



**A SHORT HISTORY OF
TRANSPORT IN JAPAN
FROM ANCIENT TIMES TO THE
PRESENT**

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4. Canals, Rivers and Lakes

An official is on his mettle
When riding in a *choki*¹

Introduction

The transport of produce by natural water courses of rivers and lakes is one of mankind's oldest means of communication that allowed food to be carried over more extended distances from farms to settlements. Modifications to the landscape, in the form of ditches, dikes and narrow canals, were initially to improve agricultural productivity but had only a minor effect of improving transport efficiency. In the case of Japan, over the millennia, it has been the constant drive at a local level to improve irrigation systems that have had the co-benefits to water transport rather than the construction of a national network of canals as occurred in many other countries. The essential pattern of Japanese agriculture had, at its heart, river irrigation systems (Tabayashi, 1987; Kuroishi, 2019).

A sizable proportion of this chapter deals with canals in rural, agricultural regions of the study area. In the overall scheme of things, river transport is of minor importance because engineering works were directed to flood control and urban water supply. The narrative follows the chronology adopted in Chapter 1, where in the archaic period dugout canoes were key artefacts of the hunter-gatherer society. The ancient period essentially set the pattern of canal and river management for millennia with landowners reliant on local knowledge for construction, operation and maintenance. In the early medieval to the early modern periods, the ancient cultural and political locus of Japan was around

1 A *choki* was a small boat used in Edo times to ferry samurai to and from the red-light district of Yoshiwara in Edo. The poetic style is *senryū*—in this case, where the *chōnin* (townsfolk) are mocking their social superiors (Kato, 1997: 205).

Lake Biwa and Kyōto, so various ambitious plans by warlords involved large-scale canals linking the Sea of Japan and the Pacific Ocean, but they were aborted because of the mountainous terrain.

The canal infrastructure that was constructed in the commercial ports of Ōsaka and Edō during the early modern period was entirely the resources and capital of the merchant class (Chapter 3). This chapter then focuses on an early Meiji period engineering marvel: Lake Biwa Canal between Ōtsu and Kyōto, based on material in Lake Biwa Comprehensive Preservation Liaison Coordination Council Office/ Metropolitan Areas Development Division, City and Regional Development Bureau, Ministry of Land, Infrastructure and Transport (2003), van Gasteren (2001), and Sakuro (1894). Finally, the administration of rivers and canals from the Meiji period onwards, especially the contemporary role of the Ministry of Infrastructure, Land, Transport and Tourism, is explained from a regulatory perspective with the *River Act* (1896; amended 1964). The next section explains why the topography on Honshū island was unsuitable for a network of canals for transport purposes.

The Importance of Topography

Topography is a significant factor as to whether rivers are navigable and whether there is economic value in canal construction. It is worth comparing the island of Honshū with a country of similar area. Japan and Great Britain offer relevant comparisons: Honshū is an island with an area of 227,963 sq. km (roughly 1,300 km long and from 50 to 250 km wide); England, Scotland and Wales, combined, have a similar area of 229,462 sq. km (the distance from Land's End in England to John O'Groats in Scotland is 970 km). In these two countries, as of 1600—when Japan's population was approximately 5 million and that of Great Britain 4.8 million—rivers, inland waterways and coastal shipping provided the main means of transporting bulk materials and the occasional passenger.

There are clear topographical differences between Japan and Great Britain. The navigable parts of English river systems are more extensive than those in Japan because of the lower mean terrain, whereas most of Japan, apart from coastal fringes, is predominantly mountainous or hilly. The longest rivers in Great Britain are the Severn (354 km), the

Thames (346 km), the Trent (297 km), the Great Ouse (230 km) and the Wye (215 km). Japanese rivers rise in the mountainous spines and plateaux that run along most of central Honshū and are short and fast flowing, especially after alpine snow melt. The latter rivers are less suitable for transport purposes.

The largest drainage basin in Japan is the Tonegawa (Tone River)—322 km long with its source at Mount Ōminakami in the Echigo Mountains and it flows into the Pacific Ocean at Chōshi in Chiba Prefecture. Emptying into Ise Bay, the Kisogawa (Kiso River) is 227 km long, with headwaters between the Hida and Kiso Mountains. (Details on the Shinano, Tone and Yoda Rivers can be found on the homepage of the Australian Bureau of Meteorology (2019)). The Arakawa is 169 km long with its source in the Kantō Mountains then passing through Saitama and Tōkyō prefectures with its lower reaches referred to as the Sumidagawa (Sumida River) where it enters into Tōkyō Bay. Despite the dangers of the fast-flowing rivers, currents and shoals, river navigation was negotiated by Japanese boatmen whose skills have been honed from Jōmon times.

Based on the above conditions, there was no obvious incentive in Japan to think about investment in canals to extend the river systems as a national waterway network. This investment happened in Britain from 1741 onwards.² These transport developments in Britain were driven by local projects: with private landowners as entrepreneurs (many initially exploiting coal); finance raised locally—primarily from those likely to benefit from the canal; consortia of business interests forming joint-stock companies; and, importantly, the rise of skilled surveyors and engineers (Barker and Savage, 1974: 36–44). As described by Osborne (2013: 266–282), it was private capital that invested in British canals from the day that the Duke of Bridgewater’s proposal was approved by the UK Parliament in March 1759 to build a canal that linked coalmines at Worsley to Manchester. In comparison, the Tokugawa *bakufu* had little economic interest in business and therefore canal construction.

2 In the UK, there is a wealth of published material on inland water transport, such as Willan (1936); Hadfield (1968) and Barker and Savage (1974).

Archaic Period

In Jōmon times, the coastlines and rivers were obvious sources of fish. The shoreline of Lake Biwa was an especially important location for Jōmon peoples and their hunter-gather lifestyles because of its abundance of food from land and water. Approximately 460 rivers of various sizes flow into Lake Biwa with a unique arrangement of attached lakes (most now filled for paddy fields) but only one outflow (the Seta River) that eventually empties into Ōsaka Bay as the Yodo River as a communications corridor (Uemura, 2012). Dated from the early Jōmon period, more than 30 dugout canoes (*maruki-bune*) have been discovered—the largest number ever found in Japan.

Ancient Period

In the early Yayoi period, water management was exercised by farmers where irrigation dikes drained paddy fields on the natural wetlands. As agriculture extended to upland areas in the 2nd century B.C. intake dams stretched across streams up to 10 metres wide and diversion canals were created. Inter-community organisations created canals 20 to 30 metres wide on alluvial uplands. Excavations at Toro (Shizuoka Prefecture) uncovered third century paddy fields totalling 7.5 hectares and irrigated by a canal more than 370 metres long (Tabayashi, 1987: 57).

According to Tabayashi (1987: 58), only a strong government could carry out the ambitious program of constructing and maintaining the well-ordered pattern of rural fields, paths and ditches, known as the *jōri* system. These waterways would have also served to transport rice. The *jōri* system of land division was introduced after the Taika Reform of 645 where tracts of land were divided into squares with sides measuring six *chō* (654 metres). This system made it possible for government to allocate land to cultivators, but the system was discontinued during the Heian period (794–1183).

As covered in Chapter 3, canals were indispensable elements of port expansions from ancient times through to the Edō period (Sakura, 2014). Dating the Horie Canal is difficult but there is no doubt of its importance by the 6th and 7th centuries A.D. The total length of the artificial canal

was 3 km and was cut through three parallel sand bars, each separated by narrow lagoons, immediately to the north of the Uemachi Terrace in the Ōsaka region (Pearson, 2016, Figure 5.18, p. 50).

Medieval Period

Various, both institutions and organisations—local elites, the regional *daimyō*, merchants, influential politicians or local government—have been instrumental in formulating ambitious plans for canals throughout Japanese history to connect Lake Biwa with the ocean. Given the ancient cultural and political locus of Japan was around Lake Biwa and Kyōto, these plans involved large-scale canals linking the Sea of Japan and the Pacific Ocean (Yoda, 2012:294). Towards the end of the Heian period, Taira no Kiyomori (1118–1181)—head of a powerful warrior clan—ordered his son, Shigemori, the local governor (*shugo*) of Echizen Province to build a 25-km long canal starting from Shiotsu in the north of Lake Biwa towards Tsuruga facing the Sea of Japan. The obstruction of Mount Fukasake caused work to stop 12 km from the port of Shiotsu, where a statue of *jizo bosatsu* (patron saint of dead children) was erected.

The legitimacy of the national government decreased so that it no longer carried out major water utilisation, river flood control or canal projects and improvements were organised by local authorities such as by the *shōen* estates and by the *daimyō*. Clearly, the skills to build canals in Japan existed from the 12th century when there was a tradition of building elaborate systems of moats around castles. The *Jinkouki*—a book on mathematics for the education of ordinary people published first in 1627—sets out examples of the calculation of volumes of soil to excavate (Wasan Institute, 2000: 135–137).

Early Modern

River Management

During the Warring States period, warlords developed the vast alluvial flood plains on major rivers that set up a cycle of flood damage and flood control measures. As noted by Aoyama (1999: 2) this led to the expansion of “local government” river administrative districts and the

“integration of river administration measures”. A specific example is the 128-km long Fujigawa that rises from Nokogiriyama (2,685 metres) in northwest Yamanashi as the Kamanashigawa then changes its name to the Fujigawa before emptying into Suruga Bay (Shizuoka Prefecture). During the *sengoku* period, many *daimyō* used advanced castle engineering to control the upper and middle reaches of wild rivers (Tabayashi, 1987: 58). For example, the local warlord Takeda Shingen built extensive dikes (*Shingen—zusumi*) along the Kamanashigawa to control the latitudinal inundation of floodwaters.

Continuing the time-honoured approach to irrigation practices, the Tokugawa government formed water management association of villages in each region to ensure the collective operation and maintenance of water facilities as well as to regulate both water rights and distribution systems in each village. In general, land development efforts during the Edō period brought a rapid expansion of paddy fields and of rice yields. Paddy areas doubled and rice production tripled. New laws and policies shaped the relationship between water rights, ownership of land, the village community system and taxation.

Both land and water were managed and owned by all village residents and agricultural works and environmental management became an everyday matter (Kuroishi, 2019: 155). The “Kantō method” attempted to control flood waters by widening riverbeds, by lengthening rivers through the creation of meanders, by sending excess water into holding basins and by altering the paths of rivers (Tabayashi, 1987:58). By the mid-Edō period, the provincial “integration of river administration measures” become the national government’s river administrative system.

From a national transport perspective, the Tokugawa government was primarily interested in rivers as a strategic means of imposing control of the country along the major highways radiating from Edō. Boats were essential in the crossing of rivers and bays on the national highway system of the Tōkaidō. From the militaristic perspective, the Tokugawa government regarded the shallow ford of the Seta River near Ōsaka as a strategic point for transporting an army across the river. Therefore, it was naturally reluctant to dredge the riverbed despite it hindering economic progress. In fact, during the Edō period, the government allowed dredging only five times over 200 years.

Occasionally, infrastructure projects were undertaken by the national government. For example, between 1624 and 1674, the Tokugawa *bakufu* constructed an extensive dike system to protect populated areas along the lower reaches of the Fuji River near the castle town of Sunpu. Water transport from Suruga Bay up-stream prospered in the Edō and early Meiji periods. Commercial river services were withdrawn in 1923.

Canals in the Edō Period

Kanazawa, located on the coast of the Sea of Japan, 260 km north northwest of Kyōto, was one of the largest of cities by population during the Edō era. In 1631, the castle was destroyed by fire. Maeda Toshitsugu (1617–1674), the *daimyō* of Kaga (today, Ishikawa Prefecture), ordered the construction of the Tatsumi Canal (11 km long of which 4 km are in tunnel), primarily for the purpose of fire protection and also to provide water for the gardens and moats of the rebuilt castle. The canal was completed in 1632. However, there is no evidence that it was used for transport purposes.

Kyōto was also an important city with respect to canal development in the Edō era. Toyotomi Hideyoshi granted a formal trade licence (*shuinjō*) to Suminokura Ryōi (1554–1614), to manage overseas trading operations by importing goods from a tributary state of the Ming Dynasty, Yue Nan (now Vietnam). When Toyotomi Hideyoshi died in 1598, Suminokura Ryōi became a trusted advisor and supplier of merchandise to Tokugawa Ieyasu and he was granted a *shuinjō* licence by his new patron to continue his overseas trading business.

The first canal constructed in Kyōto demonstrates the dynamics of the three-way interactions amongst merchant organisations and the *daimyō* and *bakufu*. Between 1605 and 1611, Suminokura Ryōi formed an enterprise with the other two leading merchant families (Chaya Shirōjirō and Gotō Shōzaburō) to construct canals and to make the four rivers of Kyōto (Tenryu, Takase, Fuji and Hozu Rivers) more navigable for shipping goods. The Takase River in central Kyōto is, in effect, a 9.7-km long canal that rises from Nijō-Kiyamachi, meeting the Uji River at Fushimi Port, and crosses the Kamo River on its way. It was constructed in 1611 and contributed substantially to the economic prosperity of the city.

Similarly, the short sections of canals built around the port areas of Edō and Ōsaka were primarily the initiatives of merchant organisations. The growing economic importance of merchants in the early Edō period has been documented in the previous chapter with respect to land reclamation and canals that enhanced the rapid development of both ports. Colour wood-block prints of the time depict the canal frontages in the commercial district of Nihonbashi in Edō and the commercial canals of Ōsaka (Hashizume, 2019; Reith-Banks, 2019).

The earliest modifications to the undulating terrain surrounding modern-day Tōkyō were undertaken in the mid-15th century. In 1467, Ōta Dōkan (1432–1486), a warrior and military strategist, was the architect and builder of a fortress at Edō for Uesugi Sadamasa (who, in 1439, had been appointed Governor-General of the Kantō region). The first civil work undertaken in Edō changed the route of the Hira River for defence moats around the castle and to link the castle with the port (Sakura, 2014, Fig. 1, p. 296)—the transshipment point for the goods that were transported from Kamakura (Sakura, 2014: 925).

To secure the fortification of Edō Castle from attack an elaborate system of moats and canals were dug, including access to Tokugawa land at Hama-Rikyū (now a public park) on marshes in Hibiya Bay that provided rich duck shooting and hawking opportunities. Quarrying of Kanda Hill provided the material for land reclamation that became the merchant town of Edō, as extensively documented by Sadler (1937), Naito (1993) and Kato (2000). The early construction initiatives ordered by Tokugawa Ieyasu included a defensive moat to the east of the castle and short parallel canals from Edō Bay for ships and boats to access the castle.

In the layout of the castle and surrounds, Tokugawa Ieyasu continued the Japanese tradition of cultural borrowings from the Chinese. He was clearly aware of the layout of Chinese Imperial cities and of the study of geomancy. There is much political symbolism in the layout of early Edō with the castle on the highest ground surrounded by the *daimyō* mansions, with the line of sight to Mount Fuji providing a spiritual axis for the castle. In the northeast corner—the traditional location for major temples that would act as a defence from evil forces—sat Sansō-ji, the oldest Buddhist temple in Tōkyō founded in 628.

Thirty-six square enclosure gates (*masugata*) controlled access to the city. As further defence in the northeast were the *Shōgunal* vassals'

mansions. Lower-ranking samurai lived in different areas. Parts of the southwestern section of the city were merchant and artisan districts. The commercial centre was located around Nihonbashi (Bridge of Japan)—between the castle to its west, and the river to its east—this centre was connected to the Sumida River, and a canal extended to the port providing access to incoming and outgoing shipping trade. To construct the city, building materials were commanded from the *daimyō* estates and shipped to Edō.

On Tokugawa Ieyasu's authority, Ōkubo Tōgoro (date of birth unknown, died 1617) dug a waterway from Koishikawa (in present-day Bunkyo Ward) to satisfy the needs of the burgeoning new town growing up around Nihonbashi. By 1629, this rudimentary supply line had been expanded into the Kanda Canal, which channelled supplies from Inokashira Pond in present-day Mitaka into the Kanda River, then into a canal cut through the surrounding hillsides. After filling the ponds and streams in the Kōrakuen Garden (constructed by Tokugawa Yorifusa, the 11th son of Tokugawa Ieyasu) over an area of some 70,000 square metres, the canal waters then entered the heart of the city along a wooden aqueduct across the Kanda River.

Altogether, this water system served the eastern sections of Edō, supplying about 25 per cent of the total demand. The extent of the natural river systems and the canals can be interpreted from a map of Edō in 1849 (Reith-Banks, 2019). Transport by a small wood craft (*choki-bune*) propelled by a pole pushing off the canal's bottom became the common means of getting from point to point, with wooden bridges across canals for road transport. Today, visitors to Tōkyō would be largely unaware of the original canal system because they have been filled in to make way for road and rail constructions (Seidensticker, 2019).

The original courses of rivers have changed substantially, especially the Tone River (Sakura, 2014, Figures 2 and 3, pp, 927–928). The Ginza district of Tōkyō provides a good example of how canals have been replaced by more modern transport infrastructure (Tokyo Reporter, 2008). On the first floor of the Shiodome Media Tower, an exhibition of aerial photographs of the area taken from a balloon one century ago were on display. The images show how the roads, bridges and canals in existence from the Edō era have intermingled to produce the contemporary streetscape of Tōkyō (Figure 2).



Figure 2. Major Buildings in Modern Tōkyō Superimposed on the Original Canal System of Ginza, c. 1900 (Scale: from Higashi Ginza Station in the south to Shin-Sukibashi in the north = approximately 1 km).

Source: Tokyo Reporter, 2008.

Lake Biwa Transport and Canals

In the Azuchi-Momoyama period (1568–1600), Toyotomi Hideyoshi, during his land grab to unify Japan, revived an ancient plan to connect Lake Biwa with the Sea of Japan. He ordered the owner of Tsuruga lands, Ōtani Yoshitsugu (1558–1600), to build a canal from Oura on Lake Biwa to Tsuruga located on the Sea of Japan. These works were aborted because of the difficult mountainous terrain. The 12-km long canal is named *taiko no ketsu wari bori* [the taiko's morning sickness canal]. On numerous occasions throughout the Edo period, merchants resurrected the idea of linking Lake Biwa to the Sea of Japan, but all were thwarted by opposition either from the Tokugawa *bakufu*, or from local villages along any proposed route.

Lake Biwa itself was, of course, navigable. The navigation and management of later *maruko* ships, and their design, corresponding to the depths of Lake Biwa, can be determined from ancient documents written and bequeathed to Katayama Minato, Tsukide Minato and Oura Minato who in the Edo period were resident in the former Ika-gun (Lake Biwa). Furthermore “*The Katayama Minato Katayama*” document and the “*Tsukide Minato Takebes*” document describe Lake Biwa water transport during the Edo era. The numbers of the *maruko* ships (*maruko bune*) and the circle ships (*maru bune*) exceeded 1,300 in the golden age of transport on Lake Biwa in the 18th century (Kawanabe *et al.*, 2019).

Lake Biwa water transport in the Edō era was the economic lifeline of the country carrying cargo and passengers from as far away as in the north of Japan to Kyōto and Ōsaka and offering an alternative means of travel on a part of the road journey from Kyōto to Edō. The principal freight was rice that came from regions north of Kyōto along the Sea of Japan coast, overland to the north end of Lake Biwa, then overland again at the south end of the lake to the Yodo River and on to Ōsaka. In a similar fashion, travellers taking the more expensive boat option used Lake Biwa and the Yodo River to avoid parts of the Nakasendō and Tōkaidō highways.

The objective of connecting Lake Biwa with the Sea of Japan at Tsuruga was revived again in the 19th century. At the end of Edō period, Maeda Yoshiyasu, *daimyō* of the Kaga domain (Ishikawa Prefecture), asked the mathematician Ishiguro Nobuyoshi (1760–1836) to survey the area in order to build a more efficient transport system between Kyōto and the Kaga domain. He started from the Tsuruga area and created a highly precise route survey from Tsuruga to Lake Biwa (recent research for the Shinminato Historical Museum by Shimasaki³ has verified the accuracy of this survey). Ishiguro also measured onwards from Lake Biwa to Ōtsu and made a very rough preliminary plan in 10 days. However, the Tokugawa government was unravelling fast, and the *daimyō* no longer had power of influence on the national government, so Ishiguro Nobuyoshi was not able to continue his survey in that area.

Modern Period

Lake Biwa Canal

In the early Meiji era, Kyōto was having water shortage problems. The city government lobbied the national government to construct a canal (*biwako sosui*) from Lake Biwa to the city (City of Kyoto, n.d.). In 1868, with the transfer of the national capital from Kyōto to Tōkyō, the city witnessed an economic decline. The Prefecture Mayor, Kunimichi Kitagaki (1836–1916), was appointed in 1881 and aspired to inject new life back into the community by commissioning the construction

3 Material collected during an interview with Mr Yoshitsu Shimasaki at the Shinminato Museum, Imizu City, Tōyama Prefecture, Japan.

of Lake Biwa Canal for the purposes of town water supply, irrigating surrounding paddy fields, water to fight fires and electrical power generation for cotton spinning.

It is pertinent to note that in a state recently liberated from feudalism and emerging as a modern democratic state the proposed Lake Biwa Canal project was not without its opponents. Many local farmers along the proposed route of the canal were opposed to its construction but the negotiated outcome of the conflict was a promise that the canal would provide irrigated water to the rice paddies in seasons when the rainfall was insufficient for a good rice harvest (Kitagaki, 2010).

The historical significance of this integrated development project is that it was the first project in the Meiji era that did not involve foreign engineers. Minami Ichirobe and Shimada Michio conducted the survey and made the plan based on Western mathematics—although their work was possibly based on Ishiguro's earlier survey because the route is almost the same and the locations of the outlets are exactly as Ishiguro Nobuyoshi had planned. Preparatory work was also undertaken for a transport canal, with Minami Ichirobe (who had been the chief engineer working with the Dutch advisor van Doorn on the construction of the Asaka Canal in Fukushima Prefecture) conducting a preliminary route survey. Shimada Michio made the necessary measurement of the route between Ōtsu on Lake Biwa and Kyōto—a 20-km long canal. The volume of rock estimated in the tunnelling through the mountain at Mount Nagana had been previously calculated in a thesis at Imperial College London—illustrating again the influence of foreign technology in the early Meiji period.

Tanabe Sakuro, a graduate of the School of Engineering, Imperial University of Tōkyō, was engaged by the Kyōto Prefecture as Chief Civil Engineer and started work on the project in May 1883. Permission to begin construction was sought from the national government in May 1884 who gave authorisation in January 1885 but with approval for a more ambitious building plan. Today, this is known in the construction industry as “scope creep” that effectively doubled the initial budget allocation by the local government of 600,000 yen.

The Prefecture Assembly resolved to proceed and financed the revised project by imposing heavier taxes on Kyōto residents. The construction cost estimate was 1,250,000 silver dollars (twice the annual budget of the Prefecture) with one-quarter paid for by a national government grant,

one-third paid by the Meiji Emperor and the remainder raised through local taxation (van Gasteren, 2001). The canal was completed by navy labour (altogether involving 4 million workers) within five years with three tunnels, including the 2,436-metre long tunnel through Mount Nagana that required bricks and timber especially for the purpose, and generated a brickwork factory nearby. An impression of the canal at Ōtsu on Lake Biwa as it looks today is obtained from the photograph in Figure 3.



Figure 3. Photograph of the Lake Biwa Canal at Ōtsu on Lake Biwa, 2018.

Source: Photographs by Author and Dr Masaki Arioka.

The difference in height between Lake Biwa and Kyōto is approximately 73 metres with a mean grade of 1: 0.00037. Its width is from 6 to 10 metres—advantageous to the water transport of goods (primarily rice

and cotton) coming from the Lake Biwa hinterland to Kyōto and beyond. The canal stimulated agricultural production around Lake Biwa and the goods transport canal opened up the markets in Kyōto and Ōsaka as the road alternative means of transport was costly on the unsealed Sanjō road that was especially difficult for laden packhorses and porters in the hilly terrain—slippery after rain and impassable after snow. However, the return journey from Kyōto is against the gravity flow of water so the barges had to be poled by boatmen and pulled by assistants using ropes. Traffic is only one-way in the narrow tunnels so that boat ponds were constructed at the tunnel portals to allow boats to pass each other.

When the Kyōto City Council was created in April 1889 it took ownership of the canal on completion exactly one year later in 1890. In June of that year work commenced on the Kamo River canal that would allow goods to be transshipped from the Lake Biwa Canal via the Kamo and Yoda rivers to Ōsaka. In 1891, the first phase of the Keage Power Station was completed with power delivery commencing six months later. At the eastern end of Lake Biwa Canal is an ingenious device that solved the steep gradient problem. A scale working-model of this is on display in the Lake Biwa Canal Museum of Kyōto (<http://www.city.kyoto.lg.jp/suido>). At either end of the double track incline railway is a metal open carriage that is designed to take the wooden boat. Gravity takes the carriage on wheels downwards pulling the other carriage upwards. The rails extend a short way underwater so effectively the boats float on and off of the carriages.

The economic impact of the multi-functional canal is especially interesting. In fact, by far the greatest income from the canal came from selling electricity to the emerging industrialisation processes in Kyōto: fabrics and silk; tobacco factories; engineering machinery; and electrical goods. The farmers received water for irrigation when they needed it, and the reservoir of water was a source for fire protection given that the buildings in Kyōto were then constructed of timber.

Lake Biwa Canal was a transport artery that brought goods and new wealth to the city and for the waterpower it provided in the stimulation of new industries, such as cotton spinning. The canal facilitated the construction of Japan's first industrial hydro-electric power generation plant using a Pelton waterwheel (a water impulse turbine patented in 1880) and a Stanley generator. The energy generated by the water wheels allowed the spinning of cotton. The Kyōto City Water Department commemorated the 100th Anniversary of the completion of Canal

Number 1 with a three-volume collection in the Lake Biwa Museum that is a rich source of data for further analysis.

In 1923, there was another grand plan to link Ōsaka to Tsuruga via Lake Biwa. As the military influence on the national government of Japan increased, Yoshida Kozaburo, an army captain, proposed the “Great Hanton Canal” linking Ōsaka with Tsuruga (Yoda, 2012: 294). The plan included lowering the level of Lake Biwa by a staggering 43 metres to reduce the number of locks required along the route. This would have reduced the surface area of the lake by about one-half and would have resulted in reclaimed land for cultivation. However, its main policy objective was to allow the movement of 4,000-ton warships and 3,000-ton steamships. Twelve years later, the Chief Engineer of the Lake Biwa Canal expanded on this plan, re-branding it as the Great Lake Biwa Canal that would allow 10,000-ton ships to pass through this proposed waterway complex.

This plan of linking the Setō Inland Sea with the Sea of Japan was aborted with the onset of the Pacific War. In the mid-20th century this planned transport infrastructure was clearly obsolete. It therefore appears somewhat anachronistic that, in 1961, a partnership between a political entrepreneur, Baron Ono Tomochika, and the Mayor of Yokkaichi (a small town in Mie prefecture at the head of Ise Bay on its west bank) came up with a new plan to cut a canal joining Ise Bay with the Sea of Japan. The overall distance was about 130 km with a substantial portion of the route using the current level of Lake Biwa.

Meiji Administration of Rivers and Canals

The Imperial Constitution of 1889 stimulated work on new laws and regulations including the 1896 *River Law* that contained many pre-Meiji practices (Aoyama, 1999: Word of Recommendation). The 1896 *River Act* was one of the earliest comprehensive modern river codes in the world (Infrastructure Development Institute, 1999). Its purpose was water control and thus the law contained only one Article (Number 28) on river transport: that covered prohibitions, restrictions and permission for the navigation of boats/ships and rafts. The national government was the regulatory authority for major rivers and prefectural government the authority for smaller rivers. In essence, the relevant river administrator specifies the maximum dimensions of boats and ships and their draught

that are permitted to pass through the various locks on the river system. Various revisions were made during the modern era.

In the same year that the first *River Act* was promulgated, the great flood of 1896 caused serious damage in the Kyōto region, including 111 casualties and 7,885 collapsed houses. Local government initiated a large-scale disaster prevention program, targeting the entire Lake Biwa and the Yodo River Basin. The program comprised of the widening and dredging of the shallow fords of the Seta River, construction of the Nango Araizeki Weir, and improvement works on the lower reaches of the Uji and the Yodo Rivers.

As a result, the Seta River flow capacity increased fourfold. Weir gates were installed to maintain the water level of Lake Biwa and the flow of the Seta River control. The gates, however, were manually operated, requiring one full day to open and two days to close. It is clear that Japanese canals in the modern era were primarily constructed and modified for the purposes of flood mitigation.

Modern Democratic Period

After the end of the Pacific War, Japan underwent substantial social and economic change to the extent that the *River Law* required reform. Japan had constructed some 3,000 dams since this first law. A new *River Act* in 1964 dealt primarily with water control, water rights and allocation, and, in essence, divided rivers into class A (national government management—today, its administration is by the Ministry of Land, Infrastructure, Transport and Tourism) and Class B (prefectural government management). Management of the former involves a wide range of players from government institutions and private organisations, as detailed in the Tone River case study published by the OECD (2015).

Two of the most important flood control activities are the central government's administration of levees and sluice gates (Atsumi, 2009), including the planning and administration of super levees (Hashiguti *et al.*, 2009; Nakamura *et al.*, 2013). When the *River Act* was amended in 1997—where rapid post-war industrialisation had polluted and degraded rivers—it included more emphasis on “environmental conservation”.

Recently, the Japan Ministry of Land, Infrastructure, Transport and Tourism (2019: 87) revised the *River Act* to promote a greater involvement

of more organisations in civil society to contribute towards river conservation: “river administrators may designate private organizations such as NPOs that conduct activities related to active river maintenance and conservation of the river environment...” The River Cooperative Organization System provides assistance for river management projects. For example, the Ecology Research Club Hiroshima is a river cooperative organisation that conducts activities such as participating in activities to beautify the Ota River, providing hands-on learning for children, training instructors and observing tidal flats at discharge channels (Japan Ministry of Land, Infrastructure, Transport and Tourism, 2019: 88, Figure 3–2–8).

Another example of the involvement of non-government organisations is the promotion of recreational boat cruising for domestic and international tourists. In March 2018, after 67 years, a tourist boat cruise connecting Kyōto with Lake Biwa was revived. Lake Biwa Canal Cruise is available by advance reservation only. A 12-person boat travels down the canal. In 2018, the Canal Cruise operated from 29 March to 28 May and from 6 October to 28 November to capture scenery in the distinctly Japanese ‘four seasons’ (https://japan-magazine.jnto.go.jp/en/special_keihan04.html).

Conclusions

For reasons of mountainous terrain on Honshū, rivers have played little part in the history of transport in Japan other than where coastal roads required a boat crossing from one bank of the river to the other. Water transport has been related to the constant drive at a local level to improve irrigation systems that have had the co-benefits to water transport rather than the construction of a national network of canals as occurred in many other countries. Over the centuries these rivers in Japan have been modified not for navigation and transport but more for irrigation, flood control and water supply. For example, the course of the Tone River has been artificially changed to prevent flooding of the Edō and Tone canals that were built in more recent years in Saitama, Musashi and Asaka to supply water to Tōkyō. An estuary barrage was constructed to control the salinity of up-stream water (www.water.go.jp).

Japan had no ‘canal age’ and the story of canals can best be summarised by the author as “the age of aborted canals”. The little there

was of canal construction in Japan dates from at least the 6th century although there have been numerous plans to cut across the island of Honshū to link the Sea of Japan with the Pacific Ocean via Lake Biwa. Table 8 lists these plans with the proposed routes (that amounts to 24 km of construction), the instigators and the approximate dates of each plan. A sketch map of the routes proposed for the various canal plans that have been summarised in Table 8 can be found in Yoda (2012, Figure 1, p. 294). It should be noted that the sketch map is a little deceptive because it does not show the mountainous terrain that blunted construction between the northern end of Lake from Oura and Shiotsu to Tsuruga. Topography explains why the maximum length of canal construction was only 12 km.

Table 8. Canal Plans to Link the Sea of Japan with the Pacific Ocean via Lake Biwa, Mid 12th to the Mid-20th century.
Source: Author.

Canal Plan	Completed Length km	Instigator	Date
25-km long canal starting from Shiotsu in the north of Lake Biwa towards Tsuruga	12	<i>Provincial Government</i> —Taira no Kiyomori, head of a warrior clan in Echizen Province	Mid-12th C
Canal from Oura on Lake Biwa to Tsuruga	12	<i>Provincial Government</i> —Toyotomi Hideyoshi ordered the owner of Tsuruga lands, Ōtani Yoshitsugu to build the canal	Late-16th C
Lake Biwa to Tsuruga	0	Kyōto <i>merchants</i> lobby Tokugawa <i>bakufu</i>	1722
Route survey from Tsuruga to Lake Biwa	0	<i>Provincial Government</i> —Maeda Yoshiyasu, <i>Daimyō</i> of the Kaga domain	Mid-19th C
Ōsaka to Tsuruga via Lake Biwa	0	Lobbying of National Government by Yoshida Kozaburo, an army captain; Ministry of Construction allocated money for survey	1923

Canal Plan	Completed Length km	Instigator	Date
130 km canal joining Ise Bay with the Sea of Japan	0	Private initiative—Baron Ono Tomochika, businessman, and Mayor of Yokkaichi (<i>local government</i>)	1961

From the mid-12th century the key players in these canal proposal and construction attempts have been the war lords controlling the necessary territory, Taira no Kiyomori, Toyotomi Hideyoshi and Maeda Yoshiyasu, merchant associations from Kyōto, military strategist, Yoshida Kozaburo, and a business entrepreneur, Baron Ono Tomochika, together with local government support from the Mayor of Yokkaichi. Table 9 summarises those canals that were constructed in the study area for the purposes of water transport, although the Lake Biwa Canal was built also for irrigation and electricity generation. In the case of the canals built in Ōsaka and Edō they were part of land reclamation on marshy ground to provide access to warehouses and commercial properties. The table lists the names of the key individuals responsible for these initiatives, noting that it was first the merchant class that were responsible for canal building in the Edō period, then the local government of Kyōto in the construction of the Lake Biwa Canal in the late 19th century.

Table 9. Japanese Canal Construction During the Early Modern and Modern Periods—Key Agents.

Source: Author.

Canal Constructed	Date	Key Agents
Ōsaka port and commercial district	Early 17th C	<i>Merchants</i> —Doton Nariyasu, Suminokura Ryōi
Kyōto Takase River Canal (9.7 km) from Nijō-Kiyamachi to Fushimi Port,	1611	<i>Merchants</i> —Suminokura Ryōi, Chaya Shirōjirō and Gotō Shōzaburō
Edō port and commercial areas around Nihonbashi	Early 17th C	<i>Shōgun</i> —Tokugawa Ieyasu
Lake Biwa Canal (20 km)	1885	<i>Local Government</i> —Kyōto Prefecture Mayor, Kitagaki Kunimichi

The key players in these successful canal developments came both from the institutions of government and from merchant organisations. In Ōsaka and Kyōto, the prime movers of commercial canal developments were local merchants including Doton Nariyasu, Suminokura Ryōi, Chaya Shirōjirō and Gotō Shōzaburō. The canals that formed the core of 17th century Edō commercial developments on the banks of the Sumida River were under the direction of the *Shōgun* Tokugawa Ieyasu and his successors. The multi-functional Lake Biwa Canal, undertaken in the late 19th century at the initiative of the Kyōto Prefecture Mayor, Kunimichi Kitagaki, and funded by the national and prefecture governments and the Meiji Emperor, represents Japan's best example of a formerly important transport canal—now a tourist attraction.

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