

The History of the Tama River: Water and Rocks in Modern Japanese Economic Growth

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Introduction

The Tama River has its headwaters in the Okutama mountains west of Tokyo.¹⁾ From there it flows 138 kilometers, first as a rushing stream through a narrow valley, then spreading out and snaking its way through flatlands until it reaches Tokyo Bay at Kawasaki. The river today is holiday destination; in less than two hours one can escape the crowded streets and concrete buildings of Tokyo and fish for trout along its upper reaches; downstream the gently flowing river is flanked on both sides by green parks, baseball diamonds, soccer fields, and nature reserves, offering relief to what is otherwise residential and industrial urban sprawl.

This placid picture belies the extraordinary role the Tama River has played in the creation of Japan as a modern capitalist economy. During the Edo period (1600–1868), water from the Tama River was vital to the existence of the more than one million people who lived in Edo, the capital of the Tokugawa Shogun and the city now known as Tokyo. The Tama not only supplied their drinking water, but fed them as well. Irrigation projects allowed for the development of vast tracks of agricultural land to the west of the city. After the Meiji Restoration of 1868, the Tama River continued to supply resources important for the construction of modern Japan. People in the capital city, remained dependent on Tama water, but new and increasing demands were made on an old river product — gravel. Mixed with cement to form concrete, gravel, along with silk, cotton, and tea, made modern Japanese economic growth possible. The Tama River, until the middle part of the twentieth century, was Japan's major source of gravel.

This paper examines how the Tama River was exploited, both in a positive and negative sense. Tama River products, water and gravel, are part of the story of Japanese economic development over the past 400 years. At the same time, the fate of the Tama River is part of the darker side of Japan's modernization. Beginning in the seventeenth century, attempts to control water flow and extract resources from the river have meant that the Tama has lost much of its natural pedigree: it has been straightened, smoothed, cemented, dammed and raped of its rocks and robbed of its water. The paper will first briefly look at the role played by the Tama water in the development of Edo and then take a more detailed look at gravel from the Tama River and its importance in the building of modern Japan. A concluding section will take note of

the massive environmental damage inflicted upon the Tama River and its ironic consequences.

Water and the Development of Edo: 1600–1868

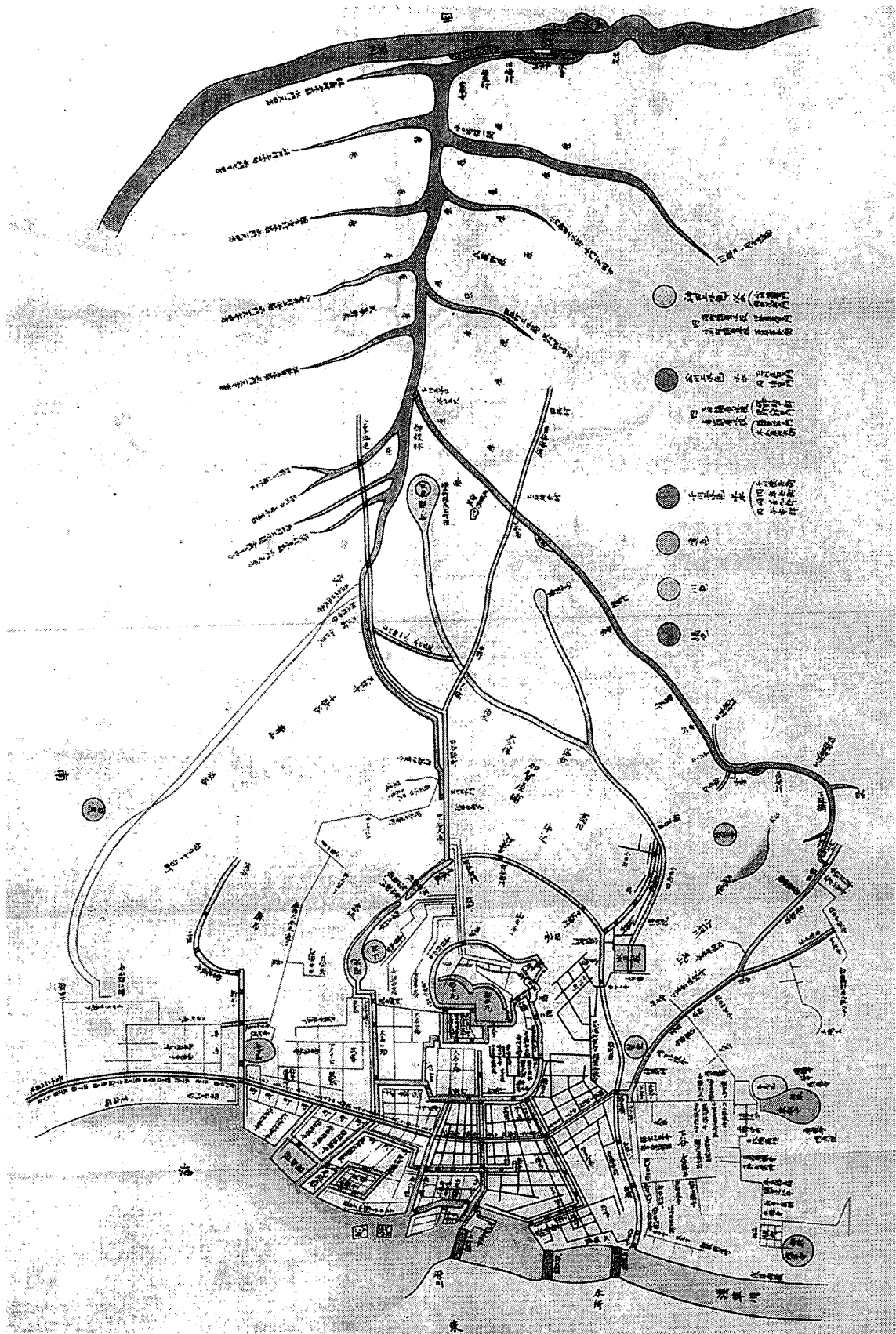
Water from the Tama River was essential in making Edo into one of the world's largest cities. In 1600 the population of Edo numbered a few thousand; by the early years of the eighteenth century the city was home to more than a million people. What began as the political and military headquarters of the ruling Tokugawa family became a teeming commercial center. Access to fresh water was of vital importance. Work began on the Kanda aqueduct system early in the seventeenth century; when completed at mid-century it brought water 29 kilometers into Edo from artesian springs at Inokashira through an intricate series of open canals and underground wooden pipes, culminating in some 3,663 subsidiary ducts which distributed water to various parts of the city.²⁾ Rapid population growth rendered this system inadequate and in the 1650s a far more ambitious project was begun to draw water from the middle reaches of the Tama River at Hamura, about 50 kilometers from the center of Edo. The Tama Canal was a major technological feat; it took more than sixty years to complete, but succeeded in supplying the thirsty population of Edo with drinking water.

A series of secondary aqueducts branching off the Tama Canal (Map 1) allowed new agricultural fields and farming communities to develop in lands to the west of Edo.³⁾ Beginning in 1722, the Tokugawa regime encouraged the opening of new fields (*shinden*) in the area, capping a century of massive human manipulation of the natural environment, especially in the area of river control and the creation of new productive lands through a series of irrigation and reclamation projects. Historians have called the late seventeenth and early eighteenth century Japan's "age of development" (*kaiha-tsu jidai*). The Tama River itself was tapped at several points for irrigation. Water was diverted into canals and into a complex network of paddy fields before being returned to the river. By the eighteenth century, an intricate series of canals and branch canals had been dug on the northern and southern parallel of the lower reaches of the Tama River.⁴⁾ This created new lands producing rice, other grains, and vegetables needed to feed the growing population of Edo.

The Tama River was crucial in other ways to the existence of Edo. Water served as a highway linking the city with the hinterland. Lumber and other wood products, cedar bark shingles, charcoal, roofing thatch, cotton, silk, tobacco, paper, rice, wheat, barley, soybeans, pressed sesame oil, vegetables, horse fodder and other goods flowed into Edo. Fishermen were also active on the river; they provided the people of Edo with *ayu* (sweetfish) and other freshwater fish.

Rocks and Modern Economic Growth 1868–1968

River rock is another of the many "special products" of the Tama River, but it came into prominence only after the Meiji Restoration of 1868. During the Edo period, pebbles were used in the courtyards of temples, shrines and palaces of the nobility;



Map 1 The Tama Canal Around 1700

gravel was used on roads, especially toward the end of the Edo period when wheeled transport increased; large rocks were in demand for rock walls and building material. Boats piled with bales of stone were a common sight on the river. Digging, cleaning, and sorting rocks provided a steady income. It was estimated that one man could dig and pack 1 *tsubo* (about 3.3 square meters) of stones in one day and could sell the load for 1 *kan* and 200 *mon* in silver and copper currency (about the same cost as 11 liters of Japanese rice wine).⁵⁾

The demand for gravel increased dramatically in the second half of the nineteenth century. Trade with Europe and the United States began in 1859; Yokohama, close to Edo, became a thriving international port. By 1868 the Tokugawa government was replaced by a centralized imperial state committed to a policy of Westernization and industrialization. In 1872, Japan's first railway line was opened between Yokohama and Tokyo. The government took the initiative in bringing new industries to Japan. A modern silk filature was set up in 1870, followed by cotton spinning mills equipped with imported machinery. Other model factories in such areas as sugar, beer, glass, chemicals, woolen fabrics, and cement were established at government expense. By the turn of the century, these pump-priming measures had paid off: Japan was a net importer of raw materials and exporter of finished manufactured products.

What do rocks have to do with Japan's modern economic growth? Three new uses for gravel caused a rapidly expanding demand. In 1871, four Yokohama businessmen set up the Tama River Gravel Company with the idea to sell gravel to foreign merchants for use as ballast. Japan's prime export items, silk and tea, were too light for efficient shipping. More weight was needed and thus gravel for export came into demand. The development of a national railroad system was more significant in making gravel one of Japan's most important natural resources. The rocks were needed for railroad embankments and beds. The wooden ties could thus be easily leveled and assured of good drainage. The rail system expanded rapidly; by 1900 all major cities, from Aomori in the northern part of Honshu, to Kagoshima, in the southern island of Kyushu, were linked by rail, with the capital of Tokyo at the center.⁶⁾ By that time there were nearly 7,000 km of track and therefore 7,000 km of gravel beds laid in Japan. The expansion of the rail network necessarily meant an increased demand for Tama River gravel.

A third new demand for gravel came from the construction of Western-style buildings and the use of new building materials. The Japanese government set up a model cement plant in 1873. Private enterprise followed with the establishment of the Onoda Cement Plant in 1881 and Toyo Cement in 1882. In 1884, one of the Meiji period's most dynamic entrepreneurs, Asano Sōichirō, purchased the government cement works. He renamed the plant Asano Cement (now Nihon Cement), and helped build one of the richest industries in modern Japan.⁷⁾ Cement was used to make concrete, the building stuff of Japan's new age of civilization and enlightenment — it was used in Western-style buildings, factories, shipyards, railroads, mines, and roads. And concrete required the use of gravel. Large-scale projects, such as the breakwater at Futtsu on

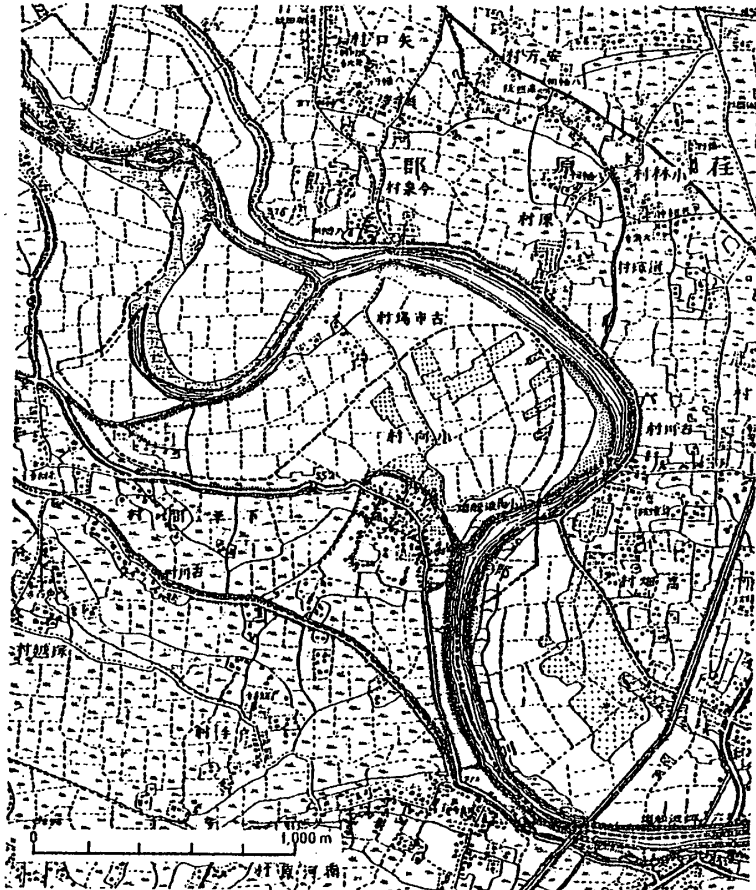
the Bōsō side of the entrance to Tokyo Bay (construction began in 1882), the new naval yard and port facilities at Yokosuka (1884), the Yokohama Dockyard (1890) and a profusion of smaller projects involving the use of concrete meant that the demand for gravel escalated rapidly.

Japan's modern economic growth achieved the "take-off" stage by the 1890s, spearheaded by the transformation of Tokyo into a modern commercial and industrial center. This was the first of three construction booms which led to an ever increasing demand for gravel. During the first period, the population of Tokyo expanded rapidly. In 1897 the population of Tokyo was 1,330,000; by 1920 the number of residents had swelled to 3,350,000.⁸⁾ Streets were widened and paved, at first with concrete and later with asphalt. Both surfaces required great quantities of gravel. Large government buildings, public halls, rail stations, banks, department stores and other modern business office buildings were constructed. Tokyo and other large cities were gradually rebuilt with bricks, mortar, cement, and gravel replacing wood as the prime building materials. Japan's first ferro-concrete building was built in 1903 in Kobe; ten years later such buildings were a common sight in modern sections of large cities throughout Japan.

A more fundamental transformation of Tokyo took place after the Great Kanto Earthquake, which struck just before noon on September 1, 1923. It resulted in the deaths of more than 100,000 persons and destroyed 73 percent of the homes in Tokyo and 85 percent of the homes in Yokohama. Rebuilding began immediately. During this second construction boom, the proven superiority of ferro-concrete buildings meant that nearly all new building projects involved vast quantities of concrete. The Marunouchi side of Tokyo Station emerged as a new business hub, filled with the national headquarters of major banks, insurance companies, and industrial concerns, the Kishimoto Building, the Showa Building, the Marunouchi Hotel, the Central Post Office, and the First National Bank were all quickly built — these modern buildings were ferro-concrete structures.

Gravel thus was an important natural resource necessary for Japan's modernization. And the Tama River, close to Tokyo and long known for the quality of its rocks, became the obvious source of supply. In 1883, two gravel pioneers, Watanabe Fukutaro and Akimoto Genzō, developed pits along the lower reaches of the Tama River, especially around the area of Yaguchi (Map 2) where the river snakes and where significant gravel beds were known to exist.⁹⁾ They began to transform the collection of gravel into an industry. Teams of men and horses were employed to dig, cart, clean, and sort the stones. Large gravel (around 6.4 cm in circumference) was used for railroad beds; medium gravel (around 3.2 cm in circumference) was used for road construction; small pebbles (around 2 cm in circumference) were used along with cement in construction projects. The gravel had to be washed thoroughly, especially if it were to be used for the making of concrete. The rocks were transported at first by horse cart and boat and later by specially constructed rail lines.

By 1900, the need for increasing quantities of gravel forced the Tokyo City Council

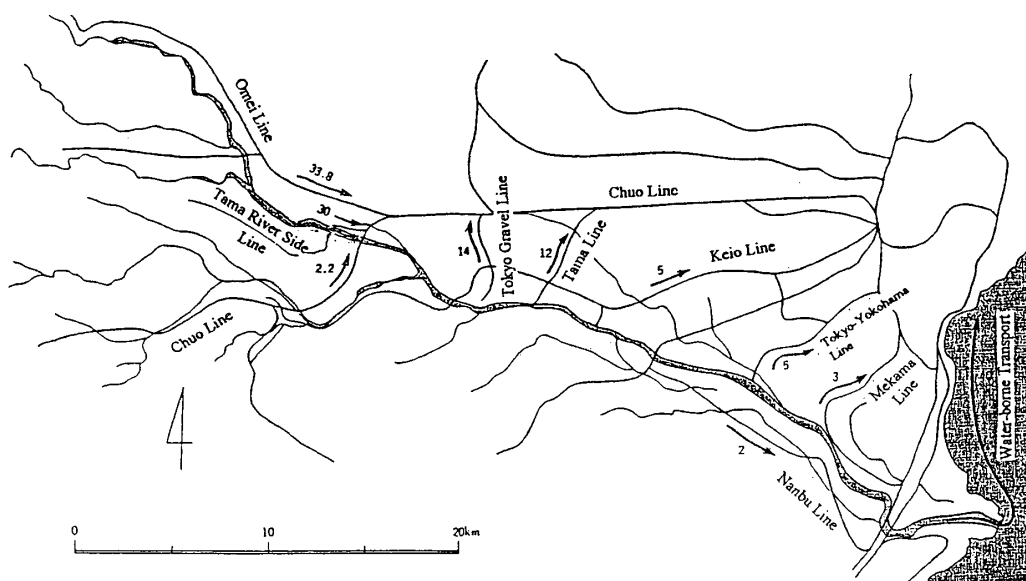


Map 2 S-Shaped Curve in Tama River at Yaguchi
(around 5 km from the mouth of the river)

to set up its own gravel works. It employed more than 200 men as diggers and operated a fleet of 100 gravel boats and 60 transport craft in the Todoroki area of the Tama River, producing around 7,000 tons of gravel a year. The municipal concern remained in operation for 18 years before it gave in to competition by private gravel companies. As demand increased in the early part of the twentieth century, the gravel industry became mechanized. Steam shovels and special gravel digging and sorting machines, water-borne dredges, conveyer belts, and gravel washing machines were used. Trucks and rail lines were used to transport the rocks. What backbreaking work remained was given to Korean and Taiwanese laborers.

In 1907 the Tama Electric Railroad (now the Toyoko Line) transported gravel from the Todoroki area to depots in Shibuya. The Tama Gravel Line, opened in 1910, linked gravel pits at the Tama River in Fuchū with the Kōbu Rail Line at Kokubunji. In 1917, the Tama Line (now Seibu Tamagawa Line) linked pits at Koremasa with the Kōbu Line at Musashi Sakai. The Keio Line linking Tokyo and Hachiōji, which opened in 1916, also carried gravel into the city. Map 3 shows the various gravel rail lines along the Tama River and the volume of gravel carried in 1925.¹⁰⁾

The increase in demand for gravel before and after the Great Kanto Earthquake in 1923 can be shown from statistics which give a rough idea of the scale of the Japanese

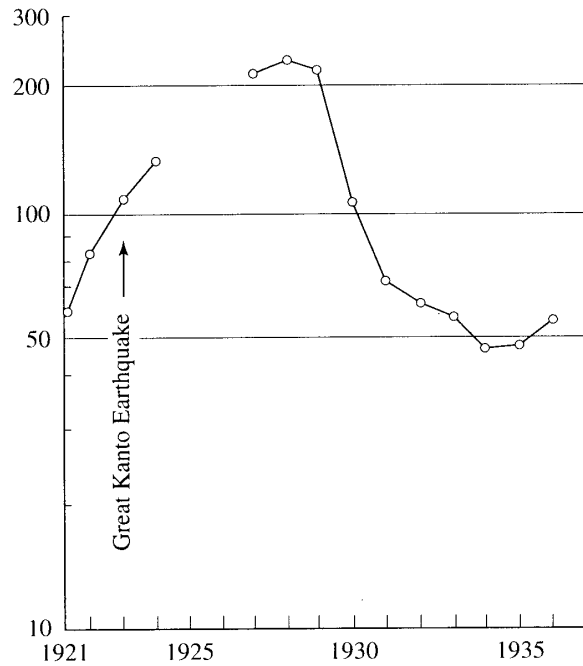


Map 3 Gravel Rail Lines along the Tama River

gravel industry. Between 1912 and 1915, an estimated 86,250 tons of gravel was taken from the Tama River. In the period 1916 to 1919, this figure grew to 115,000 tons. In the next few years major projects, such as the Water Purification Plant in Sakai and the construction of Japan's first "industrial park" along the coast north of Yokohama, significantly increased the demand for gravel. In 1922, 1,150,000 tons of gravel was extracted from the Tama, a ten-fold increase over 1919. Again, after the Great Kanto Earthquake, demand for gravel continued to rise: in 1925 the figure was 1,400,000 tons and in 1925, 1,450,000 tons.¹¹⁾ A separate set of statistics (Graph 1) gives the volume of gravel transported into Tokyo depots.¹²⁾ These figures, beginning in 1921 with 553,511 tons of gravel, doubled by 1924 to 1,317,149 tons, and nearly doubled again by 1928 when a peak was reached at 2,260,000 tons. Thereafter the Japanese economy slowed down, especially after the Great World Depression, and the demand for gravel fell off considerably. Rock bottom came in 1936, when only 473,000 tons were excavated.

During the boom years, the Tama River remained the largest single source of gravel. In 1922, for example, 46 percent of the 2,500,000 tons of gravel produced came from the Tama; by 1925, the volume of gravel taken from rivers throughout Japan had grown to 3,802,000 tons, of which Tama contributed 38.1 percent.¹³⁾ (Chart 1 and Map 4) During these years two giant gravel companies (the Tokyo Dai-ichi Kairyo Jimusho and the Tokyo Jari Goshi Kaisha) began to operate out of Fuchū, with a combined production in 1924 of over 300,000 tons of gravel. Each company had a work force of around 200 to 250 workers and was equipped with the latest in river mining technology. At the same time, with demand outstripping supply, new operations were begun in the upper reaches of the Tama River.

The so-called "economic miracle" of Japan's postwar recovery in the 1950s and 1960s was the cause for a third explosion in the demand for gravel from the Tama River. Tokyo, Yokohama, and nearly all other major cities in Japan had been destroyed

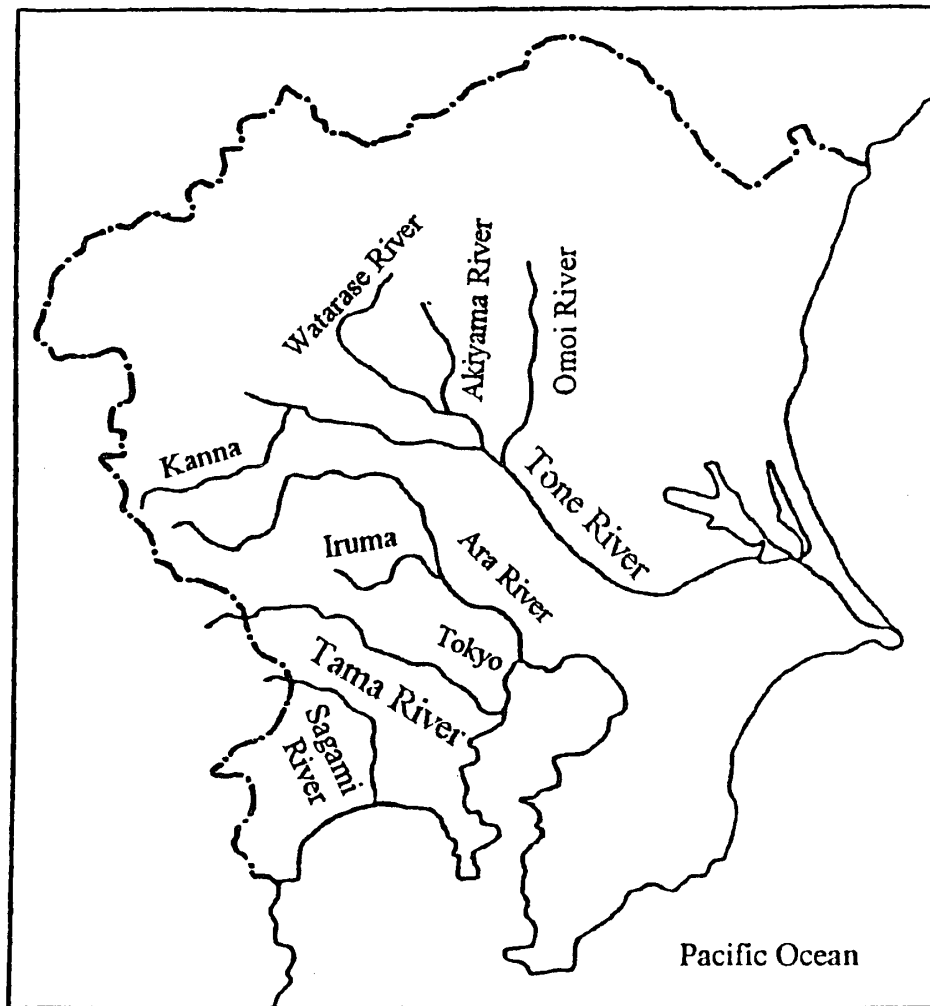


Graph 1 Volume of Gravel transported into Tokyo 1921–1936 (in 10,000 ton units)

River	1922	1925
Tama	1150	1450
Sagami	380	830
Iruma	215	414
Ara	200	363
Omoi	71	115
Akiyama	152	200
Kanna	38	200
Tone	100	140
Watarase	23	50
Others	172	40

Chart 1 Gravel Production by River (in 1,000 ton units)

during the war years. Reconstruction began in earnest in the early 1950s when the Korean War served as a major stimulus for Japanese economic recovery. Again, gravel for concrete was in high demand. The pits at Koremasa reopened in 1946 and yielded some 3 million tons of gravel before they were closed in 1968. (The resulting hole has since been turned into a speedboat race course.) Throughout the 1950s, some 600,000



Map 4 Gravel Producing Rivers in the Kanto Region

tons of gravel were dug out of the Tama River yearly. By the early 1960s, however, damage to the river caused the government to impose restrictions on excavation, and by 1968, river gravel collection had come to a halt, having been replaced by mountain gravel, crushed rock, and imported materials.¹⁴⁾

Environmental Irony

One of the first Western language accounts of the Tama River is by Engelbert Kaempfer who ferried across the “deep but smooth” river in 1690 on his way to Edo. If he had traveled a few years earlier, he could have walked across the great Rokugo Bridge into the world’s largest city. The bridge was originally built in 1600 soon after Tokugawa Ieyasu set up his headquarters in Edo. It was part of the Tokaido Highway which linked Osaka and Kyoto with Edo, but the 218 meter bridge suffered repeated damage by floodwaters. It was repaired in 1612 and 1643, washed out and rebuilt in 1646, 1659, and again in 1670. Floods destroyed the bridge in 1671 and again in 1672; again it was rebuilt but damaged and repaired in 1684; washed out in 1686, repaired, but destroyed again in 1688.¹⁵⁾ At this point the Tokugawa government gave

up any pretence of bridging the Tama River. For the next two hundred years ferries carried all traffic across the river; there were 27 crossing sites, but the Tokaido Crossing at Rokugo was the busiest. Some 70 percent of all goods and people going in and out of Edo were ferried over the Tama River. Even after the Meiji Restoration of 1868, government attempts to maintain a bridge across the Tama River failed until 1925, when a ferro-concrete structure was built.

Increasing human manipulation of the river was the direct cause of increased flood damage. According to the *Tamagawa-shi*, which lists all major incidents of flood damage along the Tama River, floods occurred on an average of every six years in the period 1600 and 1700, and once every three years between 1700 and 1800.¹⁶⁾ The Tokugawa regime attempted various means to control the river. Special dykes, levees and embankments were built, channels were widened, and waters diverted. Specialists at water management, such as Tanaka Kyūgu and, later, Kawasaki Hei'emon were invited to apply their talents. They dug channels and constructed protrusions and other stoneworks in the river at strategic places. However, the damage to agricultural communities and to crops caused by floods only increased. In the first half of nineteenth century, between 1800 and 1868, the river flooded on 30 occasions and with increasing ferocity.¹⁷⁾

The policies of rapid Westernization and industrialization placed new demands on the Tama and other river systems close to Tokyo in the later half of the nineteenth century. Flooding continued with even more frequency. In the 32 years between 1868 and 1900, 22 were flood years. The Meiji government employed Western engineers to help solve the problem, but to no avail.¹⁸⁾ The floods of 1907 and 1910 were unprecedented in the scale of their damage. The Great Meiji Flood of 1910, for example, killed 1,231 persons nationwide and some 518,002 houses were lost. It was reported that the cost of the flood was between four and five percent of the national product for that year.¹⁹⁾

The massive extraction of gravel was also responsible for serious environmental damage to the Tama River. Beginning in the 1890s, trees which had lined the Tama were felled and embankments at places removed for their gravel. Pits, some of them more than 10 meters deep, pockmarked the river, especially in its lower reaches. In some areas the course of the river was changed and the removal of banks and levees encouraged flooding. A report which followed the 1907 floods which swept through more than 50 towns and villages along the Tama River, noted that "in recent years gravel operators have emerged in the lower parts of the Tama River one after the other. Every day it is possible to see more than 100 (gravel) boats at work in the water and both sides of the river are being dug away. It is indeed shocking to see what damage is being caused by this reckless digging. Not only has the important task of water management been dangerously abandoned, but the very course of the river has been changed."²⁰⁾

The report failed to stop the digging. At first the gravel industry was concentrated along the lower reaches of the river, around Todoroki, but with increased demand,

new gravel pits were opened along the central and upper reaches between Fuchū and Hamura. In all areas the digging went increasingly deeper and began to eat into the river bed itself. The once-clear waters were muddied. Fishermen complained, with good reason, that gravel excavation was the cause of a marked decline in sweetfish and other river fish.²¹⁾ By the 1920s, the gravel industry was no longer a cause of flooding; quite the reverse, the removal of rocks significantly lowered the water level, in some places exposing the foundations of bridge supports. In the absence of stones and gravel, the river emptied into Tokyo Bay without impediments to slow down its flow.²²⁾ The “deep but smooth” river was no more. Shallow waters virtually brought river traffic to an end. Moreover, with less resistance at high tide, sea water was able to reach further upstream. In 1933, for example, sea water entered the Tama River Water Plant intake ducts near Denenchōfu, about six kilometers from the mouth of the river. A concrete dam was hurriedly constructed across the river at Chōfu to prevent sea water from entering the city’s water supply. Low water levels also spelled disaster for many of the irrigation systems that fed off the Tama. In 1934 environmental protest and the effects of economic depression brought the Tama gravel industry to a temporary halt. By this time, the river was transformed nearly beyond recognition.

The fate of the Tama River in modern times is filled with irony. Economic demands on the river, such as the excavation of gravel, had serious environmental consequences. Early in the twentieth century, the central government became more aggressive in its attempt to control rivers such as the Tama. Laws were passed and monies from the national budget (7.4 million yen over ten years) were allocated to “re-form” the river. In 1920 construction work began. The lower reaches of the Tama River were straightened, banks were reinforced with concrete, inlets and outlets of water into the main stream were cemented and placed under human control. By the end of the 1920s plans were drawn to dam the river at its source. Construction was begun at Ogōchi in the Okutama mountains in 1936; the new dam would be Japan’s version of the Hoover Dam project then underway in the United States. When completed, in 1940, in time for the 2600th anniversary of the founding of Japan, the dam would be the fourth largest in the world.²³⁾ The costs of war delayed the project and it was abandoned until after the war. The Ogōchi Dam, which requiring the use of over 3 million cubic meters of concrete, was finally completed in 1958. Ironically, the very gravel that had been extracted from the Tama was returned in the form of concrete, damming the river at its source and at several places downstream, encasing its banks, and controlling other waters as these entered or left the main stream.

Notes

- 1) A version of this article was delivered at a C Session panel, “New Directions in Environmental History,” at the 1998 International Congress of Economic History held in Madrid, Spain. I wish to thank my colleague, Ken Robinson, for his comments and editorial suggestions. The major source on all aspects of the Tama River is the multi-volume *Tamagawa-shi*, published by the Kasen Kankyō Kanri Zaidan, in 1986. Volume 1 is primarily devoted to the history of the Tama River. A shorter account may be found in Miwa Shūzō, *Tamagawa*, Yūrindō Publishers, 1988.

- 2) Hatano, Jun, "Edo's Water Supply," in James McClain, John Merriman, Ugawa Kaoru, eds., *Edo and Paris: Urban Life and the State in the Early Modern Era*, Cornell University Press, 1994, p. 245 and Susan Hanley, *Everyday Things in Premodern Japan — The Hidden History of Material Culture*, University of California Press, 1997, pp. 107–110.
- 3) Details on the Tama Canal may be found in *Tamagawa-shi*, pp. 582–665. Map is taken from *Tama ikan hyaku-nenten no kiroku*, Machida-shi Jiyū Minken Shiryō-kan, ed., 1993, p. 10 (original in the archives of the Tokyo Suidō Kyoku).
- 4) For details, see *Tamagawa-shi*, pp. 516–554; map is taken from insert following p. 542.
- 5) *Tamagawa-shi*, p. 974.
- 6) For details on all aspects of the expansion of rail transport in late nineteenth century Japan, see Steven Ericson, *The Sound of the Whistle: Railroads and the State in Meiji Japan*, Harvard University Press, 1996.
- 7) On Asano Sōichirō, see his biography: Asano Taijirō and Asano Ryōsuke, *Asano Sōichirō*, Aishinsha, 1923. See especially pages 325–347 for information on the establishment of the Asano Cement Company. The cement industry developed rapidly in Japan. By 1914 some 600,000 tons were being produced; this figure jumped to 1,000,000 tons by 1918 and doubled to 2,000,000 tons in 1923 and nearly doubled again in 1929. Thereafter the Great Depression slowed growth, but the prewar production of cement peaked in 1939 at 6,500,000 tons. (Doboku Gakkai, ed., *Nihon dobokushi, 1912–1940*, published in 1965, p. 1623) During the war years cement production declined dramatically, but a postwar building boom revived the industry. The prewar peak was achieved in 1952; by 1956 Japan was producing 13,737,594 tons of cement. Ten years later, in 1966, this figure had nearly tripled at 38,567,179 tons. (Doboku Gakkai, ed., *Nihon dobokushi, 1941–1965*, published in 1973, p. 152). For further information on the cement industry in Japan, see Nagata Shirō, *Nihon semento sangyō-shi*, Kensetsu Bunkasha, 1957, and Yamada, Junji, *Konkuriito no bunka-shi*, Bunichi Sōgō Shuppan, 1986.
- 8) Yazaki, Takeo, *Social Change and the City in Japan*, Japan Publications, 1968, p. 391.
- 9) *Tamagawa-shi*, p. 976.
- 10) *Tamagawa-shi*, p. 984.
- 11) *Tamagawa-shi*, p. 979.
- 12) *Tamagawa-shi*, p. 985.
- 13) *Tamagawa-shi*, p. 982. See also *Shiryōhen Tamagawa '94*, Tokyo Kankyō Jōka Zaidan, 1994, p. 9.
- 14) *Tamagawa-shi*, pp. 995–1002.
- 15) Miwa, pp. 66–67. See also Constantine Vaporis, *Braking Barriers: Travel and the State in Early Modern Japan*, Harvard University Press, 1994, p. 52.
- 16) *Tamagawa-shi*, pp. 251–52, 266–268.
- 17) *Tamagawa-shi*, 279–80.
- 18) C. J. Van Doorn from Holland remained in Japan from 1872–1880; he worked on taming the Yoko River and Tone River and was responsible for introducing Western technology relating to water management. Other foreign engineers included I. H. Lindow, (in Japan 1872–1875) and Johannes D'ijke (in Japan 1873–1901).
- 19) Seidensticker, *High City Low City*, Tuttle Publishers, 1984, p. 58
- 20) *Tamagawa-shi*, p. 978.
- 21) Decline in water purity was the cause of the disappearance of seven species of fish from the Tama River in the first half of the twentieth century. See *Tamagawa-shi*, pp. 907–910.
- 22) Details on the environmental impact of gravel extraction can be found in *Ōta-ku shi, shiryō-hen, minzoku*, Ōta-ku Shi Hensan Inkai, ed., 1983, pp. 68–71.
- 23) *Tamagawa-shi*, p. 818, 772.