Lake Biwa Canal at Kyoto Japan: sustainable development and revitalization

G V Shevtsova¹,² and M S Parkhomchuk¹
¹ Kyiv National University of Construction and Architecture, Department of Architecture Fundamentals and Architectural Design, 31 Povitroflotskyi Prospect str., Kyiv 03037, Ukraine
² Kyoto University, Yoshida-honmachi, Sakyo-ku, Kyoto 606-8501, Japan
E-mail: shevtsova.gv@knuba.edu.ua

Abstract. Lake Biwa Canal (engineer Tanabe Sakuro) connects Lake Biwa and Kyoto. It was built in the end of the 19th c. in order to revive Kyoto, which decayed after the transfer of the capital to Edo (Tokyo) in 1868 and served to supply Kyoto with drinking and industrial water, as well as for cargo transportation. The aim of the work is to determine the historical periods of Lake Biwa Canal’s existence and to highlight its significance for ensuring the sustainable development of Kyoto. The research was conducted at Kyoto mainly with field studies and interview methods. As a result, three historical periods of the Lake Biwa Canal existence were identified. In the first period (1885-1951), the canal combined water supply, transportation and landscape-shaping functions and was fundamental to the sustainable development of Kyoto. In the second period (1951-1990th), the transport role of the canal became unclaimed, and its role in sustainable development of the city significantly decreased. In the third period (since 1990th), the canal was designated as National Historic Site, and a campaign of its revitalization began. The Canal acquired touristic and educational functions and increased its role in the sustainable development of Kyoto. Thus, at the time of its construction, the Lake Biwa Canal was the main driving force that saved Kyoto from decline. Now, we can talk about the opposite process, when Kyoto City supports the sustainable development of the Canal.

1. Introduction
Lake Biwa Canal is an interesting and original industrial project completed in Kyoto in the end of 19th c., at the time of Industrial Revolution. It was constructed for transfer the industrial, agricultural and potable water from Lake Biwa to Kyoto, used also for cargo and passenger boats transportation. In the time of its creation, the Canal played a great role for revitalizing Kyoto that declined due to decreasing of population caused by the transfer of the capital to Tokyo after Meiji Restoration in Japan. It was the period when Japan, that delayed its technical progress due to the centuries of isolationist policy of Tokugawa shogunate’s governance finally opened its borders to the world. Japan quickly gained new technical experience sending the young people to study technical sciences, medicine and architecture to the progressive countries of Europe and America. Lake Biwa Canal construction was the first Japanese big industrial project completed only by local engineers with no foreign forces. Lake Biwa Canal is still more than 130 years in use, now playing not only its direct role of water supply to the Kyoto but also becoming a great touristic and cultural attraction of the city. The history of the Canal was not so smooth and in the second part of 20th c., there was a period of its decline when the industrial role of the
Canal was diminished and its touristic significance was not developed yet. The revitalization of the Canal namely started from the end of 20th c. and is now in process.

The aim of the article is to determine the historical periods of Lake Biwa Canal existence estimating its significance for ensuring the sustainable development of Kyoto.

Japan has quite interesting diversity of historical waterways with theirs preserving, popularizing and revitalization experience. Some of them, like the revitalization experience of historical Hachiman-bori Canal at Omi-Hachiman city now designated as Japanese Important Cultural Landscape property is lightened in the scientific literature [1]. At the same time, Lake Biwa Canal revitalization experience is not so good described in scientific field. Thus, the sources of the research became a grate historic material base of Biwa Canal Museum [2–4], internet resources [5, 6], booklets [7] and some conference materials [8, 9]. Mainly the indispensable information was gained from author’s personal field research as well as from interviews provided with Lake Biwa Canal Museum scientists, Kyoto city officials, local volunteers, members of Lake Biwa Canal Line Charm Creation Committee and other peoples engaged in the process of Lake Biwa Canal revitalization. During the research, we explored the structure and modern condition of the First Lake Biwa Canal and Kyoto incline, experienced the excursion-boat transportation and examined the revitalization events of Keage Filtration Plant.

The research was conducted at Kyoto (Japan) under Hakuho Foundation Japanese Research Fellowship program 13th (2018-2019) at the base of Kyoto University.

2. Lake Biwa Canal structure and history

The Lake Biwa Canal structure is consists of two mains canals. The construction of the First of them was started in 1885 and completed in 1890. It begins from Biwa Lake at Kannon-ji area (Otsu city) and runs until Fushimi area of Kyoto (figure 1). It is approximately 20 km long (for about 11 km to Keage point) and consist of the system of open-water sections interleaved with 4 tunnels, the longest First (Nagarayama) tunnel is 2440 m long and the shortest Second one is just about 124 m long (figure 2), all works were fulfilled mostly by manpower [7]. The Second Canal was completed 20 years later to increase the volume of Kyoto water supply. It is only 7.4 km long but is deeper and running completely in the tunnel constructed near the First Canal.

Figure 1. Lake Biwa Canal: general scheme. 1-2 – Keage Incline, 3 – Lake Biwa Canal Museum, 4 - Nanzenji Suirokaku aqueduct (by author).
The idea of Canal construction for water delivering from Lake Biwa to Kyoto was popular there from the middle ages but of course, at that time it was impossible to fulfill it technically. But in the end of 19th c. when Japan start to adopt quickly the foreign industrial skills this ancient idea was refreshed by Kunimichi Kitagaki, the 3th Kyoto Prefectural Governor. He planned to build new factories that needed energy of water for the electricity, as well to develop the boat transportation trough the Canal [5]. The expenses of construction were partly covered by Emperor and partly by Kyoto city [5]. The executor and senior engineer of the project became Sakuro Tanabe, quite young specialist who graduated from Imperial College of Engineering in Tokyo (a precursor of the University of Tokyo’s Faculty of Engineering) where he studied under the direction of Henry Dyer, a Scottish engineer who do a lot for establishing Western-style technical education in Japan. The graduation thesis of Tanabe Sakuro was concerned of Lake Biwa Canal construction, so Kyoto’s authorities decided to invite him immediately for the project fulfilling. The construction of the First Canal started in 1885, took for about 5 years and was completed in 1890. During the construction, there were used many new for Japan technical skills such as vertical shaft tunnel construction method used for the longest Nagarayama (the First) tunnel [8]. The two constructive shafts (47 and 20 m deep) are still preserving and visible as from inside the tunnel the same as in the mountain forest over the tunnel where can be found the heads of these vertical shafts now using for emergency exit and ventilation of the tunnel (figure 2, figure 3).

At the same time, Canal construction required big works of soil and stone transportation as well as development of grate production complex of instruments and materials including brick and shaft factories erection. With the completion of the First Canal, the first in Japan business-use hydraulic power station was constructed at Keage area for generating electricity using water from the Canal [7]. This emerge was utilized for electric lighting and factories of Kyoto in realizing so called “Electric Power Project” of Kyoto authorities. At the same time, the Canal became a waterway for charcoal, wood, rice and so cargo boat transportation as well for the
people transportation and many of them used this way for sightseeing (“Ship Transportation Project” of Kyoto authorities).

The two very interesting features of Lake Biwa Canal can be seen in the area of Keage – the point where the First Canal is entering Kyoto. Here was constructed for about 3 km long Branch Canal (see figure 1) passing upon Nanzenji temple grounds though special brick construction similar with Ancient Rome aqueduct known as Nanzenji Suirokaku. The second interesting feature is the way of boats transportation from Keage point to nearby Nanzenji moorage pond where was impossible to complete waterway because of 36 m height differences of Lake Biwa and Kyoto watersheds. Therefore, the boats reached to the Kyoto using so called Keage Incline – a 582 m long slope equipped with rails [7]. Namely, from Keage point, the boats were loaded on small open railway cars moved down the incline with the principle of cable car to Kyoto’s Nanzenji pond where the Canal continued at Kyoto area (figure 4). Lake Biwa Canal Museum poses a unique video of Keage incline boat railcars running from the end of 1940th.

Figure 4. Keage Incline and Nanzenji Suirokaku aqueduct (by author).

The water from the Canal also was used for rice milling and spinning factories (“Hydraulic Power Project” of Kyoto authorities) as well as for fire prevention of Imperial Palace and surrounding big temples and shrines such as Higashi-Honganji, Nanzenji and so. A special feature is also the utilization of Canal water for the creation of several temple and aristocratic villas’ water-pond landscape gardens (Honen-in temple, Heyan-jingu shrine, villa Murin-an and so), the most interesting of them are the masterpieces of famous Japanese garden designer Shigemori Mirei [10] (figure 5).

Figure 5. Honen-in temple, Heyan-jingu shrine and villa Murin-an landscape gardens using the water from Lake Biwa Canal, the beginning of 20th c. (by author).

Several years after, the water flow of the first Canal become insufficient for increased electricity needs of Kyoto. To resolve this problem, the second Kyoto Mayor, Kikujiro Saigo fulfilled several big projects including the Second Lake Biwa Canal construction, road-widening project and municipal electric railway creation [5, 7]. The Second Canal construction was started in 1908 and completed in 1912. The 7.4 km long Second Canal was constructed completely in the tunnel nearly to the section of the First Canal from Lake Biwa to Keage where Keage Filtration Plant was erected. This filtration plant purifying potable water from the Second Canal had improved gravelly the quality of Kyoto potable water and is still in use until now. In addition,
there were constructed three new power stations (are still in operation now) giving energy to electric railway of Kyoto. Later it turned fatality for lake Biwa Canal development: the railway finally gained main role for cargo and passenger transportation of the area initiating gradually decreasing of Canal boats transportation. Due to this, in 1948 Keage Incline was closed, and in 1951 boat transportation of Lake Biwa Canal was interrupted completely for the long time. Industrial and potable water supply role of the Canal constantly remained. Lake Biwa Canal was renovated several times; the largest renovation of the both Canals was fulfilled in 1968 – 1974 and is known as Showa’s Major Renovation of Lake Biwa Canal.

3. Further existence and revitalization process of Lake Biwa Canal

In the end of 1960th – the beginning of 1970th Lake Biwa Canal gained some attention from Kyoto authorities mostly in the meaning of water-landscape arrangement of surrounding touristic area. A small canal branch flowing from Keage was improved as landscape “Philosophers’ Path” with sakura-trees growing on the both sides. This allowed to create a pleasant walking area from Nanzenji to Ginkakuji touristic attractive temples. At the same time, the former Keage Incline with preserved rails was restored as Sakura Garden [9]. At Yamashina area along the Canal way from Biwa Lake was created Higashiyama Ryokuchi Park flourishing now with very interesting species of local flora and fauna (figure 6) [9]. Recently it became evident the grate role of historic canals for aquatic ecosystems [11] that could be seen also in this example. Local senior people Sawa Minoru and Mita Takahashi reminding that at hot summertime the children from Rakoto School located near the Canal at Higashiyama Ryokuchi Park used to swim in the water calmly flowing in the shallow section of the First Canal.

Figure 6. City recreation landscaping of Lake Biwa Canal: “Philosophers’ Path” and Keage Incline sakura-trees blossoming, Higashiyama Ryokuchi Park, the second half or 20th c. (by author).

In 1983 Nanzenji Suirokaku brick aqueduct and Keage Incline were designated as Kyoto City Historical Sites [9]. In 1996 Lake Biwa Canal was designated as National Historic Site [5]. Connectively to this event, at Keage area near the former Nanzenji pond (finishing point of Keage Incline, see figure 1) was constructed Lake Biwa Canal Museum that is gathering artefacts, archive and scientific materials of the Canal history (figure 7), but the Canal itself in this time still gave the impression of a partly abandoned place.

Figure 7. Lake Biwa Canal Museum and its collection (by author).
In 2015 according to Kyoto City and Otsu City Majors’ agreement there was created the “Trial Project of Restoration of Lake Biwa Canal Boat Traffic” with “Lake Biwa Canal Boat Ride Planning Committee”. That led to the creation of “Lake Biwa Canal Boat Traffic Project” that renewed in 2018 after 67 years long interruption the tentative (touristic) boats transportation of the First Canal. This activity was started by “Lake Biwa Canal Line Charm Creation Committee” and is not in full scale yet [12]. Namely, the navigation of Biwa Canal is active only for several month in spring and autumn periods – the seasons of sakura blossoming and red momiji maple leaves along the Canal (figure 8). The small boat excursions are limited with several (8-10 per day) quite expensive courses requiring previous reservation [12]. Usually all places for navigation season are booked in 2-3 days after the reservation opening for about 2 month before the start of the event.

![Figure 8. Current touristic boats operation of the First Canal (by author).](image)

Keage Filtration Plant also practices some popularization activities. Namely in May, when on its territory blossoms many azalea bushes, it organizes the days of “open visit” when everybody can observe the modern and historical facilities of water filtration process (figure 9). The event is accompanied with children educational classes getting know more about water distribution and filtration system of Kyoto, including filtration plant field orientation concourses, quizzes and competitions as well as pipe running water degustation. Everybody is proud there of the fact that Kyoto’s running water is one of the most pure in the world and might be drunk with no boiling having nearly the same quality as bottled water. To emphasize this achievement, the Waterworks Bureau of Kyoto City designed the image mascot of a firefly, the tiny insect that lives only near pure flowing water.

![Figure 9. Keage Filtration Plant and its popularization activities, azalea blossoming and firefly mascots (by author).](image)

According to the information from Dr. Shirakawa Tetsuo, a scientist of Lake Biwa Canal Museum, they also looking for the possibilities to present Lake Biwa Canal industrial and landscape area for UNESCO Heritage tentative list.

4. Historical periods of Lake Biwa Canal development

Thus analysing the historical perspective of Lake Biwa Canal it can be determined the existence of three historical periods of its development (figure 10). The First period took place from 1885
until 1951; it can be characterized as a period of construction and primary flourishing of the Canal. At this time, the Canal obtained and reinforced all its main functions like industrial and potable water supply, transportation and garden-landscape shaping functions (see figure 10). In this time, the Canal became the main revitalizing force for Kyoto city.

The Second period can be determined from 1951, when the transportation function of the Canal was lost and until the end of 20th c., when Kyoto City started the program of Canal revitalization. During this period, the transportation function of the Canal was ceased due to historical circumstances (such as rail and car roads development), its revitalizing role for Kyoto city seriously diminished and the Canal felt some decline (see figure 10). At the same time, the landscape-recreation and ecological function of the Canal intensified.

The Third period has begun in the end of 1980th, when the Canal was designated as National and Kyoto City Historic Sites, and Lake Biwa Canal Museum was constructed. It is the time when Kyoto authorities and local people realized attractive potential of Lake Biwa Canal starting to develop this resource as a place of touristic, educational, ecological attraction and historical heritage also trying to revitalize its lost a half century ago transportation function (see figure 10).

Up at the Nejirimanpo small tunnel leading under the Keage Incline it is still preserved a memorial plaque showing the autographed hierologic inscription of Kimimichi Kitagaki, the 3rd Kyoto Prefectural Governor, who inspired the idea and started the construction of the Canal: “Enjoy the 100-year dream”. These worlds probably can characterize the effectivity and the significance of Lake Biwa Canal project in the best way.

5. Conclusion
Grate historical project of Lake Biwa Canal construction has determined in the end of 19th c. the urban development of modern Kyoto. Its existence led in the end of 19th – the beginning of 20th c. to the great vitality of Kyoto’s industry and trade boat transportation shaping the new significance of Kyoto. Lake Biwa Canal continues to supply potable and industrial water to Kyoto for about 130 years adapting recently new functions and getting new values as a Historical Heritage, touristic attraction, educational hub and recreation zone of the city. In the beginning of 20th c. Lake Biwa Canal became the main drawing force that saved Kyoto from decline providing its sustainable development. It could also be seen the opposite process of Canal revitalization by Kyoto City authorities and local volunteers that took place from the end of 20th c. and is currently in the progress.
Galyna Shevtsova https://orcid.org/0000-0002-2401-8104
Mykhailo Parkhomchuk https://orcid.org/0000-0003-3891-4716

References

[1] Shevtsova G and Linda S 2020 Series Advances in Social Science, Education and Humanities Research 471 402–406 URL https://www.atlantis-press.com/proceedings/ahii-20/125944697

[2] Tanabe S 1891 Biwako sosui koji zufu (Plans and Diagrams of the Lake Biwa Canal construction) (Tokyo: Tanabe Sakuro) (in Japanese) URL https://dl.ndl.go.jp/info:ndljp/pid/846121?itemId=info%3Andljp%2Fpid%2F846121&__lang=en

[3] Biwako Sosui kinenkan Josetsu tenji zuroku (Lake Biwa Canal Museum. Permanent exhibition catalog) (Kyoto: Biwako Sosui kinenkan) (in Japanese)

[4] 2012 Kyoto-shi Suido hyakunenshi. Shiryoussatsu (100 Year History of Kyoto City Water Supply System. Material edition) (Kyoto: Biwako Sosui kinenkan) (in Japanese)

[5] Lake Biwa Canal Museum. History of Lake Biwa Canal URL https://biwakososui-museum.city.kyoto.lg.jp/en/about/

[6] Lake Biwa Canal museum of Kyoto (Kyoto: Waterworks Bureau City of Kyoto) URL https://web.archive.org/web/20121010232821/http://www.city.kyoto.lg.jp/suido/cmsfiles/contents/0000007/7524/21kinenkanleaf_eng.pdf

[7] The history of Keage power station. Birthplace of utility hydropower generation (Kyoto: Kansai Electric Power)

[8] Tanaka N 2002 Technology transfer during the construction of Lake Biwa Canal The 1st International Conference on Business Technology Transfer (ICBTT 2002) URL https://www.jsme.or.jp/tsd/ICBTT/conference02/NaotoTANAKA.html

[9] Shiroshita S 2006 Setting an Industrial Tourism Route of the Lake BIWA Canal in KEAGE, KYOTO Industrial heritage and urban transformation. Productive territories and industrial landscape (TICCIH XIII International Congress) URL https://web.archive.org/web/20070630155145/http://www.ticcihcouncil2006.net/paper/Paper%202006/Shiroshita_JPN%202%2020060717.pdf

[10] Tschumi Ch 2005 Mirei Shigemori: Modernizing the Japanese Garden (Berkeley, Calif: Stone Bridge Press)

[11] Lin H Y, Cooke S J, Wolter C, Young N and Bennett J R 2020 Biological Conservation 251 108764 URL http://www.fecpl.ca/wp-content/uploads/2020/08/Lin_2020_On-the-conservation-value.pdf

[12] The Lake Biwa Canal cruise Kyoto-Otsu URL https://biwakososui.kyoto.travel/en/