

Living with Water

Enjoying Water

Tremolo is a technique in classical guitar in which the same note is played repeatedly in rapid succession. The well-known song “Recuerdos de la Alhambra” entrances listeners by utilizing this technique in a melody to convey a sense of flowing water. In fact, the song’s writer, Francisco Tárrega, was inspired to compose it by the Fountain of the Lions at the Alhambra.

Located on a hilltop in the historic town of Granada in Spain, the Alhambra was built by an Emir of the Islamic Nasrid dynasty that ruled the Iberian peninsula. The palace delights the eyes of visitors with the decorative effects of Islamic architecture and water features that include fountains fed by the nearby river Darro [1].

The literal meaning of “Sharia” (Islamic law) is “the path to water.” With water being of particular importance in the arid climate of the Middle East, entertainments that involve water are considered soothing and it is said that fountains were already a feature of the Mesopotamian culture of 3000 BC.

Water has been delighting people in many different ways ever since. The Dubai Fountain in the modern Middle Eastern city of Dubai is among the world’s largest and fascinates tourists from around the world [2]. The water for this fountain is supplied by a Hitachi water recycling plant that uses a combination of reverse osmosis (RO) membranes and membrane bioreactors (MBRs). Other involvement by Hitachi in water-based cultural attractions includes use by the Bellagio Hotel in Las Vegas, which pioneered fountains as a tourist attraction, of a system made by Sullair, LLC (a Hitachi group company) to power the fountains in its water show, and the involvement of Hitachi Aqua-Tech Engineering Pte. Ltd. in the construction

[1] The Generalife Garden of a Separate Villa off the Alhambra



[2] The Dubai Fountain



of the “Rain Vortex,” an indoor waterfall at the Changi Airport Jewel complex in Singapore that opened April 2019.

Water is essential to our existence, with the human body being approximately 70% water. Moreover, the value generated by interaction with water takes many different forms. In this article, my aim is to use Hitachi’s involvement with water as a lens through which to consider how water is part of our lives.

Supplying Water

Of particular importance in the relationship between people and water is the water used for daily life. Many of the great civilizations of the past emerged alongside major rivers, such as those in the Indus Valley and Egypt. As their populations grew and became more urbanized, however, the need arose for plumbing. Ancient Rome is said to have reached a population of one million, with a water supply drawn from the Tiber River established from early times. The city’s system of 11 aqueducts extended for a total of 504 km. The Romans also had knowledge of concrete and used it in the construction of aqueduct bridges.

While the water infrastructure of the Roman Empire rivaled that of modern times, the culture and skills that sustained this system were lost to Europe with the fall of the empire. The development of infrastructure for the supply of clean water had to wait until the latter half of the 19th century and the urbanization of cities like London and Paris that accompanied the Industrial Revolution.

Hitachi was founded as a repair shop for mining machinery adjacent to a mountainous region. As the company’s business expanded, a new plant was built in 1930 at a site conveniently located near the Joban railway line in Sukegawacho (now part of Hitachi City).

The plant expansion also brought a rapid rise in the town's population. The factory manager of the time, Kumeo Baba, formulated plans for infrastructure in the surrounding area sufficient to cater to a town of 1.5 million people. A water company wholly owned by Hitachi was subsequently established in 1940 to draw water from the Kuji River about 20 km to the south and supply it throughout the region. The water company was transferred to Hitachi City after the Second World War and became the basis for the city's municipal water department.

Baba would later look back at this as one of the most notable memories of his time as plant manager, making the comment that, "While the water business may not be glamorous, it is extremely vital." It is work that puts into practice the creed of Hitachi's founder Namihei Odaira of "contributing to society through the development of superior, original technology and products." The Odaira Museum displays a *hengaku* (memorial inscription) by Kumeo Baba that embodies his view of the water business, expressing the idea that supply enough water to nurture the public.

Moving on to recent times, Male', the capital of the island nation of the Republic of Maldives in the Indian Ocean, lacked any large sources of water and faced a major problem obtaining the water that its people needed to live. At the request of the Maldives government, Hitachi became involved in the running of the Male' Water and Sewerage Company Pvt. Ltd. (MWSC) in 2010 and has contributed in ways that include better oversight of seawater desalination operations and the water distribution network. Hitachi Aqua-Tech Engineering, which supplied MWSC's seawater desalination plant, is seeking to have such systems adopted more widely in places where acquiring an adequate supply of water is a challenge, primarily in Southeast Asia. This is a mission that is very much in step with the above inscription of Kumeo Baba.

Utilizing Water

Water embodies great strength, hydroelectric power generation being an obvious example. In "*Shizumeru Taki*," (the sunken waterfall) a novel by Yukio Mishima, the bulk of the story takes place at a dam construction site in the mountains. It includes a scene in which construction company employees argue about the building of the dam at their barracks. One of them makes the point that an engineer has become so obsessed with dam construction that he has forgotten what the dam

is intended to do for society at large, with the result that only the dam's functional utility is appreciated.

While a dam clearly harnesses the power of water to deliver major benefits (economic value), it also has the potential to significantly detract from environmental and social value.

On the subject of dam development in Japan, the Kurobe Dam (also known as the Kuroyon Dam) comes to mind. The project involved difficult work in the Kurobe Gorge, a secluded location that is designated as a national park, and the company in charge, The Kansai Electric Power Company, Inc. engaged in numerous discussions about the conservation of the surrounding environment with the Environmental Department of the Ministry of Health and Welfare that at the time had jurisdiction over national parks. As part of efforts to protect the environment, a six-story generator hall 40-m high, 125-m long, and 20-m wide was constructed 150 m under the ground to house the three hydroelectric turbines. As Japan at that time had no experience with turbines able to cope with the huge amounts of water from the Kurobe Dam, which had a head of 545 m and a capacity of 200 million tons of water, two of the turbines were supplied by the Voith GmbH & Co. KGaA of West Germany. The third, however, was a vertical shaft single runner six-jet Pelton turbine made by Hitachi that commenced power generation in June of 1963. It had a maximum output of 95,000 kW, a maximum head of 580 m, and a maximum flow rate of 18.7 m³/s. The success of this project led to the installation of a fourth turbine, also made by Hitachi, in 1973.

While Japan at this time was experiencing a period of high growth with rapid industrial development and widespread adoption of home appliances, the Kansai region was beset by chronic electricity shortages. Power from the Kuroyon Dam underpinned the economic growth of Kansai and cultural lifestyle improvements among its people. It is a source of pride that my forerunners at Hitachi were participants in this centennial project of Kansai Electric Power Company that derived not only economic value, but also environmental and social value from the energy contained in water.

Purifying Water

When the songwriter Francisco Tárrega mentioned above was three years old, an incident happened that resulted in one of his neighbors throwing him into a ditch. Even in Europe,

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sewerage infrastructure was still poor in the latter half of the 19th century when he lived there. The ditch was covered in filth, and as a result of this incident, Tárrega gradually lost his sight.

Sewers have a long history, traces of which can be found in the Mohenjo-Daro ruins of the Indus Valley civilization. In the case of Rome, sewers came before a water supply.

London had eight water companies in the early half of the 19th century, most of which took their water directly from the Thames. Unfortunately, untreated sewage was also discharged into the same river. The Chelsea Waterworks Company started using sand filters in 1829. While cholera was widespread in London in the mid-19th century, the low rates of the disease in areas served by this company led to the progressive incorporation of water purification into the water supply and sewerage infrastructure.

Along with slow filtration using sand, other methods include a rapid filtration technique using chemicals to coagulate suspended material that was developed in America toward the end of the 19th century, and also filtration using RO membranes and microbial treatment.

Hitachi has considerable experience with water and sewage treatment in Japan and elsewhere, including its work in Dubai and the Maldives referred to above. In the case of microbial treatment, Hitachi has developed an energy-efficient comprehensive immobilizing nitrogen removal system that uses bacteria for efficient nitrification and denitrification. This systems have been installed at sludge treatment plants in Japan and Malaysia.

Protecting Water

The Kokubunji, Fuchu, and other river terraces that the Tama River has cut through the Musashino Uplands in western Tokyo are known locally as "*hake*." Dating back to the late Meiji Period when the population of Tokyo had already passed two million, leading figures from the political and business worlds have been building villas at places like Seijo and Denen Chōfu on the Kokubunji river terrace from which Mount Fuji can be seen in the distance.

Springs of water filtered by the ground can be found dotted around the land at the base of cliffs. During the golden age of Japanese cinema, major movie companies like Toho Co., Ltd. built studios at these *hake* because of their need for pure water to use when developing film. In addition to studio

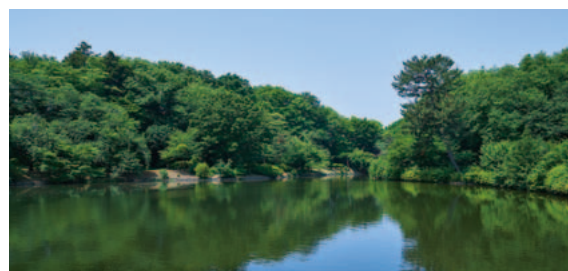
scenes, some of Akira Kurosawa's "*Shichinin no Samurai*" (seven samurai) was also shot in the surrounding area to take advantage of the terrain of these *hake*. Suntory Limited, too, in search of pure water, chose a *hake* as the site for its Tokyo-Musashino Brewery when it first got into the beer business in 1963. The company's Premium Malts beer was also produced here. The clean water of *hake* has its part to play in famous movies and premium beverages.

Fed by spring water, the Nogawa is a small river that runs through the Kokubunji river terrace. Its headwaters encompass a green belt that retains the scenery of Musashino, including Jindaiji Temple, the National Astronomical Observatory of Japan, and Nogawa Park.

Further upstream is Ohike, the source of the river, surrounded by a deep forest [3]. The area was also home to a villa, this one belonging to Shigezō Imamura, a banker from the Meiji Period. It was here in 1942 that Hitachi established its Central Laboratory, with Kumeo Baba as its inaugural General Manager. In April 2019, Hitachi also launched the "*Kyōsō-no-Mori*" (collaboration forest) at the laboratory site as a facility for developing innovations to solve the challenges of society through open collaborative creation.

During the construction of the Central Laboratory, Namihei Odaira gave an instruction to "build around existing trees rather than cut them down" so as to protect the natural environment of Musashino. The protection of forests is essential for headwater conservation and for maintaining good water quality. Odaira was also conscious of water conservation, charging the Central Laboratory with the mission of focusing 10 or 20 years ahead rather than just on those issues that are immediately apparent. Water conservation efforts by Hitachi include lending its support to the "Tokyo Waterworks – Corporate Forests" program of Tokyo Metropolitan Government and participating from 2017 in a forestry project at Kōshū City in Yamanashi Prefecture.

[3] Ohike at Hitachi's Central Research Laboratory



Controlling Water

While water is beneficial, there are also times when it can do great damage.

The southern part of Ibaraki Prefecture was struck by torrential rain for a period around 1937, with flooding in the vicinity of Tsuchiura. When Kumeo Baba encountered the flood on his return from a trip to Tokyo, he commandeered pumps awaiting shipment and started installing them at flooded locations as soon as he got back to the factory. The result was that the water receded within a single day.

Yu the Great was a legendary ruler of ancient China who established the Xia dynasty and was renowned for his flood control work on the Yellow River. He followed in the footsteps of his predecessor Emperor Shun, coming to be worshiped as a water deity.

Flowing across the Loess Plateau as it does, the Yellow River collects a very high level of silt. Its mean annual flow is 58 billion m³ and it carries an annual average of 1.6 billion tons of silt. For comparison, another major river, the Yangtze, has a mean annual flow of 961.6 billion m³ but carries only 530 million tons of silt. In other words, the Yellow River with only about 1/16th the flow of the Yangtze has three times as much silt. This is why the Yellow River has silted up so badly in its lower reaches, so much so that the river bed has become raised above the level of the surrounding land and frequently overflows its banks. Flood control of the Yellow River was a major societal challenge for successive generations of Chinese rulers.

At the time of the Yuan and Ming dynasties, the frequently flooding Yellow River flowed south, joining with the Huai River to empty into the Yellow Sea. A Ming dynasty government official, Pan Jixun, implemented a program of building dykes to flush out silt with a confined current, combining the dispersed flows of the river to better harness the power of the water for this purpose. Although this proved successful at controlling flooding for many years, the Yellow River once again burst its banks in 1855, changing the river to its present-day course that empties instead into the Bohai Sea.

In more modern times, population growth combined with agricultural and industrial development within its catchment started to place great strain on the river, which had a low flow to begin with. In 1972, the water level dropped so much

[4] Yellow River and South-to-North Water Transfer Project



in its lower reaches that the river ran dry, an event that was subsequently repeated numerous times.

In 2002, when Zhu Rongji, a descendent of Zhu Yuanzhang, the first emperor of the Ming dynasty, was Premier of the People's Republic of China, a plan was devised for the massive South-to-North Water Transfer Project that would divert water from the heavy flows of the Yangtze and use it to prevent the Yellow River from running dry [4]. This was a very far-sighted approach to using the supply of water to nurture the public.

In 2005, Hitachi installed three adjustable-vane mixed-flow pumps that can discharge 100 m³/s at the Baoying pumping station, the project's first such station. Hitachi Pump Manufacture (Wuxi) Co., Ltd. also participated in the project in the role of a Chinese manufacturer, with its involvement including the supply of 54 pumps.

And, Living with Water

This article has looked at the relationship between people and water and at how Hitachi itself is involved. It has left me with a sense that, for all its undoubted benefits, if people focus solely on water's economic value the result will be a great loss in social and environmental value.

One example of this has been described as the greatest environmental destruction the world has ever seen. With the primary aim of boosting agricultural productivity, the Soviet Union in the 1940s introduced extensive cotton and wet rice farming using water from the rivers feeding the Aral Sea in Central Asia.

The Soviet government used this cotton and other farming to boast to the world about the superiority of a planned economy. From the 1960s, however, water levels in the Aral Sea began falling dramatically, with the result that the world's fourth largest lake by area was reduced to a number of small separate lakes. Moreover, an aggressive program of irrigation in this arid region led to salt damage and falling agricultural production.

The "economic calculation debate" of the 1930s was an argument between socialist and free market economists about the merits of a planned economy. Addressing the mathematical approach of Polish economist Oskar Lange that used general equilibrium theory, Friedrich Hayek, who would go on to win a Nobel Prize, dismissed it as nothing more than desktop theorizing, noting that no realistic ways existed for collecting sufficient data and that people are not always explicitly aware of their own wants.

History has proved Hayek's ideas right, but what about the era of Society 5.0 in which advances in the Internet of Things (IoT) are making the acquisition of large amounts of data much easier?

The NEXPERIENCE methodology for collaborative creation with customers developed by Hitachi uses techniques such as design thinking to identify the customer's latent needs, and applies simulation and AI to collected data to determine in greater detail the chain of consequences that will arise from a particular innovation.

Hitachi has been involved with water in a variety of ways since its formation. Drawing on this experience, it hopes to utilize methods such as NEXPERIENCE to devise new ways of living with water that bring greater social, environmental, and economic value.

The wellspring of this mission lies in the "collaboration forest" that embodies the ideas of Namihei Odaira and Kumeo Baba.

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