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# East Meets West: Lake Biwa Canal, Kyoto, Japan

## Abstract

In the late 19th century the Japanese Emperor Meiji led Japan into the modern age. Realising the importance of Japanese participation in world trade, he despatched diplomatic missions, as well as students, to Europe and the United States to discover new techniques in transport, infrastructure, agriculture, water management, and harbour building. In addition he invited Westerners with technological expertise to Japan. This article relates how Western engineering skills met Japanese intellectual curiosity, resulting in the development of important waterworks and infrastructure in Japan, including the Lake Biwa Canal in Kyoto.

The article has been adapted from a lecture that was presented at the Annual Meeting of the International Association Dredging Companies, on 16 May 2001 in Kyoto, Japan.

## Introduction

Surrounded by mountains, Kyoto was the Imperial residence and capital of Japan from 784 until 1868. The emperor, however, played a merely formal and ritual role. The power was really vested in the *shogun* in Yedo, today's Tokyo.

In 1868 all this changed. In that year the 16-year-old crown prince Mutsuhito was invested as Emperor Meiji and he understood that Japan was destined to play a much more international role. Meiji means "enlightenment and peace" and the Emperor Meiji was full of these ambitions. Together with some Western-oriented ministers, Meiji was about to transform Japan from a feudal, medieval society into a modern state, modelled on a Western blueprint.

Meiji's justifiable fear was that his country would otherwise become a colony in the hands of the Western powers. He knew that the guns of the US naval vessels in the harbour of Yokohama were loaded and had been



Robert van Gelder, President of the Board of the IADC (left) with Louis van Gasteren in Kyoto, Japan at the statue of Japanese Engineer Tanabe Sakuro. Mr van Gasteren is a filmmaker and founder of the Artec Foundation, an organisation dedicated to bringing artists and scientists closer together. He is also one of the founders of the Foundation "Four Centuries Dutch-Japanese Relations", which through a film and a publication celebrates the role of Dutch engineers in Japan during the Meiji period. He has recently been awarded the "Zilveren Anjer" (Silver Carnation), the highest award of honor from the Prince Bernhard Cultural Foundation.



Figure 1. Men at one of the tunnels of the irrigation canal, leading from the lake of Inawashiro to the dry Asaka plain, near Koriyama. The successful digging of this canal with its many tunnels proved to be an example for the Lake Biwa Canal. Courtesy of the Municipality of Koriyama.

ready for serious action ever since Commodore Perry had arrived in 1853. The Westerners wanted to have access to Japan for commercial reasons and so, willing or not, Japan had to participate in the world economy.

Ministers and civil servants were recruited from the former knightly classes. By government decree, the class of the *Samurai* was abolished in 1871. And an official edict issued in 1876 banned the wearing of swords. Japanese officials were forced to adopt Western dress — including the bowler hat. Missions were despatched abroad by the same government to discover the outside world, to learn and to adopt what was most suitable for Japanese needs. The most famous one was the *Iwakura Mission*, which, following a tour of the United States, visited almost every country in Europe. In addition, Japanese students were sent abroad, and Western experts were invited to teach in Japan. In retrospect, these trips — gathering information from 1860 until 1873 — can be considered as uniquely historical. The country had chosen between life and death.

The choice for life expressed itself in the official slogan: *National Prosperity, Military Strength*. The seat of government was transferred from Kyoto to Yedo, later to be called Tokyo, or eastern capital, home base of the *shogun* (who resigned shortly afterwards). The information obtained must have been overwhelming for Japan's new rulers, since it was an inventory of what the country needed to be able to play a role amongst the dominant Western powers.

#### A WIDE RANGE OF NEW TECHNOLOGIES

Western experts instructed the Japanese in new techniques in transport, infrastructure, agriculture,

water management, harbour building and the development of the armed forces. They also introduced the steam engine, gas and electricity. New forms of energy replaced the traditional Japanese water and wood economy.

The Englishman Brunton installed lighthouses along the coast. Americans gave lessons on the exploitation of mines and started large-scale agricultural projects in Hokkaido. Railroads were constructed by the British, streetcars were presented by the Belgians, the French built shipyards, the Germans established a medical department at Tokyo university, and the Dutch started water management at a scientific level.

With 3000 rivers and rain 10 times heavier than in Holland, Belgium, France or the UK, with shallow harbours, unsuitable for the steamships, and with rivers, unfit for transport, it was a difficult assignment.

Data show that the number of foreign employees reached as many as 2300 by 1889. The breakdown of the professional disciplines shows that the number of civil engineering-related employees was 146. Amongst them the 108 British engineers were the largest group. Most of them were employed in the railway and surveying sections. For rivers, harbours and agricultural water management, the Dutch were most active, since they were specialists in this field.

In 1872 a nationwide system of elementary schools was established. In the same year, the first railway — between Tokyo and Yokohama — was opened by the Emperor. Ordinary people could witness modernisation happening before their own eyes. In February of that year, the Dutch engineer Van Doorn was invited to come to Japan, together with the engineer Lindo as his assistant.

## THE JAPAN PEIL

Van Doorn as Chief Engineer received a salary of 500 yen, equivalent to that of a Japanese minister. He is best known for the design of the Nobiru Harbour near Sendai and the survey of the plans for an irrigation canal, leading from the lake of Inawashiro to the dry Asaka plain, near Koriyama. The successful digging of this canal with its many tunnels proved to be an example for that of the Lake Biwa Canal (Figure 1).

Second Engineer Lindo, with a salary of 400 yen, surveyed the three rivers in the Kanto plain near Tokyo — the Tone, Yedo and Ara. Since there were no standards for water level measurement, the engineers were faced with difficulties in regard to design and planning of their projects. It was Lindo who started surveying by setting up scales in the rivers and fixed points at the river mouths. In this way he was able to establish an *ordnance datum*, the first in Japan, in 1872, at Choshi, located at the mouth of the Tone River in the Pacific Ocean. He called it the *Japan Peil* or JP. The Dutch word *Peil* means water level.

In addition, he put a water level scale in Horie, located at the mouth of the Yedo River and established its height relationship with the Japan Peil. On June 10, 1873, he set up a water level scale at the mouth of the Ara River and this became the basis of the later established Tokyo Peil (TP), now the Japan Standard, 24.4140 metre above the zero level of Lindo. The Tokyo Peil was approved by the Emperor in 1891 and can still be found opposite the Imperial Palace in Tokyo.

### The metric system

Lindo executed his measurements using the metric system. Over centuries, Japanese surveyors had modified the Chinese measuring system. However, it did not dispose of very large or very small units and these became important with the introduction of the new technologies. The decimal system provided the right answer and the metre and the cubic metre entered the scene.

The British and Americans, however, involved with commercial interests, had brought the Anglo-Saxon system to Japan. The government now had to make a choice and it decided to adopt the metric one. Debates in the Japanese senate took weeks, and were broadly reported in newspapers at the end of the 19th century.

Measuring depth correctly was important as the harbours opened up to Westerners and were modernised. For instance, Captain Kuhe of the hopper dredger *Ayame* was taking no risks and, as was reported in the English-language newspaper, *The Japan Weekly Mail* on October 25th 1890, “six runs being taken with and against tide” before he was willing to deliver his high-quality product.

Earlier in 1887, the Dutch waterman Johannis de Rijke, who worked in Japan for 30 years, ordered the suction dredger *Kisogawa Maru* for his Kiso river works near Nagoya. The dredger was built in the Netherlands by Smit, Kinderdijk (Figure 2).

## JAPAN'S RIVER CIVILISATION

All this leads to the paddy fields, food supply, and Japan's river civilisation. In addition to technical innovations, the Meiji Government had to insure a stable food supply. Whoever dominates food, dominates the population. Food, in fact is dependency and therefore power. So, in Japan, water supply determines the social and political balance. Cheap rice imports are still a political issue. The slogan at a recent symposium in Osaka was “Water management is the basic system that sustains civilisation”.

This was equally true in the late 19th century when Western European hydraulic engineers came to Japan and deepened and constructed harbours. Though they worked in an unpretentious way on the riverbanks, they had an enormous impact. During the presence of the *oyatoi gaikokujin*, hired foreign employees, the Japanese government established the Imperial University in Tokyo, and the British set up an Engineering College in the same city. It was Brunton again who emphasised the importance of practical training for students. No theory, but direct action. It was he who championed the brick stone as an answer to the many fires by which the wooden houses and other construc-

Figure 2. The suction dredger *Kisogawa Maru*, built in the Netherlands for Johannis de Rijke. Courtesy of J.D. Smit, Kinderdijk.





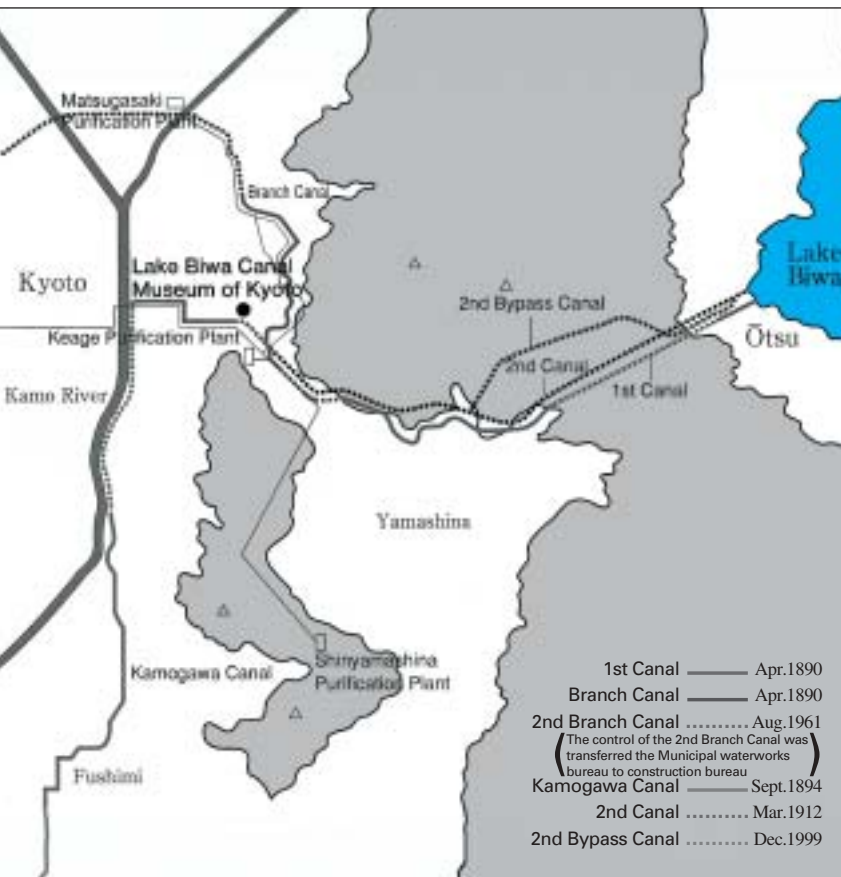


Figure 3. Map of the Lake Biwa Canal. Lake Biwa is situated 7 miles east of Kyoto and its water surface is 140 feet above Kyoto's ground level.

tions as well were so easily destroyed. Earthquakes also became a basic issue in the discussion of his preference.

Graduates of the Imperial College of Engineering and those who returned from Western institutes ousted the foreign employees and caused their dismissal from Japan. Amongst them was Okino Tadao, who on the basis of a design by Engineer De Rijke, finished the building of the harbour of Osaka. Another student, first levy of the Engineering College, was Tanabe Sakuro (1861-1944) who was responsible for the digging of the Biwa Canal.

The Biwa Canal had already been planned in the 12th century but the population had always been against it because they feared that Lake Biwa would run dry. They were anxious about modernisation, they feared the disappearance of their salmon and were scared to death when they learnt about accidents with steamships. But the time had come.

#### THE LAKE BIWA CANAL

The Biwa Lake is situated 7 miles east of Kyoto and its water surface is 140 feet above Kyoto's ground level

(Figure 3). After the Emperor's move from Kyoto to Tokyo, Kyoto fell into decline. The government decided to stop this process and became convinced that a canal between Biwa and Kyoto could provide transportation and waterpower to modernise the city's textile industry. The canal could also solve irrigation problems and supply drinking water.

An energetic person, Kitagaki Kunio, was appointed governor of Kyoto and he strongly promoted the construction of the canal. The Japanese chief engineer of Van Doorn, who had made the design for the Asaka Canal, was asked to make a study of the site. Johann de Rijke also reviewed the site in February 1884 and they both declared the canal feasible, although the latter had his doubts regarding the financing and recouping of costs.

The Emperor agreed and not only verbally. The total estimates for the works amounted to a million and a quarter silver dollars. Of this about one third was a gift from the Emperor, and a quarter from the Central Government, whilst the remainder was to be raised by local taxation.

#### Tanabe Sakuro

At this point the young architect Tanabe Sakuro enters the picture. In 1883, years before these considerations, he had written his thesis at the Imperial Engineering College on the Biwa Canal. In 1889, Professor T. Alexander published in the journal *Engineering* a laudatio on this genius.

Tanabe was indeed a genius, a man of mathematical talent. He took his degree in 1883 after six years of study. The college had printed — in pamphlet form — an original work of Tanabe's *On shearing stress due to travelling load systems*. Whilst just about to complete the practical part of his study, he lost the use of his right hand. He soon learned to write both Japanese and English with his left hand, and actually drew his diploma designs with it. They comprised a scheme for improving the navigation of a Japanese river by a canal cut, for he had already turned his attention in particular to hydraulic engineering. These designs were exhibited at the world exhibition in America.

Tanabe gained the confidence of the governor of Kyoto (and even married the governor's daughter). In August 1885 he started building and digging. One of the problems in the design proved to be the sharp drop in the canal as it emerged 118 feet above the eastern part of Kyoto. The Dutch recommended that locks should not be used, but rather that an inclined plain with rails be installed to carry the canal boats up and down. This suggestion and the existing textile mills in Holyoke and Lowell, Massachusetts, run by waterpower, brought Tanabe to the United States. Although he had not proposed generating electricity by waterpower to the

Kyoto government, the idea was already in his mind. During his U.S. trip he became convinced about the addition of that function.

Tanabe consulted two engineers in the US — Clemens Herschel and James Francis. Following their advice and after having visited the first hydroelectric plant in Aspen, Colorado, he ordered two turbines: 120 horse-power Pelton wheels from the manufacturer in Oakland.

### Three tunnels

The canal itself is a mixture of traditional and modern architecture. There are three tunnels, one of them 2.4 kilometres, the largest ever built at the time. Tanabe wrote in articles in US and British engineering journals about “cheap labour” and how the stonemasons and miners had to be trained to accustom them to modern excavation techniques, for instance the Adachi brothers, who were foremen during the canalisation work of the Asaka canal from the Inawashiro Lake. Tanabe used a telephone line, dynamite, and imported steam pumps from England, and combined all of these together with ancient Japanese foot-tread-water-wheels when these could not keep up with flooding.

Frequent cave-ins added greatly to the difficulties in the work. At one point, near the Biwa entrance, 65 men were trapped by a cave-in for 48 hours. Women sorted and carried the bricks for the tunnels, as there were no mules and even no tow-path.

The canal was planned for small, wooden canal boats, pulled from the back by a single man. Rice would be the cargo on the easy way downstream pull to Lake Biwa. As a boat emerged from the third and last tunnel, it was attached to a cradle with steel wheels, which carried it down the 576-metre incline at an angle of 1:15 in less than 15 minutes. Meanwhile, at the other track another boat was being carried up, since the process was operated by a continuous steel rope moving around drums, one at the top, the other in a pool at the bottom. The drums were turned by a 50-horsepower motor, which got its electric power by two generators belted to the Pelton wheels. These turbines, driven by the force of the canal water, were the first hydroelectric power utilised for a public purpose.

Right behind the last tunnel the canal splits into two canals. One goes via the incline to Kyoto, the Yodo river and Osaka, the other via a beautiful aqueduct, goes north and east for irrigation purposes. Its power brought streetlight and streetcars to Kyoto and electricity to the mills. It was so successful that a second hydroelectric power plant was built in 1912.

When after 5 years in April 1890 the canal was finished, the governor of Kyoto proclaimed three whole days of celebration. On 1st of April a religious ceremony took

place, followed on April 8 by a feast for 1200 guests. On April 9 the Imperial family and the government attended the opening of the canal.

### Conclusion

The three tunnels express the intermix of technology, art and politics in the Meiji era. They all bear an inscription on the entrances and exits, made by members of the Meiji Government.

Minister Ito Hirobumi wrote: *Ten thousands kinds of weather* — which probably means that the canal can withstand the onslaughts of nature.

Yamagata Aritomo left a poem: *This structure has its own integrity.*

Inoue quoted Confucius: *Pious men enjoy the mountains, scholars the waters.*

Saigo warns the people: *One reaches the fountainhead only after climbing the mountain.*

Minister Matsukata is optimistic: *After the rain passes, see the colour of the pines.*

And Sanjo Sanetomi is exultant: *How beautiful are the mountains and rivers.*

Tanabe is said to have written, *An elegant sight, an extraordinary idea.* And it is certain that it was he who financed and made the stone monument at the top of the incline honouring the 17 workers who died building the canal: *For every victim that fell, a million benefitted.*

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