.

As mentioned above, historical researches on environmental pollution and infant mortality, as well as modern research, have focused on air pollution. In particular, historical studies have discussed the relationship between coal-based air pollution and infant mortality. Bailey (2018) using Army Service Records stated that air pollution negatively affects the health of children and post-adult height. Karen et al (2016) studied the effects of the installation of coal-fired electricity generating plants in the United States between 1930 and 1962, finding that this increased infant mortality within a 30-miles. These studies have shown that air pollution has the negative impact on health of children and later life.

On the other hand, there are few studies on water pollution and air pollution in historical research, and there are some studies focusing on the modern era. According to the study by Michael Greenstone and Rema Hanna (2014), there was no significant difference in water quality control in India, although there was a decline in infant mortality due to air pollution control. The research of Elizabeth Brainerd and Nidhiya Menon (2014) examined that the difference in seasonal planted crops in India changed the concentration of pesticides in water due to the use of pesticides, which negatively affects the health of infants. And it has been found that the poor are most affected. Guojun He and Jeffery M. Perloff (2016) found that invisible contamination of surface water in China increased infant mortality, but when pollution becomes more visible, people take action to avoid polluted water. Therefore, the infant mortality rate will be improved.

Kyi Mar Wai et al (2017) examined heavy metal poisoning and infant mortality. It was indicated that cadmium exposure was associated with low birth weight (weight less than 2500 g at birth), and low birth weight increased infant mortality. It was also said that there was no relationship with premature birth. But according to Jie Yang et al (2016), in China, there was a relationship between cadmium concentration and premature birth. Although it may vary depending on the amount of exposure between groups, it is undeniable that heavy metal poisoning cause premature birth, low birth weight, and the resulting increase in infant mortality. In Japan, during late 19th century, there was the mine damage called the Ashio Copper Mine Poisoning Incident. In the mine damage that spread over Gunma Prefecture and Tochigi Prefecture near Tokyo, the flooding of the Watarase River contaminated the soil with heavy metals, withered rice and mulberry, and then was exposed to repeated flooding and heavy metal contamination, resulting in a decline in fertility rates. There were also increases in stillbirth and infant mortality.

Also, from the 1920s to the 1960s, the unusual disease called “Itai-itai disease”, which caused severe pain throughout the body and broke bones, was prevalent in the Jintsu River basin in Toyama Prefecture. In the later studies, the cause was drainage from the upstream mine, which contained a large amount of cadmium, which was accumulated in fish and food, causing heavy metal poisoning inside the human body through meals.

In the light of these results might expect significant effects of heavy metal poisoning. Nevertheless, there are few historical studies on heavy metal poisoning caused by mining pollution. Although soil contamination caused by heavy metal poisoning have been discussed, there are few studies on the effects of it on the human body. Therefore, in this paper, I would like to find the negative effects caused by mining pollution, especially the relationship with infant mortality.

Mechanism of water pollution and soil pollution

The mechanism of water pollution and soil pollution is as follows. When ores are mined, unnecessary ores are discarded. After they are exposed to rainwater, heavy metals are run out, and the water is mixed and contaminated in rivers and soils. In addition, polluted water containing heavy metals and mud generated during the beneficiation, and waste ores and wastewater containing heavy metals generated during metal refining. These wastes pollute rivers and soil. It can also be polluted by floods. Because a large amount of timber is used during refining, flooding is occurred and a large amount of waste ore thrown into ponds and rivers run out. Moreover, SOx and NOx cause the trees around the mine to wither, so the water retention capacity of the mountain is lost and it causes frequent flooding. Once a flood occurs, waste ore that has accumulated in large quantities in the upstream reaches the downstream. Since waste ore contains a lot of heavy metals, the soil and rivers in the downstream area are immediately contaminated with heavy metals. Heavy metals accumulate in fish and crops from contaminated water and soil, and these accumulate in the human body that ate foods, so people are polluted by heavy metal. In particular, when the mother becomes poisoned with heavy metals, the fetus and infants are more affected due to bioconcentration[1], and the IMR and the stillbirth rates increase. Because of this mechanism, the IMR is not necessarily high in the towns and villages near the mine, but it is sometimes very high in the towns and villages in the middle and lower reaches of the river.

Characteristics of the Statistics

The data we use for analysis is very unique. It was compiled by the group called Aiikukai, and statistics on birth, stillbirth, and infant death in 1933 were compiled by each prefecture, county, and town, village. Aiikukai was the imperial foundation founded by the Emperor of Japan in 1934. In the early 1930's, public health centers and the Ministry of Welfare were not established in Japan. The government gave the important role of protecting children and mothers health to the Aiikukai to promote health research and development. At that time, Japan had no Ministry of Health or Health and

1 Bioconcentration is the phenomenon in which certain chemical substances are concentrated in the organism through the food chain in the ecosystem.

no health care for children and mothers. This was a statistic prepared by the research group and can be analyzed by each town and village. The "Statistics on Birth, Stillbirth and Infant Death by National Prefectural County, Municipalities" created by the Ministry of Health and Welfare, established in 1938, was the same survey conducted in 1938 by the Aiikukai. These two statistics were researched in the same way, so it is possible to analyze the time series by villages and towns.

Analysis

In this analysis, the villages and towns around the Yoneshiro River in Akita Prefecture were targeted. Akita Prefecture is located in the northern part of Japan, and the Yoneshiro River basin has many mines upstream, including the Kosaka Mine and Osarizawa Mine (Figure 1). At the Kosaka River near the Kosaka Mine, it was polluted by the drainage from the mine and fish could no longer be seen. At the Osarizawa Mine, waste and sludge containing heavy metals were washed away by the floods, causing significant damage. It has been the area known to have been damaged by mining pollution. The analysis targets are 65 towns and villages in Kazuno County, Kitaakita County and Yamamoto County aournd the Yoneshiro River. We use the infant mortality rate (IMR) and the stillbirth rate (SBR) in 1938 as the objective variables and the linear distance from Yoneshiro River where the source of mining pollution as the explanatory variable.

The analysis results are shown in Table 1, 2 and Figure2. The distance from the Yoneshiro Riveer and the IMR were found to be negatively related. On the other hand, no correlation was obtained for the distance and the SBR.

As a result, it was found that the IMR was higher around the Yoneshiro River due to river pollution because of mining pollution. This can be clear by looking at Figure 3. This Figure is created using GIS. The IMR is not necessarily high near the mine, but the IMR is high in the middle and lower reaches of the Yoneshiro River. Near the mine, the river does not accumulate so much in the rapid stream in the upstream area, and there is a deposit of mine from the place where the flow becomes slow. In the county's date, IMR was 131.4 for Akita Prefecture as a whole, 145.3 for Kazuno County, 166.9 for Kitaakita County, and 144.7 for Yamamoto County. This result may state that the mining pollution affected infant mortlity in the three counties as a whole. In addition, Akebono Village, Miyagawa Village and Nishikigi Village in Kazuno County had the SBR of over 100 ‰ both in 1933 and 1938. The fact that the high SBRn the villages near the mine may also suggest that the mining pollution give negative effects on the stillbirth.

Figure 1: Akita Prefecture in Japan and the Yoneshiro River and mines

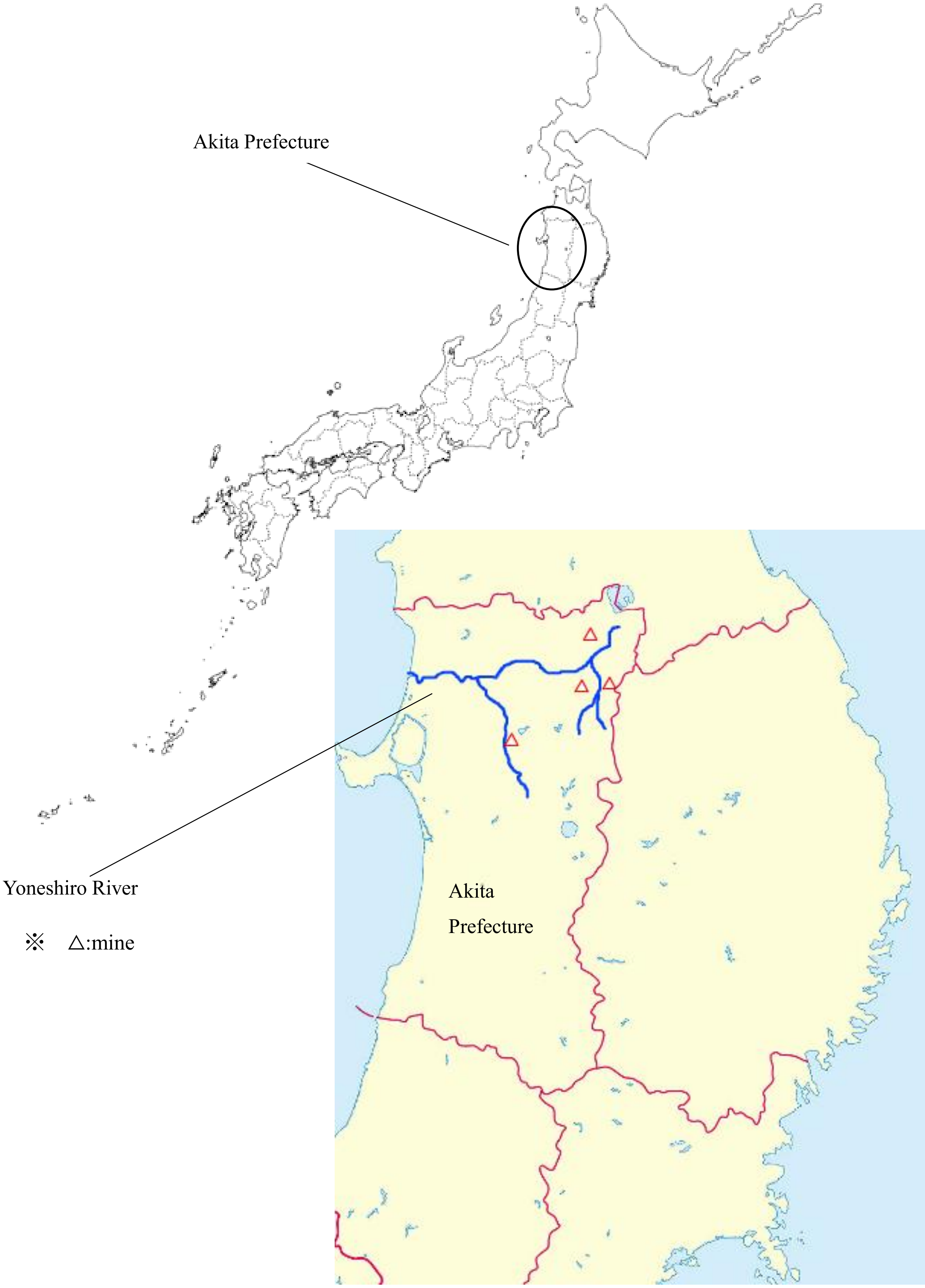


Figure 2: Scatterplot of IMR and distance from the Yoneshiro River

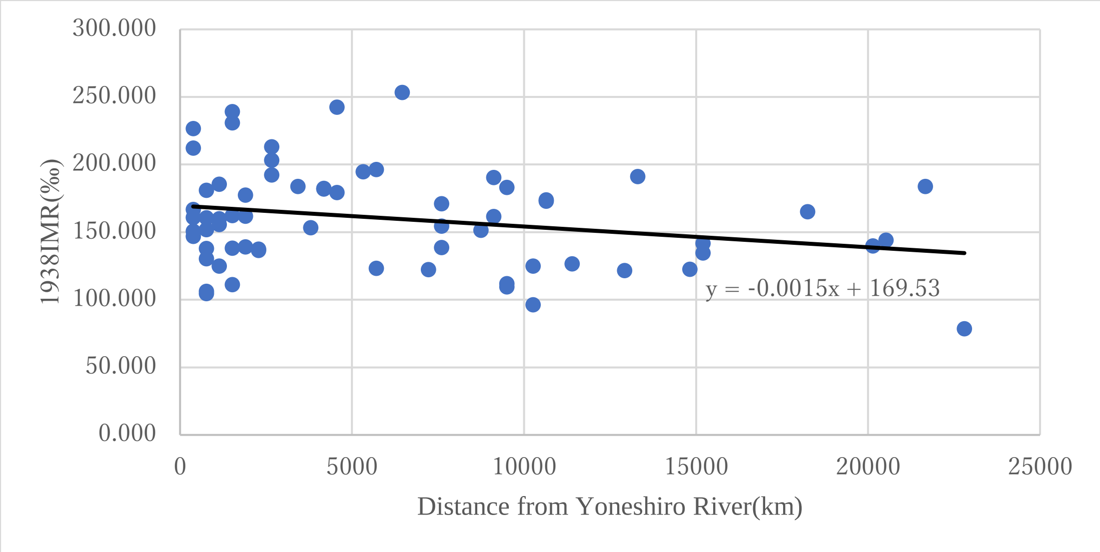


Table1: IMR and distance from the Yoneshiro River

IMR	t
Distance from the Yoneshiro River	-2.046※
F-statistic	4.188
R-squared	0.062
observations	65

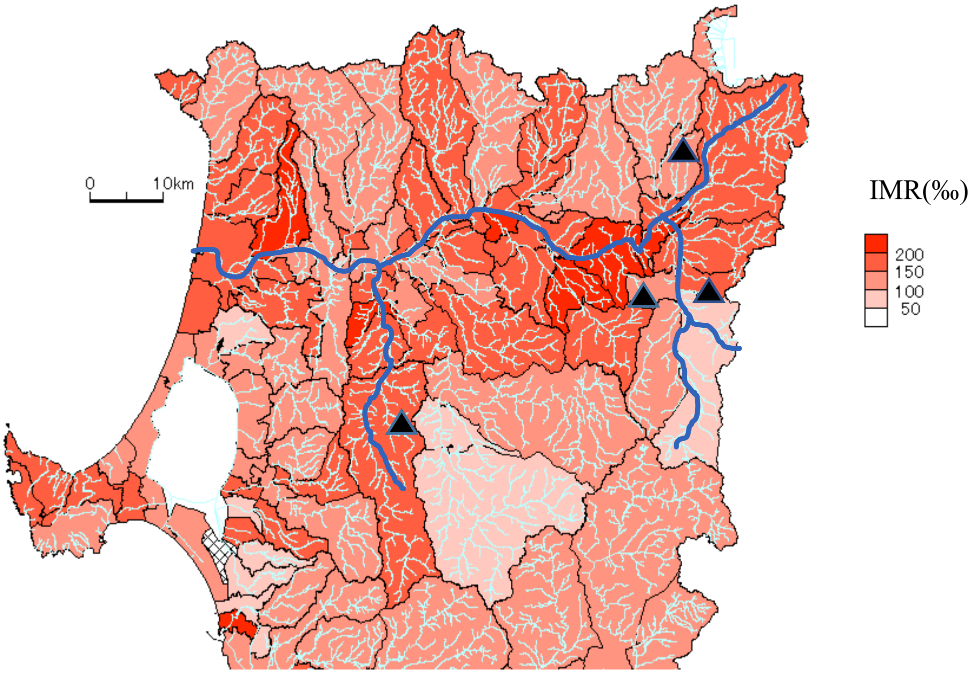
Regression Analysis (IMR)

※=Significant at the 5 percent level

Table 2: SBR and distance from the Yoneshiro River

SBR	t
Distance from the Yoneshiro River	-0.575
F-statistic	0.331
R-squared	0.005
observations	65

Figure 3: IMR around the Yoneshiro River



Conclusion

This paper clarified the relationship between environmental pollution, especially mining pollution and infant mortality in Japan in the 1930s. Around the Yoneshiro River, in Akita Prefecture, heavy metals accumulated in the mother's body due to rivers contaminated with mining pollution, which was responsible for the high IMR. Moreover, it was not clarified by the regression analysis, the high SBR was recorded in the villages near the mines, suggesting that the mining pollution give negative effects on the stillbirth. However, the IMR is not only related to environmental pollution, but also is related to nutrition, the local medical situation and the local historical background. So in the future, we would like to expand the case analysis to the whole of Japan and to analyze relationship between the IMR and the other factors.

References

Arceo-Gomez, Eva O., Rema Hanna and Paulina Oliva, 2016 "Does the Effect of Pollution on Infant Mortality Differ Between Developing and Developed Countries? Evidence from Mexico City" *Economic Journal* 126 (591):257-280.

Asami, Teruo, Satoshi Saeki, Hiroshi Goto, Masanori Nakazawa and Shoua Kubota, 2000. "*Kouzan,Seirenjo Shuhen no Dojo Oyobi Kasenteishitsu no Gin Niyoru Osen.* (Contamination of Soil and River Sediments around Mines and Smelters with Silver)" *Journal of Japan Soil Fertilizer* 71 (2):179-186.

Bailey, Roy E., Timothy J. Hatton and Kris Inwood, 2018. "Atmospheric Pollution, Health, and Height in Late Nineteenth Century Britain" *Journal of Economic History* 78 (4):1210-1247.

Brainerd, Elizabeth and Nidhiya Menon, 2014. "Seasonal Effects of Water Quality: The Hidden Costs of the Green Revolution to Infant and Child Health in India" *Journal of Development Economics* 107: 49-64.

Chay, Kenneth Y., and Michael Greenstone, 2003. "The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variation in Pollution Shocks Induced ay a Recession" *Quarterly Journal of Economics* 118 (3):1121-1167.

Clay, Karen, Joshua Lewis and Edson Severnini, 2016 "Canary in a Coal Mine: Infant Mortality, Property Values and Tradeoffs associated with Mid-20th Century Air Pollution" NBER Working Paper (22155), Cambridge.

Coneus, Katja and C. Katharina Spiess, 2012. "Pollution Exposure and Child Health: Evidence for Infants and Toddlers in Germany" Journal of Health Economics 31: 180-196.

Currie, Janet, 2013. "Pollution and Infant Health" *Child Development Perspectives* 7 (4):237-242.

Genowska, Agnieszka, Jacek Jamiotkowski, Krystyna Szaftaniec, Urszula Stepaniak, Andrzej Szpak and Andrzej Pajak, 2015. "Environmental and Socio-economic Determinants of Infant Mortality in Poland: An Ecological Study" Environmental Health 14(61).

Greenstone, Michael and Rema Hanna, 2014. "Environmental Regulation, Air and Water Pollution, and Infant Mortality in India" *American Economic Review* 104 (10):3038-3072.

He, Guojun and Jeffery M. Perloff, 2016. "Surface Water Quality and Infant Mortality in China" *Economic Development and Cultural Change* 65 (1):119-139.

Higami, Emiko and Kenichi Tomobe, 2014 "How the infant mortality was reduced in the early-twentieth century Osaka" *Sociology Study* 4(5):446-460.

Jorgenson, Andrew K., 2004 "Global Inequality, Water Pollution, and Infant Mortality" *Social Science Journal* 41 (2):279-288.

Ministry of Health, Labor and Welfare, 2006. *Namari no Dokusei ni Kansuru Chiken ni Tsuite* (Knowledge about Lead): The 1st Study Meeting on Safety Measures for Lead-containing Metal Accessories.

Mokyr, Joel and Cormac O Grada, 1996. "Height and Health in the United Kingdom 1815-1860: Evidence from the East India Company Army" *Explorations in Economic History* 33(2): 141-168.

Seko, Yoshiyuki, 1998. "*Chikyu Kankyou Henka no Kankyou heno Eikyou* (Effects of global environmental changes on health)" *Environmental of the Earth* 2(2): 207-213.

Sunagawa, Yukio, 2004. *Jikiso ha Hituyou Dattaka-Ashio Koudoku Jiken no Shinjitu* (Was Direct Complaint Necessary?: The Truth of Ashio Mine Incident. Tokyo): Bensei Publishing Company.

Wai, Kyi Mar, Ohn Mar, Satoko Kosaka, Mitsutoshi Umemura and Chiho Watanabe, 2017. "Prenatal Heavy Metal Exposure and Adverse Birth Outcomes in Myanmar: A Birth-Cohort Study" *Environmental Research and Public Health* 14 (11):1339.

World Health Organization (WHO), 2017. *Inheriting a sustainable world: Atlas on children's health and the environment*. WHO.

Yang, Jie, Wenqian Huo, Tongzhang Zheng, Yuanyuan Li, Xinyun Pan, Wenyu Liu, Huailong Chang, Minmin Jiang, Aifen Zhou, Zhengmin Min Qian, Yanjian Wan, Wei Xia and Shunqing Xu, 2016. "Maternal Urinary Cadmium Concentrations in relation to Preterm Birth in the Healthy Baby Cohort Study in China" Environmental International 94:300-306.